KARNATAKA STATE COUNCIL FOR SCIENCE AND TECHNOLOGY
Indian Institute of Science Campus, Bengaluru

COMPENDIUM OF 39TH SERIES STUDENT PROJECT PROGRAMME (Biofuel Projects)

SUPPORTED BY
KARNATAKA STATE BIOENERGY DEVELOPMENT BOARD
DEPARTMENT OF RURAL DEVELOPMENT AND PANCHAYAT RAJ, GOVERNMENT OF KARNATAKA

2015-2016
STUDENT PROJECT PROGRAMME: 2015 - 16

BIOFUEL PROJECTS

COMPRENDIUM OF

39TH SERIES SPP: BIOFUEL PROJECTS

KARNATAKA STATE COUNCIL FOR SCIENCE AND TECHNOLOGY

Indian Institute of Science Campus, Bangalore - 560 012

Supported by

KARNATAKA STATE BIOENERGY DEVELOPMENT BOARD

Department of Rural Development and Panchayath Raj, GOVERNMENT OF KARNATAKA

Size: A4 Pages: 198

Compiled and Edited by:
Dr. S. G. S. Swamy, Fellow and Principal Investigator – SPP, KSCST
Mr. S. N. Sondur, Fellow and Principal Investigator – Biofuel Cell, KSCST
K. N. Venkatesh, Project Assistant, KSCST
Dr. Savitha G, Consultant, Biofuel Cell, KSCST
Ms. Prajanya G. P., Project Associate, Biofuel Cell, KSCST

© KSCST

Karnataka State Council for Science and Technology
Indian Institute of Science Campus, Bangalore - 560 012
Telephone: 080 - 23341652, 23348848, 23348849
Telefax: 080 - 23348840
E-mail: office@kscst.iisc.ernet.in, spp@kscst.iisc.ernet.in, office@kscst.org.in
Website: www.kscst.iisc.ernet.in/spp.html
www.kscst.org.in/spp.html

Funded and Supported by:
Karnataka State Bioenergy Development Board, Government of Karnataka
#116, 8th Cross, Railway Parallel Road,
Kumara park West, Bangalore - 560020
## CONTENTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Foreword</td>
<td>01-01</td>
</tr>
<tr>
<td>2.</td>
<td>About KSCST</td>
<td>02-03</td>
</tr>
<tr>
<td>3.</td>
<td>About KSBDB</td>
<td>04-05</td>
</tr>
<tr>
<td>4.</td>
<td>Acknowledgement</td>
<td>06-06</td>
</tr>
<tr>
<td>5.</td>
<td>Synopsis of B.E. Seminar Projects</td>
<td>07-78</td>
</tr>
<tr>
<td>7.</td>
<td>Synopsis of M.Tech Projects</td>
<td>101-117</td>
</tr>
<tr>
<td>8.</td>
<td>Synopsis of MBA Projects</td>
<td>118-128</td>
</tr>
<tr>
<td>9.</td>
<td>Synopsis of B.E. Exhibition Projects</td>
<td>129-165</td>
</tr>
<tr>
<td>10.</td>
<td>List of Biofuel Project Proposal received</td>
<td>166-182</td>
</tr>
<tr>
<td>11.</td>
<td>List of Biofuel Projects selected for sponsorship</td>
<td>183-191</td>
</tr>
<tr>
<td>12.</td>
<td>List of Biofuel Projects selected for Final S &amp; E</td>
<td>192-198</td>
</tr>
</tbody>
</table>
FOREWORD

Innovation and technology are needed for self-reliance in the energy sector which could be decentralized based on the exploitation of natural resources that are renewable. Karnataka State Council for Science and Technology (KSCST) founded in the year 1975 has always been in the forefront in providing solutions to the decentralized energy requirements in the State through S&T interventions.

Some of the success stories arising from the activities of the Council include – Design of novel biogas plant, Solar collectors, Solar pond, Gasifiers, Design of high efficiency cooking stove (ASTRA Ole), setting up of rural energy centres. Apart from playing a catalytic role in the implementation of sustainable technologies to society-centric problems / issues, the council has also been promoting research, development and innovation in universities.

During the year 2010-2011 KSCST with the support of Karnataka State Bioenergy Development Board (KSBDB) set up the biofuel cell in KSCST with an objective to evolve programmes for the development of biofuel in the State. In this venture we are proud to be associated with KSBDB.

Council initiated Student Project Programme, popularly known as SPP, as early as 1977. The main purpose of this programme is to bring out hidden talent and innovative spirit in the minds of young engineers graduating from colleges across the State. Under this programme, the Council has been providing both technical and financial support to projects undertaken by final year engineering students and other universities of colleges. Since the 35th series of SPP, KSBDB has come forward for funding the projects on biofuel and bio energy related projects. It was for the first time that under SPP M.Tech, MSc and MBA projects were also invited for sponsorship by KSBDB. Under the 39th series 144 projects proposals were received, 68 projects were sanctioned out of which 50 (BE – 33, MTech – 05, MSc – 07 and MBA - 05) projects have been selected for final seminar and exhibition.

This is the 39th SPP Seminar and Exhibition in the series of Student Project Programme which is being conducted without any interruption since its inception in 1977. I am very pleased that BLDE Association's Vachana Pitamah Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura (Bijapur) is hosting this programme. I hope that this Seminar and Exhibition will inspire students to be more innovative and build innovative society and justify the purpose of declaring this decade as Decade of Innovations. I thank the Karnataka State Bioenergy Development Board (KSBDB), Government of Karnataka for their continued support in conducting of this programme.

Prof. S. Subramanian
Secretary, KSCST
ABOUT KSCST

Karnataka State Council for Science and Technology (KSCST) was established in 1975 to play a catalytic role in promoting the application of Science and Technology in developmental processes of the state in order to benefit a large segment of people. KSCST is the first State Council to be set up in the country to fulfill the long-felt need of bringing together administrators, field level officers from various government departments, scientists and technologists from research laboratories and research institutions. The Council has chosen many areas like Energy, Agriculture, Water, Housing, Waste management, Health and Education for its activities. The objectives of the Council are:

- To identify areas for application of Science and Technology to development needs, objectives and goals for Karnataka, and in particular, to the prevailing conditions of backwardness, rural unemployment and poverty;
- To advise government on the formulation of policies and measures including technical, administrative and legal devices, which will promote such applications to identified needs, objectives and goals; in particular to health, education and manpower utilisation with special emphasis on the development of human skills in the rural areas and in the slums; and which will promote the scientific management of the natural resources of the State;
- To promote effective coordination and to develop and foster communication and other links between centres of scientific and technological research, Government agencies, farms and industries so that promising Research and Development work is initiated, promoted and effectively deployed in agriculture, in government and elsewhere;
- To initiate, support and coordinate applied research programmes in universities and other institutions in areas identified to be specially suitable for the application of Science and Technology;
- To prepare Science and Technology plans relevant to the development needs of the State;
- To consider, and advise the government on such other matters as relevant to the application of Science and Technology to the problems of Karnataka State.

The Council has executed a number of projects in these areas such as ASTRA OLE, Low cost housing, Solar energy applications, Zoning atlas, Mapping for use in district administration, Water resources development, Hand pumps for drinking water wells in villages etc.

The Council has constantly involved several institutions and governmental agencies to identify research areas of major concerns in sectors such as Housing, Energy, Water supply, Ecology and Environment, Industries and Rural employment.

The Council has undertaken several path breaking programs in the area of Energy. To name a few, it has setup a rotor windmill for pumping water at Ungra, a community biogas service unit supplying water and electricity in Pura, Energy Parks in different parts of the state, Solar water heating systems in several places. It has also set up Microhydel stations at Elaneer village in Dakshina Kannada district and Vanachalu village near Mercara, which uses a modern technology of cross flow turbines.

The Council has assisted the state in district level planning in 30 districts through setting up of Natural Resources Data Management System (NRDMS) centers in these districts. These centers use modern scientific tools like Geographic Information System (GIS) and spatial data support system for identifying locations with problems like drinking water supply, location of hospitals, schools, etc.

Rainwater Harvesting is one of the important programmes of the Council. Last year, the Council opened a “Help Desk” jointly with BWSSB, to promote Rainwater Harvesting in Bangalore City. The Council has conducted state-level survey on treatment of municipal solid and liquid wastes and their
recycling. Patent Information Centre (PIC) has been functioning to bring awareness about Intellectual Property Rights (IPR) among scientific and student communities and to assist in filing applications.

One of the major objectives of the Council has been to improve the quality of education in our colleges and, in view of this; the Student Project Programme (SPP) was started during 1978–79 to sponsor engineering student projects. This innovative programme has been playing a very important role in engineering education sector for last three decades and has become a flagship programme of the Council. Many projects, sponsored in this programme, deal with technology applications very relevant to the State. During the 39th series (2015-16) of this programme, activities of which were initiated October 2015, a total of 144 projects from 62 colleges were sponsored by the Council. Since its inception in 1978, the Council has supported more than 8000 projects under this programme.

Under the Biofuel/Bioenergy projects supported by Karnataka State Bioenergy Development Board (KSBDB) 68 projects were sponsored this year and 50 projects have been selected for the State level Seminar and Exhibition to be held at BLDE Association’s Vachana Pitamaha Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura (Bijapur). This compendium provides a glimpse of the projects under taken by the students of BE, MTech, MSc and MBA. The detailed project report of all the projects has been prepared separately by the students themselves for submission to VTU and KSCST. The compendium reflects the student’s potential in bringing out a product from an idea conceived during their final year guided by the faculties of the department. The results and discussion of the work carried out under the project indicates that the projects have the scope for further development in the field of Biofuels.

* ~ * ~ *
KARNATAKA STATE BIOENERGY DEVELOPMENT BOARD

Karnataka took the lead in constituting the Biofuel Task force during September 2008 for effective planning and implementation of the biofuel program. The Task force was entrusted with the responsibility of advising the Government and to create an enabling atmosphere in the State. The Task Force gave its recommendations to the Government for the effective implementation of the programme in this State. The work carried out by the Biofuel task force and by seeing the potential of biofuel development in the State, the Government constituted Karnataka State Biofuel Development Board under Registrar of Societies Act. Karnataka State Biofuel Development Board (KSBDB) was constituted under the Rural Development and Panchayat Raj Department during December 2010 with the objectives of taking forward the Biofuel Policy of Karnataka. Karnataka State Biofuel Development Board currently has been renamed as Karnataka State Bioenergy Development Board.

Aims and Objectives of KSBDB

KSBDB acts as an independent autonomous body with the following objectives

1. Help Government design and adopt Biofuel programme.
2. Implementation of such programme in tune with the policy.
3. Identification of suitable land for raising Biofuel crops.
4. Selection of suitable mix of plant species for different geo-climatic conditions.
5. Raising of quality seedlings through self help group, Village forest, committees (VFCs).
6. To ensure total participation of the communities.
7. To create awareness among the farmers to adopt Biofuel activities for the additional income.
8. To provide right impetus to ethanol production and usage.
9. Promotion of crops such as sugar cane, beet sugar, sweet sorghum, cassava etc., as feedstock for ethanol production.
10. Setting up information and Demonstration centres for Biodiesel production.
12. Programmes for value addition and usage of value added products in rural areas.
13. Establishment of clonal orchards in different regions across the State.
14. Encouraging various research activities in the entire Biofuel value chain involving Universities and research organisation.

KSBDB in association with the State Forest Department, University of Agricultural Sciences, and other institutions has initiated action for producing seedlings for raising of plants for establishing plantation and also for the community to grow in the marginal land. The large scale planting requires supply of the feedstock supply is assured with high oil content and good yield of seeds. In this context, clonal orchards of the selected species are established across the State in different agro climatic zones. To meet the required demand of the planting material, appropriate species suitable to the different agro-climatic / ecological regions as many number of clonal orchards required for different species and the regions ranging from Coastal, Western ghats, Transition zone, Eastern plains along with the latitudinal variation of the bio-climate are being considered. This effort is expected to meet the requirement of the seed material for nurseries to raise quality seedlings with known high oil content and yield of seeds.
KSBDB has set up Information and Demonstration centres in all the 32 districts of the State to provide information on biofuel for students, scientists, entrepreneurs, farmers, biofuel cultivators, researchers and general public. Recently KSBDB is also set up one more I & D center in Central University Karnataka located in Gulbarga those making it a total of 33 centers. The I & D centres provide information of harvesting, processing, marketing, value addition and serve as a role model. 32 such I & D centers are functioning with an installed pilot plant capacity of hundred liters per day. The responsibilities of the information and Demonstration Centres shall meet the needs of all stakeholders in biofuel development. The I & D Centers shall endeavour to contribute to the socio-economic development of the nation by demonstrating the entire Biofuel value chain.

The biofuel programme in Karnataka is designed to bring about total participation of the farming community, landless labourers, Self Help Group and NGOs. The plantation on Government land has been taken up with the total involvement of Village Forest committees, Tank User Groups and Watershed Committees set up at village level. KSBDB development programme has been recognised both at the National and International level. The Karnataka model biofuel programme is being implemented in other States of the country and also abroad.

To ensure effective implantation, monitoring, evaluation of programs of KSBDB District Level Committees are formed at all the Districts under the Chairmanship of Chief Executive Officer of Zilla Panchayat and the members are from Departments of Agriculture, Horticulture, Sericulture, Representatives of lead NGOs, Principal Coordinators of I & D centres of KSBDB and convened by the Deputy Conservators of the Forests, Social Forestry Division and Co-convened by the integrated Rural Energy Programme (IREP Engineer).

Research programme are initiated in association with Universities and various Educational Institutions. KSBDB has initiated many activities in promoting and implementing biofuels across the state with focus on use of non-edible oil species and community participation. KSBDB has associated with KSCST for various levels of research to be carried out in this direction. This attempt of associating with KSCST under their Student Project Programme and inviting Engineering students and Post graduates students to take up biofuels as their academic project and it has received a tremendous response from many colleges and Universities across Karnataka. The support from KSBDB came during the 35th series of SPP wherein 31 projects were sponsored. Subsequently support also came for 36th, 37th and 38th series of SPP also. 39th series of SPP once again KSBDB has shown keen interest and has come forward to support 68 projects including 6 MBA projects. Out of 68 projects 50 projects (33 - B. E., 05 - M.Tech, 07 - MSc and 05 - MBA) have been selected for the final seminar and exhibition to be held at BLDE Association’s Vachana Pitamaha Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura (Bijapur).
ACKNOWLEDGEMENT

This compendium of Biofuel Projects carried out by the students of the final semester B.E., M.Tech, MSc and MBA is bought about under the 39th Series of Student Project Programme, a flagship programme of Council, with funding support of the Karnataka State Bioenergy Development Board (KSBDB). We place on record our sincere gratitude and appreciation for Karnataka State Bioenergy Development Board with a special mention to Shri. Parmesh Pandey, IAS, Managing Director, KSBDB for their constant guidance and encouragement in our entire activities related to Biofuel projects.

We wish to place on record our gratitude to the Secretary KSCST, Prof. S. Subramanian who has been always encouraging and guiding us in our work to complete this programme.

This compendium consists of synopsis of 50 projects selected for the final Seminar cum Exhibition of SPP out of the 68 projects sanctioned. These projects were scrutinized before sanction of support and evaluated for the selection to final Seminar cum Exhibition by the Working Group Members consisting of

1. Prof. Udipi Shrinivas, Member KSBDB and Chairman of working group
2. Dr. H.N. Chanakya, Chief Research Scientist, CST, IISc
3. Dr. R. T. Naik, Senior Scientific Officer, Dept. of Mechanical Engg., IISc
4. Dr. Ravindranath H. Aladakatti, Senior Scientific Officer, Centre for Animal facility., IISc
5. Smt. Sheetal Singh, Head City Managers Association Karnataka, DMA
6. Prof. Panneer Selvam, Dept. Management Studies, SIT, Tumkur
7. Mr. Dayananda G. N., Marketing Manager, KSBDB

We appreciate their support and guidance with all sincerity and place on record our gratitude to all the members of the Working Group who spent their valuable time and provided their expertise in the process of scrutiny and evaluation and for their constant support and guidance.

We are thankful to all the Principals, Head of the Departments, faculties and guides of those Engineering colleges and University Departments who actively responded to our call for proposals and encouraged and guided their students to take up projects in this field.

Our sincere appreciations to all the students who have put in their hard work in carrying out the project work in all sincerity and on time.

Lot of effort has been put in to bring about this compendium by the staff of the Council. We are thankful to Shri. K. N. Venktesh, Biofuel Cell team consisting of Dr. Savitha G. consultant, and Ms. G. P. Prajanya, Project Associate, KSCST. We also thank all the staff of KSCST who have directly or indirectly helped us in completing this compendium.

(Dr. S. G. Sreekateswara Swamy) (S. N. Sondur)
SYNOPSIS OF B.E.
SEMINAR PROJECTS
1. COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A C.I. ENGINE UNDER VARIOUS BIODIESELS FOR DIFFERENT COMPRESSION RATIOS

PROJECT REFERENCE NO.: 39S_B_BE_061

COLLEGE : MALNAD COLLEGE OF ENGINEERING
BRANCH : DEPARTMENT OF AUTOMOBILE ENGINEERING
GUIDES : DR. Y. M. SHASHIDHARA
STUDENTS : MR. KARTHIKKAMATH K.,
MR. AKASH G.,
MR. DHARSHAN BANDARY C.S.,
MS. DHANURAJU H.D.

Introduction:
Biodiesel emerges as one of the most energy-efficient environmentally friendly options in recent times to fulfill the future energy needs. Biodiesel is a renewable diesel substitute that can be obtained by combining chemically any natural oil or fat with alcohol. During the last 15 years, biodiesel has progressed from the research stage to a large scale production in many developing countries. In Indian context, non-edible oils are emerging as a preferred feedstock and several field trials have also been made for the production of biodiesel. Vegetable oils either from seasonal plant crops or from perennial forest tree's origin, after being formulated, have been found suitable for utilization in diesel engines. Many traditional oil seeds like Pongamia glabra, Jatropha, Mallous philippines, Garinica indica, Thumba, Karanja and Madhuca indica etc. are available in our country in abundance, which can be exploited for biodiesel production purpose. Many vegetable oils, animal fats and recycled cooking greases can also be transformed into biodiesel. Biodiesel can be used neat or as a diesel additive in compression ignition engines.

The compression ratio of an internal-combustion engine or external combustion engine is a value that represents the ratio of the volume of its combustion chamber from its largest capacity to its smallest capacity. In a piston engine, it is the ratio between the volume of the cylinder and combustion chamber when the piston is at the bottom of its stroke, and the volume of the combustion chamber when the piston is at the top of its stroke. A high compression ratio is desirable because it allows an engine to extract more mechanical energy from a given mass of air-fuel mixture due to its higher thermal efficiency.

In this work, an attempt is made to study the variation of performance and emission of the engine by varying the compression ratio under different biodiesel modes of operation and to understand the suitable compression for the given biodiesels.

Objectives:
1. To study the performance and emission characteristics of the diesel engine using various biodiesels.
2. To compare the effect of variation of compression ratio on the performance and emission characteristics under various biodiesels.
3. To optimise the compression ratio for the biodiesel based on performance and emission.

Methodology:
In the present work a vertical water cooled 4stroke diesel engine developing 3.75KW power is used. Basically, four non-edible oils such as Simaruba, Calipholiyum, Mahua and Pongam...
oils are transesterified to produce Simaruba oil methyl ester (SOME), Calipholiyum oil Methyl ester (COME). Cotton seed oil methyl ester (CSOME) and Pongama oil methyl ester (POME). The compression ratio of the engine is changed by changing the clearance volume of the engine and it is achieved by designing hemispherical bowls and augmenting them on the crown of the piston. Experiments are conducted on the diesel engine for various loading condition for different compression ratio such as 18:1, 20:1 and 22:1 under various biodiesels such as SOME, CSOME, POME and COME modes of operation. The performance parameters like fuel consumption and thermal efficiencies are measured. Further the emission components like smoke density or opacity (HSU) is measured using gas analyser under various biodiesel modes of operation. The obtained results are compared for various compression ratios of the engine and optimum compression ratio is evaluated for each of the biodiesels.

**Results and conclusions:**

Fig. 1, Fig. 2 and Fig. 3 show the variation of specific fuel consumption, thermal efficiency and smoke density with brake power respectively for compression ratio 22:1. Similar results are obtained for compression ratios 18:1 and 20:1.

**8.1 Fuel consumption:**

![Variation of specific fuel consumption with brake power of all oils for compression ratio 22:1](image1)

**8.2 Brake thermal efficiency:**

![Variation of brake thermal efficiency with brake power of all oils for compression ratio 22:1](image2)
8.3 Smoke density

Conclusions:
- A slight increase in fuel consumption is observed when the compression ratio is increased from 18:1 to 20:1 under all biodiesels modes of operation. Moderate drop in fuel consumption is noticed under all biodiesel modes of operation when the compression ratio is changed from 18:1 to 22:1.
- About 22% drop in fuel consumption is observed under COME when compression ratio is increased from 20:1 to 22:1 and about 16% drop in fuel consumption is recorded while the compression ratio is increased from 18:1 to 22:1.
- A comparable change in thermal efficiency under all biodiesels is seen when the compression ratio is switched over from 18:1 to 20:1. However, the thermal efficiency of the engine under COME is increased by 28% for the change of compression ratio from 20:1 to 22:1. Further, under POME, COME and SOME biodiesel modes of operation, efficiency is increased by 25% compared to normal diesel operation for the increase in compression ratio from 18:1 to 22:1.
- No significant change in mechanical efficiency under all biodiesel modes of operation when the compression ratio is changed from 18:1 to 20:1. A marginal increase in mechanical efficiency under all biodiesel modes of operation when compression ratio is increase from 18:1 to 22:1.
- Noticeable increase in opacity of the engine exhaust is recorded when compression ratio is changed from 18:1 to 20:1 under all biodiesel modes of operation. However, about 10% decrease in smoke density in all biodiesel modes of operation when compression ratio is changed from 20:1 to 22:1.
- About 6% decrease in smoke density is observed in all biodiesel modes of operation when compression ratio changes from 18:1 to 22:1. Further, under SOME, COME and CSOME there is a gradual decrease of about 15% is noticed when compared to normal diesel operation for the increase in compression ratio from 18:1 to 22:1.
- It is concluded from the experiments that CSOME, COME and POME are found to be potential alternative fuels for pure diesel for the engine compression ratios of 18:1, 20:1 and 22:1 respectively in terms of performance and emission characteristics.

Future suggestion/scope
- Experiments may be made for different Compression ratios like 16:1, 17:1 and 19:1 and 23:1
- The study may be made for other biodiesels such as Jatropha, Mahua, Rubber seed, Castor, Rice bran and so on.
2. SYNTHESIS OF BIODIESEL USING MADHUCA INDICA OIL BY TRANSESTERIFICATION PROCESS FOR THE ENGINE PERFORMANCE TEST

PROJECT REFERENCE NO.: 39S_B_BE_090

COLLEGE : THE OXFORD COLLEGE OF ENGINEERING, BANGALORE
BRANCH : AUTOMOBILE ENGINEERING
GUIDES : DR. RAJU B.R., DR. SUREKHA M.
STUDENTS : MR. KARTHIK S.
MR. VINAY KUMAR P
MR. GIRISH KUMAR L.
MR. VIGNESH P.

OBJECTIVES OF THE PROJECT WORK:
The main objective of the project work is displayed as below:-
 To significantly increase the performance characteristic of any conventional diesel engine.
 To reduce the exhaust emission from the diesel engine such as CO, CO2, HC and NOx.
 To reduce the cost of the fuel with the biodiesel when compared to the petroleum diesel.

INTRODUCTION:
The process for biodiesel synthesis typically includes the extraction of oil from the seeds followed by the initial purification of the oil. Esterification process was then carried out with the oil and methanol in the molar ratio 1:6 with 2% of acid catalyst (H2SO4) and headed with transesterification process with the involvement of oil and methanol in the volumetric ratio 1/3rd along with 4% of heterogeneous catalyst (CaO). The product hence obtained from the above procedure was left for settling and finally the residue was separated and biodiesel was obtained. Different blends of biodiesel were prepared (B10, B20, B30 and B40) and the performance characteristic of diesel engine was carried out with each of the above blends and the readings were obtained. The various engine parameters found were Brake power, specific fuel consumption, thermal efficiency and mechanical efficiency of the engine. The results hence obtained from the different blends were compared with that of the petroleum diesel and a performance graph was successfully plotted. Lastly, the emission test was suitably conducted and the emission percentage of HC, CO, CO2 and NOx were recorded.

Key Words: Madhuca Indica, Methanol, Catalyst, Transesterification Process, Bio-Diesel Blends, Diesel Engine Parameters.

METHODOLOGY:

TRANSESTERIFICATION:
The 500 ml of acid ester from the Esterification process was again taken into the three necked RB flask and known volume of methanol was added as per the volumetric ratio 3:1. The 4% of heterogeneous catalyst CaO was also added to mixture and similarly the setup was placed on hot plate and a reflux condenser was used. The standard reaction time maintained was about 4 hours. The temperature was kept constant to about 60°C to 65°C since the boiling point of methanol was found to be 62.5°C. The chemical reaction involved in this process is :-
Base Catalyst

Acid esters + methanol (or ethanol) → methyl esters + glycerol

The yield of biodiesel can be calculated from the following formula:

\[
\text{YIELD OF BIODIESEL (\%) = \frac{\text{METHYL ESTERS PRODUCED (g or ml)}}{\text{AMOUNT OF OIL TAKEN (g or ml)}} \times 100}
\]

RESULTS AND CONCLUSION:
From the comparative study, various blends of methyl esters were prepared from Madhuca Indica oil as a main source gave a significant variation in the performance characteristics was observed as well as a productive reduction in the emission exhaust was accounted from the conventional diesel engine. The blend of Biodiesel with B40 was furnished to give the optimum results when compared to that of other blends and the petroleum diesel with the reduction of CO and HC. It was also noted that the blend B30 has gives better reduction in fuel consumption. From the above test it can be concluded that the biodiesel produced using Madhuca oil can be successfully used as a blend with petroleum diesel and further reduction in cost was importantly noted. Since a heterogeneous catalyst CaO was used, it was particularly reused back for the next following process. A final yield of 86% of Mahua methyl esters was approximately estimated.

SCOPE OF FUTURE WORK:
- Generally, it believed that the crude oil and petroleum will become very scarce and costly to find and produce. Although fuel economy of the engine is greatly improved, increase in the number of automobiles alone dictates that there will be a great demand for fuel in the near future. Hence, alternative fuel technology, resource availability and use will become more common in the coming decades.
- Concern regarding the emission problems of diesel engines, combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. Hence the emission of major exhaust pollutants like CO, CO2 & HC can be reduced.
- Another reason for the development of the fact is that a large percentage of crude oil must be imported from other countries which control the larger oil fields.

* ~ * ~ *

3. MICROWAVE ASSISTED OPTIMIZATION FOR RELEASING FERMENTABLE SUGAR AND PRODUCTION OF BIOETHANOL FROM AGRICULTURAL RESIDUES

PROJECT REFERENCE NO.: 39S_B_BE_009

COLLEGE : N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE
BRANCH : BIOTECHNOLOGY
GUIDES : MR. VINAYAKA B. SHETTY, DR. C. VAMAN RAO
STUDENTS : MR. RAKSHITH K.G
1. INTRODUCTION
The ever-escalating demand for fuel and the inability to replenish such requirements has triggered the need to find a renewable alternative, one among which is "Biofuel" either as a whole or as a blended fraction. The increased production of biofuel in the form of bioethanol using basic food material has resulted in concerns about food versus fuel threats and inflating food crop prices due to which, the focus has shifted towards lignocellulosic feedstock. Bioethanol is by far the most predominantly used biofuel in the world either as a whole like in countries like Brazil or as a blended fraction of around 5 to 15%. Most of bioethanol production is sourced from sugarcane and corn which proves to be detrimental to the country’s economy over a long run. Hence lignocellulosic sources are more reliable and sustainable. India produces nearly 250 million tons of surplus agricultural residues per annum due to which lignocellulosic biomass is envisaged to provide for the mass production of bioethanol. The lignocellulosic material used in this study is Cocoa Pod Shells (CPS) and is made up of lignin, hemicellulose and cellulose. Pretreatment of the biomass helps to break the lignin and hemicellulosic bonds, exposing the cellulosic content for hydrolysis to produce sugar, which can be converted to ethanol by fermentation. In this study, CPS which was processed using suitable techniques following which, hydrolysis was carried out. The process of hydrolysis was optimized using a statistical approach wherein points generated through OFAT (One Factor at a Time) analysis, were used and central composite design (CCD) was generated to obtain the optimized condition yielding maximum reducing sugar concentration. The hydrolysate was fermented to produce bioethanol by *Pichia stipitis*.

2. OBJECTIVES
i) To optimize the pre-treatment process for the raw material.
ii) To produce bioethanol by fermentation based on optimized conditions.

3. METHODOLOGY
A. Chemical pre-treatment (acid) for hydrolysis of lignocellulosic matter [Upstream processing]
- Raw material was sun dried to remove the moisture. Size reduction and sieving unit operation was carried out to achieve uniform size raw material for hydrolysis.
- The uniformly sized raw material was weighed and hydrolysed using specific concentrations of acid.
- Neutralization was carried out using suitable alkali (NaOH).
- Fermentable sugar estimation was done using DNSA method (Miller G I, 1972).
- OFAT was carried out for screening significant parameters such as acid concentration, weight of raw material, time of irradiation, temperature for microwave assisted hydrolysis.
- Based on significant parameters, response surface methodology (RSM) (central composite design) was adopted. Released fermentable sugar (glucose) was considered as “response”.
- Mathematical polynomial model relating response and independent process variable was be established.
- Model was then experimentally validated.

B. Fermentation
- Based on the optimized parameter, hydrolysis will be carried out and fermentation was optimized by considering ethanol as response.
- OFAT will be carried out to screen the significant parameters.
Based on these parameters, RSM was adopted and a mathematical polynomial model will be obtained. The model will then be validated.

C. Product recovery [Downstream processing]

Fermented broth will be distilled to recover ethanol and concentration will be determined using potassium dichromate technique and gas chromatography.

4. RESULTS

- OFAT was carried out and the optimum parameters obtained were 6% acid and 10g/100ml at 300W and 8 minutes.
- RSM Analysis for these parameters were carried out using CCD with 12 runs following which an ANOVA (Analysis Of Variation) table was obtained resulting in the quadratic effects of $X_1$ (concentration of acid) and linear effects of $X_2$ (weight of CPS) emerging as significant.
- The second order polynomial equation obtained is $Y_1 = 2.828945 + 0.944391X_1 - 0.07737X_1^2 + 0.274215X_2 - 0.0007X_2^2 - 0.00183X_1X_2$ where, $Y_1$: dependent response; $X_1, X_2$: independent variables.
- The final optimized conditions are 6%v/v of acid and 0.15657kg/l of CPS.
- The model was validated and the samples were fermented using *Pichia stipitis*. Growth study of which revealed that the optimum inoculation time was between 2-4hrs.
- Fermentation at 2% inoculum yielded bioethanol.

SCOPE FOR FUTURE WORK

- Fermentation process can be optimized by considering inoculum size and fermentation time as variables
- Scale up studies can be undertaken

4. PRODUCTION OF BIO- BUTANOL FROM *Saccharum spontaneum*

PROJECT REFERENCE NO.: 39S_B_BE_010

COLLEGE : N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE
BRANCH : BIOTECHNOLOGY
GUIDES : MR. SANDESH K., DR. C. VAMAN RAO
STUDENTS : MS. SANA AMIN
            MS. ANJU MARIAM PRASAD
            MS. HARSHAKIRAN T S
1. INTRODUCTION
Biofuels can serve as an alternate fuel to reduce environmental pollutions and greenhouse gas emissions. One such fuel is bio-butanol, which has higher energy density and reduces carbon emission. Biofuels are produced from biomass, which is in abundance in nature, contains hemicellulose, cellulose, pectin and lignin. Before conversion of biomass into biofuel, cellulose, hemicellulose present in biomass must be converted into reducing sugar, which on fermentation will yield butanol.

In this study biomass of Saccharum spontaneum (Kans grass) was chosen as a biomass for butanol production. Saccharum spontaneum contains rich in carbohydrate and fiber content. It used as a source for bioenergy as it has a capacity for dry matter production (Chandel et al. 2010). They are also called the waste land weeds (Kumar et al 2009). It is abundantly present as wild grass which normally grows in the river bank.

Kans grass is powdered and pre-treated using sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3), sulphuric acid (H_2SO_4), hydrochloric acid (HCl) and subjected to pressure cooking. The results showed that HCl has greater potential to convert cellulose and hemicellulose into reducing sugar, therefore HCl was used for the pre-treatment of biomass and effect of biomass loading, pressure cooking time on reducing sugar were studied and optimized.

The optimum conditions for pretreatment were found to be 0.8N of HCl when used for treating 5% w/v of biomass subjected to 30min of pressure cooking yielded reducing sugar 11.44 mg/ml. The model is validated by conducting experiment at these optimum values and comparing it with predicted values from the model.

Keywords: Kans Grass (Saccharum spontaneum), Biobutanol, pre-treatment, Optimization.

2. Objectives:
i. Carry out pre-treatment of Saccharum spontaneum by using acid and alkali to release sugars
iii. Carry out fermentation of released reducing sugar for the production of bio-butanol.

3. Materials and Methods
3.1.1 Raw material collection
Kans grass used in the present study is collected from Mangalore situated in Dakshina Kannada district Karnataka.

3.1.2 Analysis of reducing sugars in the hydrolysate
Pre-treated samples were analysed for reducing sugar concentration by Miller method. The chemicals used for DNSA method are Di-nitro Salicyclic acid and Glucose.

METHODOLOGY:
3.2.1 Preparation of Raw material for hydrolysis
Kans grass is processed by chopping into small pieces of approximately 4in length using chop saw machine. It is then dried in the hot air oven at 100°C for 2 days and powdered using domestic grinder to get size of Tyler #10 (1.7mm). To prevent microbial degradation the powdered raw material is stored in deep freezer at -20°C.

3.2.2 Pretreatment of raw material
Raw material is subjected to acid hydrolysis and alkali hydrolysis. Acid hydrolysis is done using sulphuric acid (H_2SO_4) and hydrochloric acid (HCl). Alkali hydrolysis is done by using sodium hydroxide (NaOH) and sodium carbonate (NaOH).

3.2.3 Central Composite Design (CCD)
The Central Composite Design for three factors encompassing 16runs+4centre points is applied using STATISTICA 10 software for the optimization of pre-treatment of Saccharum spontaneum for biobutanol production. The three levels (-1, 0, 1, +1) for the CCD design is concentration of HCl (0.2N, 0.4N, 0.6N, 0.8N and 1N), concentration of biomass (1, 3, 5 and 7%w/v), and pressure cooking time (10, 20, 30 and 40 min).
Results and Discussions

The release of reducing sugar in pre-treated samples was studied by varying one factor at a time. 3 factors studied are concentration of acid/alkali, biomass concentration and Pressure cooking time.

Table: 1 Effect of varying concentration of acids and alkali (The biomass concentration (3%w/v) and pressure cooking (20min) time was kept constant)

<table>
<thead>
<tr>
<th>Concentration</th>
<th>HCl</th>
<th>H$_2$SO$_4$</th>
<th>NaOH</th>
<th>Na$_2$CO$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1N</td>
<td>1.15</td>
<td>0.192</td>
<td>0.154</td>
<td>0.154</td>
</tr>
<tr>
<td>0.5N</td>
<td>0.64</td>
<td>0.964</td>
<td>0.414</td>
<td>0.141</td>
</tr>
<tr>
<td>1N</td>
<td>4.56</td>
<td>1.928</td>
<td>0.167</td>
<td>0.169</td>
</tr>
<tr>
<td>1.5N</td>
<td>4.11</td>
<td>0.514</td>
<td>0.157</td>
<td>0.162</td>
</tr>
<tr>
<td>2N</td>
<td>3.53</td>
<td>2.634</td>
<td>0.167</td>
<td>0.168</td>
</tr>
</tbody>
</table>

Alkali pre-treatment using NaOH and Na$_2$CO$_3$ resulted in less release of reducing sugar concentration of 0.414mg/ml and 0.169mg/ml respectively (Table 1). The above results conclude that alkali pre-treatment for Saccharum spontaneum biomass is not feasible, since it yielded less concentration of sugar.

From Table 1 it is evident that HCl pre-treatment yielded higher concentration of reducing sugar (4.5mg/ml) at low concentration of acid when compared to H$_2$SO$_4$. If used at a higher concentration H$_2$SO$_4$ will degrade the reducing sugar and convert it to furfural. Utilizing less concentration of acid to get high release of reducing sugar would make the pre-treatment process economical. Due to this reason acid HCl is selected for further study.

Table: 2 Effect of varying concentration of Biomass (Concentration of acids and alkali (0.5N) and pressure cooking time (20min) was kept constant)

<table>
<thead>
<tr>
<th>Biomass Concentration</th>
<th>3%w/v</th>
<th>Reducing Sugar, mg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HCl</td>
</tr>
<tr>
<td>3</td>
<td>0.964</td>
<td>0.64</td>
</tr>
<tr>
<td>5</td>
<td>4.177</td>
<td>1.22</td>
</tr>
<tr>
<td>7</td>
<td>1.285</td>
<td>0.835</td>
</tr>
</tbody>
</table>

From Table 2 it is observed that increasing biomass concentration has no effect with H$_2$SO$_4$ pre-treatment, whereas HCl pre-treatment yielded higher concentration of reducing sugar (4.5mg/ml). NaOH and Na$_2$CO$_3$ yielded less concentration of reducing sugar and fails to show a significant difference in response.

Table: 3 Effect of varying pressure cooking time (Concentration of acids and alkali (0.5N) and biomass loading (3%w/v) was kept constant)

<table>
<thead>
<tr>
<th>Pressure Cooking time</th>
<th>10min</th>
<th>Reducing Sugar, mg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HCl</td>
</tr>
<tr>
<td>10</td>
<td>2.148</td>
<td>3.52</td>
</tr>
<tr>
<td>20</td>
<td>5.790</td>
<td>5.79</td>
</tr>
<tr>
<td>30</td>
<td>5.740</td>
<td>5.27</td>
</tr>
<tr>
<td>40</td>
<td>6.90</td>
<td>6.90</td>
</tr>
</tbody>
</table>

From Table 3, it is evident that, there is no significant difference in response between both the acids. This shows that, increase in heat, accelerate the release of sugar. Heat helps in breaking the bond between cellulose and lignin. Breaking the lignin barrier makes acid to
penetrate easily into the biomass and convert cellulose and hemicellulose into fermentable sugar.

**Optimization of pretreatment of Saccharum spontaneum**

Table: 4 CCD design for optimization of pretreatment of Saccharum spontaneum

<table>
<thead>
<tr>
<th>Runs</th>
<th>HCl, (N), X1</th>
<th>Biomass, (% w/v), X2</th>
<th>Pressure Cooking Time, X3 (min)</th>
<th>Reducing sugar, (mg/ml), Y1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.600000</td>
<td>3.000000</td>
<td>20.00000</td>
<td>3.9417</td>
</tr>
<tr>
<td>2</td>
<td>0.600000</td>
<td>3.000000</td>
<td>40.00000</td>
<td>6.602</td>
</tr>
<tr>
<td>3</td>
<td>0.600000</td>
<td>7.000000</td>
<td>20.00000</td>
<td>11.541</td>
</tr>
<tr>
<td>4</td>
<td>0.600000</td>
<td>7.000000</td>
<td>40.00000</td>
<td>18.044</td>
</tr>
<tr>
<td>5</td>
<td>1.000000</td>
<td>3.000000</td>
<td>20.00000</td>
<td>6.372</td>
</tr>
<tr>
<td>6</td>
<td>1.000000</td>
<td>3.000000</td>
<td>40.00000</td>
<td>7.193</td>
</tr>
<tr>
<td>7</td>
<td>1.000000</td>
<td>7.000000</td>
<td>20.00000</td>
<td>8.940</td>
</tr>
<tr>
<td>8</td>
<td>1.000000</td>
<td>7.000000</td>
<td>40.00000</td>
<td>16.740</td>
</tr>
<tr>
<td>9</td>
<td>0.463641</td>
<td>5.000000</td>
<td>30.00000</td>
<td>8.711</td>
</tr>
<tr>
<td>10</td>
<td>1.136359</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.196</td>
</tr>
<tr>
<td>11</td>
<td>0.800000</td>
<td>1.636414</td>
<td>30.00000</td>
<td>3.657</td>
</tr>
<tr>
<td>12</td>
<td>0.800000</td>
<td>8.363586</td>
<td>30.00000</td>
<td>18.995</td>
</tr>
<tr>
<td>13</td>
<td>0.800000</td>
<td>5.000000</td>
<td>13.18207</td>
<td>4.509</td>
</tr>
<tr>
<td>14</td>
<td>0.800000</td>
<td>5.000000</td>
<td>46.81793</td>
<td>12.592</td>
</tr>
<tr>
<td>15</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>9.500</td>
</tr>
<tr>
<td>16</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.440</td>
</tr>
<tr>
<td>17</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.440</td>
</tr>
<tr>
<td>18</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.440</td>
</tr>
<tr>
<td>19</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.440</td>
</tr>
<tr>
<td>20</td>
<td>0.800000</td>
<td>5.000000</td>
<td>30.00000</td>
<td>11.440</td>
</tr>
</tbody>
</table>

The response surface graph of $Y_1$ as a function of concentration of HCl (% $X_1$), concentration of substrate (% $X_2$) and pressure cooking time (X3 min) is shown in Fig 1 (a,b,c).

It is observed that, the reducing sugar concentration increases with increase in concentration of HCl and pressure cooking time, and reaches maximum at 0.8N of the acid and 30 min of heating. Further increase in the two factors, results in decrease in the reducing sugar concentration as the sugar gets converted to furfural. Reducing sugar concentration was found to increase with increase in the amount of substrate used.
Fig:1 (a,b,c); 3D plot showing the effect of (a) HCl, Biomass (b) Biomass, time (c) HCl, pressure cook time on reducing sugar.

The optimized levels of variables ($X_1$, $X_2$ and $X_3$) are determined by using desirability profiles for $Y_1$. The optimized factors for obtaining high yield of reducing sugar were 0.8N of HCl, 5g of substrate and 30min of pressure cooking time.

The response of reducing sugar ($Y_1$) is assigned a desirability of 1.0 for the highest observed value of $Y_1=18.995$ mg/ml and desirability of 0 for $Y_1=3.657$ mg/ml to get overall desirability. The levels of variable giving the highest desirability were selected as the optimum levels for reducing sugar.

The regression equation for the reducing sugar ($Y_1$) as a function of concentration of HCl ($X_1$, N) Biomass ($X_2$, % w/v) and pressure cooking time ($X_3$, min) is represented by the following equation.

$$y_1 = -20.4505 + 29.0771x_1 - 10.0196x_2^2 + 1.5764x_2 + 0.0211x_2^2 + 0.4568x_3 - 0.0090x_3^2 - 2.1645x_1x_2 - 0.0339x_1x_3 + 0.0676x_2x_3$$

$\rightarrow$ Eq. (1)

Validation of Model

The Table 5 shows the comparison of experimental and predicted results. The strength of linear relationship between predicted and experimental values was found to be 0.97 for reducing sugar.

Table: 5 Comparison of experimental and predicted values of reducing sugar

<table>
<thead>
<tr>
<th>HCl N</th>
<th>Biomass (% w/v)</th>
<th>Time Min</th>
<th>Experiment</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>4</td>
<td>15</td>
<td>4.762</td>
<td>2.53</td>
</tr>
<tr>
<td>0.6</td>
<td>4.5</td>
<td>35</td>
<td>12.323</td>
<td>10.33</td>
</tr>
<tr>
<td>0.5</td>
<td>5.5</td>
<td>25</td>
<td>13.335</td>
<td>9.63089</td>
</tr>
<tr>
<td>0.7</td>
<td>3</td>
<td>25</td>
<td>7.676</td>
<td>5.66200</td>
</tr>
<tr>
<td>0.7</td>
<td>6</td>
<td>25</td>
<td>14.769</td>
<td>11.48164</td>
</tr>
</tbody>
</table>

$R$-Square 0.973882

At Optimum Condition

| 0.8   | 5              | 30       | 11.426     | 11.1      |

5. Conclusion

The pre-treatment of *Saccharum spontaneum* was done using HCl. The pressure cooking process was adopted to facilitate the release of more amounts of sugars. The concentration of HCl used for pre-treatment was found to be more economical. The optimum conditions of pre-treatment were, subjecting 5% w/v of the raw material to 30min of pressure cooking by treating it with 0.8N HCl. At optimum conditions the concentration of reducing sugar was 11.426mg/ml.
The model was validated by conducting experiments at optimum conditions and comparing it with predicted values from the model. The experimental value of concentration of reducing sugar was found to be similar to the predicted values of the model giving an R-square value of 0.97.

5. Design and fabrication of economically viable hybrid Photobioreactor (closed bobble column) prototype for cultivation of elite Microalgae for enhanced lipids (biodiesel) Yield

PROJECT REFERENCE NO.: 39S_B_BE_005

COLLEGE : NEW HORIZON COLLEGE OF ENGINEERING
BRANCH : BIOTECHNOLOGY
GUIDES : MR. R.S. UPENDRA, DR. PRATIMA KHANDELWAL
STUDENTS : MS. AAKRUTI RUIA
            MS. AMULYA GRACE
            MS. ANJALI TIWARI

Introduction / background:
The present era relies on fossil fuel combustion to produce their fuels. Fossil fuels are non-renewable sources of energy, and are rapidly depleting. The main source of fuels is by coal at an average 49% of fuels are obtained from burning coal, studies estimated that by the year 2051 coal will be depleted (Bauer et al., 2015). However, fossil fuels combustion leads to the emission of carbon in the environment and the increasing amount of carbon is leading to global warming, world is now looking for new ways to produce fuels in an eco-friendly manner. Biofuels are such one alternative, can be produced by utilizing organic matter derived from plants, animals or microorganisms (Rudolf, 1926). Biofuels are a key factor that can reduce the global warming issue and also meet the rising demand of fuels. Biofuels have been researched upon for a long time and have been modified, thus there are four generations of biofuels (Table 1). Fourth generation which are most researched upon and utilized microalgae for lipid subsequently converted in to biofuels (Yafei et al., 2014). Keywords: Microalgae, renewable energy Hybrid photobioreactor, Lipid yield, FTIR.

Table 1: Generations of Biofuels

<table>
<thead>
<tr>
<th>GENERATION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Agricultural food crops based (e.g. Wheat, sugar etc)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Agricultural non-food crops (e.g. Wood etc)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Algal species used for oil production</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Microalgae for lipid based biofuels extraction</td>
</tr>
</tbody>
</table>

Objectives:
Microalgae are unicellular photosynthetic organisms that assimilate lipids, which can be converted in to Biofuels. Microalgae help to mitigate carbon dioxide, because of their photosynthetic properties and utilize it to produce lipids. Microalgae biomass is a zero waste generation, as every part of the biomass is utilized to generate other value added
products such as Bioethanol, Nutraceuticals, Biofertilizer, Biodiesel and Gasoline (Clayton et.al, 2010). Biofuels are being adapted in various countries as alternative fuels (Herve et.al, 2011). Scanty research was documented on using Microalgae as feedstock for Biodiesel production. Photobioreactor (PBR) is specially designed for effective cultivation of microalgae, however hybrid PBR have been meagerly researched. Scanty research has been done on tubular type PBR and the various light source tested being of less impact on the growth of microalgae. With the lacunae discussed the present investigation aimed in following objectives.

1. Design and fabrication of hybrid photobioreactor (combing flat plate and tubular type of photobioreactor).
2. Mass cultivation of newly isolated species (Chlorella rotunda) in the indigenously designed photobioreactor.
3. To enhance the yield of biomass and lipid content for biodiesel and other value added products

Methodology:
The present study designed a hybrid PBR (flat plate and tubular) based on both batch and continuous kinetic modules, considering the different design dimensions i.e height, breadth, width, diameter of tubular column, surface area and volume Fig.1.

Study utilized LED as the source of artificial blue light to support the growth of microalgae. Initially preserved microalgae culture was revived on BBM plate. The purity and metabolic stability of the revived microalgae was accessed through morphological and microscopic (both light and SEM) observations. The designed and fabricated hybrid PBR was tested for microalgae cultures, in both batch and continuous cultivation process (Turbidostat). Optimized modified Bold’s Basal media (BBM) (Mounisha et.al, 2015) was used in the present investigation. Further the study compared the growth of microalgae and its biomass yield @ both optimal (PBR cultures) and flask cultures conditions. Further growth kinetics of the microalgae was studied measuring the absorbance at visible range (550nm). Finally lipid estimation was carried out considering certain time interval for both the cultures (PBR and Flask) colorimetrically and final confirmation of the lipids was down using FTIR analysis.

Results and Conclusions:
The results reported that indigenously designed PBR supported exponential growth, and was reported due to the provision of optimal growth conditions provided by the PBR compare to the flask cultures Fig.2.
The molecular and phylogenetic analysis revealed that the microalgae spp was found to be *Chlorella rotunda*. The lipid estimation reported the lipid concentration 2.4 mg/ml for PBR cultures, was 4 folds higher than the flask cultures (0.24 mg/ml) Fig.3. The doubling time measured was reduced from 63 hrs in shaken flask cultures to 2.88 hrs in first batch PBR. A second batch was done to further reduce the doubling time in PBR cultures providing carbon dioxide a source. In the second batch, doubling time was reduced to 1.5 hrs and the lipid content increased further to 3.7 mg/ml which is 1.5 folds higher than the first batch (2.5mg/ml).

**Fig 3: Comparison of lipid yield under optimized and un-optimized conditions**

The preset study concludes by reporting the designed and fabricated PBR supported for the mass cultivation of microalgae *Chlorella rotunda*.

**Scope for future work**: The pilot plant studies need to be carried out for the suggested PBR design.

* ~ * ~ *
6. Production of Clean Biofuel from Microalgae

PROJECT REFERENCE NO.: 39S_B_BE_006

COLLEGE : R.V. COLLEGE OF ENGINEERING, BANGALORE
BRANCH : BIOTECHNOLOGY
GUIDES : PROF. SHIVANDAPPA
STUDENTS : MS. VIDYASHREE S.
            MS. NAVYASHRI S.

1. Introduction
To meet the growing fuel requirements, alternative fuels have been extensively researched. Biodiesel is the fuel which is produced from different feedstock like plant based oils or animal fat or grease. It is a clean burning and renewable fuel. It is currently used in blended forms with petroleum diesel in diesel engines. Even a 20% blend of biodiesel with 80% petroleum diesel reduces emissions significantly and helps the environment. One of the most recent break through has been biodiesel production from microalgae. To produce biodiesel from algal oil different microalgae species were reviewed. The conventional biodiesel production utilizes chemical catalyst in trans-esterification which poses many drawbacks. Hence, recent research has been focused on alternative eco-friendly catalyst like enzymes.

Microalgae are microscopic photosynthetic organisms that are found in both marine and fresh water environments. Microalgae are organisms which efficiently convert solar energy into biomass. Micro algal fuel has high calorific value, low density and viscosity and hence makes it a better feedstock than plant based feedstock. The distinct characteristic of algae is that there are a number of species of algae which can be used and optimized to produce biofuels of different characteristics.

Biodiesel can be produced by any organic sources of oil like waste oil, animal fat and seed oils. Waste oils supply is limited hence it is not a feasible feedstock for biodiesel production. Using seed oil as feedstock reduces the seeds for food supply hence it is not viable. There is a need for a feedstock source which is abundant as well as a productive source of feedstock. The oil yield by different feedstock is shown in Table 1.1. The table shows that microalgae has the highest oil yield, hence it was considered as feedstock for this present work.

Enzyme Trans-esterification:
It is the process of conversion of triglycerides into methyl esters in the presence of enzymes as a catalyst. Enzyme trans-esterification has advantages like (a) Temperature conditions close to room temperature (b) Process of recovery of catalyst, product separation and waste water treatment is eliminated. (c) Environment friendly and biodegradable. Commonly used enzyme for trans-esterification is lipase. Pseudomonas sp. produces extracellular lipase which can be extracted conveniently as Pseudomonas is widely researched and validated microbe Lipases are group of enzymes that hydrolyse oils and fats in biological systems. Most species of animals, plants, fungi, bacteria produce lipase. Lipase from *P.aeruginosa* has been most researched and widely used hence lipase was extracted from *P. aeruginosa* in this present work.
Table 1.1: Comparison of oil yield between different feedstock

<table>
<thead>
<tr>
<th>CROP</th>
<th>OIL YEILD (L ha&lt;sup&gt;-1&lt;/sup&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>446</td>
</tr>
<tr>
<td>Canola</td>
<td>1,190</td>
</tr>
<tr>
<td>Jatropha</td>
<td>1,892</td>
</tr>
<tr>
<td>Palm</td>
<td>5,950</td>
</tr>
<tr>
<td>Microalga</td>
<td>136,900</td>
</tr>
</tbody>
</table>

Key words: Trans-esterification, Algal Biodiesel, Lipase, FFA-Free Fatty Acid.

2. Objectives

There is currently a lot of research to produce biodiesel from different feedstocks to get better oil content as well as yield of Biodiesel. Vast land area is required usually to produce feedstock. The comparison between different feed stocks with oil yield and land required is shown in Table 1.2. As observed in the table 1.2 algae has the highest oil yield and least land requirement hence in the present work algae was considered as oil feedstock.

Table 1.2: Comparison of feed-stocks with oil yield and land required

<table>
<thead>
<tr>
<th>Crop</th>
<th>Oil in Litres per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jatropha</td>
<td>3400</td>
</tr>
<tr>
<td>Castor</td>
<td>1413</td>
</tr>
<tr>
<td>Sunflower</td>
<td>952</td>
</tr>
<tr>
<td>Safflower</td>
<td>779</td>
</tr>
<tr>
<td>Palm</td>
<td>5950</td>
</tr>
<tr>
<td>Soy</td>
<td>446</td>
</tr>
<tr>
<td>Coconut</td>
<td>2689</td>
</tr>
<tr>
<td>Algae</td>
<td>100000</td>
</tr>
</tbody>
</table>

Table 1.3: Oil content of various microalgal species

<table>
<thead>
<tr>
<th>MICROALGA</th>
<th>OIL CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botryococcusbraunii</td>
<td>25-75</td>
</tr>
<tr>
<td>Chlorella sp</td>
<td>28-32</td>
</tr>
<tr>
<td>Cryptothecodiniumcohnii</td>
<td>20</td>
</tr>
<tr>
<td>Cylindrotheca sp.</td>
<td>16-37</td>
</tr>
<tr>
<td>Dunaliellaprimolecta</td>
<td>23</td>
</tr>
<tr>
<td>Isochrysis sp.</td>
<td>25-33</td>
</tr>
<tr>
<td>Monallanthussalina</td>
<td>20</td>
</tr>
<tr>
<td>Nannochloris sp.</td>
<td>20-35</td>
</tr>
<tr>
<td>Neochlorisoleoabundans</td>
<td>35-54</td>
</tr>
</tbody>
</table>

Fig 1.1: Percentage of Land area for different feedstocks.
It is seen that the land required for algae growth is least compared to other feedstock as shown in Fig 1.1. From the table 1.3 it is observed that B. braunii has the highest oil yield compared to the other microalgae species. Hence in the present work B. braunii has been used to extract Algal oil. There are many drawbacks of chemical method of trans-esterification which are overcome by enzyme trans-esterification hence in this present work we have compared chemical and microbial trans-esterification of various oils to demonstrate the feasibility of enzyme trans-esterification over chemical method.

As discussed above, to overcome the problems following objectives were chosen for the present work
1. To isolate P. aeruginosa from Soil & water
2. To isolate and culture B. braunii
3. To extract and purify the Lipase from P. aeruginosa
4. To extract the algal oil from dried algal mat
5. Microbial trans-esterification of algal oil to produce Biodiesel

3. Materials & Methodology

Materials used:
The materials used in the present work are summarized and provided in the following section under different headings.

1. **Media:** LB Agar (Hi-media laboratories), EMB Agar (Hi-media laboratories), Spirit Blue agar (Hi-media laboratories), King’s B Agar (Hi-media laboratories) for culturing, isolating and screening of P. aeruginosa and Lipase. Kuhl’s Basal Media for culturing B. braunii.

2. **Sample collection for algae:** water sample containing algae traces was collected from Ulsoorlake, Bengaluru

3. **Culture and growth of B. braunii:** Aquarium of 8 liters capacity with aerator was procured from local stores, Vijayanagar, Bengaluru.

4. **Sample collection for P. aeruginosa:** Soil sample was procured from Football ground, RVCE and tap water was procured from biotechnology laboratory, RVCE. Standard culture was procured from Radiant Research Lab Pvt. Ltd, Peenya, Bengaluru.

5. **Experimental setup for Extraction, Purification of Lipase and Trans-esterification:** Remi Refrigeration Centrifuge, Simtronics- Hot Water bath, Remi Bacterial Incubator and 0.5 µm pore size dialysis membrane bag with MWCO-20kDa

6. **Algal Oil Extraction:** Closed type Soxhlet extraction apparatus. 4:1 Hexane: Petroleum Ether (v/v) solvent.

7. **Trans-esterification:** RankemH₂SO₄, Methanol, NaOH pellets(fisher), Lipase enzyme extracted, water bath, phenolphthalein indicator.

8. **Oils for comparative studies:** Pongamia oil, Groundnut oil and Rice bran oil were procured from Biodiesel Lab, RVCE.

1) **To isolate *P.aeruginosa* from Soil & water**: *P.aeruginosa* was isolated by serial diluting 1gm of soil in distilled water and sample from all the dilutions were plated onto equal number of petriplates containing LB Agar and incubated overnight. The colonies obtained in LB Plates were sub-cultured by inoculating colonies onto EMB agar and kept for overnight incubation. Resultant colonies in EMB plates were then plated onto petriplates containing Mac- Conkey medium and incubated overnight. For selective isolation of lipolytic bacteria *P.aeruginosa*, colonies from Mac-Conkey plate were then transferred into King's B media, which is specific to lipolytic bacteria and incubated for 24 hours. After the incubation, Biochemical and spirit blue test were conducted for screening of *P.aeruginosa*.

2) **To isolate and culture *B. braunii***: After following standard operating procedure, sample was collected from Ulsoor lake and inoculated into modified kuhl's medium for the growth of *B.braunii* and kept in tissue culture rack for about 2-3 weeks. Microalgae obtained after 2 weeks of incubation was screened by microscopic observation. At the end of the 3rd week, fresh medium was added and continued incubation with aerator and proper light and dark photoperiod. The culture was then used to extract oil for the production of Biodiesel.

3) **To extract and purify the Lipase from *P.aeruginosa***: Colonies from Mac-Conkey plate were transferred onto King's B broth and incubated overnight, then broth culture was centrifuged and the supernatant obtained was subjected to purification by ammonium sulphate precipitation. After precipitation, reaction mixture was again subjected to centrifugation, pellet was then suspended in phosphate buffer and dialysis was carried out to obtain crude enzyme extract.

4) **To extract the algal oil from dried algal mat**: The algal mat obtained in the aquarium set up was dried and grounded to fine powder form. It was then subjected for hexane mediated solvent extraction and finally algal oil extraction was done using Soxhlet apparatus. Later extracted algal oil was used in the process of biodiesel production.

5) **Microbial trans-esterification of algal oil to produce Biodiesel**: The algal oil was subjected to enzyme mediated trans-esterification using the lipase as catalyst to obtain
algal biodiesel. Resulting biodiesel was used for quality studies, the qualitative parameters studied for the algal biodiesel were reported in result section.

4. Results and Discussion

The experimentation of biodiesel production was carried out as shown in methodology section with parallel workflow of isolation of Lipase from *P. aeruginosa* and growth of *B. braunii* to extract algal oil. The algal oil obtained from *B. braunii* was subjected to transesterification in the presence of Lipase isolated from *P. aeruginosa* as the biocatalyst. The Biodiesel from algal oil extracted by *B. braunii* was produced using Lipase isolated from *P. aeruginosa* as biocatalyst in transesterification process.

*Isolation and Screening of Pseudomonas aerugino*:
The isolation of *P. aeruginosa* from soil and water samples was experimented by inoculating the samples on the nutrient media, differential media and specific media used for culture and growth of *P. aeruginosa* sequentially. The bacterial colonies obtained from these media were identified and screened by microscopic observation and biochemical tests specific to *P. aeruginosa*.

![Image of soil samples and bacterial colonies](image)

**Fig 1.3**: Single colony seen in fourth dilution culture of water (A) and colonies seen in third dilution culture of soil sample (B)

**Fig 1.4**: Colonies in third dilution of soil (A) soil sample (B)

**Fig 1.5**: Colonies observed only from third dilution of growth of colonies in fourth dilution of water
**Purification of Lipase by dialysis method:**
The P.aeruginosa culture was used to extract the lipase by dialysis.

![Fig 1.6: P.aeruginosa culture in King’s B broth](image)

![Fig 1.7: Lipase concentrated in dialysis bag by Ammonium sulphate](image)

![Fig 1.8: Purified crude Lipase](image)

**Culture and growth of B.braunii:**
As discussed in the methodology section, an aquarium setup of 8 litres capacity as shown in figure 4.19 was used for open pond culturing. As *B.braunii* mat formation requires more surface area and lesser height above the support ground, only 3 litres of media was poured into the aquarium tank with these constituents,
1. Macronutrient (2X)
2. Micronutrient (0.5X)
3. Soil Extract (increased conc. than default)
4. Vitamins (Thiamine & Biotin)

![Fig 1.9: (A)Water sample containing algae traces collected from Ulsoor lake, Bengaluru (B) Aquarium set up., (C) Growth of B.braunii after 7 days](image)

![Fig 1.10: Algal oil extraction by soxhlet apparatus at 70°C by Hexane: Petroleum](image)

![Fig 1.11: Solvent layer containing algal oil](image)
**Microbial Trans-esterification of Algal oil with purified crude lipase to produce Biodiesel:**

Algal oil obtained from algal mat was mixed with methanol and subjected to Trans-esterification in the presence of optimum lipase of 50µl as experimented in section 4.6.2. The mixture was kept in water bath at 40°C for 6h.

After incubation for 6h, Biodiesel was produced along with glycerol and Lipase enzyme was recovered as shown in figure 4.36 and 4.37. The Biodiesel obtained was screened by method mentioned in the methodology section; accordingly the pink colour in the biodiesel vial and standard petroleum diesel vanishes after 10-15seconds. The yield of algal biodiesel is 64.32% as shown in table 1.4.

![Fig A: Biodiesel from algal oil](image1)
![Fig B: Lipase enzyme recovered](image2)
![Fig C: screening of trans-esterification; Pink colour fades in Standard Petroleum diesel and Algal Biodiesel produced.](image3)

**Table 1.4: Yield of Algal Biodiesel**

<table>
<thead>
<tr>
<th>Algal Oil obtained (ml)</th>
<th>Methanol added (ml)</th>
<th>Lipase added (µl)</th>
<th>Biodiesel Obtained (ml)</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3</td>
<td>1.5</td>
<td>4.5</td>
<td>64.32</td>
</tr>
</tbody>
</table>

Comparative studies of chemical and microbial Trans-esterification on three different oils - *Pongamia oil, Groundnut oil and Rice bran oil*

To compare various parameters between Chemical trans-esterification and Lipase mediated trans-esterification, both methods were performed on 3 different oils

**Effect of FFA content of oil in Chemical Trans-esterification**

Experiments were made to compare the Lipase-mediated trans-esterification with chemical method of trans-esterification. One significant parameter i.e., FFA content of oil that would affect the yield of Biodiesel was considered to represent the differences between two processes although there are many parameters. After performing six experiments on chemical Trans-esterification, the readings of chemical method are tabulated in table 1.5.

**Table 1.5: Yield of Biodiesel from different edible oils based on their FFA content by Chemical Trans-esterification**

<table>
<thead>
<tr>
<th>Oil</th>
<th>Quantity added(ml)</th>
<th>Methanol used (ml)</th>
<th>FFA content</th>
<th>NaOH used (g)</th>
<th>Biodiesel obtained(ml)</th>
<th>Yield(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pongamia oil</td>
<td>250</td>
<td>125</td>
<td>20%</td>
<td>8.5</td>
<td>90</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4%</td>
<td>8.5</td>
<td>225</td>
<td>90%</td>
</tr>
<tr>
<td>Cooking oil</td>
<td>250</td>
<td>125</td>
<td>27.4%</td>
<td>8.5</td>
<td>50</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.96%</td>
<td>8.5</td>
<td>212.5</td>
<td>85%</td>
</tr>
<tr>
<td>Rice Bran oil</td>
<td>250</td>
<td>125</td>
<td>36%</td>
<td>8.5</td>
<td>40</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.78%</td>
<td>8.5</td>
<td>112.5</td>
<td>45%</td>
</tr>
</tbody>
</table>
The observations in table 1.5 suggests that yield of biodiesel is less when the FFA content of the oil is high and the yield is high only when the FFA content of the oil is low as shown in figure 1.12. The less yield of Biodiesel when FFA of oil is high is because of the catalyst used in the chemical trans-esterification is tending to form soap readily than forming biodiesel due to high FFA content of oil. This is similar to acid-base neutralisation process and therefore it can be observed that yield of biodiesel is increased as the FFA level of oil is reduced. Hence, the FFA content of oil must be reduced before using chemical Trans-esterification method to produce biodiesel.

**Effect of FFA content of oil in Lipase-mediated Trans-esterification**

After performing 12 sets of experiments as mentioned in chapter 3 on Lipase-mediated Trans-esterification the reading observed are as shown in table.

**Table 1.6: Yield of Biodiesel from different edible oils by Lipase-mediated Trans-esterification**

<table>
<thead>
<tr>
<th>Oil</th>
<th>Quantity added (ml)</th>
<th>Methanol used (ml)</th>
<th>FFA content</th>
<th>Lipase used(µl)</th>
<th>Biodiesel obtained(ml)</th>
<th>Yield(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pongamia oil</td>
<td>250</td>
<td>125</td>
<td>20% 4%</td>
<td>25</td>
<td>165</td>
<td>66%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>183</td>
<td>73.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>182</td>
<td>72.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>170</td>
<td>68%</td>
</tr>
<tr>
<td>Cooking oil</td>
<td>250</td>
<td>125</td>
<td>27.4% 3.96%</td>
<td>25</td>
<td>100</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>125</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>122</td>
<td>48.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>110</td>
<td>44%</td>
</tr>
<tr>
<td>Rice Bran oil</td>
<td>250</td>
<td>125</td>
<td>36% 9.78%</td>
<td>25</td>
<td>105</td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>120</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>126</td>
<td>50.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>123</td>
<td>49.2%</td>
</tr>
</tbody>
</table>

![Fig 1.12: The impact of FFA content of oil on biodiesel yield by Chemical method](image1)

![Fig 1.13: The impact of FFA content of oil on biodiesel yield by enzymatic method.](image2)
The observations made in table 1.6 suggest that yield of biodiesel is optimum for 50µl of the lipase and the yield of biodiesel do not show any significant increase with increase in the amount of lipase used. Further the readings in table 1.6 and figure 1.13 suggests that yield of Biodiesel is unaffected when the FFA content of the oil is high also the yield does not show much difference when the FFA content of the oil is low. This clearly suggests that FFA content of the oil does not have any impact on yield of Biodiesel during Lipase-mediated Trans-esterification process.

The results also indicates that Yield of Biodiesel from oil having High FFA content is more through Lipase mediated Trans-esterification than Chemical method of Trans-esterification as shown in figure 1.13. The lipase is regenerated and can be reused with zero-residue while the chemical in chemical Trans-esterification will be completely used and toxic to the environment.

![Fig 1.14: Comparison of yield via enzyme method and chemical method of Trans-esterification of different oils with high FFA content](image)

Observations from above data suggests that in chemical method, the FFA content of the oil affects the biodiesel yield while in the case of microbial enzyme method, FFA content of the oil doesn’t depend on the yield of biodiesel. To get the desirable yield in chemical method, the FFA content of the oil must be reduced to less than 4% which is a tedious process. However, in the case of microbial method albeit yield is average, it is economical in large scale production.

**Testing of Fuel properties of Biodiesel**

Additionally to measure the quality of the algal biodiesel obtained from Lipase mediated Trans-esterification, we have tested 3 properties namely Kinematic Viscosity, Flash point and density. Totally 18 samples tests were performed on the biodiesel obtained from Pongamia oil, Groundnut oil, Rice bran oil via both chemical and enzymatic method trans-esterification and finally algal Biodiesel from enzyme trans-esterification. The readings of the experiments performed on Biodiesel obtained through chemical trans-esterification are tabulated in table 1.7 and the readings of the experiments performed on Biodiesel obtained through Lipase-mediated trans-esterification are tabulated in table 1.8

<table>
<thead>
<tr>
<th>Fuel Properties</th>
<th>ASTM standards</th>
<th>Pongamia Biodiesel</th>
<th>Cooking oil Biodiesel</th>
<th>Rice bran Oil Biodiesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematic Viscosity (C.st)</td>
<td>1.6 – 6</td>
<td>3.56</td>
<td>4.51</td>
<td>6.2</td>
</tr>
<tr>
<td>Flash Point(°C)</td>
<td>&gt; 130</td>
<td>153</td>
<td>195</td>
<td>260</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>870 – 900</td>
<td>898</td>
<td>892.4</td>
<td>914</td>
</tr>
</tbody>
</table>
Table 1.8: Fuel properties of Biodiesel produced by Lipase-mediated Trans-esterification

<table>
<thead>
<tr>
<th>Fuel Properties</th>
<th>ASTM standards</th>
<th>Pongamia Biodiesel</th>
<th>Cooking oil Biodiesel</th>
<th>Rice bran Oil Biodiesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematic Viscosity (C.st)</td>
<td>1.6 – 6</td>
<td>1.8</td>
<td>2.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Flash Point(°C)</td>
<td>&gt; 130</td>
<td>147</td>
<td>132</td>
<td>214</td>
</tr>
<tr>
<td>Density (kg/m$^3$)</td>
<td>870 – 900</td>
<td>865</td>
<td>873</td>
<td>917</td>
</tr>
</tbody>
</table>

The above values indicate that fuel properties of Biodiesel obtained from microbial trans-esterification are consistent with range of ASTM standard values alike Biodiesel obtained from chemical trans-esterification.

5. Conclusion and scope for future work

This chapter presents the conclusion drawn about the microbial lipases, B.braunii as the potential biodiesel feedstock and microbial trans-esterification process when compared to chemical trans-esterification, and the future scope of this project.

From the observations made in results sections we can conclude that Lipase mediated Trans-esterification is advantageous over chemical trans-esterification as

1. Algal oil yield was around 49.21% which is higher than other plant seed oil yield. The algal biodiesel yield was 64.32%.
2. Crude Lipase extracted from *P.aeruginosa* had enzyme concentration of 158µg/ml.
3. Fuel obtained from enzyme trans-esterification has fuel properties similar to that of chemical trans-esterification.
4. The biodiesel fuel properties obtained by enzyme trans-esterification were consistent with the ASTM standard fuel properties.
5. The enzyme trans-esterification can be performed at 35-40°C while chemical method needs 80°C which is energy intensive.
6. The two step FFA reduction is waivered in microbial lipase method as it does not have any effect on FFA content of oil.
7. Lipase from *P.aeruginosa* is environmental friendly catalyst compared to NaOH.
8. The lipase enzyme can be recovered and re-used.
9. These facts show that microbial trans-esterification is more economical for mass production than chemical method with zero-chemical residue.

Further enhancement of lipase production may be achieved by genetic and computational modelling approach. High levels of expressions of lipases from several micro-organisms have been successfully achieved using Saccharomyces cerevisiae as the host. Among these the lipase cDNA from *F.heterosporum* increased lipase productivity 3-fold over that of the original strain. In the light of these findings, combining a whole cell biocatalyst with the use of a recombinant micro-organism can be expected to considerably decrease the cost of the lipase production. Such a novel system along with computational modelling approach offers a promising prospect for industrial Biodiesel Production.

Production of algal Biodiesel through microbial Trans-esterification is highly advantageous over the natural processes, there are few observations made from literature survey and seems to be the future development, they are as below:

1. Since, algae culture uses the atmospheric CO$_2$ for its growth, so it helps to reduce green gas effect
2. Few algal species (*Botryococcus* spp.) can be grown in sewage water; therefore it is useful for sewage treatment, where algal growth can take up some toxic metals for its growth.
3. Algal biomass obtained after oil extraction is rich with proteins and carbohydrates, so biomass can be used as cattle and poultry feedstock.
4. Anaerobic fermentation of biomass can yield alcohol, so alcohol obtained can assist the trans-esterification process.
5. Protein component obtained from algal biomass can be used as an ingredient in various fruit juices.
6. Petroleum products obtained from microbial trans-esterification of algal oil can be inter-converted into each other.

* ~ * ~ *

7. GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM JATROPHA CURCAS TO ENHANCE LIPASE ACTIVITY

PROJECT REFERENCE NO.: 39S_B_BE_044

COLLEGE : SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY,
HUNASAMARANAHALLI, BENGALURU
BRANCH : BIOTECHNOLOGY
GUIDES : PROF. HALIMA
STUDENTS : MR. SURYA KUMAR SHRIVASTAVA
MS. KAVYASHREE N.

INTRODUCTION
Biodiesel has been considered to have great potential as an alternative for the diesel. However, there is increase in the cost and human necessity (demand) of the edible oil will prevent it from being used for the biodiesel production. Biodiesel has been promoted as alternative fuel energy source to reduce the overall emission of carbon dioxide into the atmosphere. Therefore, biodiesel is looked into a way to mitigate the impact of the green house effect emission produced from the other fuels used for the transportation. Biodiesel is now being produced mainly from various vegetable oils like rapeseed, soybean and Palm oils. And it exhibits a great potential for the compression ignition engines so that diesel engines can also be replaced by biodiesel produced from any vegetable oils. Biodiesel usage can improve exhibiting the level of emissions and some other pollutants. Tranesterification is the process of exchanging the organic group R" of an ester with the organic group R' of an alcohol. These reactions are often catalyzed by the addition of an acid or base catalyst. The transesterification process is catalyzed by alkalis, acids and enzymes. These chemical process are very harsh and feed stock requirement is more. Enzymatic transesterification is, therefore, an attractive method for biodiesel production over chemical methods because of the reduced feedstock limitations, downstream processing and environmental impact (Jegannathan et al., 2008). The use of enzyme catalysts eliminates these problems associated with acid and alkali catalysts as well as presents other production benefits. Unlike the alkaline catalysts; enzymes do not form soaps so there is no restriction on free fatty acid content (Harding et al., 2007; Fjerbaek et al., 2009). Unlike the acid catalysts, enzymes are not severely inhibited by water, so there is little concern about water production (Dizge and Keskinler, 2008). Since the enzymes are capable of completely converting free fatty acids to Fatty acids acyl esters with low cost feedstocks such as waste oils and lard can be used (Fukuda et al., 2001).
OBJECTIVES:
Synthesis of silver nanoparticles from a green source is an ecofriendly and economical method. In the present research, the green synthesis of silver nanoparticles is from *Jatropha curcas*. Further the characterization of silver nanoparticles is carried out by UV-Vis spectroscopy, SEM and FTIR. A characteristic peak at 430 nm ensures the SPR of silver nanoparticles. The shape and size of nanoparticle can be found out using SEM. FTIR analyses the functional group attached to the silver nanoparticle. Optimizing the different parameters like pH, Temperature, Pressure, Radiations etc will enable to understand the optimum condition for the synthesis of silver nanoparticles. Lipase is a major enzyme used in enzymatic trans esterification process in biofuel production. Silver nanoparticles were allowed to interact with lipase enzyme. Free silver nanoparticles and immobilized silver nanoparticle in egg shell membrane were allowed to interact with Lipase. Silver nanoparticles increasing the lipase activity provides more economical Biofuel production.

MATERIALS AND METHODS:
Synthesis of silver nanoparticles from Jatropha curcas leaves:
To the leaf extract of the above mentioned plant extract, about 1mM silver nitrate solution was added in 1:9 ratio. Due to reduction of Ag+ ions a color changed from light green to dark brown colour which indicates the production of silver nanoparticles and can be purified by repeated centrifugation process at 15,000 rpm for 20 mins by re-dispensing in water.

Characterization of silver nanoparticle:
Further to the synthesis of silver nanoparticles, characterisation was carried out by UV-Visible spectroscopy to confirm the surface Plasmon resonance of silver nanoparticles. FTIR was carried out to know about the functional groups attached to the silver nanoparticles. Further the size and shape of the silver nanoparticle was found out using the SEM analysis.

Optimization of process parameters:
The optimization of process parameters for the synthesis of silver nanoparticles by green synthesis was studied by varying different pH, temperature, pressure, time of synthesis, silver ion concentration, plant extract concentration, radiations like UV, sunlight, microwave.

Enhance lipase activity with silver nanoparticles
Lipase is an industrially important enzyme for its production step in biofuel production. Commercially available lipase was purchased and silver nanoparticles were allowed to interact with the enzyme. A comparative study between the free silver nanoparticle and immobilized silver nanoparticles interaction with lipase was carried out. The enzyme activity was measured calorimetrically.

RESULTS AND DISCUSSION:
The colour change in the reaction mixture was recorded through visual observation. The colour change from yellow to dark brown indicated that the AgNPs were synthesised.

![Fig.4.1: Colour change of plant extract from yellow to dark brown.](image)

The sharp bands of silver nanoparticles were observed for Silver nanoparticles from *Jatropha curcas* at 430 nm. This characteristic color variation is due to the excitation of the SPR in the metal nanoparticles. The reduction of the metal ions occurs fairly rapidly. The metal particles were observed to be stable in solution after their synthesis.
FTIR spectrum of silver nanoparticles is shown in the figures given below. It revealed the possible biomolecules present in the leaf extract which was accountable as the reducing agent for silver ions and its interaction with the AgNPs. The peak at 3270.23 indicates C-H stretching due to alkynes. 1635.68 (C=C) stretching interactions to alkane.

SEM provided further insight into the morphology and size details of the silver nanoparticles. Average particle size was found to be 42 nm on SEM analysis and immobilized AgNPs in egg membrane has particle size to be 75 nm. The results showed particles were of spherical shape.

### The Optimization parameters for green synthesized silver nanoparticles are as follows

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Optimum value</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>30 mins</td>
<td>As time increases, rate of synthesis increased, after 30 mins it attained saturation</td>
</tr>
<tr>
<td>Temperature</td>
<td>40°C</td>
<td>Temperature influences the synthesis of silver nanoparticles due to the rapid movement of ions and then reached saturation after 40°C</td>
</tr>
</tbody>
</table>
### Table 1: Optimization of silver nanoparticle synthesis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver ion conc.</td>
<td>1 mM</td>
<td>Even on minimizing the concentration below 1 mM, the synthesis was enabled.</td>
</tr>
<tr>
<td>Pressure</td>
<td>15 psi</td>
<td>As pressure increases the synthesis was enhanced.</td>
</tr>
<tr>
<td>MW radiation</td>
<td>40 secs</td>
<td>Microwave radiation has greatly influenced the synthesis of silver nanoparticles.</td>
</tr>
<tr>
<td>Sunlight</td>
<td>5 mins</td>
<td>Sunlight acts as a catalyst in synthesis of silver nanoparticles.</td>
</tr>
<tr>
<td>Agitation</td>
<td>40 mins</td>
<td>No significant influence was found with agitation.</td>
</tr>
<tr>
<td>UV radiation</td>
<td>10 mins</td>
<td>No significant increase in synthesis with time.</td>
</tr>
</tbody>
</table>

The enzyme activity measurement of lipase shows 2.5 fold increase in enzyme activity and free nanoparticles showed about 2 fold increase in enzyme activity in comparison with activity without AgNps. Thus its proven that AgNps can enhance the activity of lipase enzyme.

**Scope for future work:**

The silver nanoparticles is found to interact with the lipase enzyme thereby enhancing enzyme active. Also the immobilized silver nanoparticles also showed an increase in lipase activity. So far the studies are carried out immobilizing lipase enzyme in silver nanoparticle. But the present study showed the silver nanoparticle can also be immobilized. This will enable the reuse of enzyme and reduce the amount of enzyme used. Immobilization can be carried out by electrospinning of collagen fiber too, which will be the next step of this study.

* * *

### 8. Designing Of Bioremediation Tool for Degradation Of Poly Aromatic Hydrocarbon (PAHs) Using Fungal Consortium

**PROJECT REFERENCE NO.: 39S_B_BE_098**

**COLLEGE** : THE OXFORD COLLEGE OF ENGINEERING  
**BRANCH** : BIOTECHNOLOGY  
**GUIDES** : DR. B K MANJUNATHA  
**STUDENTS** : MS. PAVANI BHAT,
OBJECTIVES:

- Isolation of crude oil degrading Fungi from soil samples of Coastal regions of Karnataka.
- To study the capability of fungi and fungal consortium for PAHs biodegradation in lab condition by evaluating TPH in residual oil, Total Plate Count, BOD, COD level and by Spectral analysis viz., UV, GC and Mass Spectroscopy.
- Taxonomic characterization for the PAHs utilizing isolates.
- Standardisation of immobilisation studies for in situ and ex situ bioremediation using individual/fungal consortium & screening for Biosurfactant production and enzymes.

OBJECTIVES ACHIEVED:

- Total of 45 fungal strains were isolated from oil/PAHs contaminated soil samples collected from MRPL and other regions of Coastal Karnataka. Among these isolates 16 fungal strains were selected based on the preliminary screening by DCPIP method.
- Out of 16 fungi, 05 best strains were selected based on the degradation potency and morphological characteristics for further PAHs utilisation studies.
- Study of capability of fungi for PAH degradation in lab condition by assessing TPH in residual oil, Total Plate Count, BOD, COD and spectral analysis like UV visible spectroscopic studies, GC-MS studies for potent isolates.
- Taxonomic characterisation of potent isolates by 18S rRNA sequencing.
- Screening for bio surfactants and dehydrogenase enzyme.
- Consortium development and assessment of degradation by the consortium culture.
- Immobilisation studies using Sodium alginate beads and assessment of degradation by immobilised isolates.
- Process optimisation for consortium by Response Surface Methodology.

SUMMARY OF THE INVENTION:

The present proposal primarily aims at developing a bioremediation kit for the degradation of Poly Aromatic Hydrocarbons (PAHs) in Crude oil using fungal consortium. The potent fungal strains were isolated from Mangalore Refineries and Petrochemicals Limited (MRPL) and other regions of Coastal Karnataka. The hydrocarbon utilisation by the potent strains was studied for test hydrocarbons like Crude oil, Benzene, Toluene, Naphthalene and Paraffin, for a period of 10 days. Degradation process was assessed by measuring percentage of TPH in residual oil, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Plate Count and spectral analysis like UV spectrophotometric analysis and GC-MS studies. The present study revealed that, among the 16 isolates obtained from PAH contaminated soil, 5 strains showed maximum degradation of Crude oil i.e. M2B, M5A2, M6A, M4B and M5B2, with 65.31%, 67.68%, 60.45%, 62.01% and 63.24% degradation respectively. These 5 strains also showed consistent performance in the degradation of other PAHs and hence, were selected for consortium development. M2B also showed 60%, 96.4% and 62.66% Benzene, Toluene and Engine oil degradation; M5A2 showed 85%, 96%, and 68% Benzene, Toluene and Naphthalene degradation; M6A showed 75% and 60% Benzene and Toluene degradation; M4B showed 70%, 83.6% and 62.66% Benzene, Toluene and Engine oil degradation; M5B2 showed 80%, 98.7%, 62% and 66.6% degradation of Benzene, Toluene, Naphthalene and Engine oil respectively. Growth parameters viz., TPC, BOD and COD also indicates the corresponding rise in Colony.
Forming Units (CFU). 18S rRNA sequencing was used to identify the strains and, M5A2 was identified as *Aspergillus terreus*, M6A as *Aspergillus aculeatus*, M4B as *Scedosporium boydii*, and the strains M2B and M5B2 as *Aspergillus* sp. The consortium developed using these 5 potent strains showed degradation efficiency of 76.4%, 87.13%, 90.08%, 73.22% and 69.38% of Crude oil, Benzene, Toluene, Naphthalene and Paraffin respectively, on 10th day of incubation. The degradation process for this consortium was further optimised using Response Surface Method (RSM), where it was revealed that a temperature of 32.5°C, pH 8, Salinity 12.5% and inoculum size 12.5 mL were the optimum conditions, showing a maximum Crude oil degradation of 81.25%. Immobilisation studies were also carried out using alginate method, and revealed that consortium showed above 60% degradation of all the test hydrocarbons within 6 days of incubation. The fungal isolates were also screened for biosurfactant production and dehydrogenase enzyme.

**OUTCOME OF THE STUDY:**

- 16 species of fungi that could grow in the presence of PAHs were isolated, and 5 potent species capable of maximum PAH degradation were identified among them.
- Degradation studies were performed for the 5 species using Crude oil, Benzene, Toluene, Naphthalene and Paraffin as test hydrocarbons. These species showed consistent performance in degradation of all the test hydrocarbons.
- 18S rRNA sequencing technique was used to identify the 5 species as *Aspergillus terreus*, *Aspergillus aculeatus*, *Scedosporium boydii* and 2 of them as *Aspergillus* species.
- Biosurfactants, which could help the degradation process by increasing the bioavailability of the hydrocarbons to the organisms, were found to be produced by the isolated species.
- A consortium was developed using these 5 potent fungal strains, which showed increase in the degradation efficiency of the isolates after 10 days of incubation.
- For this consortium, optimisation of media was done to determine the optimum conditions that facilitate the growth and increase the performance of the consortium. The optimum conditions were found to be: pH 8, Salinity 12.5%, Temperature 32.5°C and inoculum size 12.5 mL. This knowledge can help during Ex-situ remediation of contaminated soils.
- Immobilisation studies using Sodium Alginate method was performed for the individual potent isolates as well as for the consortium, which showed higher degradation of test hydrocarbons in less time i.e. within 6 days of incubation. This is because when different strains with unique substrate specificity (for PAHs) were brought together in the form of consortium, Crude oil/Engine oil which contains different types of hydrocarbons can be efficiently biodegraded. Further, immobilisation process will increase the viability, efficacy and reusability of the microbes in the remediation process.
- Evaluation of consortium capability in the oil spillage site may give valuable input on the performance of the consortium. The consortium has shown better performance compared to the individual isolates both in normal as well as immobilised conditions. This could be because the isolates that form the consortium are specific to different fractions of PAHs, hence can degrade a variety of PAHs when present together.
- The study provides potential bioremediation kit for the degradation of toxic hydrocarbons as well as the crude oil.
- Further studies viz., process optimisation, pilot scale study and field trial could provide required data to exploit the potential of the consortium in the degradation of hydrocarbons.

* ~ * ~ *
INTRODUCTION:
The scarcity of conventional fossil fuels, growing emissions of combustion-generated pollutants, and their increasing costs has made biomass sources more attractive. Petroleum-based fuels are limited reserves concentrated in certain regions of the world. These sources are on the verge of reaching their peak production. The scarcity of known petroleum reserves has made renewable energy sources more attractive. Biodiesel fuels are attracting increasing attention worldwide as a blending component or a direct replacement for diesel fuel in vehicle engines.

OBJECTIVES:
1. Synthesis of Heterogeneous Mg/Al Hydrotalcite catalyst.
2. Characterisation of Heterogeneous Mg/Al Hydrotalcite catalyst.
3. Biodiesel synthesis from different oils under optimum conditions like Reaction time and Catalyst concentration.
4. To draw a comparison for synthesis of Biodiesel from different oils using homogenous and heterogeneous catalysts.
5. Confirmation tests for Biodiesel

METHODOLOGY
For the production of Biodiesel and for the synthesis of Hydrotalcite catalyst, the various materials used are as follows:
Sunflower oil, Sesame oil, methanol, Magnesium nitrate, Aluminium nitrate, Sodium carbonate and Sodium hydroxide pellets were purchased from Merck India Ltd. All the chemicals were of analytical grade and used without any further purification.
The Experimental Setup included the following:
Round bottom flask, Condenser, Thermometer, Oil bath, Separating funnel, Magnetic stirrer with PID temperature control, Stir bar, Mechanical shaker, Centrifuge

PROCEDURE:
1. SYNTHESIS OF Mg/Al HYDROTALCITE CATALYST
   • 150 mmol (22.2g) of Mg(NO$_3$)$_2$ and 50 mmol (10.65g) of Al(NO$_3$)$_3$ were dissolved in 200 ml of distilled water.
• This solution was added slowly into a 400 ml aqueous solution of 400 mmol (42.4g) of Na$_2$CO$_3$, which was then poured into a conical flask and pre-heated to 60 °C.
• During co-precipitation, the slurry was vigorously stirred with a magnet bar with the drop-wise addition of a 1M solution of NaOH.
• After complete addition of the metal nitrates solution, the suspension was stirred at 60 °C for 1 h, followed by ageing for 18 h, without stirring.
• The synthesized solid was washed, filtered, dried at 80 °C. The dried solid was ground into a fine powder, which was further calcined in air at 500 °C to produce hydrotalcite as shown in Figure 1.

2. CHARACTERIZATION OF CATALYST
The characterization of the synthesised Mg/Al Hydrotalcite catalyst was done using X-Ray diffraction and Scanning Electron Microscope techniques. The Figure 2 shows the X-Ray diffraction image of the synthesised Mg/Al Hydrotalcite catalyst. In the XRD analysis, which measures Intensity and 2θ has prominent 2θ peaks obtained at 11.8, 23.8, 35.2, 40, 48.5, 62.4, and 66.4. On comparison with JCPDS- Joint Committee on Powder Diffraction Standards data for Mg/Al Hydrotalcite, the formation of Mg/Al Hydrotalcite was confirmed and some other peaks were due to intermediate compounds. The XRD pattern of Mg/Al Hydrotalcite catalyst corresponds to a typical Hydrotalcite structure with strong, sharp and symmetric peaks for the (003), (006) and (012) planes as well as broad and symmetric peaks for the (015) and (018) planes. The three strong peaks are characteristic of a layered structure.

• The Mg/Al Hydrotalcite formation was analyzed by Scanning Electron Microscope-SEM technique. The Figure 3 shows the SEM image of the synthesised Mg/Al Hydrotalcite catalyst having the ‘Rose Petals’ morphology characteristic of Hydrotalcite materials observed for the sample. Hydrotalcite had a relatively uniform hexagonal platelet like structure. Hydrotalcite had a well-developed platelet structure of a typical layered material with a uniform size of 1μm width.

3. SYNTHESIS OF BIODIESEL BY TRANSESTERIFICATION
a) Estimation of acid value:
Acid Value is the amount of NaOH required to neutralize free fatty acid per gram of oil.
Procedure for Acid value: 5 gm. of oil was taken in a conical flask and 2-3 drops of phenolphthalein indicator was added into it. The solution was then titrated against 0.1N NaOH until it turns from colourless to pale pink. The amount of rundown of NaOH to neutralize oil was noted down. The standard titrimetric method is as shown in Figure 4. Acid value was calculated using the formula:

\[
\text{Acid value (mg NaOH/g of oil)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Molecular weight of NaOH}}{\text{Weight of oil (g)}}
\]
The acid value of oil should be <2 % to carry out the transesterification reaction. If the acid value is > 2%, an additional esterification step has to be carried out to reduce the free acid content of the oil.

**Figure 4:** Estimation of acid value using the standard titrimetric method

**b) Esterification to decrease free acid content:**
To decrease free fatty acid content in non-edible unrefined oils, a three necked round bottom flask was charged with the oil and methanol in the mole ratio of 1: 6 and preheated at 60 °C for one hour. To this mixture, sulphuric acid was added in the mole ratio of 1: 0.07 and continuously stirred for 4 h at 60 °C. After stirring, the mixture was allowed to separate in a separating funnel overnight. The acid value of the oil was determined by a standard titrimetric method.

**c) Transesterification of oil with methanol:**
A three necked round bottom flask was charged with 50 ml of the oil and preheated at 60 °C for one hour with continuous stirring. After one hour, the calculated amount of catalyst, according to varying catalyst wt % (1wt%, 2wt%, 5wt%) and methanol were added slowly to the mixture, with continuous stirring at 60 °C for the required number of hours. The transesterification reaction is carried out as shown in Figure 5.

**Figure 5:** Transesterification reaction

**d) Isolation of biodiesel**

**Procedure followed using Homogenous NaOH catalyst:**

After the completion of the transesterification reaction, the reaction mixture was transferred to a separating funnel, to obtain separate layers of biodiesel and glycerol, as shown in Figure 6.

**Figure 6:** Formation of biodiesel and glycerol layers after transesterification reaction

The reaction mixture contained glycerol at the bottom and methyl esters- Biodiesel at the top with impurities of unreacted oil and methanol, of which methanol was removed first by distillation as shown in Figure 7.

**Figure 7:** Distillation to remove Methanol

- After distillation, the residue was poured into a separating funnel and left there until the two layered mixture was formed.

- Petroleum ether (in order to completely separate glycerol) was added to the top layer, shaken well and allowed to settle for one hour as shown in Figure 8. Glycerol at the bottom was removed as a separate layer and weighed. Remaining petroleum ether was distilled out from the top layer to obtain Biodiesel as shown in Figure 9.

**Figure 8:** Separation after addition of petroleum ether

**Figure 9:** Distillation to remove Petroleum ether
Methanol was added again in order to remove any unreacted oil in the mixture to the total esters in which biodiesel was completely miscible leaving unreacted oil as a separate layer. This mixture was allowed to settle in the separating funnel, as shown in Figure 10 for an hour and unreacted oil layer was removed and weighed. **Figure 10:** Removal of unreacted oil using methanol

Finally, methanol was distilled out as shown in Figure 11 from the biodiesel layer to get pure Biodiesel as shown in Figure 12.  

**Figure 11:** Distillation to remove Methanol  
**Figure 12:** Pure biodiesel obtained from Transesterification reaction

**Procedure followed using Heterogeneous Mg/Al Hydrotalcite catalyst:**

- After the completion of the transesterification reaction, the heterogeneous catalyst was separated from the reaction mixture by centrifugation as shown in Figure 13.

**Figure 13:** Centrifugation to separate heterogeneous catalyst

- The liquid mixture was then transferred to a separating funnel to obtain separate layers of biodiesel and glycerol as shown in Figure 14. The mixture contained glycerol at the bottom and methyl esters- Biodiesel at the top along with impurities of unreacted oil and methanol, of which methanol was removed first by distillation as shown in Figure 15.

**Figure 14:** Biodiesel and Glycerol  
**Figure 15:** Distillation to remove methanol layer formation after centrifugation

- After distillation, the residue was poured into a separating funnel and left there until the two layered mixture was formed.
- Petroleum ether was added to the top layer, shaken well and allowed to settle for one hour as shown in Figure 16. Glycerol at the bottom was removed as a separate layer and weighed.
Remaining petroleum ether was distilled out from the top layer to obtain Biodiesel as shown in Figure 17.

**Figure 16:** Separation after addition of petroleum ether

**Figure 17:** Distillation to remove Petroleum ether

- Methanol was added again in order to remove any unreacted oil in the mixture, to the total esters, in which biodiesel was completely miscible, leaving unreacted oil as a separate layer. This mixture was allowed to settle in the separating funnel as shown in Figure 18 for an hour and unreacted oil layer was removed and weighed.

**Figure 18:** Removal of unreacted oil using methanol

- Finally, methanol was distilled out as shown in Figure 19 from the biodiesel layer to get pure Biodiesel as shown in Figure 20.

**Figure 19:** Distillation to remove Methanol  
**Figure 20:** Pure Biodiesel obtained from transesterification reaction

The yield of biodiesel was calculated using the formula:

\[
\text{Biodiesel Yield (\%) } = \frac{\text{wt. of biodiesel produced}}{\text{wt. of oil taken}} \times 100
\]

**CONFIRMATION TESTS FOR BIODIESEL**

1. **Flash point** - The flash point is the lowest temperature at which vapors of a fluid will ignite. Measuring a flash point requires an ignition source. At the flash point, the vapor may cease to burn when the ignition source is removed.
   - For Biodiesel, Flash point is the lowest temperature at which it can form an ignitable mixture in air near the surface of the liquid. Biodiesel will ignite briefly as shown in Figure 21, but the vapor might not be produced at a rate to sustain the fire.

**Figure 21:** Determination of Flash point

2. **Fire point** - The fire point of a fuel is the temperature at which the vapour produced by that given fuel will continue to burn for at least 5 seconds after ignition by an open flame as shown in Figure 22.
• In general, the fire points can be assumed to be about 10 °C higher than the flash points.

**Figure 22**: Determination of Fire point

3. **Cloud point** - Cloud Point is the temperature at which the crystals of solid biodiesel first become visible.

• Manual testing method involved: the test sample is first poured into a test jar to a level approximately half full. A cork carrying the test thermometer is used to close the jar. The thermometer bulb is positioned to rest at the bottom of the jar. The entire test subject is then placed in a constant temperature cooling bath. At every 1 °C, the sample is taken out and inspected for cloud then quickly replaced. Successively lower temperature cooling baths may be used depending on the cloud point.

4. **Pour point** - The pour point of a liquid is the temperature at which it becomes semi-solid and loses its flow characteristics.

• Manual testing method involved: The sample is cooled inside a cooling bath to allow the formation of paraffin wax crystals. At about 9 °C above the expected pour point, and for every subsequent 3 °C, the test jar is removed and tilted to check for surface movement. When the specimen does not flow when tilted, the jar is held horizontally for 5 sec. If it does not flow, 3 °C is added to the corresponding temperature and the result is the pour point temperature.

* * *

10. **Synthesis & Characterization of catalyst for the conversion of crude glycerol derived from biodiesel to value-added products**

**PROJECT REFERENCE NO.: 39S_B_BE_074**

**COLLEGE**: M S RAMAIAH INSTITUTE OF TECHNOLOGY

**BRANCH**: CHEMICAL ENGINEERING

**GUIDES**: DR. ARCHANA, SMT. SRAVANTHI V.

**STUDENTS**: MS. HEZIL NORONHA

MS. INDRAJA S.

MS. SPOORTHI S.

Fossil fuels at present serves as the primary source of energy. Fossil fuels are nothing but hydrocarbons which on combustion gives carbon dioxide. This has given rise to environment concerned problems like global warming, pollution etc leading to the search for new, and clean alternative fuels. Biodiesel has gained wide interest as an alternative fuel. Biodiesel can be used directly in diesel engines without or with modifications. It is basically produced by transesterification of triglycerides with low molecular weight alcohols like methanol or ethanol. One drawback of producing biodiesel to the maximum is the glycerol production as a by-product of biodiesel.
Glycerol produced during the transesterification has wide application in various fields. Many different reactions can be carried out with glycerol to convert it into value-added products like formic acid, acetol, triacylglycerol, monoethers etc. One effective reaction for the conversion of glycerol is esterification. Monos, Di, triacylglycerol are produced by the esterification of glycerol. These products basically are useful as anti-knocking agents and in cosmetics, fuel additives etc. The esterification reaction is carried out between glycerol and acetic acid. This reaction is a slow reaction and thus use of catalyst will enhance the rate of reaction. Homogeneous and heterogeneous catalysts both can be used. Though homogeneous catalysts poses strong catalytic activity use of these catalysts suffer from several drawbacks. Thus, as an alternative way to overcome these drawbacks heterogeneous catalysts are developed and studied. There are five main classes of heterogeneous catalyst. Ion exchange resins and zeolites are well established as catalysts for esterification reaction. Mixed oxide is one class of catalyst which is currently being studied for the esterification reaction. Mixed oxide show high selectivity and stability towards water and are thermally stable; thus this class of catalysts are attracting a lot of researchers.

In our current work, we synthesized a cerium based mixed oxide. Pure cerium has a fluorite structure and this is responsible for superior physical and chemical properties of any cerium based catalysts. Possibility of transformation from Ce$^{3+}$ and Ce$^{4+}$ aids in accepting or removing oxygen from ceria. But use of pure CeO$_2$ as a catalyst is probably of little interest because of its low texture stability, reduction in surface area, loses in redox properties and oxygen storage capacity under high thermal conditions. Doping of ceria with cations has been an efficient way to generate oxygen vacancies and improve the thermal stability and also the surface area of the compound.

We synthesized CeO$_2$-Al$_2$O$_3$ mixed oxide and these oxides has to be characterized and on the results obtained; if the mixed oxide can be used as a catalyst then we will carry out an esterification reaction of glycerol and study the kinetics of the reaction.

**CATALYST SYNTHESIS**

The cerium-based mixed oxide was synthesized by two methods.

1. **Wet Chemical Method** – 50ml of 0.1M solution of cerium nitrate and 50ml of 0.1M solution of Aluminium sulphate solutions were mixed. 100ml of 2M sodium hydroxide solution was added dropwise to the above mixture. The resulting solution was refluxed for 3 hours at a temperature of 80$^\circ$C. The obtained precipitate was filtered and the filtrate was washed several times with deionised water to remove the impurities. The precipitate was dried at 110$^\circ$C for 4 hours, powdered and stored.

2. **Combustion Method** – Cerium nitrate, aluminum nitrate, urea and distilled water were mixed in proper proportion and the combustion process was carried out in the furnace at a temperature of 460$^\circ$C. The obtained product was cooled, powdered and then heated to 600$^\circ$C to remove any impurities present. This was then cooled and stored.

**CATALYST CHARACTERISATION**

Characterization - The mixed oxide produced is characterized by BET, XRD, TPD and SEM. **X-RAY DIFFRACTION ANALYSIS (XRD):** Structural properties of the product metal oxide can be studied by X-Ray Diffraction analysis. The average crystallite size can be calculated using Debye-Schere formula, also the crystalline and amorphous phase of the product may be determined by comparing the pattern obtained with the standard pattern. The XRD pattern is expected to get diffraction peaks due to crystalline cubic fluorite structure of CeO$_2$. Crystallite size depends on the type of foreign oxide present & the type of precursor used. Crystallite size will be in nanometer range.
TEMPERATURE PROGRAM DESORPTION (TPD-NH₃): To understand the acid-base properties of the prepared mixed oxide TPD of CO₂ and NH₃ is used. Temperature programmed desorption of ammonia is used to determine the acidity and the acid strength of solid catalyst. Usually narrow peaks in the pattern release strong acidic sites. The amount of ammonia desorbed is always higher for the sample that has high surface area. Similarly, the basicity of synthesized product is determined by conducting TPD of CO₂.

SCANNING ELECTRON MICROSCOPE (SEM) & BET ANALYSIS: surface topography and composition of the mixed oxide can be obtained by SEM analysis. To determine surface area and porosity of the mixed oxide BET analysis is used. The corresponding N₂ adsorption – desorption isotherm exhibited for mixed oxide is same. The amount of gas adsorbed at a given pressure allows determining the surface area.

Based on the characterization results if the catalyst possesses more acid sites the synthesized catalyst will be applied for the esterification of glycerol with acetic acid and its kinetics will be studied. If the characteristics analyzed for the mixed oxide do not satisfy, it will be used as an adsorbent and new ion exchanged heteropoly acid will be synthesized and applied for esterification of crude glycerol to value added product.

The synthesized mixed oxide will be applied as a catalyst for the reaction between acetic acid and glycerol. The reaction is given below

\[ \text{CeO}_2-\text{Al}_2\text{O}_3 \]

Glycerol + Acetic acid \[ \rightarrow \] Triacylglycerol

The above reaction is intended to be studied by varying different parameters. Thus, effect of temperature, effect of mole ration of the reactants, effect of stirrer speed and effect of catalyst loading will be studied for the reaction. Further, the activation energy, order of the reaction, rate constant and frequency factor can be calculated using Arrhenius Equation.

* ~ * ~ *

11. EFFECT OF INJECTION TIMING, INJECTOR OPENING PRESSURE ON DIRECT INJECTION DIESEL ENGINE USING DAIRY SCUM BIO-DIESELOIL

PROJECT REFERENCE NO.: 39S_B_BE_042

COLLEGE : A.G.M. RURAL COLLEGE OF ENGINEERING AND TECHNOLOGY, VARUR, HUBLI

BRANCH : MECHANICAL ENGINEERING
INTRODUCTION
One of the criteria for selecting a particular fuel for CI engines is that it should be available abundantly and also renewable in nature. In the present work Dairy scum bio diesel is selected for testing which can be used in existing CI engine with less modification. The Dairy scum is available in large quantity locally and on large scale production cost is comparable with existing bio fuels [1]. A effort is made in this work to vary the injection timing i.e. $10^\circ$, $20^\circ$, $25^\circ$, $30^\circ$ before TDC and Injector opening pressure of 200 bar, 220 bar, 240 bar, 260 bar to optimize the performance parameters like, Brake power, brake thermal efficiency, specific fuel consumption, emission of carbon monoxide, carbon dioxide, nitrogen oxide and unburned hydrocarbon of diesel engine.

Literature Survey
A number of studies Wanger[3], Statt and Gateau, [4] have shown that Bio-diesel fuel exhibits chemical and thermodynamic properties that are quite similar to those of diesel fuel. Although thermodynamically similar, differences in the physical properties of density, viscosity and isothermal compressibility exists between Bio-diesel and diesel fuel[2]. These properties strongly affect injection pressure, injection rate and spray characteristics. Hansen and Jensen have been carried out on the preparation of bio diesel from soybean, canola, sunflower, palm and waste cooking oil and found the properties of Bio-diesel such as density, viscosity, cetane number, cold flow properties and heating value are not the same[3]. An increase in the fuel viscosity will generally result in the penetration rate and a corresponding decrease in the cone angle. The fuel injection timing was mainly influenced by the fuel properties, such as its density and bulk modulus. Hence the objective of the present work was focused on to study the effect of injection timing, injector opening pressure on performance of diesel engine[4].

Methodology
Following are the methodology used to determining the effect of injection timing and injector opening pressure on direct injection diesel engine.

1. Selection of suitable non-edible Dairy scum oil as substitute for diesel oil.
2. Characterization of the bio diesel and its blend.
3. Development of an experimental setup with necessary instrumentation.
4. Study of performance, emission and combustion characteristics of a C.I. engine with DSME (Dairy Scum Methyl Esters) and its blends to optimize parameters.

OBJECTIVE
Following are the methods used to determining the effect of injection timing and injector opening pressure on direct injection diesel engine.

1. To characterize the properties of Dairy scum bio diesel.
2. To study the effect of injection timing (IT), injector opening pressure (IOP) on the performance of direct injection diesel engine using diary scum bio diesel.
3. To study the emission characteristics of bio diesel.

ESTIMATING AND COSTING
Costs for all resources required to achieve the stated objectives of the project are included in the table 1.
Table 1: Estimated cost for the project

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Cost(Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy scum bio diesel</td>
<td>2500</td>
</tr>
<tr>
<td>Cylinder head</td>
<td>3000</td>
</tr>
<tr>
<td>Pistons(3)</td>
<td>4000</td>
</tr>
<tr>
<td>Injector assembly</td>
<td>4500</td>
</tr>
<tr>
<td>Transportation charge</td>
<td>4000</td>
</tr>
<tr>
<td>Labor charge</td>
<td>5000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23000</strong></td>
</tr>
</tbody>
</table>

**Possible Outcomes**
The engine parameters i.e. Brake Thermal Efficiency (BTE), Break Power (BP), Specific Fuel Consumption (SFC), Percentage emissions of CO, NOx, un burnt hydro carbons, heat release rate, were measured and compared with the base engine operated with diesel engine.

Table 2: Experimental setup

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make and Model</td>
<td>Kirloskar, TV1</td>
</tr>
<tr>
<td>Engine type</td>
<td>single cylinder, four stroke, water cooled, direct injection, diesel engine</td>
</tr>
<tr>
<td>Orientation</td>
<td>Vertical</td>
</tr>
<tr>
<td>Ignition System</td>
<td>Compression Ignition</td>
</tr>
<tr>
<td>Bore * Stroke</td>
<td>87.5 mm * 110 mm</td>
</tr>
<tr>
<td>Displacement Volume</td>
<td>660 cc</td>
</tr>
<tr>
<td>Compression Ratio</td>
<td>17.5 : 1</td>
</tr>
<tr>
<td>Arrangement of valves</td>
<td>Overhead</td>
</tr>
<tr>
<td>Combustion Chamber</td>
<td>Open Chamber (Direct Injection)</td>
</tr>
<tr>
<td>Rated Power</td>
<td>5.2 kW (7 HP) @1500 rpm</td>
</tr>
<tr>
<td>Cooling Medium</td>
<td>Water cooled</td>
</tr>
<tr>
<td><strong>Eddy current dynamometer</strong></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>AG-10</td>
</tr>
<tr>
<td>Type</td>
<td>Eddy current</td>
</tr>
<tr>
<td>Maximum output</td>
<td>7.5 KW at 1500-3000 rpm</td>
</tr>
<tr>
<td>Dynamometer arm length</td>
<td>0.180 meter</td>
</tr>
<tr>
<td>Fuel measuring unit range</td>
<td>0-50 ml</td>
</tr>
</tbody>
</table>

**CONCLUSION**

- Retarded injection timing of 27° BTDC resulted in better engine performance compared to 19° BTDC and 23° BTDC for Dairy Scum Oil Methyl Ester (DSOME). Retarding the injection timing favors engine performance in terms of increased BTE and reduced emissions.
- Increased injector opening pressure of 240 bar and Five hole nozzle injector of 0.3 mm size resulted in overall better engine performance with increased brake thermal
efficiency (BTE) and reduced HC, CO, smoke emissions. Increasing beyond 240 bar negates delayed injection with reduced engine performance.

- Biodiesel of DSOME were found to be more feasible and can be used in the existing diesel engine without major modification. However increasing injection pressure more than 205 bar and increasing the number of holes in the injector, performance closer to diesel engine operation can be obtained.

* * *

12. PRODUCTION OF BIODIESEL FROM SEMECARPUS ANACARDIUM (BIBA) SEED OIL AND PERFORMANCE STUDY ON CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_062

COLLEGE : AMRUTA INSTITUTE OF ENGINEERING AND MANAGEMENT SCIENCES
BRANCH : MECHANICAL ENGINEERING
GUIDES : MR. RAMESH N
STUDENTS : MR. PRAVEEN KUMAR,
MR. CHANDAN C,
MR. ESHWARA A.K.,

INTRODUCTION
Fossil fuels are currently the dominant global source of CO₂ emissions and their combustion is stronger threat to the environment. Increasing of the industrialization, energy demand, limited reserves of fossil fuels and increasing environmental pollution have jointly necessitating the exploring of some alternative to the conventional liquid fuels, vegetable oils (edible and non-edible oil) have been considered as appropriate alternatives to the conventional liquid fuels, vegetable oils have been considered as appropriate alternative due to their prevalent fuel properties. It was thought of as feasible option quite earlier. However despite the technical feasibility, vegetable oils as fuel could not get acceptance, as they were more expensive than petroleum fuels. This led to the retardation in scientific efforts to investigate the further acceptability of vegetable oils as alternate fuels. Later, due to numerous factors as stated above created resumed interest of researchers in vegetable oils as substitute fuel for diesel engines. In view of the potential properties, large number of investigation has been carried out internationally in the area of vegetable oils as alternate fuels. Some of the vegetable oils from farm and forest origin have been identified. India imports the petroleum products at an annual cost of 50 billion USD in the year 2012-2013. Just by replacing 5% of petroleum fuel by bio fuel could enable India to save 2.5 billion USD. According to latest documents from April 2013-Feb 2014 got an import of 57335.97
million USD but from April 2014-Feb 2015 got an import of 53739.04 million USD. We come to know that the demand of import of petroleum products decreased by 6.27%.

**METHODOLOGY**

Transesterification is a chemical reaction used for the conversion of vegetable oil/Seed oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of a catalyst like NaOH. After the chemical reaction, various components of vegetable oil break down to form new compounds. The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If methanol is used in the chemical reaction, methyl esters are formed, but if ethanol is used, then ethyl esters are formed. Both these compounds are Biodiesel fuels with different chemical combinations. In the chemical reaction alcohol replaces glycerine. Glycerine that has been separated during the transesterification process is released as a by-product of the chemical reaction. Glycerine will either sink to the bottom of the reaction vessel or come to the surface depending on its phase. It can be easily separated by centrifuges, and this entire process is known as transesterification.

**Different Properties Studied**


**RESULTS AND DISCUSSION**

The experiments were conducted on a direct injection compression ignition engine for different brake power and different blends (Biodiesel-B10, B20, B30 and B100) of biodiesels. Analysis of performance like brake specific fuel consumption, brake thermal efficiency, Exhaust gas temperature and emission characteristics like hydrocarbon, oxides of nitrogen, carbon monoxide and carbon dioxides are evaluated. The biodiesel used is as per ASTM standard, there is no modification in the engine. The experiment is carried out at constant compression ratio of 17.5:1 and constant injection pressure of 200bar by varying brake power.

**CONCLUSION**

- SAOME satisfies the important fuel properties as per ASTM specification of Biodiesel.
- The existing petro-diesel engine performs satisfactorily on biodiesel fuel without any significant engine modifications.
- Most of the major exhaust pollutants such as HC are reduced with the use of biodiesel and the blend as compared to petro-diesel. But NOX emissions increase when fuelled with petro-diesel. Biodiesel fuel blends as compared to petro-diesel fuel. This is one of the major drawbacks of biodiesel.

**SCOPE OF FUTURE WORK**

Some aspects are identified with the present work, and are presented below.

- Biodiesel production technology needs further study in the aspects of elimination of biodiesel purification process by using newly developed heterogeneous base catalyst like, Zeolites, MgO and ZnO etc instead of homogeneous catalyst (H2SO4& NaOH).
- The properties of blend may be further improved to make use of higher percentage of Semecarpus Anacardiumoil in the blend by preheating the blend.
- Further study of low volatility of Semecarpus Anacardiumoil need to be investigated to know the effect on engine.

*～*～*
13. PERFORMANCE EVALUATION OF CARBON NANO TUBE (CNT) BLENDED SIMAROUBA BIODIESEL IN CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_013

COLLEGE : CANARA ENGINEERING COLLEGE
BRANCH : MECHANICAL ENGINEERING
GUIDE : PROF. PARAMASHIVAIAH B.M
STUDENTS : MR. DHEERAJ POOJARY
           MR. ALEN RICKSON CRASTA
           MR. ARUN KUMAR
           MR. CHETHAN KINI

INTRODUCTION
The most harmful effect of our present day civilization is global warming and environmental pollution. With rapid industrialization and urbanization we are also making our planet unsafe for us and for the generations to come. The vehicle population throughout the world is increasingly rapidly. In India the growth rate of automotive industry is one of the largest in the world. It is quite evident that the problem cannot be solved with the conventional fossil fuels however stringent the emission control norms may be. The consumption of diesel fuels in India is 28.30 million tonnes which is 43.2% of the consumption of petroleum products. The requirement was met by importing crude petroleum as well as petroleum products. With the expected growth rate of diesel consumption of more than 14% per annum, shrinking crude oil reserves and limited refining capacity, India will be heavily dependent on imports of crude petroleum and petroleum products.
There are several alternative sources of fuel like vegetable oils, biogas, biomass, primary alcohols which are all renewable in nature. Among these fuels, vegetable oils appear to have an exceptional importance as they are renewable and widely available, biodegradable and non-toxic and environment friendly. In a country like India it is observed that biodiesel can be a viable alternative automotive fuel. Unlike fossil fuels, biodiesel is a renewable source of energy, because it comes from biological sources like plants and animals which can be replenished by farming. On the other hand, fossil fuels come from underground deposits of hydrocarbons which cannot be renewed. Biodiesel is a fastest growing alternative fuel and India has better resources for its production the vegetable oils cannot be used directly in diesel engines as alternative fuel because of high viscosity of vegetable oils leads to problem in pumping and spray characteristics. The best way to use vegetable oils as fuel in diesel engines is to convert it into incomplete combustion. It is a fact that biodiesel is a safer, more economical and infinitely more environmentally friendly than the conventional petroleum diesel that the majority of people currently use.
Rapid socio-economic changes in some developing countries like ours (India), China, etc, are influencing dramatically the fuel consumption pattern world over. In India Approx 6600 crore liter of diesel is burnt annually. One should remember that one litre of diesel emits approx 3.0 Kgs of CO$_2$ emissions. Thus India emits approximately 20,000 crore of tones of carbon dioxide annually. Diminishing world petroleum reserves and the impact of environmental pollution of increasing exhaust emissions lead to search for suitable alternative fuels. Today the prime mover used for heavy duty machines are the engines, the
efficiency of the engine is improved by reducing the fuel consumption rate or effectively utilizing the fuel. This work deals with an innovative method to improve the engine performance and emission of biodiesel + nanoparticles fuel. **Simarouba**: Simarouba belongs to the family Simaroubaceae Quasia. It had also been known as paradise tree, Laxmi taru, Acetuno, a multipurpose tree that can grow well under a wide range of hostile ecological condition. Its origin is native to North America, now found in different regions of India. It is a medium sized tree generally attains a height about 20m, trunk diameter approximately 50 – 80 cm and life about 70 years. It grows under a wide range of agro climatic conditions like warm, humid and tropical regions. Its cultivation depends upon rainfall distribution (around 400 mm), water holding capacity of the soil and sub-soil moisture. It is suited for temperature range 10 – 40 0C, pH of the soil should be 5.5–8. It produces bright green leaves 20-50cm length, yellow flowers and oval elongated purple colored fleshy fruits. Its seeds contain about 40 % kernel and kernels content 55 -65% oil. The amount of oil would be 1000 – 2000 kg/ha/year for a plant spacing of 5m x5m. It was used for industrial purposes in the manufacture of soaps, detergents and lubricants etc. The oil cake being rich in nitrogen (7.7 to 8.1%), phosphorus (1.07%) and potash (1.24%) could be used as valuable organic manure. Simarouba is a rich source of fat having melting point of about 290°C. The major green energy components and their sources from Simarouba are biodiesel from seeds, ethanol from fruit pulps, biogas from fruit pulp, oil cake, leaf litter and thermal power from leaf litters, shell, unwanted branches etc. **Carbon Nano Tubes**: Carbon nanotubes have been attracting great interest due to their wide scope of possible applications, such as composite reinforcement material, hydrogen containers, field emission sources, super-capacitors, molecular sensors and scanning probe tips. Offering attractive mechanical/electric/thermal properties, carbon nanotubes could constitute a model system for evaluation of the potential to achieve a significant improvement in bulk properties by adding nanoscale modulators at low weight percentage. In the following section, the structure, main characteristics and entanglement of CNTs are discussed in detail. **OBJECTIVES OF THE WORK** Main objective of the work is to prepare stable dispersion of CNT in Simarouba Methyl Ester diesel blend (SME20) Biodiesel blend and investigation of engine Performance. The objective of the research includes: 1. Optimization of SDBS dispersant Quantity for Stable Dispersion of CNT in SME20 biodiesel. 2. To conduct extensive Test on CI Engine to find Performance Characteristics like • Brake thermal efficiency (BTE). • Specific fuel consumption (SFC). **METHODOLOGY** The experimental investigations will be carried out in 2 phases. 4.1 Phase 1- Fuel preparation &Modification: Simarouba biodiesel SME is Prepared by Transesterification of Simarouba vegetable oil. Bio diesel blend (SME20) is prepared with dosing levels mass fractions 20ppm, 40ppm, 60ppm of CNT dispersed in the SME20. 4.2 Phase 2 - Engine Test: Extensive tests will be conducted on a single cylinder CI engine, at injection Timing 23°btdc. Injection pressures 200, 230 bar and various loads of 20, 40, 60 & 80% of full load to evaluate the Performance characteristics. **Phase 1**: Fuel preparation & Modification: In the first phase, fuel is prepared and modified as explained below. • Preparation of Simarouba oil. • Transesterification and preparation of SME biodiesel. • Testing of fuel Properties of SME biodiesel. • Preparation of the blend with petro diesel. • Stable dispersion of CNT in the fuel blend.
• Characterization of dispersed fuel.
• Preparation of final fuel for engine test.

**EXPERIMENTAL DETAILS:**
The engine tests were performed on a single cylinder four stroke air-cooled CI engine. The performance test is initially carried out using diesel fuel. Subsequently the tests are conducted using SME20 biodiesel blend and nanoparticle added SME20 biodiesel blend. The experiments are carried out in two phases. In the first phase, the nanofuels with different dosage level are prepared and various physicochemical properties of the modified nanofuels were determined and compared with those of the base fuels (SME20). In the second phase, extensive engine tests were conducted using nanofuel blends of SME2020, SME2040 and SME2060 to determine performance characteristics.

* ~ * ~ *

**14. PERFORMANCE TEST ON A CI ENGINE USING THE BIO- DIESEL EXTRACTED FROM TERMINALIA-CATAPPA SEEDS**

**PROJECT REFERENCE NO.: 39S_B_BE_060**

**COLLEGE** : GM INSTITUTE OF TECHNOLOGY

**BRANCH** : MECHANICAL ENGINEERING

**GUIDES** : DR. GANESH D.B.

**STUDENTS** : MS. ROOPA T.

MS. LAKSHMI D.J.

MS. MADHUSHREE A.H.

MS. NAYANA KUMARI M.C.

**INTRODUCTION:**
World energy crisis has become the foremost crucial topic in this new era. Unstable price of petroleum fuel in the world market and recent environmental concerns on gas emission during combustion have led to intensive search for alternative energy sources that are not only renewable but sustainable. Without doubt, one of the most important evolutions in the renewable energy sector is the development of biodiesel.

Biodiesel has better properties than that of petroleum diesel such as renewable, biodegradable, non-toxic, and essentially free of sulphur and aromatics. Biodiesel fuel has the potential to reduce the level of pollutants and the level of potential or probable carcinogens stated that Biodiesel has become more attractive recently because of its environmental benefits and fact that it is made from renewable resources. However, the bottleneck to produce biodiesel in commercial scale is the high cost of edible virgin oil, in which account for more than 70% of the overall biodiesel production cost. In addition, using edible virgin oil such as rapeseed, sun flower, soybean and palm oil in biodiesel production has raised the concern of food versus fuel debate. Thus, recent biodiesel development has shifted to use non-edible and waste oil as a new and sustainable feedstock for long term production. It is strongly believed that using these oils will help in
improving economic feasibility of biodiesel and minimize the hurdle of food versus fuel phenomena.

Rudolf Diesel, the inventor of diesel engine, is the first who used peanut oil as alternative fuel for diesel engine at the 1900 world exhibition in Paris. Speaking to the Engineering Society of St. Louis, Missouri, in 1912, Diesel said, “The use of vegetable oils for engine fuels may seem insignificant today, but such oils become in course of times as important as petroleum and the coal tar products of present times”. However the undesirable injection problems caused by the higher viscosity of neat vegetable oils were the main obstacles in their use as alternative fuel. This issue has been resolved by using some suitable techniques like dilution, pyrolysis, transesterification, preheating and emulsion to get methyl esters of such oils. These methyl esters of animal or vegetable oils are called biodiesel, and are being investigated for use as fuel for modern diesel engines due to their cleaner burning tendency and environmental benefits.

Currently commercial biodiesel production is using methanol (non-renewable) as the main reactant to produce biodiesel due to its wide availability and low cost.

**OBJECTIVES:**

- To extract the oil from the *Terminal catappa* plant seeds.
- Measuring the free fatty acid content in the raw oil and converting the extracted oil to Bio-Diesel by Transestrification of the properties of *Terminal catappa methyl ester* (TCME) like density, viscosity, flash point, fire point and calorific value.
- Running a CI engine using the bio diesel extracted from TCME.
- Determination Additive at different injection pressures in order to evaluate their performance in regard to brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature. These parameters were also to be determined for CI engine operation with neat diesel fuel for the comparison.
- Studying the effect of TCME bio-diesel blends with Additive on the performance and emission characteristics to determine the best blend.
- Biodiesel in the coming years may face competition from non-ester renewable diesel fuels

**METHODOLOGY:**

- Vegetable oils and animal fats are principally composed of Triacylglycerol’s (TAG) consisting of long chain fatty acids chemically bound to a glycerol (1, 2, 3-propanetriol) backbone.
- The chemical process by which biodiesel is prepared is known as the transesterification reaction, which involves a TAG reaction with a short-chain monohydric alcohol normally in the presence of a catalyst at elevated temperature to form Fatty Acid Alkyl Esters (FAAE) and glycerol.

\[
\text{Catalyst} \quad \text{Triglycerides} \quad \text{Alcohol} \quad \text{Alkyl Esters (Biodiesel)} \quad \text{Glycerol}
\]

- Three moles of biodiesel and one mole of glycerol are produced for every mole of TAG that undergoes complete conversion.
- The cleaned seeds were milled to powder by grinding, with grinding machine. All chemicals and reagents used for this extraction work were of analytical grades.
- 1000ml *Terminalia catappa* seed oil is taken in round bottom flask.
- Prepare the solution of potassium meth oxide and add to the round bottom flask containing *Terminalia catappa* seed oil.

- Continuously stirred for 60 minutes with constant heating (70 to 800c).

- Mixture is fed it in to the separating flask. This allows the separation of ester and glycerin in to two different layers.

- The top layer which is separated is biofuel and bottom layer is glycerin which can be used manufacture of detergents.

**EXPECTED OUTCOME OF THE PROJECT**

- Bio diesel is alternative fuel even though alter fuel we are not able to use it completely for all our requirements because of shortage of raw materials to produce the biodiesel hence there is a need for search of various raw material available in nature

- We are introducing a pool of new seed for production of bio diesel plant.

- The variation of brake thermal efficiency at various loads. The brake thermal efficiency slightly increases with increasing load. Among the blend B20 shows improved brake thermal efficiency than the other blends and diesel.

- The specific fuel consumption decrease with increase in load among the blend B20 shows same fuel consumption at initial load and increase at next load compare to diesel.

- Engine performance of biodiesel and their blends are similar to those of diesel fuel. Performance of diesel engines varies with composition of blend used.

**APPLICATION OF THE PROJECT**

- Producing hydrogen for fuel cell vehicles.

- Cleaning up oil spills, tool and grease.

- Generating electricity.

- Heating your home.

- Cooking and illumination.

- Adding lubricity to diesel fuel.

- Removing paint and adhesives
15. DEVELOPMENT OF TABLE TOP BIOGAS UNIT

PROJECT REFERENCE NO.: 39S_B_BE_014

COLLEGE : GLOBAL ACADEMY OF TECHNOLOGY, BANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. POORNACHANDRA
STUDENTS : MS. POOJA J.
            MS. CHITRA H.N.
            MS. SANGEETHA

INTRODUCTION:
The primary goal of the present project work is to produce bio gas in order to supplement Liquid Petroleum Gas used for cooking purpose. The natural gas produced by this way can be enough to provide cooking fuel. Food waste from every house which is thrown will be collected as a raw material for the production of bio gas following anaerobic digester system. The anaerobic digestion of kitchen waste produces primarily methane (CH4) which can be used as bio fuel. Producing of methane cooking gas from the waste and compost was practiced by years in remote locations and farms around the world. Biogas production is a tricky business dependent on keeping temperamental micro-organisms alive and in perfect balance to keep the gas flowing. Environmentalists are turning to biogas as a means to help farmers stop the flow of runoff into rivers and to make power and fertilizer in a green way.

Keywords: Kitchen waste, Fermented food particles, Bio gas.

OBJECTIVES:
The primary objective of the project is to utilize Kitchen waste collected from different sources as feedstock for our reactor which works as anaerobic digester system to produce biogas energy.

METHODOLOGY
The anaerobic digestion method followed to create high-quality renewable fuel, and reduce carbon dioxide & methane emissions using Kitchen food waste. The table top digester of 2600ml capacity is connected in series will be used for the experimentation. Measured quantity of fresh cow dung will be added to the calculated percentage of water thoroughly by hand or with the help of stirrer. The kitchen waste is added to cow dung slurry to develop our own Inoculum at different percentages. Variety of kitchen waste will be cut in to different sizes will be used during the study. The kitchen waste is grinded in order to get in the form of paste, so that fermentation process happens faster. Different sizes of kitchen wastes are subjected to the fermentation process and the rate of fermentation will be studied with respect to the size of particles and the type of waste used separately and analyzed. After analysis the type of kitchen waste which produces biogas faster is considered for the final experimentation and evaluated for the purpose for which it is meant for.
Figure 1: The arrangement of table top digester of 2600ml capacity is connected in series. The Figure 1 shows the experimental setup of biogas unit which is to be fabricated. It consists of 8 biogas generators connected in series and this series is connected to biogas storage and biogas storage is connected to stove as shown in Figure 1.

Figure 2: Mixing of ragi ball, rice and sambar with 5% cowdung slurry

Figure 2 shows the preparation of ragi ball, rice and sambar with 5% cowdung slurry in order to generate biogas.

- Raw materials which can be used here are cooked rice, cooked ragi, leftover sambar etc
- Cow dung (5%+water) is also used to prepare slurry.
- The raw materials required are left over cooked rice, cooked ragi, sambar and they are procured from household kitchen, hotels.

Figure 3: Final Biogas Unit
Figure 3 shows the table top biogas digester, which decomposes organic matter into methane, carbon dioxide and sludge and hence required and biofuel is obtained as an alternate to LPG which can be extensively used for domestic cooking purposes. As biogas offers benefits when compared to LPG

- Reduces pollution
- Reduces reliance on fossil fuels
- Lowers fuel import bill
- Saves on the environment (Reduces deforestation)
- Improves living standards in rural areas.
- Produces good quality enriched manure to improve soil fertility.
- Improving the hygienic conditions.

WASTE MANAGEMENT

Now a days the problem of managing waste produced by the domestic houses, hotels have been rapidly increasing, this biogas production using waste from these places would be a prominent solution for managing the waste

OUTCOME OF THE PROJECT:

Table top biogas digester was fabricated for the generation of the biogas, the leakage test was conducted and proved that there was no leakage in the fabrication process. The decomposing of organic matter into biofuel and sludge has been achieved by following anaerobic digestion method. Thus the biofuel obtained is an alternative to LPG which can be extensively used for domestic cooking purposes.

* ~ * ~ *

16. FUEL OIL EXTRACTION FROM PYROLYSIS USING SOLAR ENERGY

PROJECT REFERENCE NO.: 39S_B_BE_004

COLLEGE : MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. C.R. RAJASHEKAR
STUDENTS : MR. PRAMOD B. PARIT
MR. SHARAT R. SHETTY
MR. WINSON R. D'SOUZA
MS. SITARA S.

INTRODUCTION

Pyrolysis is a thermo chemical decomposition of organic material at elevated temperatures in the absence of oxygen. It involves the simultaneous change of chemical composition and physical phase, and is irreversible. Solar energy is radiant light and heat from the Sun harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture and artificial photosynthesis. In our project we are using Scheffler dish as the source of harnessing the solar energy the Scheffler dish is made of number of mirror which will focus all the light on to a fixed focal point where the temperatures are about 500°C. This temperature is enough for the pyrolysis process, the
plastic filed inside the boiler, will get melt after reaching temperature about 120°C, later after reaching maximum temperature about 250°C, the liquid starts to evaporated, which will liberate some gases later this gases are been passed through the condenser which will cool them & convert into liquid fuel. After collecting the liquid fuel testing can be done to check the calorific value.

**Objective**
- Recycling of waste plastic
- Pyrolysis of waste plastic
- Using Solar Energy for Pyrolysis
- Alternative fuel
- Optimum utilization of Solar Energy

**Methodology**
The methodology is explained with flow chart as shown below-

**TEST RESULTS**: a bomb calorimeter will measure the amount of the heat generated when matter is burnt in a sealed chamber (bomb) in an atmosphere of pure oxygen gas. The advanced isothermal bomb calorimeter provides a simple inexpensive yet accurate method for determination of heat of combustion, calorific value and the sulphur content of solid and liquid fuels. The outfit supplied is complete for analysis as per methods recommended the
Observations

- Thread Diameter  \( D = 8\text{cm} \)
- Nichrome Wire Length  \( L = 7.5\text{cm} \)
- Fuel sample weight  \( M = 0.9876 \text{ gm} \)
- Temperature Difference  \( T = 2.61 \text{ °C} \)
- Water equivalent  \( W = 2936 \text{ cal / °C} \)

Calculations

\[
W \quad \text{Water equivalent of the calorimeter assembly in calories per degree centigrade (2936 cal / °C)}
\]

\[
T \quad \text{Rise in temperature (registered by a sensitive thermometer) in degree centigrade}
\]

\[
H \quad \text{Heat of combustion of material in calories per gram}
\]

\[
M \quad \text{Mass of sample burnt in grams}
\]

Then \( W \cdot T = H \cdot M \)

“\( H \)” is calculated easily since \( W, T \) and \( M \) are known.

\[
H = \frac{W \cdot T}{M}
\]

\[
H = \frac{2936 \times (37.01 - 34.40)}{0.9876}
\]

\[
H = 7759 \text{ cal/gm.}
\]

Converting from cal/gm to KJ/kg We have,

\[
H = 32,485.38 \text{ KJ/kg}
\]

![Bomb Calorimeter Testing Unit Schematic Diagram](image)
CONCLUSION

The present study was conducted with one of most temperature sensitive process in industry using solar energy and the recyclable material plastic. This study also concludes that these types of innovative solar concentrators can open new landmarks in decentralized solar based systems. In addition, other benefits like reduction of fossil fuels consumption and global warming cannot be ignored. The study also suggests that such types of systems must be equipped with necessary mountings and instrumentations to monitor and control the desired output of the fuel and utilization of the same in the coming revolution.

The following key factors are highlighted during the development process of the project:

- Fuel extraction from waste plastic
- The project is environmental friendly
- Less complicated in construction
- Energy is abundant in nature, i.e., solar energy
- Lowest production cost when compared to other conventional methods
- Reduction in waste plastic
- Solar Setup can be used for other purpose like cooking.

The following are the limitations of the project:

- Due to the wind heat transfer may affect.
- Process can be done only on sunny day as solar energy is involved.
- Few toxic gases may arise, hence care should be taken during the process.

Scope of Project

- Utilization of plastic waste oil as alternative fuel for compression ignition engine has a great scope especially in Developing and undeveloped countries.
- Reduction of plastic waste in the environment.
- Reduction of greenhouse gases.

* ~ * ~ *

17. PERFORMANCE AND EMISSION CHARACTERISTICS OF IC ENGINE WITH CHICKEN FAT BIODIESEL

PROJECT REFERENCE NO.: 39S_B_BE_016

COLLEGE : REVA INSTITUTE OF TECH. AND MANAGEMENT, BANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : MR. VASANTHKUMAR K.L.
STUDENTS : MR. PRADEEP KUMAR V.
             MR. KARTHIK K.V.
             MR. MADHUSUDHAN G.E.

Introduction:

In 1895, Rudolf Diesel developed a new engine with the intention that it could use a variety of fuels, including vegetable oil (peanut oil), when he showcased it to the public at the 1900
in Paris. But the diesel engine became more widely adopted in subsequent years, because petroleum-based diesel fuel proved to be less expensive and became the fuel of choice. However in 21st century investigations on renewable energy resources are continuing extensively due to increasing dependence on petroleum products. Besides, the combustion of petroleum based fuels causes environmental problems, which threaten wild and human life. The global warming is caused of emissions like carbon monoxide (CO₂), sulphur dioxide (SO₂) and nitrogen oxides (NOₓ). Concerning environmental damage the transport sector has a clear responsibility. So many researches has been conducted in worldwide to these problems and found that Biodiesel is one of the most renewable energy sources for diesel engines. Biodiesels are produced from vegetables oils or animal fats having very long alkyl esters. However the vegetable oils and animal fats cannot be used directly in diesel engines due to their inappropriate properties such as longer molecule chains, lower vapour pressures, higher viscosities and higher flash points. These features cause poor atomization, poor vapour–air mixing, low pressure, and incomplete combustion and engine deposits. However, it is possible to reduce the viscosity and improving the physical features of both vegetable oils and animal fats through dilution, Pyrolysis, micro emulsion and esterification. Esterification is a kind of catalytic reaction in which oil or fat is reacted with alcohol to form esters (biodiesel).which can be used in conventional diesel engines without significant modifications.

Variety of vegetable oils are used in production of biodiesels. These esters have certain advantages such as lower viscosity, lower flash point, and higher vapour pressure and easier processing relative to animal fatty acid esters, but they are noneconomic and non-feasible due to their prohibitive cost. Furthermore, many vegetable oils used in the production of biodiesel are edible oils and hence are valuable and it leads to food shortages. On the other hand, Biodiesel may also be produced from fats, including inedible tallow, pork lard and yellow grease. These are in human food leads to health hazards. This is one of the reasons for their low cost. Besides, their high crenate number and heating values are close to the diesel fuel and their oxygen content make animal fats to have surplus advantages. Animal fats are highly viscous and mostly in solid form at ambient temperature because of their high content of saturated fatty acids. The high viscous fuels lead to poor atomization of the fuel and result in incomplete combustion. Transesterification and emulsification are two main solutions that have appeared as effective methods for using animal fats in diesel engine. Animal fat generated biodiesel offers a wide range of energy, environmental, and economic advantages as stated by Nelson and Schrock.

In this study, a substitute fuel for diesel engines was produced from waste chicken fat, collected from a local slaughterhouse during meat preparation process

OBJECTIVES
1) Estimate the raw material availability.
2) Converting the waste chicken fat in to crude oil.
3) Checking the crude oil thermal properties.
4) Converting the chicken fat crude oil in to biodiesel by following Transesterification, water washes.
5) Conducting the performance and emission test on the engine with pure diesel and with biodiesel blends.
6) Predicting the best performance biodiesel blend.

METHODOLOGY
Initially chicken fat was heated to 100°C for 1 hour after converting in to crude oil the sediments and impurities were removed using filter. Then the properties of the fat were determined. Oils or fats having FFA content more than 3% is difficult convert as Bio diesels using base or alkaline esterification alone. So it has to undergo pre-treatment called as Acid esterification followed by the Base esterification.

Then the final bio diesel sent for water wash. The purpose of water wash is to remove un-reacted alcohol, catalyst, or glycerine in the biodiesel. Un-reacted alcohol decreases the flashpoint of biodiesel. Biodiesel with 0.2% alcohol does not meet ASTM fuel standards.
Water wash reduces alcohol levels below 0.2% and also remove any soap or gel in the biodiesel. Mixture separated and formed two layers, at bottom milky water and biodiesel at the top. Then bio diesel is separated and same procedure was repeated about 4 to 5 times, to remove all the glycerine.

POSSIBLE OUT COMES
1) The biodiesel may be prepared successfully
2) The thermal properties of the prepared bio-diesel may comparable with diesel
3) The bio-diesel may give best performance when compared with that of diesel
4) The bio-diesel blend was best performing when compared with pure diesel, in terms of performance and emissions.

* ~ * ~ *

18. STUDY ON PERFORMANCE AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE USING VEGETABLE OIL BLENDED WITH BIODIESEL AS FUEL

PROJECT REFERENCE NO.: 39S_B_BE_017

COLLEGE : REVA INSTITUTE OF TECH. AND MANAGEMENT, BANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. SHARANAPPA GODIGANUR, MR. VEERBHADRAPPAPA TELGANE
STUDENTS : MR. NAGENDRA V.
MR. MAHESHWAR RAJU N
MR. PRAVEEN KUMAR C S
MR. SONAL K

Introduction:
India is having vast wastelands available for forest plantation. The proper propagation and cultivation of forest trees like Jatropha, honge, mahua and utilizing the same for producing bio diesel, our nation can change the backward and poor area into very prosperous and developing areas within a decade time. Non-edible oils can prove alternatives to edible oils for bio diesel production. Further, local growth associated in crushing and marketing encourages the entrepreneurs to start small industries to produce raw or finished goods. This is one of the factors that contribute to the concept of sustainable rural areas where environment and people are independent where India could be world lenders in supply of oil. According to a survey conducted in 2002, twelve most important and abundant non-edible oil-bearing trees produce 97 lakh tones of seeds per year, of which only 12% is utilized. These twelve species of trees are Neem, Mahua, Undi, Jatropha, Castor, Kusum, Pilu, Dhupa, Nahor, Kokum and Sal.

According to the estimate of the oil and gas journal, crude oil production is exited to reach a peak somewhere between 2010 and 2015 and from then it is eventually going to decrease. With this, crude oil will be expensive progressively until it becomes unaffordable while enforcing pressure on the import bill and increasing the import bill dully. Thus we need to look at other options as far as energy need is concerned. In Karnataka, the important
commercial non-edible oil yielding trees are Pongamia pinnata, Azadirachta indica, Madhuca longifolia and Schlichera oleosa, Garcinra indica, Coleophylun and many more. The oil obtained from such seeds is chiefly used for manufacture soaps, candles, paints, varnishes, linoleum, and lighting and for medicinal purposes.

Biodiesel, a diesel fuel substitute that can be made from a variety of oils, fats, and greases, is of interest to farmers for a number of reasons: It can provide an additional market for vegetable oils and animal fats; it can allow farmers to grow the fuel they need for farm machinery; and it can decrease U.S. dependence on imported oil since fuel feedstock can be grown domestically.

**Keywords:** Biodiesel, Vegetable oil, transesterification, performance.

**Objectives of the project:**

- To identify the source to collect the raw materials i.e. Pongamia oil
- Extraction of Pongamia oil.
- Production of biodiesel from Pongamia oil (transesterification).
- To blend the neat bio diesel with vegetable oil and obtain the various blends.
- To study the fuel properties such as calorific value, viscosity, flash point etc. of the blended fuel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends of vegetable oil and diesel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends of biodiesel and diesel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends vegetable oil and biodiesel samples.
- To compare the results of the performance and emission characteristics tests obtained for all the above blended fuels.
- To conclude that the diesel engine can also run with SVO blended with biodiesel up to 50% blend without any modification in engine.
- To successfully arrive at a conclusion and put light on future possibilities and scope in this particular sector.

**Methodology involved in project:**

The different stages of works are explained as follows:

**Stage 1: Extraction of Pongamia oil**

- The oil collected should be first purified by hand picking of coarse and floating impurities.
- It will be later heated to 100 °C to remove all its moisture contents and it will be strained which in turn filtered it. To obtain purified oil /clarified oil.
- Purified oil was used for experimentation.

**Stage 2: Free fatty acid test**

- 10ml of is propanol is taken in a flask.
- 3-4 drops of phenolphthalein indicator is added to propanol.
- 1 gram of Pongamia oil is then added to propanol and phenolphthalein indicator mixture.
- KOH (0.01) solution is allowed drop by drop to the Pongamia oil solution till the solution become pink for 5-10sec and then disappear.
- KOH (0.01) solution consumed to get pink color is noted down. Depending on the amount of KOH (0.01) consumed fatty acid present in the oil is decided.

**Stage 3: Production of Biodiesel by Transesterification Process**

Transesterification process was carried out for the purified scum by a 2 stage process depending upon the FFA Test results which involves
- Acid catalyzed Transesterification
- Base catalyzed Transesterification

**Acid catalyzed Transesterification**

Pongamia oil extracted from the pongamia seeds consist of high FFA contents which were causing the transesterification difficulty. This is a type of reaction that takes place in the presence of methanol (30%) and sulphuric acid (0.5%) at 60°C with constant stirring (500-600 RPM), helps in the separation of impurities which were dissolved in the methanol as an upper layer and oil in the lower layer. The oil is separated and taken for 2nd stage.

**Base catalyzed Transesterification**

The settled lower layer of the earlier stages having low FFA is used as a raw material for this stage. The product of earlier stages i.e. pure triglycerides is made to react with methanol (30%) and catalyst, KOH (11.22 gms) for 2.5 - 3 hours at 60°C with constant stirring rate. The lower portion containing glycerol and other impurities are removed and further excess of alcohol and other impurities present are removed by water wash process. The water wash product then heated above 110°C in order to remove the moisture content present in the POME.

**Stage 4: Testing for properties and Preparation of Blends**

- Testing for fuel properties like Density, Specific gravity, Viscosity, Calorific Value, Flash Point and Fire Point of i) Vegetable oil ii) Biodiesel
- For Standard fuel properties, the tests are conducted at Bangalore Test House Bangalore
- Blends such as B0,B10,B20,B40,B60and B80 are prepared for SVO & Diesel, Biodiesel & Diesel and blends B10,B20,B40 for SVO & Biodiesel and checked for layer formation

**Stage 5: Experimental works carried out**

Experimental works are carried out on single cylinder, 4-stroke, DI computerized diesel engine coupled with Eddy current Dynamometer, situated at our institution R&D Lab for performance and emission parameters of the engine. The exhaust emissions are measured using AVL DIGAS 444 gas analyzer. The Blends of different combinations of fuels are as follows.

- Different blends of Straight Vegetable oil (SVO) and Diesel
- Different blends of Biodiesel (MEOP) and Diesel
- Different blends of Straight Vegetable oil (SVO) and Biodiesel.

**Stage 5: Results and Conclusions**

The overall studies based on the production, fuel characterization, engine performance and exhaust emission of pongamia oil and its biodiesel blends of various combinations were successfully carried out. The following conclusions can be drawn:

- The production of pongamia biodiesel is a two stage transesterification process.
- The density of pongamia oil 940 kg/m^3 and density of biodiesel is 880 kg/m^3 which are more than fossil diesel 850 kg/m^3.
- The Calorific Value of pongamia oil is found to be 37590 KJ/Kg and the Calorific Value of pongamia biodiesel is found to be 38115 KJ/Kg. The calorific values of pongamia and its biodiesel are found to be less than the fossil diesel (43500KJ/Kg).
- The exhaust CO and HC emission for SVO with diesel, diesel with biodiesel are 33.73% and 40%, 16.9% and 26.66% respectively, lower than that of diesel at maximum load for maximum blend.
- The exhaust CO and HC emission for SVO with biodiesel are 37.5% and 47.33% lower than that of biodiesel at maximum load for maximum blend.
- The NOx emission for SVO with diesel, diesel with biodiesel are 14.47% and 38.8% respectively more than that of diesel at maximum load for maximum blend.
- The NOx emission for SVO with biodiesel are 26.3 % respectively more than that of biodiesel at maximum load for maximum blend.
• The BTE for SVO with diesel, diesel with biodiesel are 9.43% and 10.73% respectively lower than that of diesel at maximum load for maximum blend.
• The BTE for diesel with biodiesel for B20 blend having more efficiency of 12.51% which is more than that of diesel.
• The BTE for SVO with biodiesel are 11.52% lower than that of biodiesel.
• The BSFC for SVO with diesel, diesel with biodiesel are 15.16% and 14.06% respectively, more than that of diesel at maximum load for maximum blend.
• The BSFC for diesel with biodiesel is 9.41% more than that of biodiesel at maximum load for maximum blend.
• Emission value of CO and HC decreases as percentage of biodiesel increases in the blends.

Scope for future work

• The same studies can be done in future by varying the blends and also by adding additives to the SVO in order to reduce the viscosity and blending it with the biodiesel.
• There is a chance of pre-heating the SVO and blending it with the biodiesel and testing can be done.
• In future, one can carry out the same work studies on the C. I. D. I. engine by varying compression ratio, modifying fuel injection timing.
• Also, the increase or decrease in the fuel pressure and injection rate can be done to enhance the engine performance.

* ~ * ~ *

19. COMPARISION OF PERFORMANCE AND EMMISSION TESTS USING BIODIESEL FROM SIMAROUBA AND WASTE COOKING OIL IN CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_024

COLLEGE : RURAL ENGINEERING COLLEGE HULKOTI, GADAG
BRANCH : MECHANICAL ENGINEERING
GUIDES : PROF. SIDDESH N.
STUDENTS : MR. MANJUNATH B. SASI
MR. AVINASH A. HULIGOL
MR. JISHAAN D. SIRSANGI
MR. MANJUNATHA CHAVADI
INTRODUCTION:
The most harmful effect of our present day civilization is global energy production and supply, environmental concerns due to fossil fuels and the high price of petroleum products are the major reasons to search for alternatives to petrodiesel. The global supply global warming and environmental pollution, increasing uncertainty about of oil and natural gas from the convensional sources is unlikely to meet the growth in energy demand over the next 25 years, in this perspective, considerable attention has been given towards the production of biodiesel as a diesel substitute.

Objectives
- To determine the efficiency of a engine using biodiesel
- Blend ratios of diesel and waste cooking oil
- Blend ratios of diesel and simarouba oil
- To determine the properties of both biodiesels
- To compare the both performance test using simarouba oil and waste cooking oil
- To determine the both oils as alternate fuel using C I engine
- To compare both biodiesels with performance find the best alternate fuel among the two oils.

Methodology of simarouba
Simarouba belongs to the family simaroubaceae Quasia it had also been known as paradise tree, laxmi taru, acetone a multipurpose tree that can grow well under a wide range of ecological condition, its origin native is North America now found in different regions of India. It was a medium size tree generally height about 20m and trunk diameter approximately 50-80 cm and life is about 70 years. It will grow under a wide range of climatic conditions like warm humid and tropical regions for a temperature range of 10-400c for a melting point of 700c.

Experimental procedure for production of biodiesel (simarouba)
The main objective of study was to develop a process of producing biodiesel from simurouba glauca oil, the process mainly consist of transterification. Simarouba seeds we collected from different places in Karnataka and decorticated manually and the extraction of oil from simarouba cannel was done by using mechanical expeller and solvent extraction by soxhlet apparatus using N-hexane as solvent. Generally the FFC value is half of Acid value. Hence the percentage of FFC simarouba glauca oil is 2.67.

Calculation of acid value:
It was amount of KOH required in milli mg to neutriliesed Free Fatty Acid present in one gram of oil expressed as acid value.
Acid value=(volume of N/10 KOH in ml runs down / weight of the oil sample in gm )*5.6
=5.34

Process of alkaline transesterification:
The apparatus was equipped with digital RPM controller with mechanical stir a digital temperature indicator had been used to measure reaction temperature.

Reaction process:
750 ml simarouba oil is taken in reactor the anhydrous KOH and Potassium methoxide in reactor were added to close reaction vessel and having a speed of 600 rpm, it has been observed that best yield was obtained with catalytic conditions of 1% KOH.

2 WASTE COOKING OIL (WCO)
Waste cooking oil has been an environmental problem in food factories converting the WCO into bio diesel will reduce this problem. Recycled waste cooking oil is harmful to health but its not environmental friendly the best solution is used for industrial purpose, namely to reproduced into biodiesel.
The term WCO refers to vegetable oil has been in food production and which is no longer viable for use WCO arises for many source the disposal of WCO can be problematic and disposal in correctly.
METHODALOGY FOR WASTE COOKING OIL

Feedstock waste cooking oil

It's recognized that the production of waste cooking oil will be the function of frying temperature and length of use as well as metal used for frying. In this experiment WCO are collected from a local factory in our city.

Free fatty acids

If FFA is less than 2% then it can be used directly to transesterification and while FFA is more than 2% it need to starts esterification process to reduce FFA. The acid value of waste cooking oil was determined in order to estimate free fatty acid and give an idea of how much acid catalyst list and methanol would be needed to push the acid esterification chemical towards methane esters production.

Processing in biodiesel

Biodiesel has two main stage processes. Separation was use to separate two layer between catalyse and oil. Washing process to produce the natural biodiesel and remove catalyse glycerol, soap and methanol.

1) Esterification: Esterification is one of the process in biodiesel. It works to reduced FFA if FFA is more than 2% acid catalyzed esterification process before the based catalyzed transesterification process will eliminate most of the pre fatty acid from the vegetable oil sulphuric acid (95-98%) is used by 1% in esterification process depend from waste cooking oil.

2) Separation process: Separation needed three hour to get the top methanol and bottom oil layers of biodiesel two layers could clearly be seen in the successful basic esterification biodiesel. This process is used to reduce free fatty acid until below 2%.

3) Transesterification: Transesterification process work as to reduce viscosity in biodiesel. This process can be directly used if FFA less than 2%. Sodium hydroxide was used as catalyst in this process. The reaction was carried out using 1% of catalyst concentration.

4) Washing: The top methyl ester layer was separated and removed from every production sample. The water washing process was then used on some of the biodiesel batches. Once separated from glycerine the biodiesel is sometimes purified by washing gently with warm water to remove residual catalyst or soaps, dried, and send to storage. This is normally the end of production process resulting in a clear amber yellow liquid with a viscosity similar to petro diesel.

* ~ * ~ *

20. PRODUCTION OF ETHANOL FROM LIGNOCELLULOSE FEEDSTOCK

PROJECT REFERENCE NO.: 39S_B_BE_075

COLLEGE : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. K.K. POORNESH
STUDENTS : MR. KARTHIK M.J.
INTRODUCTION

BIOETHANOL: Ethyl alcohol is produced by chemical synthesis and by fermentation or biosynthetic processes. Pure ethanol is colorless, limpid, volatile liquid which is flammable and toxic and has a burning taste. It boils at 78.4 °C and melts at -112.3 °C, has a specific gravity of 0.7851 at 20 °C, and is soluble in water and most organic liquids.

Ethanol is isomeric with DME (Di-Methyl-Ether) and both ethanol and DME can be expressed by the chemical formula C₂H₆O. Although, they may have the same physical formula, the thermodynamic behaviour of ethanol differs significantly from that of DME on account of stronger molecular association via the hydrogen bonds in ethanol.

Keywords
Bio-ethanol, pretreatment, hydrolysis, fermentation, dehydration, gas-chromatography, idoform test, total carbohydrate, sugar reduction

OBJECTIVES
Following are made as the objectives of our present study:

- Identification of lignocellulose substrate
- Pre-treatment of the identified lignocellulose biomass
- Scarification of biomass to convert cellulose to cellulose
- Fermentation of the treated biomass
- Distillation of the fermentation broth to collect bio-mass

METHODOLOGY

Pretreatment ↓

Hydrolysis ↓

Fermentation ↓

Distillation

Pre-treatment and Hydrolysis Process:

Pre-treatment of biomass under acidic conditions

This process involves the treatment of lignocellulose biomass with different acids such as sulphuric acid, oxalic acid, per acetic acid, respectively. Dilute acid treatment is considered as a cheap and effective pre-treatment method due to low cost and easy availability of acids (Kim et al. 2005). Acid treatment is carried out in the presence of high and low concentrations of acids, and at high and low temperatures. At high temperatures, pre-treatment of biomass is performed at temperature greater than 160 °C in continuous process containing a low concentration of biomass (5–10 % substrate concentration). In general, dilute sulphuric acid is sprayed on raw biomass and incubated at 160–220 °C for few
minutes (González et al. 1986). At high temperature (160–220 °C), hemicellulose gets hydrolysed, releasing monomeric sugars and soluble oligomers from the cell

**Fermentation process:**
Here, sucrose gets converted into ethanol by using fermentation process.

\[
\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{O} \xrightarrow{\text{Invertase}} \text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6
\]

\[
\text{C}_6\text{H}_{12}\text{O}_6 + \text{H}_2\text{O} \xrightarrow{\text{Zymase}} \text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2
\]

**Distillation**
Distillation is a process of separating the component substances from a liquid mixture by selective evaporation and condensation. Distillation may result in essentially complete separation (nearly pure components), or it may be a partial separation that increases the concentration of selected components of the mixture. In either case the process exploits differences in the volatility of mixture's components. In industrial chemistry, distillation is a unit operation of practically universal importance, but it is a physical separation process and not a chemical reaction.

**RESULT:**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>INITIAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.373</td>
<td>0.53</td>
</tr>
<tr>
<td>0.4</td>
<td>0.73</td>
<td>0.67</td>
</tr>
<tr>
<td>0.6</td>
<td>0.905</td>
<td>0.75</td>
</tr>
<tr>
<td>0.8</td>
<td>0.991</td>
<td>0.82</td>
</tr>
<tr>
<td>1</td>
<td>1.638</td>
<td>1.13</td>
</tr>
<tr>
<td>SB 50</td>
<td>0.681</td>
<td>0.116</td>
</tr>
<tr>
<td>SB 20</td>
<td>0.661</td>
<td>0.20</td>
</tr>
<tr>
<td>SE 50</td>
<td>0.352</td>
<td>0.772</td>
</tr>
<tr>
<td>SE 20</td>
<td>1.750</td>
<td>0.259</td>
</tr>
<tr>
<td>WB 50</td>
<td>1.870</td>
<td>1.143</td>
</tr>
<tr>
<td>WB 100</td>
<td>1.80</td>
<td>1.239</td>
</tr>
<tr>
<td>CS 50</td>
<td>0.575</td>
<td>1.037</td>
</tr>
<tr>
<td>CS 100</td>
<td>1.474</td>
<td>0.857</td>
</tr>
<tr>
<td>GN 100</td>
<td>1.550</td>
<td>0.209</td>
</tr>
<tr>
<td>GN 200</td>
<td>0.533</td>
<td>0.505</td>
</tr>
</tbody>
</table>

**Sugar Reduction @ 540 mm OD**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>INITIAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.373</td>
<td>0.53</td>
</tr>
<tr>
<td>0.4</td>
<td>0.73</td>
<td>0.67</td>
</tr>
<tr>
<td>0.6</td>
<td>0.905</td>
<td>0.75</td>
</tr>
<tr>
<td>0.8</td>
<td>0.991</td>
<td>0.82</td>
</tr>
<tr>
<td>1</td>
<td>1.638</td>
<td>1.13</td>
</tr>
<tr>
<td>SB 50</td>
<td>0.681</td>
<td>0.116</td>
</tr>
<tr>
<td>SB 20</td>
<td>0.661</td>
<td>0.20</td>
</tr>
<tr>
<td>SE 50</td>
<td>0.352</td>
<td>0.772</td>
</tr>
<tr>
<td>SE 20</td>
<td>1.750</td>
<td>0.259</td>
</tr>
<tr>
<td>WB 50</td>
<td>1.870</td>
<td>1.143</td>
</tr>
<tr>
<td>WB 100</td>
<td>1.80</td>
<td>1.239</td>
</tr>
<tr>
<td>CS 50</td>
<td>0.575</td>
<td>1.037</td>
</tr>
<tr>
<td>CS 100</td>
<td>1.474</td>
<td>0.857</td>
</tr>
<tr>
<td>GN 100</td>
<td>1.550</td>
<td>0.209</td>
</tr>
<tr>
<td>GN 200</td>
<td>0.533</td>
<td>0.505</td>
</tr>
</tbody>
</table>
From above graph, it indicates that sugar cane extract contains the highest percentage of ethanol (11.9%).
CONCLUSIONS:
A Comparative analysis of different lignocellulose Substitute for bioethanol production was conducted, owing to be increasing importance of biofuel in the present energy scenario. The focus of biofuel in the present energy scenario. The focus was on to find a cheap and second grade organic substrate that would yield the highest percentage of ethanol. In our case its sugar cane extract which gives 11.9% of pure ethanol yield. Cost effectiveness was given higher importance from optimization. The growth indicate that sugarcane extract gives the highest percentage of ethanol by fermentation with saccharomyces. But this poses a exception of Biofuel vs food Security. The next promising substrate was found to be Groundnut shells, they are easily available as well as the percentage of ethanol obtained was feasible enough for mass production.

The identification of Lignocellulosic substrate is the first step in the production process. Next would be the optimization of ranges and condition for high yield culture growth in ethanol production.

currently the percentage of ethanol being blended with gasoline of diesel is 15%, with a further 5% increase proposed by the government in the following year. The future scope of this project would be to analyse the obtained ethanol for its fuel properties and designing an engine which would run purely on bioethanol. The advantages would be enormous, ranging from low fuel cost to zero pollution. But the downside would be the lower calorific value of the fuel.

* ~ * ~ *

21. ASSESSMENT OF BIO-OIL PRODUCTION FROM WASTE FISH FAT AND UTILISATION IN DIESEL ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_076

COLLEGE : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. MANOJ KUMAR A.P.
STUDENTS : MR. SHASHANKA P.
MR. UTHAMRAJ T. PUTHRAN

INTRODUCTION
What is BIODIESEL: Biodiesel is an alternative fuel similar to conventional or "Fossil “diesel. Biodiesel can be produced from straight vegetable oil animal oil/fats, waste cooking and fish oil. During recent years, fish wastes are considered as loss. Biodiesel production, manure composting, biogas production and burning of fish wastes to produce energy are different ways to utilize the fish waste in the world. Increasing demand for fissile fuels in the world, reduced fossil fuel's resources and pollution problems are the causes to introduce
alternative renewable resources. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petro diesel in any proportions. Biodiesel blends can also be used as heating oil. Diesel engine which uses bio-diesel as a fuel emits less amount of carbon dioxide and carbon monoxide than the conventional petro diesel. And also oxygen content in bio-diesel is more. Almost all biodiesel is produced using base catalysed Trans-esterification as it is the most economical process requiring only low temperatures and pressures and producing a 98% conversion yield.

Fish oil is derived from the tissues of oily fish. Fish oil contains omega-3 fatty acid (DHA), precursors of certain eicosanoids that are known to reduce inflammation throughout the body, and are thought to have health benefits.

Keywords, Fish oil, Bio-Diesel, Trans-esterification, performance and Emission, diesel engine, Ostwald viscometer, hydro dynamic test, flash point and fire point

OBJECTIVES
Following are made as the objectives of our present study-
• Trans-esterification test to convert waste fish oil into a bio-diesel.
• Ostwald Viscometer test to find out the viscosity of the bio-diesel.
• Hydro dynamic test to find out density of the bio-diesel.
• To find flash and fire point of the bio-diesel.
• Conduct performance and emission characteristics of bio-diesel as well as pure diesel and compare their performance characteristics at two different fuel injection pressures.

METHODOLOGY:

Trans-esterification process:
This involves animal fats and oils being reacted with short-chain alcohols (methanol or ethanol). The greater conversions into bio-diesel can be reached using methanol. Although the trans-esterification can be catalyzed by acids or bases. The trans-esterification involves following steps-
1) Free Fatty Acid Test
2) Condensation
3) Separation
4) Water washing
5) Heating

**Characteristics of Bio-Diesel:**
- The viscosity of the bio-diesel is found out by using Ostwald viscometer.
- The flash and fire point experiment is conducted to find out the flash and fire point of the bio-diesel.
- Density of the bio-diesel can be found by using Hydro Dynamic Test.

**Blending of bio-diesel:**
The bio-diesel is blended with petro-diesel as the following proportions –
1) B10 (bio-diesel 100 ml and diesel 900 ml)
2) B20 (bio-diesel 200 ml and diesel 800 ml)
3) B30 (bio-diesel 300 ml and diesel 700 ml)

**Performance and Emission test in Diesel Engine**
The performance emission test of the bio-diesel blend is done using computerized single cylinder diesel engine test Rig. Using this apparatus the Brake power, specific fuel consumption, brakes thermal efficiency, volumetric efficiency can be found out. Using five gas analyzer the Carbon-monoxide, Carbon dioxide, Hydro carbon, oxygen, Nitrogen Oxide can be analyzed.

**RESULT:**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Diesel</th>
<th>Fish oil bio-diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>0.830</td>
<td>0.855</td>
</tr>
<tr>
<td>Flash point</td>
<td>54</td>
<td>164</td>
</tr>
<tr>
<td>Fire point</td>
<td>59</td>
<td>179</td>
</tr>
<tr>
<td>Kinematic viscosity at 40 degree</td>
<td>2.3</td>
<td>3.93</td>
</tr>
<tr>
<td>Calorific value</td>
<td>42800</td>
<td>36804</td>
</tr>
</tbody>
</table>

**CONCLUSIONS:**
- Biodiesel fuel is a renewable energy source unlike petroleum-based diesel.
- One of the main biodiesel fuel advantages is that it is less polluting than petroleum diesel.
- Biodiesel increases the combustion temperature thereby increasing the Break Thermal Efficiency.
- Another advantage of biodiesel is that it can also be blended with petroleum diesel, thereby reducing the consumption of diesel.
- It reduces the emission of Carbon Monoxide and Unburnt hydrocarbons.
- Biodiesel produces Glycerin as a byproduct which can be used as a cosmetic ingredient.
- NOx(Nitrous oxide) emissions increase significantly with the use of pure biodiesel in most of the tests conducted both on heavy duty engines and passenger car emissions.

**FUTURE WORK:**
- The performance and emission characteristics can be found at different compression ratios.
22. PRODUCTION AND OPTIMIZATION OF SIMAROUBA BIODIESEL USING RSM AND PERFORMANCE, COMBUSTION, EMISSION ANALYSIS ON CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_048

COLLEGE: SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR
BRANCH: MECHANICAL ENGINEERING
GUIDES: MR. ARUN S.B.
STUDENTS: MR. ANIRUDDHA R.
MR. TALAVARA MANJUNATHA
MR. SUMAN
MR. GUMMALLA HARISH

INTRODUCTION:
Energy is considered as a critical factor for economic growth, social development and human welfare. Since their exploration, the fossil fuels continued as the major conventional energy source with increasing trend of modernization and industrialization, the world energy demand is also growing at faster rate. To cope up the increasing energy demand, majority of the developing countries import crude oil apart from their indigenous production. This puts extra burden on their home economy. Hence, it is utmost important that the options for substitution of petroleum fuels be explored to control the burden of import bill.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Homogeneous catalysed Transesterification process</th>
<th>Heterogeneous catalysed Transesterification process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reaction is Very fast</td>
<td>Reaction is relatively slow</td>
</tr>
<tr>
<td>2</td>
<td>Reaction is 100% complete</td>
<td>Conversion is relatively poor</td>
</tr>
<tr>
<td>3</td>
<td>Catalyst dissolved in the reaction mixture</td>
<td>Catalyst does not dissolve in the reaction mixture</td>
</tr>
<tr>
<td>4</td>
<td>Purification is difficult</td>
<td>Purification is much easier</td>
</tr>
<tr>
<td>5</td>
<td>Biodiesel purification is by water washing</td>
<td>Biodiesel purification is by decalcification process</td>
</tr>
<tr>
<td>6</td>
<td>Catalyst cannot be recycled</td>
<td>Catalyst can be recycled and reused</td>
</tr>
<tr>
<td>7</td>
<td>Glycerin is pure and needs further purification.</td>
<td>Biodiesel and glycerin are obtained in pure form.</td>
</tr>
<tr>
<td>8</td>
<td>Process is cheaper</td>
<td>Catalyst synthesis procedures leads to high cost</td>
</tr>
</tbody>
</table>

**Methodology:**

- Simarouba seeds
- Mechanical expeller
- Raw oil
- Filtered oil
- Transesterification
- Bio-diesel
- Washing
- Drying
- Final bio-diesel

- Blending of bio-diesel with commercially available diesel at different ratios
- Performance study of that blends on CI engine

* ~ * ~ *
23. DEVELOPMENT OF DUAL FUEL ENGINE AND ITS PERFORMANCE AND EMISSION ANALYSIS

PROJECT REFERENCE NO.: 39S_B_BE_052

COLLEGE : SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE
BRANCH : MECHANICAL ENGINEERING
GUIDES : MR. MAHABOOBBASHA
STUDENTS : MR. MAHESH B.V.
           MR. SANTHOSH
           MR. A. PREM KUMAR
           MR. BHASKAR RAJ

Project descriptions:

Fuel consumption is increasing day by day and this gives rise to shortage to fuel as well as increases pollution. There is a need for alternative fuels to sustain the transport, run stationary engines etc. and it should also be environmental friendly. One such alternative fuel is biodiesel. Biodiesel can be blended with diesel up to 20% and can be used in diesel engine without any modification. For running the engine with biodiesel alone, there are engine modification required. Another alternative is making use of the dual fuel technology. In this technology we make use of compressed natural gas and diesel to run the engine. There is a remarkable reduction in the diesel consumption with better efficiency and performance.

Objectives of the project highlighting its importance:

a. To development of dual fuel engine.
b. To study the performance and emission characteristics of duel fuel engine.
c. To compare the performance and emission characteristics of diesel with Dual fuel engine (CNG as primary fuel and blends of Bio-diesel as pilot fuel).
d. Energy security by substituting of diesel with biofuels.

Methodology:

e. The engine is initially run as in diesel mode.
f. By modifying the existing diesel engine to operate in dual fuel engine with CNG as primary fuel and blends of biodiesel as pilot fuel.
g. Experiments are carried out at different loads in steps of 2 kg up to maximum limit.
h. Emission parameters like Unburned Hydrocarbon (UHC), CO, CO₂, particulate matters and NOx are noted down using Exhaust Gas Analyzer.

* ~ * ~ *
24. PRODUCTION AND PURIFICATION OF LIQUID FUEL FROM HOUSEHOLD PLASTIC WASTE FOR CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_032

COLLEGE : VSM INSTITUTE OF TECHNOLOGY, NIPANI
BRANCH : MECHANICAL ENGINEERING
GUIDES : PROF. SANTOSH K HULLOLI
STUDENTS : MR. MAHESH B KUTOLI
           MR. KALLAPPA S SHEGUNSHI
           MR. MITHUN A IMAGOUDANAVAR
           MR. AMIT S MALAJI

INTRODUCTION:
Plastics were invented in 1860, but have only been widely used in the last 30 years. Plastic are light, durable, modifyable and hygienic. Plastic are made of long chain of molecule called Polymers. Polymers are made when naturally occurring substance such as crude oil or petroleum are transformed into other substance with completely different properties. These polymers can then be made into granules, powders and liquids, becoming raw materials for plastic products.

Plastics have become an indispensable part of today's world. Due to their light weight, durability, energy efficiency, coupled with faster rate of production and design flexibility, these plastics are employed in entire gamut of industrial and domestic areas. Plastics are produced from petroleum derivate and are composed primarily of hydrocarbons but also contain additives such as antioxidants, colorants and other stabilizers. Disposal of the waste plastics poses a great hazard to the environment and effective method has not been implemented. Plastics are non-biodegradable polymers mostly containing carbon, hydrogen, and few other elements like nitrogen. Due to its non-biodegradable nature, the plastic waste contributes significantly to the problem of waste management. According nationwide survey which was conducted in the year 2000, approximately 6000 tones of plastic were generated in India, and only 60% of it was recycled, the balance of 40% could not be disposed off. Today about 129 million tones of plastics are produced annually all over the world, out of which 77 million tones produced from petroleum.

In India alone, the demand for the plastics is about 8 million tones per year. More than 10,000 metric tones per day plastics are produced in India and almost the same amount is imported by India from other countries. The per captia consumption of plastics in India is about 3kg when compared to 30kg to 40kg in the developed countries. Most of these come from packaging and food industries. Most of the plastics are recycled and sometimes they are not done so due to lack of sufficient market value. Of the waste plastics not recycled about 43% is polyethylene, with most of them in containers and packaging.
OBJECTIVES

This project attempts to show how human has been utilizing the energy and explore prospects of optimizing the same one of the alternative fuels is household plastic waste oil. Fuel obtained from pyrolysis process shows nearly same properties as that of diesel fuel. So we can use plastic oil as alternative fuel. The objectives of this project are given below.

- To collect the household plastic waste from different places.
- Drying and Storing of plastic waste.
- To develop and fabricate the pyrolysis unit to produce liquid fuel from plastic waste.
- Conversion of household plastic waste into liquid fuel.
- To purify the produced liquid fuel by water washing method.
- To conduct the different experiments to determine the different properties of liquid fuel.
- Compare the properties of liquid fuel with diesel fuel.

* ~ * ~ *
SYNOPSIS OF
M.SC., PROJECTS
1. EVALUATION OF BIOPESTICIDE PROPERTIES OF AZADIRACHTA INDICA SEED CAKE

PROJECT REFERENCE NO.: 39S_B_MSC_005

COLLEGE : MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN,
BENGALURU
BRANCH : BIOCHEMISTRY
GUIDES : DR. SUNEETHA P.
STUDENTS : MS. SYEDA MERAJ FATIMA
MS. AMRITHA SINGH
MS. MITU KUMARI KARN

INTRODUCTION
Agriculture has been facing the destructive activities of numerous pests like fungi, weeds and insects from time immemorial, leading to radical decrease in yields. Pests are constantly being introduced to new areas either naturally or accidentally, or, in some cases, organisms that are intentionally introduced become pests. Global trade has resulted in increased numbers of invasive non-native pest species being introduced to new areas. Controlling these invasive species presents an unparalleled challenge worldwide. Agriculture and forests form an important resource to sustain global economical, environmental and social system. For this reason, the global challenge is to secure high and quality yields and to make agricultural produce environmentally compatible. Chemical means of plant protection occupy the leading place as regards their total volume of application in integrated pest management and diseases of plants. But pesticide cause toxicity to humans and warm-blooded animals. Despite many years of effective control by conventional agrochemical insecticides, a number of factors are threatening the effectiveness and continued use of these agents. These include the development of insecticide resistance and use cancellation or de-registration of some insecticides due to human health and environmental concerns. Therefore, an eco-friendly alternative is the need of the hour. Improvement in pest control strategies represents one method to generate higher quality and greater quantity of agricultural products. Therefore, there is a need to develop biopesticides which are effective, biodegradable and do not leave any harmful effect on environment. There are number of biopesticides are currently in use. Biopesticides represent only 2.89% (as on 2005) of the overall pesticide market in India and is expected to exhibit an annual growth rate of about 2.3% in the coming years [1]. In India, so far only 12 types of biopesticides have been registered under the Insecticide Act, 1968. Neem based pesticides, Bacillus thuringensis and Trichoderma are the major biopesticides produced and used in India. Whereas more than 190 synthetics are registered for use as chemical pesticides. Most of the biopesticides find use in public health, except a few that are used in agriculture. Besides, i) transgenic plants and ii) beneficial organisms called bio-agents: are used for pest management in India. The phytochemical analysis and the insecticidal property of various parts of neem plant such as leaves, flower, and fresh fruits has been investigated so far but not much effort are made to validate the biopestisidal property of Neem seed cake extracts which is a low value by product of biofuel industries in future (Siddiqui et al., 2004; Siddiqui et al., 2003).

OBJECTIVE
- To evaluate the pesticidal properties of Azadirachta indica seed cake extracts
- To investigate the different phytochemical constituents present in the various extract
To investigate the larvicidal activity of different extracts

**METHODOLOGY**

**Collection of Neem seed cake:**
The Neem seed cake after procured from G.K.V.K. Biofuel Demonstration Center, Bangalore, it will be shade dried and further subjected to solvent extraction.

**Solvent extraction:**
The Neem seed cake will be extracted with different solvent systems which includes Petroleum ether, n-hexane, Methanol and Ethanol using Soxhlet extractor, the extract concentrated by evaporated using rota evaporator. The concentrated extract will be suitably diluted before use.

**Biopesticide activity:**
The 2nd-3rd instars larvae of Helicoverpa sps will be fed with varied concentrations of diluted neem seed cake extract and the mortality of the larvae will be monitored during the study.

**Phytochemical analysis:** The presence of various phytochemical constituents will be determined qualitatively by conduction different phytochemical reactions.

**Results and discussion:**
The neem seed cake was extracted by soxhlet method using various solvents including Petroleum ether, n-hexane, Methanol and Ethanol. The investigation of phytochemical composition these extracts revealed that terpenoids, carbohydrates and saponin were presence among all the extracts that were tested, where as protein was found to be positive for hexane methanol and ethanol extracts. The reducing sugar, flavanoids and steroids were found to be absent in all the extracts tested. The total phenol contents were quantified in the extract the results showed that methanol was found to be having high content of phenols (0.08 mg/g seed cake), the ethanol extract has 0.0575 mg/g, pet-ether extract has 0.05mg/g and comparatively lowest phenol was documented in hexane extract(0.03mg/g). The flavanoids contents were found to highest in methanol extract 0.32mg/g, in case of ethanol extract was found to be 0.209mg/g, the pet-ether extract accounts for 0.0864mg/g and hexane extract showed comparatively lowest flavanoid content 0.06mg/g.

The investigation of bioassay experiment of the various extracts revealed that ethanol extract (0.2mg) showed highest mortality (100%) over methanol extract which exhibited 93% mortality rate at 0.2 mg concentration (Table-1).

**Table-1: The rate of mortality of Helicoverpa larvae**

<table>
<thead>
<tr>
<th>Concentration of extract (mg/L)</th>
<th>Mortality (%) (Methanol extract)</th>
<th>Mortality (%) (Ethanol extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.025</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>0.05</td>
<td>24</td>
<td>31</td>
</tr>
<tr>
<td>0.1</td>
<td>76</td>
<td>85</td>
</tr>
<tr>
<td>0.2</td>
<td>93</td>
<td>100</td>
</tr>
</tbody>
</table>

Based on the above results we conclude that ethanol extract has greater potential to kill the pest larvae and thus one can selective extract herbal based pesticide and use of such biopesticide could be beneficial as it does not cause much to the environment.

* ~ * ~ *

2. ENHANCEMENT OF BIOETHANOL PRODUCTION BY IMMOLIZING OF HYDROLYTIC ENZYMES AND MARKER ASSISTED ANALYSIS BY RAPD METHOD OF AMMORPHOPHALUSSP

PROJECT REFERENCE NO.: 39S_B_MSC_013

COLLEGE  : GARDEN CITY COLLEGE OF SCIENCE AND MANAGEMENT STUDIES, BANGALURU
BRANCH : BIOTECHNOLOGY
GUIDES : DR. SARABJOT KAUR
STUDENTS : MR. PRAKASH M. BHUYAR
           MS. DEEPIKA DADHICH

Introduction
Fossil fuels are the major sources of energy but due to its rapid exhaustion and negative impact on environment forced human to explore for an alternative energy source. At present, about 100 million gallons of ethanol per year are used as a fuel, but 12 million gallons per year would be required to completely replace gasoline used. In this regard, our study aimed to produce bio-ethanol using *Amorphophaluscommutatus*, which is rich in starch and cellulose substrates. Furthermore, enhancement of the bio-ethanol production by immobilization of hydrolytic enzymes is studied and marker assisted analysis will be carried out.

Keywords: Ammorphophalus sp., Fermentation, Immobilization, Bioethanol, RAPD.

Objectives
- Collection of plant material from Western Ghats of Maharashtra.
- Extraction of enzymes and immobilization of hydrolytic enzymes by using *Aspergillusniger* and *Trichodrama*.
- Ethanol fermentation by using immobilized yeast spices.
- Distillation, calculation and comparative analysis of alcohol content obtained.
- Marker assisted analysis by using RAPD.

Methodology
a) Collection and pre-treatment of plant material
The plant materials were collected from Western Ghats, Dapoli and nearby places and used for alcohol production. Retreatment was done by 20% dilute sulphuric acid and distilled water. The pre-treated plant was then grinded in mixer and slurry was made with distilled water by 1:5 proportion. This slurry was then used for further studies.

b) Estimation of Starch by Anthrone reagent
**Materials:** Anthrone reagent (Dissolve 200 mg Anthrone in 100 ml ice cold 95% sulphuric acid, 80% ethanol, 52% perchloric acid, std. glucose (100 mg / 100 ml).

**Procedure:** 0.5 gmo of *Amorphophallustubers* was homogenized in hot 80% ethanol to remove sugars. Resides were washed repeatedly with hot 80% ethanol. To the residues, 5 ml water and 6.5 ml 52% (HClO₃) perchloric acid was added. Centrifuged and supernatant was taken. Extraction was repeated using fresh perchloric acid. Centrifuged and the supernatant was taken and make the volume 100 ml. Pipette out 0.1 or 0.2 ml supernatant and make the volume to 1 ml by water. Prepare standard by taking 0.2, 0.4, and 1 ml of
working standard make the volume 1 ml in each tube by D/W. Add 4 ml Anthrone reagent to each tube. Heat for 8 min. in boiling water bath cool rapidly and read intensity of green to dark green at 630 nm.

c) Estimation of reducing sugar by DinitroSalicylic Acid (DNSA) method

Materials: Dissolve 1 gm DNSA, 200mg crystalline phenol and 50 mg sodium sulphite in 100 ml 1% NaOH. (Store at 4°C). Procedure: 100 mg tuber powder was weighed, 5 ml 80% ethanol was added twice and supernatant was collected, evaporated it by keeping in water bath at 100°C. 10 ml water was added. Pipette out 0.5 ml of extract in test tubes and equalized the volume by 0.5 ml water. 3 ml of DNSA reagent was added later. The contents were heated in boiling water bath for 10 min. cooled and O.D. was measured at 540 nm. Similarly run the series of standard using glucose (100mg/100ml). Finally graph was plotted.

d) Hydrolysis

Hydrolysis of starch by using saccharification method the pre-treated slurry was taken in 6 different flask and different optimum conditions were maintained – Aspergillus+Trichoderma+pH6.5 /Aspergillus+Trichoderma+normal pH 3.0 , Temp 25ºC / Aspergillus+Trichoderma+N2 source( ammonium sulphate 12gm) / Aspergillus+pH6.5 / Aspergilus+normal pH3.0 , Temp 25ºC / Aspergillus+ N2 source( ammonium sulphate 12gm). Graph of before v/s after hydrolysis plotted

e) Fermentation

After saccharification filtration was done using muslin cloth and filter paper. Six conditions were maintained as before and inoculated with loop full culture of Saccharomyces cerevisiae. Incubation of 24 hrs in aerobic conditions is favourable for the growth of yeast cells at room temperature. Anaerobic conditions are provided to media for ethanol production.

f) Extraction, assay and partial purification of Enzymes

After hydrolysis hydrolytic enzymes were extracted from hydrolyzed slurry such as a sample was taken in a flask and mixed with citrate phosphate buffer (4.5) in 1:10 ratio then the enzyme activity was calculated as per formula and enzyme assay. Enzyme Activity = 1 unit of amylase activity (U) was defined as the amount of enzyme that liberated 1.0µmole of D-glucose from starch in 1.0µl reaction mixture under the assay conditions. After extraction process the enzyme was partially purified by salting out and dialysis which was further used for immobilization.

g) Immobilization of Hydrolytic Enzymes –

Immobilization was carried out by using 3 different matrixes. Sodium alginate beads – 2ml enzyme was incorporated in 150 ml sodium alginate sol. Beads were prepared in CaCl2 sol. Agar agar cubes – 2ml enzyme was added in 2% agar agar sol. after solidify cubes were cut. Gelatine cubes – 1.5 ml of enzyme in 20 ml of gelatine solution after solidify cubes were cut.

h) Hydrolysis with immobilized enzymes -

Hydrolysis of starch by using matrixes which are preapred with encapsulating hydrolytic enzymes. The pre-treated slurry was taken in 3 different flasks and each flask was inoculated with each matrix such as Gelatin matrix, Agar-agar matrix, Sodium alginate beads. The inoculated flasks were kept for hydrolysis

i) Fermentation By Immobilization Of Yeast Cells -

Immobilized yeast cells preparation - For the immobilization in beads 3% sodium alginate was dissolved in 0.10 litre water and added to 0.10 L suspension of saccharomyces cerevisiae in a beaker the solution was mildly shaken CaCl2 solution with the final concentration of 2% was prepared in a separate beaker. Fermentation - After saccharification process, the filtrate was added in three different flasks. The pretreated slurry was inoculated with immobilized cells of Saccharomyces cerevicesa encapsulated in alginate beads. As ethanol fermentation is an anaerobic process, it requires yeast Saccharomyces cerevisiae. So for fermention process, we use Saccharomyces cerevisiae. Then anaerobic conditions are provided to media for ethanol production. After that distillation was carried out by using soxlet apparatus.
j) **Estimation of alcohol by specific gravity method**
In this process, "specific-gravity bottle" is used to hold a known volume of liquid i.e water at a specified temperature. The bottle is weighed, filled with the ethanol whose specific gravity is to be found, and weighed again. The difference inweights is divided by the weight of an equal volume of water to give the specific gravity of the liquid. (Girish et al., 2014).

k) **Estimation of alcohol by potassium dichromate assay** - 1 ml of alcoholic sample was added directly to the distillation flask, diluted to 30 ml with distilled water and then distilled. distillation was carried out at 70 degree Celsius and 20 ml of distillate was collected in 50 ml volumetric flask containing 25 ml of potassium dichromate solution the contents in the volumetric flask were heated at 60 degree celsius in the water bath for 20 minutes the final volume was made up to 50 ml with distilled water after mixing and cooling the contents of the flask than absorbance was recorded at 600 nm the amount of Ethanol in each sample was determined by using the standard curve of Ethanol.

l) **RAPD Methodology**
Genomic DNA has to be isolated using the CTAB method. The final yield of genomic DNA will be quantified spectrophotometrically and on agarosegel. DNA amplification reactions will be assembled in 25 μl volumes containing template DNA, 1X reaction, 100 μM of each of the dATP, dTTP, dCTP and dGTP, 5 pM primer and 0.5 U of Taq DNA polymerase (Bangalore gene, India). The primers will be added to a final concentration. The samples will be amplified in a thermal cycler through initial denaturation for 3 min at 94°C; 40 cycles of denaturation for 2 min at 94°C; annealing for 1 min at 37°C; elongation for 1 min at 72°C followed by final extension for 7 min at 72°C, stored at 4°C. The amplification products for all samples hs to be resolved on 1.2% agarose gel. From the preliminary screening, 3 RAPD primers that could amplify visible variability bands were used for this study.

8. **Result and Discussion:**
Total starch content observed before hydrolyses was 76μmole. After hydrolysis it decreased to 21μg/ml, 57μg/ml, 34μg/ml, 42μg/ml, 46μg/ml, 45μg/ml in conditions such as asp+tricho+pH, asp+tricho normal, asp+tricho+N2source, asp+pH, asp normal, asp+N2source respectively as shown in Fig.1 Total sugar content observed before hydrolyses 20μg/ml but after hydrolysis it increased to 35μg/ml, 60μg/ml, 48μg/ml, 34μg/ml, 42μg/ml, 47μg/ml in conditions such as asp+tricho+pH, asp+tricho normal, asp+tricho+N2source, asp+pH, asp normal, asp+N2source respectively as shown in Fig.2.
Total sugar content observed before hydrolysis was 19µmole but after hydrolysis it increased to 35µg/ml, 54µg/ml, 83µg/ml, in conditions such as agar agar, sodium alginate, gelatin respectively as shown in Fig. 5. Total starch content observed before hydrolysis was 76µmole but after hydrolysis it decreased to 9µg/ml, 7µg/ml, 3µg/ml, in conditions such as agar agar, sodium alginate, gelatin respectively as shown in Fig. 4.

**Total starch and sugar per 100gm of sample**
DNA isolation was carried out by CTAB method, the four samples were loaded in 1% agarose gel and visualized on U.V. illuminator after electrophoresis. Assessment of genetic diversity among the amorpphallus species from western Ghats using the RAPD markers. A total of four samples were collected in Maharashtra. Genetic diversity was estimated by RAPD technique using three arbitrary selected primers these primers produced different banding pattern. Based on the banding pattern observed we concluded that among the four samples used, two samples showed similar banding pattern and other two samples showed different banding pattern

9. Scope for future work
As a high demand of fossil fuels this project study will help to find out new biological source which will help for biofuel for world as a being plant source which is environment friendly. This bioethanol was less costly than fossil fuels. Keeping in view the importance of developing cheaper and cleaner forms of energy, Bio-fuel forms one of the key thrust areas in future energy planning. The present work is a start for future energy production.

* ~ * ~ *
3. ISOLATION SCREENING AND CHARACTERIZATION OF LIPASE PRODUCERS USING NON-EDIBLE DE-OILED SEED CAKE AS A SUBSTRATE

PROJECT REFERENCE NO.: 39S_B_MSC_007

COLLEGE : GULBARGA UNIVERSITY, KALABURGI
BRANCH : BIOTECHNOLOGY
GUIDES : PROF. G.R. NAIK, MISS. ASMITA R.S.
STUDENTS : MS. AKSHATA ANIL MOGHEKAR
           MS. KAVYA RANI RATHOD
           MS. RESHMA BEGUM S

INTRODUCTION
Lipases are groups of hydrolyase which catalyze the hydrolysis of triglycerides to glycerol and free fatty acids over an oil water interface in addition lipases catalyze the hydrolysis and trans-esterification of other esters as well as the synthesis of esters and exhibit enantio-selective properties. The ability of lipases to perform very specific chemical transformation has made them increasingly popular in the food, detergent, cosmetic, organic synthesis and pharmaceuticals industries. Lipases have emerged as one of the leading biocatalysts with proven potential for contributing to the bio-industry and have used in lipid metabolism and multifaceted industrial applications.

Lipase is a physiologically necessary enzyme. It occurs in many plants and animals as well as in microorganisms. However, its richest source is bacteria, fungi and yeast. Microbiological lipases, especially those originating from bacteria, are more stable than those from plants or animals. They possess unique qualities and, because of them, are used more often for industrial purposes.

Heavy consumption of fossil fuel resources, their effect on climate change and concern over energy security are the main drivers for the increased interest in biofuel. India is emerging fast in using non edible oils for the production of biodiesel. The trees borne oil yielding seeds like Jatropha curcas, Ricinus communis, Shorearobusta, mixed seed cake could grow well on waste land and could withstand draught and dry conditions producing non-traditional oil seeds.

The technology of biodiesel production consumed only extracted vegetable oil from nonedible seeds and left large amount of unutilized biomass as seed cake. The disposal of generated cakes as waste can lead to environmental problems and indirectly effects cost for biodiesel production. Pongamia and Jatropha has topped the biodiesel market in India and as superior sources of biodiesel production. They are rich in nitrogen phosphorous potassium content and are used as organic manure. The seed cakes have been exploited in the field of fermentation technique which has resulted in the production of bulk chemicals and value added products such as amino acids and enzymes.

OBJECTIVES
The following objective has been carried out for the industrial, economic importance of lipase.
• Collection of soil samples.
• Isolation of lipase producing microorganism.
• Screening of lipase producing microorganism.
• Enzyme assay: lipase assay extracted from screened isolates.
• Characterization of lipase producing microbes.

METHODOLOGY

Isolation of lipase producing microorganism: Twenty one Lipase producing microorganisms were isolated from different natural sources using microbiological techniques like serial dilution and other aseptic techniques. Further axenic cultures will be obtained by sub-culturing the isolates.

Screening of lipase producing microbes: The obtained organisms were being screened by qualitative plate assay, based on the hydrolytic activity on tributyrin agar plates.

Enzyme assay: lipase assay extracted from screened isolates: The crude and partially purified extract from the screened isolates were studied for catalytic activity and kinetics.

Characterization of lipase producing microbes: The characterization is in progress for species identification and biochemical tests as per the Bergey’s manual of systematic bacteriology and further species identification by 16SrRNA sequencing.

Results

Collection of Samples: The soil samples were collected from different sites of Gulbarga. The seed cakes were obtained from Biofuel Information and Demonstration Centre, Gulbarga University, Kalaburagi.

Isolation of organisms: Based on colony morphology 25 isolates were obtained on tributyrin medium supplemented with 1% (V/V) tributyrin. These isolates were sub cultured and maintained as axenic cultures.

Screening of lipase producing organisms

Primary screening: Screenings of organisms were carried out by using qualitative plate assay. The isolate KAR15 and KAR21 have shown larger zone of hydrolysis than the other isolates i.e, 44mm and 56 mm and they were selected for further secondary screening.

Secondary screening: The isolates KAR15 & KAR21 showed potentially in primary screening and were further screened for the ability to utilize the de-oiled seed cake as a substrate for the production of lipases. The lipase activity was analyzed for both crude extract and partially purified extract and titrated against 0.1 N NaOH.

After the analysis of enzyme activity using Pongamia pinnata seed cake as substrate, the value of KAR 15 in crude extract is 14000 units /ml and in partially purified the value is 13600 units /ml, whereas the value of KAR21 is 14400 units/ml in crude extract and 14000 units/ml in partially purified extract.

The value of enzyme activity using Jatropha curcas seed cake as substrate KAR 15 in crude extract and in partially purified extract is same 13800 units/ml whereas the value of KAR21 in crude extract and partially purified extract is 14200 units/ml.

Specific activity

Specific activity of enzyme was determined by estimation of protein content of enzyme fraction using Lowry’s method. The total protein content fraction produced using deoiled seed cake as substrate was determined by comparing with the standard BSA Curve. The specific activity of Lipase was calculated using the formula.

Specific Activity = Enzyme activity in units per ml / concentration of total protein content

The specific activity of KAR15 in crude extract using Pongamia pinnata seed cake is 18.42units/mg and in partially purified the value is 21.25units/mg while using Jatropha seed cake the value in crude extract is 15.33 units/mg and in partially purified the value is 19.43 units/mg.

The specific activity of KAR21 in crude extract using Pongamia pinnata seed cake is 16.94units/mg and in partially purified the value is 19.71units/mg and in using Jatropha
curcas seed cake the value in crude extract is 16.90 units/mg and in partially purified the value is 18.20 units/mg.

**Characterization:** The samples KAR 15 and KAR21 have been send for 16S rRNA sequencing.

**Summary and Conclusion:**
In present project work Bacterial strain was isolated by employing standard techniques from oil contaminated soil and further investigated for its lipase producing ability. The clear zone indicates the Lipase producing microorganism on Tributryin agar medium. We have screened twenty one microorganisms for lipase activity. Among which two strains have shown maximum activity on Pongamia pinnata seed cake that is 14 units/ml and 14.4 units/ml and Jatropha curcas seed cake is 13.8 units/ml and 14.2 units/ml. It is concluded that Pongamia seed cake, which is available locally in large quantities can serve as rich source for the production of lipase, with strains like KAR15 and KAR21. Further work required to be carried for establishing new applications of lipases.

* ~ * ~ *

4. **BIOCONVERSION OF BIODIESEL DERIVED CRUDE GLYCEROL TO POLYHYDROXYALKANOTES / POLYHYDROXYBUTRATE (PHA/PHB)**

**PROJECT REFERENCE NO.: 39S_B_MSC_008**

**COLLEGE:** GULBARGA UNIVERSITY, KALABURGI

**BRANCH:** BIOTECHNOLOGY

**GUIDES:** PROF. G.R. NAIK, MR. PRAMOD BHIMRAO KULKARNI

**STUDENTS:** MS. KOMAL SANJAY TIMANE

MS. SHOBHA GUDUR

MR. VISHNU JADHAV

**INTRODUCTION**
Biodiesel production has increased exponentially over the years; leading to the large crude glycerol generation obtained by the transesterification of vegetable oils. There are wide range of applications of pure glycerol in food, pharmaceuticals, cosmetics and many other industries. It is very cost effective to refine crude glycerol to a high purity especially for the small and medium biodiesel producers. Also the increasing amount of crude glycerol is causing storage problem and environmental hazard. Many research studies have been taken up with innovative ideas finding alternative utilization of crude glycerol. One such alternative is to use it as carbon source for PHA/PHB/PHB production. Accumulation of nondegradable plastic in the environment is one of the major causes of pollution nowadays. Indian Supreme court made a statement stating “Plastic bags threat is more serious than the atom bomb.” Plastic bags photo-degrade; over time they breakdown into smaller, more toxic petropolymere which eventually contaminate soils and waterways. As a consequence microscopic particles can enter the food chain (National Geographic
news Sept 2, 2003). The effect on wildlife can be catastrophic, birds become terminally entangled, and nearly 200 different species of sea life including whales, dolphins, seals and turtles die due to feeding on plastic accumulated in the aquatic habitat which is mistaken for food (World life fund report 2005).

Taking into consideration the tremendous threats caused by the plastic, there is need to search for the alternative which can replace this plastic. One alternative is to use the bioplastic (polyhydroxyalkanoates/Polyhydroxybuterates) produced using renewable substrates and which are ecofriendly. Bioplastics are biobased biodegradable plastics with almost similar properties to synthetic plastics made from variety of sources like polysaccharides, lipids and also proteins (Averous, 2014; Hernandez and Krochta, 2008; Siracusa et al, 2008; Gonzalez et al, 2009). The available literatures shows number of biodegradable substrates such as Fruit wastes (Preethi et al, 2012), molasses & corn steep liquor (Chaipramus & Udpuay, 2008) and Edible oil (Darshan & Nishith, 2011) etc. are available and can be used for the Polyhydroxyalkanoates/ Polyhydroxybuterates (PHA/PHB) production out of which the crude glycerol obtained from the biodiesel production process is been particularly focused.

Recently, much work has been done using biodiesel-derived waste glycerol for PHA/PHB production by Cupriavidus necator JMP134, Paracoccus denitrificans (Mothes et al., 2007), Cupriavidus necator DSM.545(Cavalheiro et al., 2009), Bacillus sonorensis, Halomonas hydrothermalis (Shrivastav et al., 2010), Halomonas sp. KM-1 (Kawata and Alba, 2010), osmophilic organism (Koller et al., 2005), Pseudomonas oleovorans NRRL B-14682 and Pseudomonas corrugate 388 (Ashby et al., 2014) from different sources of biodiesel feedstock (Jantima TEEKA et al 2010).

Looking into the problems associated with synthetic plastics and biodiesel derived crude glycerol, advantages of biodegradable plastics/ bioplastics over synthetic plastics and the potentiality of microorganisms in utilizing biodiesel derived crude glycerol and producing the bioplastic, the present work was undertaken with following objectives.

**Objectives**
1. Collection of marine samples.
2. Isolation of glycerol utilizing organisms.
3. Screening for PHA/PHB producers using biodiesel derived crude glycerol as carbon source.
4. Quantification of PHA/PHB from screened isolates.

**Materials and Methodology**

Isolation of marine organisms utilizing biodiesel derived crude glycerol:

Isolation of marine organisms was done by using standard microbiological techniques like serial dilution on sea water agar medium supplemented with 1% (V/V) crude glycerol as a carbon source, the crude glycerol was pretreated prior to its usage. The isolates were screened based on the morphological characters and axenic cultures were obtained by subsequent sub culturing the isolates.

Screening of PHA/PHB producing isolates:

Primary screening:
The obtained isolates were further screened for their potentiality to produce PHA/PHB using staining techniques like Sudan Black B and Nile blue a staining (Ostle and Holt, 1982). The Sudan Black B stain, a lipophilic stain used to stain the lipid granules, helping in differentiating the PHA/PHB producers and non producers. The Nile Blue, which particularly stains the PHA/PHB granules within the cell, illuminating bright orange fluorescence under UV light of 460nm wavelength.
Secondary screening:
The isolates showing potentiality are being further subjected to secondary screening which are being done using fluorescence microscopy, the specimen preparation for the microscopy are prepared as per the protocol prescribed by (Ostle and Holt, 1982) and further confirmation of PHA/PHB are being done using higher end technique like FTIR.

Quantification of PHA/PHB from screened isolates:
Quantification of PHA/PHB are being done using spectroscopic method using chrotonic acid as internal standard as per protocol prescribed by Giin- Yu Amy Tan et al, (2014).

Results
Collection of marine samples
The marine soil samples were collected from coastal areas of Maharashtra, Goa & Karnataka. The biodiesel derived crude glycerol was obtained from Biofuel Information and Demonstration Centre, Gulbarga University, Kalaburagi.

Isolation of Marine organisms utilizing biodiesel derived crude glycerol
Based on colony morphology 35 different isolates were obtained on Sea Water Agar medium supplemented with 1% (V/V) crude glycerol. These were sub cultured and maintained as axenic cultures.

Screening of PHA/PHB producing isolates:
Primary screening:
In primary screening by Sudan Black B all 35 isolates showed positive results. In Nile Blue A staining, among 35 isolates only 10 isolates showed bright Orange fluorescence under UV light of 460nm.

Summary and Conclusion
Global interest in biodiesel as an alternative have increased during past years, which is usually produced by transesterification of tree borne oil in presence of an alcohol and a strong base, generating crude glycerol as a primary by product. As the biodiesel production has increased over the years has led to increased production of crude glycerol, which is in impure form containing large amount of methanol and sodium hydroxide which causes environmental hazard. Hence, narrowing its commercial applications.

The present work was taken up with an objective to find out an alternative usage of crude glycerol by using it as a carbon source for isolating the marine organisms and further converting it to the PHA/PHB. Thus providing a value added market to the crude glycerol. Successfully isolated 35 different isolates which could utilize the crude glycerol as carbon source, further screening with sudan black and nile blue staining revealed 10 isolates to be potent in converting the crude glycerol to the PHA/PHB.

* ~ * ~ *
5. MICROALGAE CULTIVATION USING URBAN WASTE WATER FOR ENHANCED BIOMASS AND LIPID PRODUCTION ALONG WITH REDUCED EUTROPHICATION

PROJECT REFERENCE NO.: 39S_B_MSC_021

COLLEGE: INDIAN ACADEMY DEGREE COLLEGE, BENGALURU
BRANCH: BIOTECHNOLOGY
GUIDES: DR. SIBI G.
STUDENTS: MR. RAVIPRATAP SINGH
MR. SHIBDAS BANERJEE
MR. ROHAN BIRRU

Background:
The increasing urbanization and expansion of urban populations has resulted in greater quantities of municipal waste water. Urban waste waters are laden with organic compounds and inorganic chemicals and the major effect of releasing nutrient rich wastewater is the eutrophication of freshwater ecosystems. Finding a solution for the treatment and safe discharge of the wastewater is a difficult challenge because it entails integrated processes in which technical, economic and financial consideration come in play. The uniqueness of each situation makes it difficult to define a universal method for selecting the most adequate type of waste treatment plant.
The use of wastewater for cultivation of microalgae allows treating the wastewater and obtaining biomass with a high content of lipids for biofuels generation. Microalgae cultures offer an elegant solution to tertiary treatment of waste water due to their ability of to use inorganic nitrogen and phosphorus for their growth coupled with the production of potentially valuable biomass. It also significantly contribute to the management of water eco-systems by providing an inexpensively environment friendly system for waste water treatment. Further, Microalgae treatment of wastewater does not generate additional pollution thus it can offer an ecologically safer, cheaper and more efficient means of removing nutrients than conventional methods.

Objectives:
In this study, to intensify wastewater treatment and microalgal cultivation, the method of Urban Waste Water (UWW) based microalgae cultivation was followed with the following objectives.
- To examine the potential of urban waste water as growth medium for microalgae cultivation.
- To evaluate how well the algal biomass and lipid production increases in waste water medium.
- Nitrogen and phosphorous removal from waste water by assimilation to algal cells thereby reducing eutrophication.

Methodology:
Isolation and Identification of Algal Strains: Microalgal samples were collected from Bangalore Water Supply and Sewerage Board (BWSSB), Yelahanka and identified as described by Anderson (2005) and Stanier et al., (1971).
Physicochemical characterization of Urban Waste Water: Urban waste water was collected and subjected for analyses of total nitrogen, total phosphorus, Biological oxygen
demand (BOD), chemical oxygen demand (COD) and total organic carbon according to the standard method (APHA, 1995).

**Determination of algal growth:** Algal growth was monitored daily through testing the total volatile suspended solids (TVSS), which represents biomass concentration and was determined according to the standard method (APHA, 1995).

**Cellular pigments Assay:** Cellular pigments were determined using a spectrophotometric method after extraction with 80% acetone (Wellburn, 1994; Kirk, 1967). The amount of pigments was calculated using the formulae;

\[
C_a = 12.21A_{663} - 2.81A_{646} \quad \text{................................... (1)}
\]

\[
C_b = 20.13A_{646} - 5.03A_{663} \quad \text{................................... (2)}
\]

\[
C_t = 1000A_{470} - 3.27C_a - 104C_b/198 \quad \text{.................................... (3)}
\]

where \(C_a\) is the chlorophyll a, \(C_b\) is the chlorophyll b, and \(C_t\) is the total carotenoids (\(\mu g \text{ mL}^{-1}\)).

**Protein extraction and assay:** The extraction of proteins was performed using alkali and the total protein was estimated using Lowry’s method (Lowry et al., 1951)

**Carbohydrate extraction and Assay:** Cellular carbohydrates were estimated using the anthrone method (Gerhardt et al., 1994) after hot alkaline extraction (Levya et al., 2008).

**Total Lipid Assay:** Algae cells were harvested through centrifugation and then dried for the analysis of lipid content. The lipids were extracted using a one step extraction method (Folch et al., 1956).

The lipid content of dry weight was calculated according to the following formula:

\[\text{LW (g/g) = } (m_2 - m_0) \times V / (3 \times m_1)\]

where LW is lipid content based on dry weight, \(m_1\) is the weight of the algae powder, \(m_0\) is the weight of the empty glass tube, \(m_2\) is the weight of the tube with the dried lipids, and \(V\) is the total volume of the lower phase after washing.

The total lipid concentration (TC) was calculated by multiplying the lipid content of dry weight by TVSS using the following equation

\[\text{TC (g/l) = LW x TVSS}\]

**Results and Conclusion:**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Greyish Black</td>
</tr>
<tr>
<td>pH</td>
<td>6.6 ± 0.13</td>
</tr>
<tr>
<td>Electrical Conductivity (mS cm(^{-1}))</td>
<td>2.314</td>
</tr>
<tr>
<td>Temperature</td>
<td>30° C</td>
</tr>
<tr>
<td>BOD (mg l(^{-1}))</td>
<td>197</td>
</tr>
<tr>
<td>COD (mg l(^{-1}))</td>
<td>474</td>
</tr>
<tr>
<td>TOC (mg l(^{-1}))</td>
<td>857 ± 27.98</td>
</tr>
<tr>
<td>Total Suspended Solids (mg l(^{-1}))</td>
<td>0.19 ± 0.09</td>
</tr>
<tr>
<td>Total Phosphorous (mg l(^{-1}))</td>
<td>4.97 ± 6.7</td>
</tr>
<tr>
<td>Total Nitrogen (mg l(^{-1}))</td>
<td>7.61 ± 0.36</td>
</tr>
</tbody>
</table>

Species of Chlorella, Scenedesmus and Oscillatoria were the major isolates identified and recultivated in urban waste water at 24±2°C under continuous illumination. Based on the maximal growth rate and biomass productivity (Fig-1) in the growth medium Chlorella sp was selected and used for further studies.
The effects of growth medium on the cell growth, lipid production and chlorophyll accumulation were revealed in comparison with Bold’s Basal medium. After 10 days of cultivation, Urban Waste Water (UWW) medium obtained the maximum biomass concentration of 1.13 g/l and biomass productivity of 0.19 g/l, which was higher than those of Bold’s Basal Medium (BBM) of 1.09 g/l and 0.17 g/l respectively. This scenario was different with specific growth rate i.e 1.12 µ day⁻¹ was observed in BBM where as it was 1.06 µ day⁻¹ in UWW.

The maximum chlorophyll content (11.36 mg/l) was obtained in BBM whereas it was 9.37 mg/l in UWW medium. Total carotenoids and protein were higher in cells grown in UWW medium and recorded 4.7 and 58.7 mg/l respectively. However, total carbohydrates were increased in BBM (196 mg/l). The highest lipid productivity of 14.31 mg/l/day was achieved in the culture grown in UWW medium which exceeded the BBM 1.15 fold.
The removal rate of total phosphorous and total nitrogen by *Chlorella* sp was found as 78% and 62.3% respectively. The findings demonstrated the use of urban waste water as less cost and less energy input for algal cultivation in terms of biomass and lipid production. In addition, growing microalgae in nutrient rich waste water offers a new option to manage the nutrient load in urban waste water serving the dual roles of nutrient reduction and valuable biofuel feedstock production.

**Scope for future work:**
Urban waste water can be used as a replacement for synthetic medium for the cultivation of *Chlorella* sp for valuable biomass and biofuel production. Removal of phosphorous and nitrogen from the urban waste water by *Chlorella* sp proved that this would be a promising method to reduce the eutrophication. Although, microalgal based waste water treatment were more efficient in removing phosphorous and nitrogen from urban waste water, further studies are needed before it is applied in large scale wastewater treatment.

* * *

6. **Chemical nutrient analysis of vermicompost produced using *Pongamia pinnata* Seed Cake and its effect on the growth of *Pongamia pinnata***

**PROJECT REFERENCE NO.: 39S_B_MSC_003**

**COLLEGE**: M.S.RAMAIAH COLLEGE OF ARTS, SCIENCE AND COMMERCE,

**BANGALORE**

**BRANCH**: BIOTECHNOLOGY

**GUIDES**: DR. LAKSHMI KANTH R.N., DR. SAVITHA G.

**STUDENTS**: MR. SURAJ BEGOOR

MR. ATUL DAMANI

MR. GANGA PRASAD G.V.

**Introduction:**
Demand for biodiesel is increasing day by day as it can be economically and environmentally viable. Biodiesel is produced from the biomass which is abundantly available and eco-friendly, it can be extracted from the non-edible seeds. Seeds from *Pongamia pinnata* plants are widely used for biodiesel production (S.K.Padhi and R.K.Singh, 2011) as they are non-edible containing toxic compounds such as pongamol, karanjin, furanflavones (Edwards, C.A., 1998). The seed cake, which is left out after extraction of oil is highly nutritive (Openshaw, 2000) and can be converted to vermicompost which can enrich the soil. Vermicompost is superior to conventionally produced compost and can be used as natural fertilizer. (Mike Benge, 2004)

Earthworms used in vermicomposting, consume all kinds of organic matter in an ideal condition and convert it to a better end product (Albanell E., et al., 1988). The worms produced can be sold or can be used for other purposes viz fishing, animal feeds, the compost produced is highly rich in nutrients and have properties of pest (Nagavallemma., et.al. 1988) The process of vermicomposting provides a source of supplemental income to
farmers (Glenn Munroe, 2009). The worm manure is rich in microbial activity, pest repellence characteristics, and essential plant nutrients which can enhance the plant growth (Vermi Co., 2001, Tara Crescent, 2003).

It has been reported that vermicompost improves yield and seed quality (Sifolo S. et al., 2016) and even in the oil producing plants for better yield of seeds and oil (Mehdi Zahedifard. et. al., 2014) The vermicompost is used as source of plant nutrients as it has double the concentration of nutrients compared to normal compost (Sreenivas et al.2000, Jadhav et al.1997), and with the seed cake vermicompost produces more nutrients than regular compost, it also reduces the soil C: N ratio by retaining more nitrogen and utilization of carbon by earthworms (Thompson and Nogales, 1999). Studies by Marinari S, et al.2000; Mitchell and Edwards, 1997 proves that the vermicompost also increases macropore space ranging from 50-500μm which results in better air-water relationship in the soil and also it favourably affects the pH, soil enzymes and microbial population. An acre of land can have as many as 500,000 earthworms, which can recycle as much as 5 tons of waste or more per year (Marinari S, et al., 2000). Pongamia pinnata seed cake may enhance the process of vermicomposting, and produce highly nutritive vermicompost and increase the plant growth and yield.

Objectives:
• To prepare vermicompost using seed cake of non-edible Pongamia pinnata plant seeds.
• To assess the effect of different seed cake composition on vermiculture.
• To study the seed cake vermicompost chemical properties.
• To evaluate the vermicompost produced form seedcake on growth of Pongamia pinnata.
• Cost analysis to make this process as a source of income for the farmers and to make them aware about the benefits of seed cake vermicopost.

Methodology:
1. Collection of Materials: The house hold kitchen was used with garden waste containing leaves. General paper waste was used after shredding. Pongamia pinnata seed cake was procured from R.V College, Bangalore. Different species of earthworms were procured from vermicomposting centre, UAS GKV, Bangalore.

2. Pre – decomposition: Plastic bins of 50x30x14 cm was filled with kitchen waste, garden waste, shredded paper, and seed cake in an appropriate amount as shown in Table 1 and kept for pre-decomposition for 18 days.

<table>
<thead>
<tr>
<th>Bins</th>
<th>Seed Cake (%) (kg)</th>
<th>Kitchen Waste + Garden Waste (%) (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>100% (4.0 kg)</td>
</tr>
<tr>
<td>T1</td>
<td>20% (0.6 kg)</td>
<td>80% (2.4 kg)</td>
</tr>
<tr>
<td>T2</td>
<td>40% (1.2 kg)</td>
<td>60% (1.8 kg)</td>
</tr>
<tr>
<td>T3</td>
<td>60% (1.8 kg)</td>
<td>40% (1.2 kg)</td>
</tr>
<tr>
<td>T4</td>
<td>80% (1.2 kg)</td>
<td>20% (0.3 Kg)</td>
</tr>
<tr>
<td>T5</td>
<td>100% (0.6 Kg)</td>
<td>-</td>
</tr>
</tbody>
</table>

3. Composting: Holes were made at the bottom of the plastic bins and bedding was made using Cardboard, shredded paper and coco peat. The bedding surface was layered with the pre-decompose waste on which 100 earthworms were placed followed by garden waste, shredded paper and gunny bag on top. 5 Bins were set based on the amount of seed cake and organic wastes.
3.1 Analysis of vermiculture process and compost formed
After 35 days when compost was formed, the vermiculture efficiency was analysed by counting a number of worms and cocoons in each bin after compost formation. The weight and moisture content of compost was measured and also chemical analysis of Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sodium, and Organic Carbon was done.

4. Plant Growth analysis
Plant growth analysis of *Pongamia pinnata* using different concentration of seed cake in a vermicomposting and regular vermicomposting was done in 3 replicates which would be interpreted by statistical analysis.

**Results and Conclusions:** Results of Vermiculture process showed that 20% of seed cake vermicompost concentration is most suitable for vermiculture process as it has high moisture content (66.66%) followed by control as shown in Table 2.

**Table 2: Analysis of Vermiculture Process**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No. of Coccons</th>
<th>No. of worms alive after compost formation</th>
<th>Total weight of the waste added in bin (Kg)</th>
<th>Compost weight (kg)</th>
<th>Moisture content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Control)</td>
<td>48</td>
<td>113</td>
<td>3.0</td>
<td>2.42</td>
<td>61.29</td>
</tr>
<tr>
<td>T1 (20%)</td>
<td>44</td>
<td>114</td>
<td>3.0</td>
<td>2.44</td>
<td>66.66</td>
</tr>
<tr>
<td>T2 (40%)</td>
<td>22</td>
<td>90</td>
<td>3.0</td>
<td>2.45</td>
<td>51.51</td>
</tr>
<tr>
<td>T3 (60%)</td>
<td>10</td>
<td>40</td>
<td>3.0</td>
<td>2.54</td>
<td>42.85</td>
</tr>
<tr>
<td>T4 (80%)</td>
<td>-</td>
<td>Dead in 20 days</td>
<td>3.0</td>
<td>2.7</td>
<td>33.33</td>
</tr>
<tr>
<td>T5 (100%)</td>
<td>-</td>
<td>Dead in 6 days</td>
<td>0.6</td>
<td>0.58</td>
<td>21.95</td>
</tr>
</tbody>
</table>

Comparatively control (vermicompost without seedcake) showed more cocoon formation which indicates that the environment without seed cake may be conducive for the earthworms, but the chemical nutrient analysis in Table 3 showed that 20% seed cake has more Nitrogen, Phosphorous, Potassium, and magnesium than control followed by 40% of seedcake vermicompost. (R.M. Atiyeh., et.al 2001; S.M. Conteras., et.al. 2005; Bhat M.R and Liamye S.R 2012).

**Table 3 – Chemical Analysis of Vermicompost**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nitrogen (%)</th>
<th>Phosphorous (%)</th>
<th>Potassium (%)</th>
<th>Calcium (%)</th>
<th>Organic Carbon (%)</th>
<th>Magnesium (%)</th>
<th>Sodium (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.9</td>
<td>3.68</td>
<td>4.66</td>
<td>2.75</td>
<td>81.6</td>
<td>2.25</td>
<td>89.7</td>
</tr>
<tr>
<td>T1 (20%)</td>
<td>4.1</td>
<td>3.81</td>
<td>5.3</td>
<td>2.5</td>
<td>80.6</td>
<td>2.5</td>
<td>75.4</td>
</tr>
<tr>
<td>T2 (40%)</td>
<td>3.6</td>
<td>3.87</td>
<td>5.52</td>
<td>3.7</td>
<td>75.6</td>
<td>2.2</td>
<td>92.6</td>
</tr>
<tr>
<td>T3 (60%)</td>
<td>3.5</td>
<td>3.74</td>
<td>5.73</td>
<td>3.6</td>
<td>73.2</td>
<td>1.4</td>
<td>98.3</td>
</tr>
<tr>
<td>T4 (80%)</td>
<td>3.0</td>
<td>2.79</td>
<td>4.44</td>
<td>3.8</td>
<td>68.6</td>
<td>2.3</td>
<td>63.9</td>
</tr>
<tr>
<td>T5 (100%)</td>
<td>2.2</td>
<td>2.41</td>
<td>3.15</td>
<td>3.9</td>
<td>66.4</td>
<td>2.2</td>
<td>61.0</td>
</tr>
</tbody>
</table>
During plant growth analysis it was observed (Table 4 & Fig 2) that there was a better growth in the 20% seedcake plants than in the 100% seedcake plants. There was a decrease in the growth of the plants as compared to 20% than 40% than 60% and so on. It may be due to the more alkaline nature of the seedcake and less water retention capacity of it, which makes the plant devoid of nutrition and thus affects its growth. In contrast plants have a better nutritional availability and environment in the 20% concentration wherein the plants find it optimal for its better growth. (D. Khan., et.al. 2015; Amritphale Dilip and S.K. Sharma 2008).

Fig 2: The growth of the plants on 15th day in different concentrations along with control

Table 4: Plant growth analysis

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Morphometric Parameters</th>
<th>Control</th>
<th>T1 20%</th>
<th>T2 40%</th>
<th>T3 60%</th>
<th>T4 80%</th>
<th>T5 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Root length (cm)</td>
<td>15.6</td>
<td>20</td>
<td>16.95</td>
<td>17.25</td>
<td>14.1</td>
<td>10.65</td>
</tr>
<tr>
<td>2</td>
<td>Shoot length (cm)</td>
<td>10.7</td>
<td>13.4</td>
<td>12.4</td>
<td>11.9</td>
<td>9.7</td>
<td>6.95</td>
</tr>
<tr>
<td>3</td>
<td>Number of leaves</td>
<td>7</td>
<td>12</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Root dry weight (g)</td>
<td>0.32</td>
<td>0.38</td>
<td>0.26</td>
<td>0.22</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>5</td>
<td>Seedlings dry weight (g)</td>
<td>1.8</td>
<td>2</td>
<td>1.7</td>
<td>1.8</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Conclusions:
The vermicompost with 20% of seed cake showed optimum growth of worms for vermiculture and high nutrients suitable for growth of the plant.

Scope for future work:
- The seed cake vermicompost can be produced at a larger scale by the farmers to utilize and generate additional income by selling highly nutritive compost and worms.
- Studies on different non edible seed cakes can be utilised for the production of vermicompost.
- Studies on yield of seeds and biodiesel produced from plants grown using seed cake vermicompost can be conducted.

* ~ * ~ *
7. COFFE PULP AND ARECA NUT HUSK - A POTENTIAL SOURCE OF CELLULOSIC FEED STOCK FOR BIOETHANOL PRODUCTION USING MICROBIAL CONSORTIA

PROJECT REFERENCE NO.: 39S_B_MSC_022

COLLEGE : DAYANANDA SAGAR INSTITUTIONS, BANGALORE
BRANCH : MICROBIOLOGY
GUIDES : DR. GAUTHAM S.A., DR. SAVITHA G.
STUDENTS : MR. SHREYAS S. KUDUVALLI
MS. ANKITHA P.

INTRODUCTION:
In India, Karnataka - prominent sector for coffee and areca-nut production – the coffee pulp and areca-nut husk are used as fuel for household burning or as an agricultural compost. The present research emphasizes on the utilization of coffee pulp and areca-nut husk as a potential source for bioethanol production. Less studied in comparison - bagasse, husk, pulp etc. Employs modified approaches in microbial pre-treatment procedures for the lignocellulosic feed stock by the application of microbial consortium comprising fungi and actinomycetes. The study earmarks a novelty in pre-treatment procedures for bioethanol production using low quality feed stocks conversion into biofuels.

OBJECTIVE:
• Isolation, screening, and characterization of potent cellulolytic microorganisms from soil.
• Chemical and microbial pre-treatment of coffee pulp and areca-nut husk.
• Qualitative and Quantitative Analysis of degraded biomolecules.
• Fermentation for ethanol production.

METHODOLOGY:
Pre-treatment:
• Chemical pre-treatment with acid (2% H2SO4) and alkali (0.25N NaOH) (Kumar et al., 2009).
Microbial Treatment:
• Soil Sample collection – Rhizosphere soils from Coffee and areca nut gardens (Moncheva et al., 2000-2002).
• Soil serial dilution and plating – SCN, MRBA & PDB.
• Screening of cellulose degrading microorganisms – CMC agar media (Aneja, 1996).
• Microbial pre-treatment using potent organisms (Shenoy et al., 2011).
• Fermentation of pre-treated sample by Yeast (S. cerevisiae) (Shenoy et al., 2011).
Estimations:
• Reducing sugar estimation by DNS method (Kumar et al., 2012).
• Total sugar estimation by Anthrone method (Kumar et al., 2012).
• Protein estimation by FC method of the chemically pre-treated sample (Kumar et al., 2012).
Alcohol production and estimation:
• Fermentation of pre-treated sample using S.cerevisiae (State et al., 2014)
• Fermented sample subjected to distillation for isolation and purification of ethanol.
• The purity of sample to be estimated by subjecting to specific gravity method (Shenoy et al., 2011).

**RESULTS:**
• Coffee Pulp and Areca nut Husk samples were collected.
• Isolation of cellulose degrading microorganisms.
• Biochemical estimation of samples

**Protein Estimation.**
• The concentration of total protein in coffee sample was found to be 260µg/ml.
• The concentration of the total protein in areca-nut sample was found to be 250µg/ml.
• The protein content of both the samples was found to be almost the same.

**Total Sugar.**
• The concentration of the reducing sugar in coffee sample was found to be: 720µg/ml.
• The concentration of the reducing sugar in areca-nut sample was found to be 400µg/ml.
• The reducing sugar content was found to be higher in case of coffee pulp sample as compared to the areca-nut sample.

**Reducing Sugar.**
• The concentration of the total sugar in areca-nut sample was found to be 780µg/ml.
• The concentration of the total sugar in coffee sample was found to be 830µg/ml.
• The total sugar content was found to be little higher in coffee sample as compared to the areca-nut sample.

**Estimation of alcohol:**
• Specific gravity of sample (coffee) 1: 25.5g/26g = 0.9807
• Specific gravity of sample (areca-nut) 1: 25.5g/26g = 0.9807
• According alcohol metric density table the yield of alcohol was approximately 10-11%

**Isolation of cellulolytic organisms:**
Isolates were grown on CMC Agar plates.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of organism</th>
<th>Media used</th>
<th>Zone of clearance (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Aspergillus niger</em></td>
<td>CMC</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td><em>Aspergillus ochraceus</em></td>
<td>CMC</td>
<td>6</td>
</tr>
</tbody>
</table>

Inference: *Aspergillus ochraceus* was selected as the suitable organism for microbial pre-treatment of coffee pulp and areca nut husk.
SYNOPSIS OF M.TECH PROJECTS
1. Ultrasound Assisted Synthesis of Biodiesel from Waste Cooking Oil by Using Metal Oxide Catalyst

PROJECT REFERENCE NO.: 39S_B_MTECH_004

COLLEGE: MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL
BRANCH: CHEMICAL ENGINEERING
GUIDES: MR. S. SIVASANKARAN
STUDENTS: MR. NAVEENKUMAR ASHOK YARANAL

Energy consumption is necessary for human existence. The increasing demand for fossil fuels in all sectors of human life, like residential consumption transportation, industrial processes, and electricity made an attempt in search of alternative fuel which is economic, technically feasible and readily available. There are several alternatives such as wind, solar, hydro, nuclear, bio fuel, and biodiesel. Biodiesel which is also called as fatty acid methyl ester (FAME) is a clean burning, renewable fuel produced from vegetable oils, animal fats and recycled cooking oil etc. Once these fats or oils are filtered from their hydrocarbons and then combined with alcohol like methanol, biodiesel is brought to life from the chemical reaction. The increasing production of cooking oils from household and industrial sources is a growing global problem. This residue is regularly sent to the watercourses, which cause problems for wastewater treatment plants and energy loss, and also into the food chain through animal feeding, becoming a major cause of human health problems. Thus cooking oil will become the major material to make biodiesel. Catalysts can be generally classified into homogeneous, heterogeneous and biocatalyst. Homogeneous base catalysts like sodium and potassium hydroxides are the most studied and industrially used catalysts for biodiesel production but there are many obstacles to their utilizations it is hygroscopic in nature, hazardous for the environment and also it leads to saponification. Acidic catalysts like sulphuric acid are also being used for the transesterification reaction. The acid catalysed reaction requires higher temperatures and pressures and also the reaction is very slow.

In recent years the use of enzyme catalytic production of biodiesel has grabbed much attention because it helps in easy purification of biodiesel and glycerol. Due to long residence time and high cost, enzymatic transesterification could not be marketed.

Taking all this into consideration heterogeneous catalysis has played an important role as it is considered to be a green process. Heterogeneous catalysts are easier to be separated from the liquid products through physical means such as filtration and centrifugation. Very high yields of methyl esters are obtained, high purity glycerine is produced.

The objective of this work is to minimize the catalyst usage, lower the reaction temperature on energy input and using the lowest possible oil to methanol ratio on technical feasibility and safety considerations. Hence, it is found that sonication was able to satisfy all the above conditions.

Ultrasonication can produce a homogeneous mixture in a very short time to subsequently increase the biodiesel production yield and also helps to increase the liquid–liquid interfacial area through emulsification, which is important for the formation of vapour bubbles and cavitation bubbles in viscous liquids, such as plant oils and animal fats. Generally cavitation
is the generation, consequent growth and crumble of bubbles releasing large amount of energy in the form of high temperatures and pressures over a small location resulting in very high densities.

Diesel engines are used in various fields such as power and industrial sectors, transportation. These diesel engines are responsible for the emissions such as particulate matter (PM), NOx, smoke. In order to control these emissions, researchers have been working in this field to develop these engines and to make it more efficient. Even though methods like the alternation of fuel injection, exhaust gas recirculation was developed to reduce the emissions; it could not satisfy the standards. Therefore, researchers made an attempt to develop other methods like biodiesel, fuel additives and mixing of potential nanoparticles which act as nano catalyst.

The use of vegetable oil in the diesel engine is nearly as old as the diesel engine. Rudolf Diesel, the inventor of the diesel engine, employed peanut oil as a fuel. During the late 1930s, many works have been performed to use vegetable oils as a potential fuel. It has been found that the diesel engine fueled with biodiesel emits the lesser quantity of carbon monoxide and hydrocarbon. On the other hand, the biodiesel-fueled engine also produces a significant increase in nitric oxide (NOx) compared to diesel. Studies have also reported a drop in engine power with biodiesel-fueled compression ignition engines. It has also been reported that by adding an additive in liquid form to biodiesel significantly reduces NOx emission. Additive also increases the contact between the fuel and oxidizer which in turn enhances the combustion rate owing to its higher area-to-volume ratio. Moreover, it has been reported that by adding an additive in nanoscale to fuel increases the ignition quality of the air and fuel mixture.

Effect of emulsion fuel on combustion efficiency of the engine: Induction of water in combustion chamber through any kind of emulsion has a significant effect on the efficiency of the engine. As water content increases, the yield of torque also increases over the entire operational range. When the charge is injected into the cylinder, the water turned into steam due to very high pressure and temperature. Another basis for the improvement in combustion efficiency is low interfacial tension present in the oil-water compound, promotes better atomization for burning of injected fuel. Higher contacts with air facilitated due to better dispersion of oil-water molecules and therefore boost the burning process, which is favourable for the combustion.

The presence of water in diesel brings about an appreciable reduction in the quantity of NOx and particulate matters (PM) emissions. It was experimentally found that by adding smaller size additive to fuel change its chemical composition and enhances its combustion and performance characteristics. Additives in nanoscale also enhance the oxidation of fuel with air which in turn reduces the emissions. Further, thermal conductivity and diffusivity of fuel are also improved with the addition of an additive.

Taking all these into consideration, the present work is carried out to reduce the emissions and improve the efficiency of the diesel engine by using waste cooking oil for the preparation of biodiesel, blended biodiesel and blended biodiesel with ferrofluid (ferric oxide nanoparticles in water in oil emulsion).

For the production of biodiesel homogenous reaction has some disadvantages such as low tolerance towards FFA, and water content and the purification process is complicated. Meanwhile, heterogeneous reaction with solid catalysts eliminates these factors. Transesterification of waste cooking oil with application of ultrasonic energy at 20 kHz has been attempted. The alkali catalyst required for the reaction has been replaced by MgO. The MgO catalyst was found to be highly efficient for the synthesis of biodiesel from methanol and waste cooking oil as raw material. Under the reaction conditions of catalyst dosage 1.0, 2.0, 3.0 wt%, Methanol/Waste cooking oil molar ratio 6:1,9:1,12:1, with reaction temperature
60°C and reaction time 1 hr, the MgO catalyst was able to produce biodiesel with efficiencies in the range of 80% to 95%. MgO catalyst was characterized by XRD, FTIR, PSA, BET and the biodiesel was analysed by 1H-Nuclear Magnetic Resonance (1H-NMR). The performance and emission characteristics of a diesel engine which was improved using blended biodiesel with ferrofluid were conducted experimentally. Fe3O4 catalyst was characterized by XRD, Particle size analyser. The experiments were conducted in an experimental set-up consisting of a single cylinder CI engine. The whole experiment was divided and carried out into three parts. First is by using pure diesel, blended biodiesel (10%, 20%, and 30% by volume) in the second part, and ferrofluid (50 and 100 ppm) with blended biodiesel in the third part. Usage of ferrofluid (50ppm) with blended biodiesel showed a significant improvement in the CI engine compared to pure diesel and blended biodiesel.

* * * *

2. Bioremediation of sewage infused lake water using Algae-Bacteria consortia in a 3-stage continuous bioreactor and utilization of Algal biomass for biofuel production

PROJECT REFERENCE NO.: 39S_B_MTECH_015

COLLEGE : BMS COLLEGE OF ENGINEERING, BANGALORE
BRANCH : ENVIRONMENTAL ENGINEERING
GUIDES : DR. CHANAKYA H.N., DR. SAMPATH KUMAR M.C.
STUDENTS : MS. AFREEN AMAN

1. INTRODUCTION

The disposal of untreated or partially treated sewage water into lakes has resulted in algal blooms and eutrophication in most of the lakes all around Bangalore city. The indiscriminate discharge of industrial waste and sewage leads to degradation of lakes. The current method involves removal of solids during primary screening and removal of simple organic compounds during primary treatment. The removal of phosphorous is generally carried out through precipitation or by conversion to bacterial biomass. Thus phosphorous is lost in the form of sludge. Earlier studies have demonstrated the waste water treatment potential of algal biomass [Oswald et al., 1978; Rodrigues & Oliveira, 1987]. Wang et al. (2010) reported a nitrogen removal efficiency of 92-95% and a phosphate removal efficiency of 62-80% in secondary treated domestic effluent. The C, N and P in sewage flowing into lakes make the conditions favorable for algal growth and resulting algal blooms. This can be tapped for the triple benefit of nutrient recovery, water purification and algal biomass production. BOD removal >80% and cell yields c.0.5kg/m³ has been recorded indicating potential for improvement [CST studies, 2013] and use for replenishing evaporation loss in peri-urban lakes.
In this project, the treatment of algae is carried out using naturally available consortia of algae and bacteria under anaerobic and aerobic conditions in a three stage continuously operated bioreactor. The treatment efficiency at each step of the process is evaluated. This study will investigate the uptake of nutrients by bacteria in an anaerobic environment, the nutrient uptake by a mixed algae-bacteria consortia, and the uptake of nutrients by algal biomass in aerobic condition. Algal biofuel may offer a great alternative for fossil fuels if algal cultivation is accomplished in a sustainable manner. This study also attempts to generate a sustainable method of algal biofuel production.

**Keywords:** Bioremediation, algae, bacteria, bioreactor, biofuel

### 2. OBJECTIVES:

1. Determine the concentration of nutrients in Puttenahalli Lake and the treatment efficacy of algae-bacteria consortia.
2. Design a bioreactor for treating sewage flowing into lakes
3. Validate the functioning of the reactor
4. Study algal growth dynamics
5. Assess the biofuel production prospect of the harvested microalgal biomass.

### 3. MATERIALS AND METHODS

The 3-phase bioreactor was continuously run for a period of 23 days. The reactors were inoculated and allowed to stabilize before the experiment was started.

#### 3.1 Synthetic waste water composition

<table>
<thead>
<tr>
<th>Components</th>
<th>Quantity (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>1</td>
</tr>
<tr>
<td>Urea</td>
<td>0.2</td>
</tr>
<tr>
<td>$\text{KH}_2\text{PO}_4$</td>
<td>0.5</td>
</tr>
<tr>
<td>Detergent</td>
<td>0.6</td>
</tr>
<tr>
<td>Liquid hand wash</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 1. Composition of synthetic waste water

Ref: H.N. Chanakya et al, 2014

#### 3.2 Algal Inoculum

A mixed algal consortium was obtained from the culture maintained at C.S.T, IISc. Reactor 2 was inoculated with a culture consisting predominantly of Euglenoids, a few chlorella and scenedesmus. Reactor 3 was inoculated with a culture dominated by chlorella and oscillatoria.

#### 3.3 Bacterial inoculum

The anaerobic bacterial inoculum was obtained from the biomass based biogas plants at C.S.T, IISc. Reactor 1 was filled with 5l of anaerobic sludge.

#### 3.4 Biomass estimation

The biomass productivity was calculated using the equation

\[
\text{Biomass productivity (g/l/d)} = \frac{(N - N_0)}{T} \quad \text{Eq. (1)}
\]

Where, N (in g/L) was the concentration of the biomass at the end of the cultivation period, $N_0$ (in g/L) was the concentration of the biomass at the beginning of the cultivation period and T was the duration of the cultivation in days.

#### 3.5 Chemical analysis

Analysis like COD, TKN, TP, pH was carried out for all the samples before and after treatment using the procedures described in APHA.
3.6 Lipid extraction:
Lipid extraction from dried algal biomass was carried out using Bligh and dyer method.

4. RESULTS AND CONCLUSIONS
4.1 Determine the concentration of nutrients in Puttenahalli lake water

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>INLET</th>
<th>MIDDLE ZONE</th>
<th>OUTLET</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.34</td>
<td>8.52</td>
<td>8.96</td>
</tr>
<tr>
<td>COD</td>
<td>432mg/l</td>
<td>308mg/l</td>
<td>285mg/l</td>
</tr>
<tr>
<td>TKN</td>
<td>56mg/l</td>
<td>48mg/l</td>
<td>26mg/l</td>
</tr>
<tr>
<td>TP</td>
<td>7.32mg/l</td>
<td>5.13mg/l</td>
<td>3.95mg/l</td>
</tr>
<tr>
<td>D.O</td>
<td>0</td>
<td>3.66mg/l</td>
<td>6.13mg/l</td>
</tr>
<tr>
<td>TURBIDITY</td>
<td>182</td>
<td>116</td>
<td>75.3</td>
</tr>
</tbody>
</table>

4.2 Reactor design:

The treatment set-up consists of 3 reactors.
Reactor1: This system consisted of an initial anaerobic phase with 5l of anaerobic sludge obtained from a C.S.T based MSW biogas plant. To this synthetic waste water was added
and subjected to treatment by anaerobic bacteria. The reactor was fabricated with PVC material and tightly sealed to prevent any entry of air.

Reactor 2: The waste water incoming from reactor 1 was subjected to aerobic treatment in a 12l shallow reactor comprised mainly of Euglenoids.

Reactor 3: The waste water from reactor 2 was further subjected to aerobic treatment using green algae like Chlorella and Scenedesmus in a 15l reactor.

4.3 Validation of the functioning of the reactor

Reactor 1 gave a COD removal efficiency of 55-60%, reactor 2 and reactor 3 gave an efficiency of 30-35% and 12-15% respectively. Reactor 1 did not show a significant reduction in nitrogen and phosphate concentration. Reactor 2 showed a nitrogen removal efficiency of 16-18% and phosphate removal efficiency of 48-50%. Reactor 3 showed a nitrogen removal efficiency of 70-80% and phosphate removal efficiency of 75-77%.

4.4 Study algal growth dynamics

The dominant species of algae in reactor 2 was Euglenoids and in reactor 3 was Chlorella. Green algae showed higher biomass accumulation than euglenoids because of shading effect caused by euglenoid floc which hampered the growth of euglenoids.

4.5 Assess the biofuel production prospect of the harvested microalgal biomass

i. Biodiesel potential of harvested algal biomass

The commonly reported oil content in algae is in the range of 20-50% [Chisti, 2007]. The oil content achieved in these reactors is in the range of 20-24% which indicates good biodiesel production efficiency.

ii. Biogas potential of harvested algal biomass and anaerobic bacteria

Algal biomass serves as the substrate and digester effluent is used for inoculums. Quantity of substrate taken is, 0.5g in 50ml inoculums to achieve 1% concentration.
The biogas produced in reactor 1 is 150ml/g VS, reactor 2 produced 73.85ml/g VS and reactor 3 produced 81.38ml/g VS.

**FUTURE WORK**

1. Study the functioning of the reactor for a year and improvise on the nutrient removal efficiencies.
2. Install and monitor a pilot scale plant to examine the functioning of the reactor in a real time scenario.
4. Characterization of the lipids found in Algal Biomass.
5. Study the potential and efficacy of lipid extracted algal biomass as a fertilizer.

* ~ * ~ *

**3. PRODUCTION AND CHARACTERISATION OF BIODIESEL FROM SPENT COFFEE POWDER AND PERFORMANCE TEST IN A DIESEL ENGINE**

PROJECT REFERENCE NO.: 39S_B_MTECH_001

COLLEGE : SRI VENKATESHWARA COLLEGE OF ENGINEERING
BRANCH : CHEMICAL ENGINEERING
GUIDES : DR. UDAYA RAVI M, MR. SUNIL S
STUDENTS : MR. SURESHA V

**INTRODUCTION:**

Energy is an important input in all sectors of a country’s economy. Till date the world in general and India in particular is mainly dependent on petroleum products as source of energy. Now the world is facing major energy crisis. This energy crisis is due to two reasons; firstly the population of the world is increasing rapidly and secondly the standard of living of human beings has increased. Due to rapid increase in energy requirement, there is fast depletion of petroleum products and it is estimated that in next few decades the availability of petroleum products will be reduced substantially. Hence there is need to promote the production and usage of alternative fuels.

Among the alternative fuels, non-edible oils are one of the renewable types used in CI engines. In the present work Spent Coffee Powder Oil, a non-edible type is used for investigation. In recent decades there is a significant rise in coffee production and consumption, and consequently an increase in the coffee waste generation. Spent coffee powder has very little commercial value and is currently disposed of as a solid waste or in some cases used as fertilizer. As per the experiments conducted spent coffee powder consists of 20% oil content in it. For extracting the oil from the spent coffee powder, several solvents like hexane, ethanol, and isopropanol are used. Spent Coffee Powder Oil was transesterified to obtain methyl esters (SCPOME). The biodiesel is blended with diesel in...
10%, 20%, 30% proportions (B10, B20, B30). The properties of biodiesel and its blends are compared to that of diesel. The performance and exhaust emissions tests are conducted on a single-cylinder four stroke diesel engine with SCPOME and its blends as fuel.

2. OBJECTIVES OF THE PROPOSAL

- To extract oil from waste coffee powder using solvent extraction method.
- To produce Biodiesel from the obtained oil by the method of transesterification.
- To blend the produced Biodiesel with Diesel in various proportions (B10, B20, B30, etc.)
- To find out the properties of various blends (B10, B20, B30, etc.) like Specific gravity, Flash point, Fire point, Viscosity, Calorific value etc.,
- To test the produced biodiesel and its blends in a Diesel engine.

3. METHODOLOGY

(i) Extraction of oil

The oil is extracted from spent coffee powder by Soxhlet extraction method.

(ii) Production of Biodiesel

The Free Fatty Acid (FFA) content of the produced oil is determined by titration of the oil against 0.1N NaOH solution using isopropyl alcohol with phenolphthalein indicator. In general if the FFA content is lesser than 2% single stage alkali base process is chosen and if the FFA content is greater than 2% acid base followed by alkali base process is chosen. FFA of Spent Coffee Oil is found to be 8, Hence 2 stage transesterification is chosen.

- Acid catalyzed Transesterification

This is the first stage of transesterification; it reduces the FFA content present in the oil in the presence of concentrated sulphuric acid, as a catalyst and methanol as a reactant. The mixture is heated in a flask with constant stirring at 60˚C for 2 hours, and then it is taken out and allowed to settle for 3 hours in a separating flask. Here the FFA’s are separated.

- Base catalyzed transesterification

The settled lower layer of the earlier stages having low FFA is used as a raw material for this stage. The product of earlier stages i.e. pure triglycerides is made to react with methanol and suitable quantity of catalyst NaOH for 1ltr of oil and is heated to 60˚C with constant stirring for 2 hours. The reacted product of this second stage is made to settle down under gravity. The lower layer containing the glycerol and other impurities, are separated from the methyl esters and the upper layer is distilled to recover methanol and remaining biodiesel is heated to around 100˚C to remove the moisture content.

(iii) Characterization and Performance tests

The biodiesel produced is blended with diesel in various proportions (B10, B20, B30, etc...). The properties of the produced fuel like Specific gravity, Flash point, Viscosity, Calorific value etc., are determined and compared to that of diesel. The produced Biofuel blends are tested in a diesel engine to ascertain performance and emission characteristics.
4. RESULTS:

i. Yield Obtained for Various Solvents in Soxhlet Extraction Process.

Table 1: Comparison of yield obtained from various solvents

<table>
<thead>
<tr>
<th>Solvent Used</th>
<th>Quantity of coffee powder taken</th>
<th>Quantity of coffee oil obtained</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>50 grams</td>
<td>6.5 grams</td>
<td>13%</td>
</tr>
<tr>
<td>Ethanol</td>
<td>50 grams</td>
<td>7.5 grams</td>
<td>15%</td>
</tr>
<tr>
<td>Hexane</td>
<td>50 grams</td>
<td>10 grams</td>
<td>20%</td>
</tr>
</tbody>
</table>
ii. Characterization of SCPOME

Table 2: Properties of SCPOME & Blends

<table>
<thead>
<tr>
<th>Property</th>
<th>B10</th>
<th>B20</th>
<th>B30</th>
<th>B100</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point (˚C)</td>
<td>68</td>
<td>77</td>
<td>80</td>
<td>135</td>
<td>64</td>
</tr>
<tr>
<td>Kinematic Viscosity (cst)</td>
<td>2.62</td>
<td>2.72</td>
<td>2.90</td>
<td>3.84</td>
<td>2.54</td>
</tr>
<tr>
<td>C V (kJ/kg)</td>
<td>4094</td>
<td>3727</td>
<td>3553</td>
<td>3379</td>
<td>43800</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>855</td>
<td>857</td>
<td>861</td>
<td>875</td>
<td>850</td>
</tr>
<tr>
<td>Pour Point (˚C)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>8</td>
<td>-42</td>
</tr>
<tr>
<td>Cloud Point (˚C)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>-34</td>
</tr>
</tbody>
</table>

Table 3: Comparison of fuel properties with ASTM standards

<table>
<thead>
<tr>
<th>Properties</th>
<th>Standard</th>
<th>Range</th>
<th>Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point (˚C)</td>
<td>ASTM D93</td>
<td>&gt;130 *</td>
<td>135</td>
</tr>
<tr>
<td>Kinematic Viscosity (Cst) at 40˚C</td>
<td>ASTM D445</td>
<td>1.9-6.0</td>
<td>3.84</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>ASTM D4052</td>
<td>0.87-0.90</td>
<td>0.875</td>
</tr>
<tr>
<td>C V (kJ/kg)</td>
<td>ASTM D240</td>
<td>--</td>
<td>33790</td>
</tr>
<tr>
<td>Cloud point ˚C</td>
<td>IS:1448 (P 10)</td>
<td>-3 to 12</td>
<td>10</td>
</tr>
<tr>
<td>Ash, %w/w</td>
<td>IS:1448 (P 4)</td>
<td>0.5max</td>
<td>Nil</td>
</tr>
<tr>
<td>Pour point, ˚C</td>
<td>IS: 1448 (P 10)</td>
<td>-15 to 10</td>
<td>8</td>
</tr>
</tbody>
</table>

iii. Performance Characteristics

![BTE v/s % LOAD](image1)

![BSFC v/s % LOAD](image2)

iv. Emissions

![CO Emissions](image3)

![CO₂ Emissions](image4)
5. CONCLUSIONS:

- Oil and Biodiesel can be obtained from spent coffee powder.
- Spent coffee Powder biodiesel can be used as an alternative fuels in existing Diesel Engine without any modification.
- The production of biodiesel from Spent Coffee Powder may provide valuable, local, regional and National benefits.
- The highest yield obtained was 20% with hexane as solvent.
- The measured properties of produced methyl ester (kinematic viscosity, flash point, fire point) met the ASTM D6751 biodiesel standards.
- The brake thermal efficiency of B20 blend is slightly higher than that of Diesel.
- The brake specific fuel consumption of B20 blend is slightly less than that of Diesel.
- There was marginal increase in CO and CO₂ emission for biodiesel blends.
- Unburnt hydrocarbon emission was reduced by 14 to 16% for B20 and B30 blends.

6. SCOPE FOR FUTURE WORK

- Parameters like Molar Ratio, Catalyst Concentration, Reaction time and Reaction Temperature can be optimized to produce Maximum Yield.
- A study on performance and emission of the Engine with the biodiesel blends can be carried out by varying the Injection Pressure, Injection Timing and Compression ratio.
- Along with biodiesel blends some oxygenated fuel additives can be added and Performance characteristics can be analysed.

** * ~ * ~ * **

4. Heterogeneous catalyzed process optimization for biodiesel production from Bombax ceiba seed oil via Microwave assisted biodiesel production technology

PROJECT REFERENCE NO.: 39S_B_MTECH_006

COLLEGE : VISVESWARAYA TECHNOLOGICAL UNIVERSITY, MYSORE
BRANCH : THERMAL POWER ENERGY
GUIDES : DR. MALLIKARJUNAYYA C. MATH
STUDENTS : MR. HARSHA HEBBAR H.R.
Introduction:
Alternative fuels, also known as non-conventional energy resources or advanced fuels. They can be any type of materials or substances that can replace conventional fuels. Many researchers have explored various types of alternative fuels. They also include electricity stored in batteries and fuel cells, hydrogen, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), bioalcohol, vegetable oil, biodiesel and other biomass resources. These fuels on burning cause less emissions compared to fossil fuels. Biodiesel has several advantages over conventional diesel oil such as high flash point, low sulfur content and low emissions of greenhouse gases. The present study much focused on optimized biodiesel production from Bombax ceiba seed oil via microwave assisted transesterification process. Calcium oxide (CaO), a heterogeneous solid base catalyst is used in transesterification reaction. Further, the fuel properties of obtained biodiesel was evaluated and compared with the ASTM standards for biodiesel.

Methodology
1. Collection of Bombax ceiba seed. Extraction of oil from the seed by different extraction process.
2. Determination of Free Fatty Acid (FFA) content of Bombax ceiba oil (BCO).
3. Process optimized transesterification of BCO via microwave assisted technology selecting the molar ratio, CaO amount and reaction time as a variable parameter as shown in table 1.
4. In RSM, a five level three factor Central Composite Design (CCD) has used to study the influence of variable process parameters on BCME yield.
5. Determination of fuel properties of BCME by standard test methods.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Units</th>
<th>Symbols</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.68 (-α)</td>
</tr>
<tr>
<td>1</td>
<td>Molar ratio</td>
<td>-</td>
<td>A</td>
<td>3.95</td>
</tr>
<tr>
<td>2</td>
<td>CaO amount</td>
<td>% w/v</td>
<td>B</td>
<td>0.66</td>
</tr>
<tr>
<td>3</td>
<td>Reaction time</td>
<td>min</td>
<td>C</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Results and Discussion
The Table 2 shows the experimental and predicted BCME yield (%) of fifteen runs/experiments. Among all runs, highest yield of BCME i.e. 93.8 % has obtained for 9:1 methanol to oil molar ratio, 1.5% CaO amount and 10 min reaction time at constant agitation speed of 500 rpm and 60 °C reaction temperature. The software predicted the maximum yield of 93.84% at the same experimental trial.

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Molar ratio</th>
<th>CaO (%w/v)</th>
<th>Reaction time (min)</th>
<th>BCME Yield (% v/v)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Experimental</td>
</tr>
<tr>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>6</td>
<td>1.0</td>
<td>5</td>
<td>75.1</td>
</tr>
<tr>
<td>2</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>6</td>
<td>1.0</td>
<td>15</td>
<td>49.7</td>
</tr>
<tr>
<td>3</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
<td>6</td>
<td>2.0</td>
<td>5</td>
<td>79.3</td>
</tr>
<tr>
<td>4</td>
<td>-1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>2.0</td>
<td>15</td>
<td>61.6</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>12</td>
<td>1.0</td>
<td>5</td>
<td>84.2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>-1</td>
<td>1</td>
<td>12</td>
<td>1.0</td>
<td>15</td>
<td>47.7</td>
</tr>
</tbody>
</table>
Influence of variable process parameters on BCME yield

Fig. 1: 2D and 3D plot showing influence of methanol to oil molar ratio and CaO amount on BCME yield

Fig. 2: 2D and 3D plot showing influence of methanol to oil molar ratio and reaction time on BCME yield

Fig. 3: 2D and 3D plot showing influence of CaO amount and reaction time on BCME yield
Fuel properties of BCO and BCME and convention diesel oil

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Fuel properties</th>
<th>ASTM Standard range</th>
<th>BCO</th>
<th>BCME</th>
<th>Conventional diesel oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kinematic viscosity (cSt) at 40 °C</td>
<td>1.9 – 6.0</td>
<td>34.87</td>
<td>4.78</td>
<td>2.63</td>
</tr>
<tr>
<td>2</td>
<td>Density (kg/m³)</td>
<td>870 – 900</td>
<td>894</td>
<td>875</td>
<td>840</td>
</tr>
<tr>
<td>3</td>
<td>Flash point (°C)</td>
<td>&gt; 130</td>
<td>195</td>
<td>155</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>Fire point (°C)</td>
<td>-</td>
<td>215</td>
<td>170</td>
<td>69</td>
</tr>
<tr>
<td>5</td>
<td>Calorific value (MJ/kg)</td>
<td>-</td>
<td>38.48</td>
<td>40.32</td>
<td>42.5</td>
</tr>
<tr>
<td>6</td>
<td>Cloud point (°C)</td>
<td>-3 – 12</td>
<td>10</td>
<td>3</td>
<td>-5</td>
</tr>
<tr>
<td>7</td>
<td>Pour point (°C)</td>
<td>-15 – 10</td>
<td>2</td>
<td>-4</td>
<td>-12</td>
</tr>
<tr>
<td>8</td>
<td>Ash content (%w/w)</td>
<td>&lt; 0.02</td>
<td>0.019</td>
<td>0.004</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Carbon residue (%w/w)</td>
<td>&lt; 0.05</td>
<td>0.4</td>
<td>0.02</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Sulfur content (%w/w)</td>
<td>&lt; 0.0015</td>
<td>Nil</td>
<td>Nil</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Copper strip corrosion</td>
<td>max 3a</td>
<td>1a</td>
<td>1a</td>
<td>-</td>
</tr>
</tbody>
</table>

**Conclusion**

- Varying methanol to oil molar ratio has less effect on biodiesel yield.
- Increase in reaction time higher than optimum value leads to reverse transesterification.
- Increase in CaO amount higher than optimum value leads to soap formation.
- Fuel properties of produced biodiesel are in the range of ASTM and IS standards.
- Microwave assisted biodiesel production method gives good quality of biodiesel and it is economical.

**Scope for future work**

The performance, combustion and emission characteristics of produced biodiesel can be analyzed on diesel engine with single or multi cylinder, with constant or varying injection pressure.

* ~ * ~ *

**5. Study of Performance and Emission Characteristics of a Diesel Engine Fuelled with Blends of Neem and Simarouba**

**PROJECT REFERENCE NO.: 39S_B_MTECH_010**

**COLLEGE** : AMRITA SCHOOL OF ENGINEERING, BENGALURU

**BRANCH** : THERMAL SCIENCE AND ENERGY SYSTEM

**GUIDES** : PROF. VINOD KOTEBAVI

**STUDENTS** : MR. SUNIL KUMAR M.
1. Introduction

In the present scenario the diesel engine is a popular prime mover for transportation and for industrial experiments. But in recent years the demand in energy has increased dramatically so the production of biodiesel which is renewable, biodegradable and non-toxic fuel can be extracted from vegetable oil can be considered as an alternative fuel used in the diesel engine. Therefore the biodiesel is having very good fuel properties better than diesel fuel so that the environment will be free from hazardous pollution. The biodiesel is having high flash and fire point temperatures than diesel fuels so it is safest among all alternative fuels. The present investigation is the Study of Performance and Emission Characteristics of a Diesel Engine Fuelled with Blends of Neem and Simarouba oils.

1.1 Simarouba (simarubaceae)
Simarouba commonly known as The Paradise Tree or King Oil Seed Tree. It belongs to simarubaceae family. The height of this tree will be 7-15m. In India, it is mainly found in Andhra Pradesh, Karnataka and Tamil Nadu etc. This tree can produce 2000-2500 kg seed/hectare-year.

1.2 Neem (mellia azadirachta)
Neem belongs to family azadirachta indica. Neem oil has extracted from the fruits and seeds of the neem. Neem oil can be in golden yellow, yellowish brown, reddish brown or bright red in colour. The content of neem oil varies from 300ppm to over 2500ppm depending on the extraction technology and quality of the neem seeds crushed. In India, neem oil is not used for cooking purpose so it can be used in different methods like extracting biodiesels, preparing cosmetics, etc.

Objectives:
- Free fatty acid test to find the amount of catalyst to be added
- Preparation of biodiesel.
- Measurement of the properties like density, flash point, fire point, viscosity, calorific value, specific gravity of the biodiesel and blends.
- Testing on diesel engine and Obtain performance characteristics like brake specific fuel consumption and brake thermal efficiency of the engine.
- Measurement of emission contents like NOx, CO2, CO, HC and SMOKE for different blends with diesel.
- Comparison of performance and emission characteristics of the engine with blends and pure diesel.

3. Methodology

3.1 Extraction of biodiesel oil
The manual oil expeller was used to extract the oil from the seeds which is having high pressure screw press. It also contains a stainless helical screw. Then the extracted oil was kept at room temperature in order to settle the solid particles down. Then the oil is filtered and heated to remove the unwanted particles in the oil. Finally, the oil is kept in the conical flask and sealed.

3.2 Measurement of free fatty acid
The measurement of free fatty acid is to measure the acid content in the oil. For measuring the FFA 1g NaOH is added with 1L of distilled water and taken in burette. Then 1g of sample oil in 10ml isopropyl alcohol in conical flask and add few drops of phenolphthalein is added. Titrate the sample till pale pink colour appears. 3.5g of NaOH per litre of oil is required.

3.3 Trans-esterification process
Biodiesels are prepared by trans-esterification process, where the triglycerides of oil are converted to their monooesters by the reaction of methanol in the presence of sodium hydroxide. This process is mainly used to reduce viscosity of triglycerides and to remove the impurities. The main procedure is Take 1000ml of both simarouba and neem oil in a beaker. Then calculate the amount of methanol and NaOH is called as methoxide. Add the catalyst...
in the beaker containing oil and place on the automatic magnetic stirrer and the process should be stirred continuously. Simultaneously the oil should maintain the temperature of 500 -600 c. Allow the mixture to settle down and then transfer in separating funnel and leave it for 24 hours. After the mixture to settle down for 24 hours, two layers will be obtained. One layer is biodiesel and other is glycerol. Remove the biodiesel and collect in separate flask.

3.4 Blending
The pure biodiesel is denoted as B0. The produced dual biodiesels is blended with diesel at different proportions as 0%, 10%, 20%, 30% and 40% and they are denoted as B10, B20, B30, and B40 respectively.

3.5 Emission specifications
Smoke meter is used for measuring the capacity of the exhaust from diesel vehicles. It consists of three units. One is a smoke chamber which contains the smoke column through which the smoke from the tail pipe of a vehicle is passed and smoke density is measured. The measuring electronics is clamped on at one end. Second one is the RPM adapter which measures the oil temperature. The exhaust gas to be measured is fed into the smoke chamber.

Five gas analyzer is used for testing the emissions from automotive engines. The instrument can measure carbon monoxide (CO), Carbon Dioxide (CO2), and Oxygen in percentage, and Hydrocarbons and Nitric Oxide (NOx) in ppm. The analyzer uses the principle of Non-Dispersive Infra-Red (NDIR) for measurement.

3.6 Engine specifications
The diesel engine test was conducted using Kirloskar AV-1, 4-stroke single cylinder engine. Tests have been conducted at different blends of biodiesel with standard diesel, at an engine speed of 1500 rpm and varying load. The compression ratio and diameter of brake drum was set to 16.5:1 and 0.36m respectively.

4. Results and conclusion
The performance and emissions characteristics of diesel engine fuelled with biodiesel blends have been analysed, and compared with pure diesel fuel. The results of present work are summarized as follows:-

- Dual biodiesel satisfies the important fuel properties as per ASTM specification of Biodiesel.
- The diesel engine performs satisfactorily on biodiesel fuel without any significant engine modifications.
- The brake thermal efficiency decreases with increase in percentage of biodiesel blends.
- The specific fuel consumption increases with increase in percentage of biodiesel blends due to the lower calorific value of biodiesel blends.
- The B10 shows good brake thermal efficiency in comparison with diesel. A little increase in fuel consumption is often encountered due to the lower calorific value of the biodiesel.
- The blend B10 having same engine output and lower change in emissions compared to diesel.
- Finally, in view of the petroleum fuel shortage, B10 blend biodiesel can certainly be considered as a potential alternative fuel.
SYNOPSIS OF MBA PROJECTS
1. FINANCIAL ANALYSIS OF BIO-DIESEL MANUFACTURING

PROJECT REFERENCE NO.: 39S_B_MBA_004

COLLEGE : M.S. RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE
BRANCH : MANAGEMENT STUDIES
GUIDES : DR. Y.M. SATISH
STUDENTS : MS. DIVYASHREE R.
            MS. GOWTHAMI S.
            MS. KIRAN CHoudRY R.
            MR. HITESH C.

INTRODUCTION
Day by day environmentally clean and less harmful sources of diesel fuel for conventional engines are becoming more and more popular because of global warming problems, high level of pollution of the atmosphere created by devices and increased expansion of human diseases. There are various sources of such non-harmful diesel fuels, like ethanol and biodiesel which can be obtained from diverse vegetable oils and animal fats. The cost effective production of biodiesel provides an alternative fuel to customers, the study focuses on determining the cost of production of biodiesel and there by identifying the areas for reducing the cost. In addition to this the study also aims at financial analysis of bio diesel plant. The project's validity and profitability will be analyzed based on the Investment Appraisal.

KEYWORD
Biofuel, biodiesel, biodiesel plant, financial analysis, capital on investment, operating cost, interest on capital, cash flow, funds flow.

RESEARCH QUESTIONS
- RQ1: What is the status of the bio-fuel production in Bangalore?
- RQ2: How much cost is incurred for setting up a biodiesel plant?
- RQ3: Does government provide subsidy for equipment's?
- RQ4: How much waste oil is produced every day in Bangalore?
- RQ5: How economical could bio fuel be for commercialization?

OBJECTIVES
- To analyze the capital investment required for setting up a biodiesel plant.
- To perform financial analysis for determining profitability and its sustainability of the biodiesel plant.
- Cost incurred at each stages of the biodiesel production.
- Identifying the areas for reducing the cost.
- Evaluate the cost effectiveness of biodiesel production.

METHODOLOGY
This project includes two methods they are as follows:
1. Primary method
2. Secondary method
Primary method:
This method includes collecting the data through survey by questionnaire method.
  • During the in plant study of various biodiesel plants located across Bangalore city, the information was collected through various sources like professionals and employees of the biodiesel plants.
  • In addition to this, information was collected from Government agencies and authority associated with biodiesel ministry.

Secondary method:
  • The data was collected from the biodiesel development board.
  • The profitability analysis is done using techniques like comparative analysis and BEP.
  • The investment appraisal will be done using capital budgeting techniques such as NPV, IRR and so on.
  • Cost analysis was performed using process costing method.

LIMITATIONS OF THE STUDY
  • Time was the big constraint in carrying out of this research since the funding agency has set the time bound.
  • Lack of information about the availability of waste cooking oil.
  • Study was limited to biodiesel plants located in Bangalore city only.
  • Many of the industrialists are not co-operating and not willing to share the information.

RESULTS AND CONCLUSION
Results
  • From the study we have analyzed the capital investment required for setting up the biodiesel plant.
  • We have made comparative analysis of both seed and waste cooking oil in biodiesel production and as per the results we understand that biodiesel from waste cooking oil is more economical and can be commercialized.
  • We have calculated the cost incurred at each stage of the biodiesel production.
  • In production using seeds consist of more stages when compared to production using waste cooking oil. It consist seed crushing process because of which the total cost of producing biodiesel from seeds increases.
  • Where as in producing biodiesel from waste cooking oil directly goes into transesterification unit. Hence there is reduction in the total cost of biodiesel.
  • We have studied about the areas of cost reduction they are:
    - Feedstock can be replaced by waste cooking oil.
    - Getting subsidy for the equipment’s used in production process.
    - Procurement of waste cooking oil directly from hotels.
  • Using capital budgeting techniques such as NPV and also breakeven point analysis, we have found the cost effectiveness of biodiesel production.

Conclusion
The results of the cost–benefit analysis are first presented separately. The cost–benefit stream for the vegetable oil. The base case provides a 13.61% economic internal rate of return (EIRR), which is higher than the Indian government’s cutoff rate of 12%. At a 12% social discount rate, vegetable oil provides a positive net present value (NPV).
This project discusses the financial and economic aspects of biodiesel production in Bangalore. The project may clearly demonstrate that biodiesel is economically viable, and can generate sizable employment opportunities despite its financial non-viability under the present administered pricing scheme.
If production is limited to wasteland, the food sector will not be adversely affected. However, the biodiesel sector will not take off, even with all these advantages, unless the government intervenes to correct market and nonmarket failures that prevent the biodiesel markets from developing. Government interventions may include research on the agronomy of oilseed plants, the allocation of wasteland, the establishment of a dedicated agency for biodiesel, and the provision of an incentive package for private investors and small-scale producers.

**FUTURE SCOPE OF THE STUDY**

Study is confined to biodiesel plants located in Bangalore city. This project can be implemented in the biodiesel plants and it can be extended to other cities also.

Current energy systems need a vast transformation to meet the key demands of the 21st century: reduced environmental impact, economic viability and efficiency. An essential part of this energy revolution is bioenergy. Biofuels provides a forum for all stakeholders in the bioenergy sector, featuring review articles, original research, commentaries, news, research and development spotlights, interviews with key opinion leaders and much more, with a view to establishing an international community of bioenergy communication. As biofuel research continues at an unprecedented rate, the development of new feedstocks and improvements in bioenergy production processes provide the key to the transformation of biomass into a global energy resource. With the twin threats of climate change and depleted fossil fuel reserves looming, it is vitally important that research communities are mobilized to fully realize the potential of bioenergy.

* ~ * ~ *

**2. FINANCIAL ESTIMATION FOR SETTING ON BIODEISEL PLANT**

**PROJECT REFERENCE NO.: 39S_B_MBA_003**

**COLLEGE** : NEW HORIZON COLLEGE OF ENGINEERING, BANGALURU

**BRANCH** : MANAGEMENT STUDIES

**GUIDES** : DR. SHEELAN MISRA, MS. BABY NIVIYA FESTONMR. KEERTHI M. REDDY, MR. K.S. PRUTHVI KUMAR

**STUDENTS** : MR. PRAMOD G.R.

MR. SURESH KUMAR A.

MR. PREETHAM R.K.

MR. VAIBHAV JALAN

**Introduction**

Biodiesel is a clean burning fuel which is been extracted from vegetable oil, animal fat, waste oil, seeds oil through a chemical processes, when oil is been treated and converted in to
biodiesel it is also left behind with byproducts which is further guaranteed to be used as a raw materials. Biodiesel is an alternate for diesel engines without modification which helps common man to use and afford, it is a renewable recourses which can be extracted from various oil, the carbon emission is reduced drastically hence there is no Ozone depletion, no air pollution. The byproducts are used in soap manufacturing, feed for livestock’s, and keeping the environment clean by planting trees which in turn provide oil seeds and reducing carbon dioxide.

**Problem statement**
Considering the fast growing economy, major developments in industries, steep rise in transportation defines the need for energy which certainly emphasize on a easily available resource i.e. crude oil. Crude oil is available in few countries which are considered to be highly expensive day by day since its availability is niche. Where as its adverse effect on the environment cannot be retained due to excessive use of crude oil there is rise in carbon emission leading to Ozone layer depletion, Global warming, Air pollution causing cancer, which makes our environment unsustainable for living beings.

**Objectives**
1. To identify the Biodiesel as a business opportunity.
2. To reduce greenhouse gases.
3. To study the cost benefit analysis of Biodiesel business
4. To identify the biodiesel business as an employment generation enhancing rural development.
5. To obtain alternate diesel, this leads to less modification of engines.

**Existing process**
We are obtaining crude oil from certain countries which is been extracted in to by-products petrol, diesel, tar, grease etc. Which is been used in the engines directly.

**New and alternative process**
Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. This means that no retrofits are necessary when using biodiesel fuel in any diesel powered combustion engine. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources, is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level.

**DISADVANTAGES OF EXISTING SYSTEM**

1. Diesel engines require diesel fuel and while it’s true that not all gas stations offer diesel, the infrastructure is still excellent (Remember, most trucks and buses run use diesel fuels).
2. Pollution is high( If you are a environment friendly person i suggest to avoid its on this grounds)
3. diesel is composed of larger and heavier hydrocarbon molecules. The larger molecules resist breaking up of carbon bonds thus being less efficient than gasoline.
4. Diesel vehicles have a reputation of being smoky and smelly, a throwback to the low-tech diesels found in older vehicles.

**ADVANTAGES OF EXISTING SYSTEM**

1. Biodiesel is not harmful to the environment. A vehicle tends to pollute the environment and emits harmful gasses, if injected with HSD whereas if the engine is
using biodiesel it emits no harmful gasses rather keeps the environment pollution free.
2. Biodiesel may not require an engine modification. Biodiesel can be blended with diesel so as to improve the efficiency of the engine without any hassles.
3. Biodiesel is cheap. You can even make biodiesel in your backyard. If your engine can work with biodiesel fuel alone, then you really need not go to the gas station to buy fuel. You can just manufacture some for your own personal use.
4. Any Vehicle using Biodiesel has very low idle stating noise. It is noted that biodiesel has a Cetane number of over 100. Cetane number is used to measure the quality of the fuel's ignition. If your fuel has a high Cetane number, you can be sure that what you get is a very easy cold starting coupled with a low idle noise.
5. Biodiesel is cost effective because it is produced locally.

Conclusion

Biodiesel is an alternative fuel similar to conventional or ‘fossil’ diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. Which is renewable and convenient alternative fuel.

* ~ * ~ *

3. A STUDY ON TRAINING NEED ASSESSMENT FOR THE FARMERS WITH REFERENCE TO EXPERT FARMING PRACTICES OF JATROPHA BASED BIO-FUEL IN KARNATAKA

PROJECT REFERENCE NO.: 39S_B_MBA_006

COLLEGE : SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE
BRANCH : MANAGEMENT STUDIES
GUIDES : DR. T. JOEL GANANAPRAGASH
STUDENTS : MR. VIVEK G.
MR. MITHUN B.
MR. SUBHASH J.K.
MR. NAVEEN KUMAR S.C.

1. INTRODUCTION:
Global warming is changing climatic conditions which have real implications for everyone. One of the factors causing Global warming is burning of fossil fuels. Globally, there is a much hue and cry about alternate environment friendly sustainable energy. While bio-fuel is considered to be the alternate source of energy, there is arguable case about the cultivation which might affect the cultivation of food crops. Moreover, the question of economic viability and feasibility are yet to resolved by the ongoing research efforts. It is interesting to note that
there are variety of Tree Borne Oilseeds (TBO’s) used for producing bio-diesel which are abundantly available in Karnataka. However, the Tree borne Oil seeds (TBOs’) which is used for producing bio-fuel is also found to be used for several other benefits. It provides excellent lubricate to the fuel injection system. TBO’s are being used for extracting Lamp oil, medicinal properties and other by-products. While growing TBOs’ provides as additional source of income to farmers, there are poor people who collect TBO’s for their livelihood income. Against this backdrop a study on training need assessment for farming community with specific reference to TBOs’ was conducted in Karnataka. The study aimed at gaining insights about TBOs from experts and study about the awareness of TBO’s among farmers and training need for farmers to grow TBO’s.

The study brings out interesting results about the most commonly found TBOs, awareness of the farmers about TBOs and its benefits, interest of the farmers to grow as a hedging Plants, and the TBO’s collection for secondary source of income to the poor people and the farmers preference to use TBOs for multiple benefits.

1.1 KEYWORDS: Fossil Fuel, TBO’s – Tree Borne Oil Seeds, Hedging Plant, Intercrop, Bio-diesel extraction, KVK (Krishi Vignana Kendra), Bio-fuel Park, Pongamia, Simaruba, Neem, Hippe, Pongamia Cake, Jatropha, Gober Gas, Glycerin, Middlemen, Expelling unit, Insect Repellent, Manure,

2.1 RESEARCH GAP:
The research team reviewed the relevant literature (some of which is presented here now) and identified the research gap. The research gap of this study was identified as the training need for farmers for growing TBOs as an Intercrop and secondary source of Income.

3. OBJECTIVES:
The literature review and the discussion we had with an expert at KSBDB helped to set the following objectives:
1. To gain insights regarding TBOs and understand the opinion of experts regarding the training for farmers to cultivate TBOs.
   Brief about Objectives: It was important to gain insights on TBOs before meeting farmers and hence the objective was set to meet the experts.
2. To Know the awareness level of farmers regarding Tree Borne Oil Seeds (TBOs)
   It was essential to know if the farmers are aware the trees that are having high oil content which could be collected and sold for secondary income purpose. Apart from oil, there are other uses and the study was aimed at understanding if the farmers know the benefits and from where it could be marketed.
3. To understand if there is any training need for cultivating TBOs:
The study also made an attempt to know from the experts if any specific cultivation practice is needed for growing TBOs. Accordingly, it was also studied from farmers to know if there is any training or awareness programme is required for them.
4. To identify the need for educating low income group public regarding the awareness of TBOs for their secondary income.
   Though, TBOs are grown as Intercrop and considered by the farmers as secondary source of Income, it is also one of the sources of income to the low income group which necessitated to study if the low income group is aware of such source of income and their willingness to procure and sell it to institution expelling oil etc.

3.1 : HYPOTHESIS:
The following Hypothesis is set:
1. The farmers who are aware of TBOs are interested to grow trees yielding TBOs
2. The lower income group having awareness about TBOs are interested in collecting TBOs.

4. METHODOLGOY:
4.1 Research Design: Descriptive research design was adopted for the study to describe the expert opinion and the farmers training need assessment. Descriptive is appropriate as
the researchers did not have any control over the variables. It has been reported what is happening and what has happened with the farming community with respect to growing of TBOs.

4.2 Nature of Data: Both primary and secondary data was used for the research. Secondary data was used for the study to know about the TBOs and primary data was collected both from experts to gain insights and farmers.

4.3 Sampling Design:

i) The sample unit for the study was experts and the farmers and low income group people

a) Experts Include:
   a. Rajeshkumar, Research Associate – GKVKBanglore
   b. Mr.Dayanand, Marketing Manager, KSBDB
   c. Dr.Halesh, Bio Fuel Park, Hasan
   d. Dr.Srinivasappa, KVK, Dodapalapur
   e. Dr. Srinvas, Aspathrika, KET

b) Farmers: 25 Farmers in and around Kinnerahalli at Hasan District, Karnataka.

C) Low Income group – Housekeeping staff at SIRMVIT, Bangalore:
   TBOs collection is one of the sources of income for low income group. This study also made an attempt to know if the low income group was aware of such sources and are interested in seed collection

ii) Sample Size: The total sample size: 50
   Sample size for Experts : 5
   Sample size for Farmes : 25
   Sample size for Low Income Group : 20

iii) Sampling Technique:
   Purposive sampling technique was adopted for the study as only the respondents who are into the field of agriculture could respond to study. And low income group is studied purposefully as this seed collection may be a secondary source of income only to this group.

4.4. Method of Data Collection:
   The data for the study was collected using: 1) Expert Opinion Method – to collect data from respondents; 2) Survey Method - A structured questionnaire was designed for farmers and low income group and which was administered through interview schedule.

4.5 Tools used for Analysis:
   The statistical tools used for the study include Chi-Square test, Percentage Analysis

5. RESULTS AND CONCLUSIONS:
   The Experts opinion method gave us an insights as to the TBOs and the multiple benefits associated with the TBOs. Although, Government policies regarding Jatropha cultivation was impetus during 2006, it was later found that the Jatropha was not an economical bio-fuel crop and hence the experts were of the opinion that there are other varieties of TBOs which can be grown for multiple benefits other than Bio-diesel alone. Also they are of the opinion that TBOs could be cultivated on hedges, wasteland and also an intercrop. It is also understood, the institutions are supporting farmers for collection of seeds, and selling of seeds expelling oils.

   The farmers located in and around of Kinnerahalli, Hasan District were studied and it revealed the fact that the Government initiated efforts for spreading awareness on TBOs through institutions like KVK has really made dent in some farmers as they have a strong favorable opinion on growing TBOs. And some farmers are turned out to be Opinion Leaders to recommend to his neighbor farmers for growing TBOs for the purpose of secondary income.

   However, most of the farmers are not much aware of the TBOs especially it as grown in hedging and intercrop for their secondary source of income. It is also found that the farmers who are aware of TBOs are interested growing TBOs. Some of the farmers were informed about TBOs and its benefit by researchers and instantly they were interested in getting saplings for growing in their waste land. Accordingly, the researchers requested the officials
CONCLUSION:
Although, TBOs are one of the alternate sources for energy or bio-fuel, still a research is needed for making it more economically viable and competent source of energy. TBOs are considered for other uses like Oil, Cake, glycerin etc. and hence the necessary arrangements for creating more awareness among the farmers and low income group may be useful to society.

6. SCOPE FOR FUTURE WORK:
There are TBOs grown naturally across villages and waste land and a research can be initiated to know the places where more TBOs are grown and people who are within the proximity of these places can be created awareness for their source of income. Further, research can be undertaken to study the opinion leaders in villages and imbibe training with these farmers so as to spread the awareness among the village community to grow TBOs for hedging or intercrop so as to enable poor farmers and lower income group with a secondary source of Income.

* ~ * ~ *

4. A STUDY ON COST ANALYSIS OF PROCUREMENT AND PROCESSING OF NON-EDIBLE OIL SEEDS

PROJECT REFERENCE NO.: 39S_B_MBA_001

COLLEGE : SESHADRIPURAM INSTITUTE OF MANAGEMENT STUDIES, YELAHANKA
BRANCH : MASTER OF BUSINESS ADMINISTRATION
GUIDES : DR. BHAVANI M.R., PROF. VIDHYA P.
STUDENTS : MR. BIRENDRA SAH
               MS. FOUZIA BEGUM
               MR. ASHWIN KUMAR N.S.
               MS. RASHMI K.R.

Introduction
India is one of the fastest growing economies in the world. The Development Objectives focus on economic growth, equity and human well being. Energy is a critical input for socio-economic development. The energy strategy of a country aims at efficiency and security and to provide access, which being environment friendly and achievement of an optimum mix of primary resources for energy generation. Fossil fuels will continue to play a dominant role in the energy scenario in our country in the next few decades. However, conventional or fossil fuel resources are limited, non-renewable, polluting and, therefore, need to be used prudently. On the other hand, renewable energy resources are
indigenous, non-polluting and virtually inexhaustible. India is endowed with abundant renewable energy resources. Therefore, their use should be encouraged in every possible way.

This project aspires to contribute to the discussion regarding the development of non-edible or bio-fuel production plant in Karnataka. More specifically, operation cost, financial conditions and to see the working capital to focus on establishing a long-term relationship business and downstream agribusiness (processors, exporters and retailers) on the other. Also the provision of extension services such as finance, training, inputs, etc. enhance the development and capabilities which can stimulate the development of sustainable market linkages. However, there are high costs and risks associated with linking production of bio-fuel. Problems with regard to production costs and volumes, poor access to information, etc., raise the transaction costs of working with a large number of small farmers. In addition, the low production capacity of smallholders is an obstacle to achieve economies of scale.

**Objectives**

1. To find out the sourcing of non-edible oil seeds
2. To find out the processing cost of non-edible oil seeds
3. To estimate the marginal cost of processing of bio-fuel.

**Methodology**

The methods and methodology are selected such that the objectives can be fulfilled

**Out sourcing of non-edible oil seeds**

Availability and location of various types of non-edible oil seeds available in Karnataka state was be analyzed based on the literature review. Also, the various way of out sourcing of non-edible oil seeds was analyzed. The data will be used to create a matrix which gives the seeds out sourcing during a year.

**Processing cost of non-edible oil seeds**

Here we directly interact with farmers to know the cost of the different types of seeds and also what is the cost incurred for collecting the seeds, farming seeds, what are their carrying cost, what are the cost of its by-products, which helped us to calculate the processing cost of non-edible oil seeds.

**Marginal cost of processing of bio-fuel.**

Cost of different types of non-edible oil seeds was analyzed, because it is one of the important parameter for analyzing the cost of raw material and also marginal cost of processing of bio-fuel.

![Processing of Non-edible oil and its by-product.](image)

**Fig: Processing of Non-edible oil and its by-product.**

**Scope of the study**

Our study focuses on Hassan district, Doddabalapur, Chikkaballapur, and Tumkur in and around for the collection of data.
The study emphasized on the sourcing and processing production plants (either in large scale or in a laboratory) was the focused region for our research to gain access to the cost incurring on the procurement and processing of non-edible oil seeds. “Small is beautiful” was the baseline of our research where we have undertaken a specific seeds like Jatropha, Neem, Pongamia and Hippe, are main focused seeds and sources for the generation of bio-fuel and by-products. The study focuses on adoption and application of cost cut, cost control and cost monitor as an indicator to minimize the cost to the fullest in the process.

**Results and conclusion**

**Results**

From the above research the non edible seeds production is increasing year by year and also the government initiatives and their developmental programs have given a significant result in year 2014-15, hence for the commercialization or large scale operation in bio-fuel industry with an emerging of both domestic and foreign players.

Availability of raw material, technological advancement has gradually decreasing the cost of production of the bio-fuel and the demand for bio fuel is core objective for creation of many entrepreneurial talents so, both push from government, entrepreneurs and research institutes and pull factor from corporate customers, next best alternative for fossil fuel has created an immense opportunity to enter, grow and flourish in bio market.

**Conclusion:**

**Procurement**

Use of both organized and unorganized sources for procurement of seeds which enable a constant flow of input into production system which makes the business to expand their operations.

Use of competitive pricing technique which enables the concern to gain access to premium quality seeds at the most appropriate price for both framers and buyers.

**Processing**

The process need to be simplified and systemized so that the product flow from the start to end can be done in a better manner which yields revenue through cut down of complex process and to achieve economies of scale in a faster way.

Adoption and usage of SOP (Standard of Processing) makes the business concern to elaborate and expand its operation in a most effective way which creates an immense opportunity for low investment business with higher return on it, through usage of proper cost check in all the functional process of the business.

Edible oils are in use in developed nations such as USA and European nations but in developing countries the production of edible oils are not sufficient. In a country like India, there are many plant species whose seeds remain unutilized and underutilized have been tried for biodiesel production. Non-edible oil seeds are the potential feedstock for production of biodiesel in India. These species have shown promises and fulfills various biodiesel standards. India, with its huge waste/non-fertile lands, has taken a well noted lead in the area and commercial production. Proper processing of non-edible oil seeds and transesterification can ascertain the quality of biodiesel and can be fulfill the large commercial application

**Scope for future work:**

The future success of these non edible – oil as a sustainable source of feedstock for the bio-fuels industry is reliant on an extensive knowledge of the genetics, physiology, and propagation of these species. In particular, research should be targeted to maximizing plant growth as it relates to oil biosynthesis.

This research will help in trade related policy initiatives to elevate farmer rights in selling of the seeds. Emerge of more consumption in non-edible oil seeds lead to diversity and renew the resources. It will also help the farmers in crops improvisation in producing of seeds.

* ~ * ~ *
SYNOPSIS OF B.E. EXHIBITION PROJECTS
1. BIOELECTRICITY PRODUCTION THROUGH INTEGRATED BIOGAS AND MICROBIAL FUEL CELL

PROJECT REFERENCE NO.: 39S_B_BE_051

COLLEGE : DAYANANDA SAGAR COLLEGE OF ENGINEERING
BRANCH : BIOTECHNOLOGY
GUIDES : PROF. MADHU H.N.
STUDENTS : MS. ANJALI C.
               MS. HARSHITHA S. JOIS
               MS. NOUSHIN SEGU AMEER

INTRODUCTION

Integration of biogas and MFC systems: A microbial fuel cell (MFC) is a device that converts chemical energy to electrical energy by the action of microorganisms. When microorganisms consume a substance such as sugar in aerobic conditions, they produce carbon dioxide and water. However, when oxygen is not present, they produce carbon dioxide, protons and electrons, as shown below:

$$C_{12}H_{22}O_{11} + 13H_2O \rightarrow 12CO_2 + 48H^+ + 48e^-$$

Maximum proton and electrons will produce at acetogenesis and methanogenesis, utilizing this biogas production we were able to integrate electrochemical and combustion pathways for maximum utilization of energy conversion for light and heat energy. Integration of biogas and microbial fuel cell for electricity generation was done in a small scale semi batch biogas reactor, carbon rods were inserted and connected through salt bridge to get maximum gas yield as well as electricity. In other such setups a proton exchange membrane such as nafion is used instead of salt bridge. Microbial fuel cell and biogas production were constructed by integrating both biogas and microbial electricity to get maximum electricity from integrated process. Followed by optimization and enhancement of bioelectricity from integrated process. Innovative reactor models for different reactor volumes (Home use, industries), and substrates of different waste sources, Temperature, pH optimization was done to maximize electricity production. Maximum electricity for luminous light generation and continuous production of biogas by fermentive reaction using an establishment of interface between microbial fuel cell and semi batch reactor was setup. Electricity generated was integrated by converting methane gas to light by combustion reaction and also electricity generated from microbial fuel cell will enhance the bio electricity. Therefore biogas can be used directly to produce thermal energy, or it can be used to power a gas or diesel engine to run a generator to produce electrical energy.

OBJECTIVES

- To produce biogas from cow dung and kitchen wastes.
- To setup a microbial fuel cell using kitchen waste and cow dung.
- To design an integrated system of biogas and microbial fuel cell for electricity generation and its optimisation.
- Microbial fuel cell setup using phytoplankton
METHODOLOGY:

![Diagram](image.png)

**Fig 2:** Integration of electrochemical and combustion pathways for maximum utilization of energy for light and heat energy

**1. Pre-treatment of nafion membrane:** Nafion is a sulfonated tetrafluoroethylene-based fluoropolymer-copolymer. It is a semi-permeable membrane designed to conduct protons while being permeable to gases such as oxygen or hydrogen. Their main function is separation of reactants and transport of protons. Nafion 112 was used as the proton exchange membrane. A pre-treatment of the membrane needs to be performed in order to activate the membrane. The membrane is first boiled with 0.1N hydrogen peroxide for thirty minutes. The membrane is then boiled in distilled water for thirty minutes. After which the membrane is boiled in 0.5N sulphuric acid for thirty minutes. It is then boiled in distilled water for thirty minutes. The membrane is further stored using distilled water.

**2. Small scale set-up:** Initially the biogester model was built in a 1000ml plastic container. Graphite electrodes of area $21.205\text{cm}^2$ wound with copper wires and PEM Nafion 112 was suspended from the lid of the plastic container. To the set-up approximately 100ml of biogas plant effluent, 100g of kitchen wastes and 100g of cow dung was added. The set-up needs to be maintained under anaerobic conditions. The container is sealed using m-seal and aquarium gel. An inlet and outlet pipe is connected. The outlet pipe is connected to a water displacement system. The copper wires wound to the electrode were pulled out of the reactor in order to measure voltage and current using a multimeter.

**3. Scale-up to 2l set-up:** The next step is scaling up to a 2l set-up using plastic containers. Two such containers were built. Approximately 1l biogas plant effluent, 500g of kitchen wastes, 500g cow dung was added. A combination of graphite electrodes connected to copper wires was used for one setup and a combination of brass electrodes connected to copper wires was used for another setup. The setup was sealed using m-seal, aquarium gel, and paraffin film. An outlet pipe was connected in order to collect biogas. The copper wires connected to the electrode were also pulled out of the setup to measure voltage and current using a multimeter.

**4. Scale-up to 5l biodigester vessel:** The next step is scaling up to 5l using biodigester vessel. One vessel is a sophisticated biodigester as it has a temperature control as well as pH control. A rubber gasket is used in order to ensure good anaerobic conditions. Approximately 2.5l of biogas plant effluent was added, 1kg of kitchen wastes and 500g cow dung was added. A combination of carbon bushes was used as electrodes for one vessel and a combination of graphite electrodes was used for the other. The electrodes were connected to copper wires and pulled out of the reactor. The vessel was sealed using m-seal, aquarium gel, and paraffin film. An outlet pipe has to be connected to collect biogas. The wires were pulled out and voltage and current was measured using a multimeter.

**5. Phytoplankton setup:** For a comparative study another open set-up was built in a glass container. Water was collected from a fresh water source. 5l of water was collected from the Gowdanpalyalake, Bangalore. This setup was maintained in good aerobic conditions with sufficient sunlight and oxygen. Graphite electrodes connected to copper wires was used to measure voltage and current using multimeter.
6. **Series combination of the set up:** All the different volumes of the reactors were connected in a series. The series connection was made by connecting the negative terminal of the first set-up to the positive terminal of the second and so on. The overall voltage and current was measured using a multimeter. A voltage booster (0.5V-5V) was connected to the circuit and a LED was connected and the circuit was closed. The map of the voltage booster is included. The wires were soldered to the booster.

7. **Water displacement system:** Each of the setup is connected to a water displacement system. This serves to check the anaerobic conditions as well as to collect the biogas produced. The outlet pipe from the set-up is drawn inside an inverted vessel placed inside another vessel filled with water. Another outlet pipe is drawn outside the vessel. The volume of water displaced by the biogas produced is the displacement of the water level shown.

8. **Biogas generation:** Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. It can produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. The biogas produced by the breakdown of organic wastes is collected using a water displacement system and it is further used in a biogas lamp to produce thermal energy for cooking and lighting purposes.

9. **Bioelectricity production:** The various pathways which the microorganisms use to breakdown the organic wastes such as methanogenesis ATP conversion takes place and lots of free radicals are produced. Chemical oxidation of organic wastes takes place and can be detected as electric signals. The voltage of these signals is measured using a multimeter. A voltage booster (0.5V-5V) is used to boost the voltage signals in order to be able to light an LED light.
**RESULTS AND DISCUSSION**

### 1.1 Voltage Readings with Different Substrates

#### Graphical representation of the results

![Graph showing voltage readings over different substrates](image)

**Table 1: Voltage readings for different combination of substrates**

<table>
<thead>
<tr>
<th>SUBSTRATE</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
<th>DAY 4</th>
<th>DAY 5</th>
<th>DAY 6</th>
<th>DAY 7</th>
<th>DAY 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>COW DUNG</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>SLURRY</td>
<td>13.2</td>
<td>20.8</td>
<td>26.5</td>
<td>33.7</td>
<td>36.1</td>
<td>41.4</td>
<td>49.7</td>
<td>51</td>
</tr>
<tr>
<td>COW DUNG + SLURRY</td>
<td>11.6</td>
<td>18.6</td>
<td>24.1</td>
<td>29</td>
<td>33.2</td>
<td>37.2</td>
<td>45.6</td>
<td>55</td>
</tr>
<tr>
<td>KITCHEN WASTE WATER</td>
<td>16.4</td>
<td>22.4</td>
<td>28</td>
<td>32.7</td>
<td>51.2</td>
<td>56</td>
<td>80.4</td>
<td>94.3</td>
</tr>
</tbody>
</table>

Different substrate combinations were added in different biodigester setups and obtained voltage was recorded on daily basis. From the recorded readings it was seen that voltage obtained from only cow dung was very low. Whereas for substrates, slurry and kitchen waste high voltages were obtained. Highest was obtained from kitchen waste water. Hence the substrate combination of slurry, cow dung and vegetable waste matter was chosen a suitable substrate for good voltage readings.

### 1.2 Volume of Biogas Collected with different Substrates

**Table 2: Biogas collected**

<table>
<thead>
<tr>
<th>SUBSTRATE</th>
<th>BIOGAS OBTAINED (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COW DUNG</td>
<td>0</td>
</tr>
<tr>
<td>INOCULUM</td>
<td>125</td>
</tr>
<tr>
<td>COWDUNG + INOCULUM</td>
<td>185</td>
</tr>
<tr>
<td>KITCHEN WASTE</td>
<td>0</td>
</tr>
</tbody>
</table>

![Graph showing biogas collected over different substrates](image)
Graph representing the volume of gas collected vs. number of days

Biogas collected was measured with a water displacement system. A gradual increase in the production of biogas was observed over a period of 35-40 days. From this comparison it was noted that maximum biogas was produced with cow dung and slurry under strict anaerobic conditions. Biogas production was high with cow dung and slurry due to the process of methanogenesis, it is the last stage of anaerobic digestion.

1.3 Comparison of Conductivity Different Electrodes

<table>
<thead>
<tr>
<th>ELECTRODES</th>
<th>AREA (cm²)</th>
<th>VOLTAGE (V)</th>
<th>CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAHITE</td>
<td>42.4115</td>
<td>0.6</td>
<td>6.4</td>
</tr>
<tr>
<td>BRASS</td>
<td>48.239</td>
<td>0.7</td>
<td>4.1</td>
</tr>
<tr>
<td>LEAD</td>
<td>12.393</td>
<td>0.4</td>
<td>1.6</td>
</tr>
<tr>
<td>COPPER</td>
<td>48.239</td>
<td>0.14</td>
<td>0.22</td>
</tr>
<tr>
<td>ZINC</td>
<td>12.393</td>
<td>0.02</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Table 3: Comparison of voltage and current for different materials and area

Comparatively graphite, brass, lead exhibited maximum conduction. Thus combinations of these three electrodes were used in the set up. Graphite electrodes were more suitable for the experiments due to its amorphous nature. The microbes in the medium attach to the walls of the graphite electrode and they carry out various metabolic pathways which releases hydrogen atoms and electrons.

1.4 Voltage Readings with Different Reactor Volume Setups

<table>
<thead>
<tr>
<th>VOLUME OF REACTOR (ml)</th>
<th>ELECTRODE COMBINATION</th>
<th>AREA OF ELECTRODE (cm²)</th>
<th>VOLTAGE (V)</th>
<th>CURRENT (mA)</th>
<th>pH</th>
<th>TEMPERATURE (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>GRAPHTHE,GRAPHITE</td>
<td>10.6028</td>
<td>0.006</td>
<td>0.008</td>
<td>6</td>
<td>32</td>
</tr>
<tr>
<td>1000</td>
<td>GRAPHTHE,GRAPHITE</td>
<td>21.205</td>
<td>0.1</td>
<td>0.271</td>
<td>6.2</td>
<td>32</td>
</tr>
<tr>
<td>3000</td>
<td>GRAPHTHE,BRASS</td>
<td>42.411,48.239</td>
<td>0.7</td>
<td>1.6</td>
<td>6.5</td>
<td>35</td>
</tr>
<tr>
<td>4000</td>
<td>LEAD,LEAD</td>
<td>12.393</td>
<td>0.4</td>
<td>1.2</td>
<td>6.5</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 4: Different reactor volume and combination of electrodes

Readings were noted from four different reactor set-ups, all of it maintained strictly under anaerobic conditions and maintained in optimum temperature range of 30-35° C. Four different set-ups with different volumes were constructed. Increase in voltage and current was observed with increase in area of reactor and area of electrodes. Maximum voltage and current of 0.7 V and 1.6 mA was obtained from 3l set-up Maximum voltage was tried to obtain with series parallel connection of two or more reactor set-ups.
**1.5 READINGS OF PHYTOPLANKTONS SET-UP**

<table>
<thead>
<tr>
<th>NUMBER OF DAYS</th>
<th>VOLTAGE (mV)</th>
<th>CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.2</td>
<td>0.004</td>
</tr>
<tr>
<td>2</td>
<td>11.7</td>
<td>0.007</td>
</tr>
<tr>
<td>3</td>
<td>14.5</td>
<td>0.009</td>
</tr>
<tr>
<td>4</td>
<td>15.9</td>
<td>0.342</td>
</tr>
<tr>
<td>5</td>
<td>19.3</td>
<td>0.510</td>
</tr>
<tr>
<td>6</td>
<td>23.1</td>
<td>0.825</td>
</tr>
<tr>
<td>7</td>
<td>26.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 5: Voltage and current for phytoplankton setup

Phytoplankton collected from fresh water source was maintained in aerobic conditions, graphite – brass electrodes were used in the set-up to measure the voltage. Voltage signals were observed and recorded for 7 days, a maximum voltage of 26.2 mV was recorded.

**Comparison of Performed Experimental Results with that of Literature [1]**


Comparison of results with literature survey of similar projects showed that voltage generated was much higher than other similar projects this project was able to obtain a voltage of 0.7 milivolts in 8 days where as the literature survey showed maximum of 103 microvolts. With kitchen waste the project obtained 94.3 millivolts whereas the literature survey showed 98 microvolts. It was observed when compared with similar experiments, as shown in the above tabular column this project results showed much higher voltage production with the similar setups.

**CONCLUSION**

To conclude, the combination of slurry, cow dung and vegetable wastes can be used as a suitable substrate to obtain a maximum voltage potential with the choice of electrode as graphite in a microbial fuel cell to obtain electricity. Voltage readings of all set-ups were recorded and monitored. A maximum voltage of 0.7V was obtained from 3lt setup using graphite and brass electrode combination also a maximum current of 1.6mA was obtained from the same set-up. These setups being maintained at an optimum temperature of 35-40°C for the methanogens to progress. It was noted in this experiment that degradation of organic substrates along with cow dung results in both biogas and bioelectricity. In this project we have demonstrated successful generation of bioelectricity and fuel for domestic purpose by Integrating biogas plants and microbial fuel cell for maximum energy generation.
Therefore such small reactors will create new market potential in home appliances, waste management and agriculture sectors. UPS and battery, solar equipment challenges can easily solved by methane fuel cells.

**FUTURE PERSPECTIVE**

New market potential in home appliances, waste management and agriculture sectors. UPS and battery, solar equipment challenges can easily solved by our innovation.

Small quantity Waste source will convert to electricity production which gives solution to waste management challenges faced.

* * *

**2. Design and development of seed decorticator for Simarouba glauca seed**

**PROJECT REFERENCE NO.: 39S_B_BE_099**

**COLLEGE**: CMR INSTITUTE OF TECHNOLOGY, BANGALORE

**BRANCH**: MECHANICAL ENGINEERING

**GUIDES**: DR. VIJAYANAND KAUP, MR. S.N. SONDUR

**STUDENTS**: MS. ANGELINE KAROL D.,

MR. JAYAKRISHNA A.K.,

MR. BIREN德拉 KUMAR SAHU,

**INTRODUCTION**

In 1861 a farmer named Bernagozzi from Bologna manufactured a machine called a “Scavezzatrice,” a decorticator for hemp (a family of plants, some of which are used to make rope and strong rough cloth and others of which are used to get the drug cannabis). The present available decorticators are wood decorticator, Neem decorticator, groundnut decorticator, Jatropha decorticator, coir decorticator, grains decorticator.

In today's life, time is considered as the very important aspect for doing any sort of work so while bio diesel production primary thing is produce the Simarouba oil which is produced by the Simarouba seed. These seed should be decorticated as early as possible which is manual work and is a time consuming process. Decortication is one of the major aspects in the production of bio diesel which helps to give more amounts of decorticated Simarouba seeds which can be later produced as biodiesel. A perfect decortication has to be done with less drudgery production.

There are many ways to decorticate the Simarouba pods. Generally in the village side they use manually i.e. pods are decorticated with a worker by a rod. The decorticating capacity and quality depends on the efficiency of the worker. There may be more amounts of losses and also major thing is time consumption. So a mechanism is required to reduce the decortication time with less wastage.

Another type is to decorticate the pods is by an **Agri-machine** which is major task in our project to design and fabricate for more efficiency.

The separation of seeds from Simarouba pods in rural areas is a difficult task which involves much physical strain, time consumption and loss of energy that in turn leads to drudgery. After obtaining the Simarouba seeds, there is no suitable technology for extracting Oil from these seeds. Hence, the rural farmers have lost considerable interest in Simarouba...
Plantation and management of existing trees population. Keeping this in view, there is a need of developing a suitable hand operated Decorticator for Simarouba decortication in order to reduce drudgery. In addition, this approach facilitates not only employment generation for the rural women but also create a technical platform for production of Biodiesel through sustainable technology. Besides, the India’s demand on importing fuel can be considerably minimized.

Objectives:
- Interaction with village farmers and collection of Simarouba glauca seeds.
- To design a hand operated decorticator for Simarouba glauca seeds.
- To develop and fabricate a prototype decorticator.
- To conduct trial runs using prototype.
- To make changes if the desired output and efficiency is not achieved.

Methodology:

**Base line Survey:** Base line survey is required to understand the ground reality of the farmer community, and the socioeconomic, cropping pattern, implementation of other factors.

**Interaction with village farmer:** The interaction is carried out with lead farmers of the villages and some pre-structured questionnaires were asked. Information regarding Simarouba plantation, cultivation, collection process and separating seeds from pods are collected.

**Drying of Simarouba glauca pods:** The collected pods are wet in nature. We have to dry it for better results. In order the pods generally sun drying is preferred. The word decorticator is referred as device which helps to remove the seeds from the pods and the device varies from crop to crop based on the seed type. In the project an efficient prototype has been designed and developed to decorticate Simarouba glauca pods.

**Results and conclusion:**

**Performance of Agri-machine:** The Simarouba glauca decorticator has weight of 25kg. It consists of small casing with length of 24.2cm, breadth of 30.2cm and height of 13.0cm and mounted on stand with four legs and the legs length is 96cm. On the roller the blades are cut with T-angle and 0° inclinations. The dimension of T-angle is 1.5cm x 2cm. In this prototype there are 14 blades of length 19cm, width of 1.5 cm and gap between the blades are 2.5 cm. Above the drum, a feeding hopper is fixed which is trapezoidal with rectangular opening at the lower portion. Hopper design is changed completely an enlarged hopper is removed and made an opening just required for the pods to cut, therefore Hopper cut is equal to blade distance. Hopper is made to go diverging i.e., the size increases from top of the drum to the top of the hopper, thus increasing the efficiency. The dimension of the hopper is 16cm length at bottom and 20.5cm length at top. At the right hand side, an S-shaped handle is fixed through bearing to rotate the blades present inside the drum without friction, which facilitates decortication of the pods. The dimension of the handle is 7.2cm, 19.8cm in length and 19.5cm in height. The handle diameter is 1.5cm. The complete height of decorticator is 130cm. The height from ground to the drum is 102cm. The distance between the legs is 85cm. There is a sliding plate present that is 38cm in length at 40° inclination for the easy collection of broken/unbroken pods. The gears are made up of 23 teeth. The OD of gear is 7.8cm and ID is 3cm. The face width for the bigger gear is 3cm and smaller gear is 1.5cm.

**Working of Simarouba glauca pod decorticator:**
Certain amounts of collected Simarouba pods were fed continuously through the hopper and simultaneously the handle is rotated. Blades are mounted on the drum will be rotating as the handle is rotated, and the pods are decorticated when they lie in between these blades. Medium size pods are easily subjected to decortication and small size pods usually escape. The outlet of the decorticator will be present at the bottom through which shells of pods and seeds are collected. Efficiency is calculated by accounting number of decorticated pods and undamaged seeds.
Design and fabrication of Simarouba glauca seed decorticator:
Keeping in view of all the above and a village nomad may face practical difficulties, an attempt was made to develop an Agri-Machine which not only reduces time and energy but also facilitates safety and reduction of drudgery. The Technical details are as follows:
The Simarouba decorticator consists of 4 major parts which are made up of mild steel, they are casing roller and blades, housing assembly, Base plate and Hopper at the top. The metals used in the fabrication are of economical and easy to alter in case of any damages to the parts. At the initial phase drawings with assumed values were completed. The sketch provided an overview of the agri-machine.

Rectangular casing integrated with roller and blades:-The size of the casing is minimal with a length of 30.2cm breadth 24.2cm and width of 13cm, which results in less material usage and more efficiency. The total weight of Simarouba decorticator is of 25kg thus making it more portable and easy to carry. At the right hand side, an S-shaped handle is fixed through bearing to rotate the blades present inside the drum without friction, which facilitates easy and smooth decortication of Simarouba pods. The dimension of the handle is 12.8cm, 7.2cm in length and 19.5cm in height. The handle diameter is 1.5cm.

Housing Assembly: Housing consisting of the lower and upper enclosures with blades re-incorporated with more accurate and precise cut of the blades.

Base Plate: The base consisting with four legs and the legs length is 96cm, the leg is made up of L-angle and have dimension of 2.5cm x 2.5cm which provides stability to both the casing assembly and the person operating it. Special arrangement is also provided to the base with more metal to enhance the stability of the functional prototype.

Hopper: Hopper design is changed completely to form it a more accurate droppings of the pods thus giving an edge to the other machines. Here hopper area is cut to equal the blade distance. Hopper is made to go diverging i.e., the size increases from top of the casing to the top of the hopper, thus increasing the efficiency by precise dropping of the pods. This arrangement was designed in such a way to accommodate all the types of the Simarouba pods (Large, medium and small) distinct by their nature. The dimension of the hopper is 16cm smaller length and 20.5cm larger length. The complete height of the decorticator is 130cm. The height from ground to the drum is 102cm. The distance between the legs is 85cm.
Efficiency of decortications with modified decorticator: Bulk trails were carried on decortication of Simarouba pods to check the efficiency of the developed Decorticator. The trails were conducted initially for hand full of Simarouba pods with respect to time and the rate of decortication was calculated. Later the trials of decortication were extended for 250g and the time duration along with rate of decortication was calculated. The average efficiency achieved was found to be most significant.

Table: Evaluation of Agri-machine: Simarouba Decorticator for its performance and efficiency

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>No. of pods</th>
<th>No. of partially decorticated pods</th>
<th>No. of completely decorticated pods</th>
<th>No. of unbroken pods</th>
<th>Time taken (sec)</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>70%</td>
</tr>
<tr>
<td>2.</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>80%</td>
</tr>
<tr>
<td>3.</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>80%</td>
</tr>
<tr>
<td>Mean</td>
<td>10</td>
<td>2</td>
<td>6.33</td>
<td>1.33</td>
<td>4.77</td>
<td>76.7%</td>
</tr>
</tbody>
</table>

From the table it can be inferred that the efficiency of the machine was high up to 76.7%.

* ~ * ~ *

3. SYNTHESIS OF BUTEA MONOSPERMA BIO DIESEL AND STUDY ON PERFORMANCE, COMBUSTION CHARACTERISTICS ON CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_047

COLLEGE : SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR
BRANCH : MECHANICAL ENGINEERING
GUIDES : MR. OMKARESH B.R.
STUDENTS : MR. HARISH G.R.
            MR. AKSHAY B.
INTRODUCTION
The world energy demand is also growing at faster rate. To cope up the increasing energy demand, majority of the developing countries import crude oil apart from their indigenous production. This puts extra burden on their home economy. Hence, it is utmost important that the options for substitution of petroleum fuels be explored to control the burden of import bill.

Fossil fuels are currently the dominant global source of CO₂ emissions and their combustion is stronger threat to the environment. Increasing of the industrialization, energy demand, limited reserves of fossil fuels and increasing environmental pollution have jointly necessitating the exploring of some alternative to the conventional liquid fuels, vegetable oils (edible and non-edible oil) have been considered as appropriate alternatives to the conventional liquid fuels, vegetable oils have been considered as appropriate alternative due to their prevalent fuel properties.

Objectives
- Effective utilization of Non-Edible oil seeds.
- Butea Monosperma as potential resource for biodiesel production.
- Production of biodiesel from Butea Monosperma seeds.
- Evaluation of physio-chemical properties of oil and biodiesel.
- Study of Performance and Emission characteristics on CI engine using Butea Monosperma biodiesel and its blends.

METHODOLOGY
Seeds are collected and oil is extracted by using mechanical expeller. FFA test is conducted for the extracted oil. FFA content is found to be 2.26, so two step process is carried out i.e esterification followed by Transesterification. The result is glycerin and crude bio-diesel. Glycerin is separated. Crude bio-diesel is subjected to methanol recovery process and it is washed with warm water to remove soap content. Final bio-diesel is obtained by heating the washed bio-diesel to 100°C to remove the water content. Physico-chemical properties are determined for both oil and bio-diesel and compared. Engine testing is conducted. Performance and emission results are tabulated.
RESULTS AND CONCLUSIONS
Biodiesel has become more attractive to replace the petroleum fuels. As per reputed literature, most of the Transesterification studies have been done on edible oils like rapeseed, soybean, and sunflower etc by using NaOH catalyst. The tree borne oil like Butea Monosperma is the most potential species to produce biodiesel in India which could offer opportunity for the generation of rural employment. The process is based on the alkaline catalysed Transesterification and can be further improved to get high yield and good fuel quality Biodiesel.
For varying loads, various blends of the biodiesel with compression ratio (17.5:1) and injection pressure of 200 bar the following conclusions are drawn from this investigation.

✓ Produced bio diesel satisfies the important fuel properties as per ASTM specification f Biodiesel.
✓ The existing diesel engine performs satisfactorily on biodiesel fuel without any significant engine modification.
✓ Engine performance with biodiesel does not differ greatly from that of diesel fuel. The B20 shows good break thermal efficiency in comparison with diesel. A little change in fuel consumption is often encountered due to the lower calorific value of the biodiesel.
✓ Most of the major exhaust pollutants such as CO, CO$_2$ and HC are reduced with the use of neat biodiesel and the blend as compared to neat diesel which is very much beneficiary. But NO emission increase when fuelled with diesel-biodiesel fuel blends as compared to conventional diesel fuel. This is one of the major drawbacks of biodiesel as NO emission is hazardous to human health.
✓ Among the blends, B20 showed the better performance and emission characteristics at various loading conditions.
✓ Peak cylinder pressure of all the fuel tested increases as the load increases.

GRAPHS:

Performance characteristics:
FUTURE SCOPE
1. A detailed study can be made on biodiesel from the combination of Butea Monosperma oil using different catalyst like MgO, CaO, and CaTiO3, etc.
2. Performance of bio-fuelled engines can be improved by adding oxygenated fuel additives.
3. By varying the number of spray holes and orifice diameter of nozzle by correct combination and optimizing the engine parameters an attempt can be made to increase the efficiency.
4. Preheated Bio fuels can be used to study the effect of preheating the fuel before injection on the performance and emission characteristics of direct injection CI engine using Bio fuel as fuel.
5. Further investigations can be done to explore the knowledge of dynamics combustion with biodiesel as fuel for the better optimization.
4. PRODUCTION OF BIODIESEL FROM YELLOW OLEANDER SEED AND PERFORMANCE ANALYSIS ON SINGLE CYLINDER CI ENGINE

PROJECT REFERENCE NO.: 39S_B_BE_054

COLLEGE: SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR
BRANCH: MECHANICAL ENGINEERING
GUIDES: MR. ARUN S.B.
STUDENTS: MR. SUKANTH TEJASWI K.L.
MR. SANJAY H.S.
MR. SYED YASEEN
MR. KARTHIK R.M.

INTRODUCTION
Increasing population density and economic development, particularly in developing countries like India, has led to huge increase in energy demand. The depletion of world petroleum reserves, the instability of petroleum sources, recent increase in petroleum prices and uncertainties concerning petroleum availability have generated interest in the development of alternate fuels for diesel engines. Biodiesel is a promising non-toxic, biodegradable and renewable fuel comprised of mono-alkyl esters of long chain fatty acids, which is produced by a catalytic transesterification reaction of vegetable oils with short-chain alcohols. Biodiesel has become an interesting alternative to diesel, because it has similar properties to the traditional fossil diesel fuel and may thus substitute diesel fuel with none or very minor engine modification. Biodiesel is oxygenated and essentially free of sulphur making it a cleaner burning fuel than petrol and diesel, with reduced emissions of SO2, CO, unburnt hydrocarbons and particulate matter. Other studies have clearly indicated that the use of biodiesel may potentially reduce the dependence on petroleum diesel fuel and improve environmental aspects with satisfactory performance.
Methodology:

Differences between Homogeneous and Heterogeneous Catalysis

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Homogeneous catalyzed Transesterification process</th>
<th>Heterogeneous catalyzed Transesterification process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reaction is Very fast</td>
<td>Reaction is relatively slow</td>
</tr>
<tr>
<td>---</td>
<td>----------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Reaction is 100% complete</td>
<td>Conversion is relatively poor</td>
</tr>
<tr>
<td>3</td>
<td>Catalyst dissolved in the reaction mixture</td>
<td>Catalyst does not dissolve in the reaction mixture</td>
</tr>
<tr>
<td>4</td>
<td>Purification is difficult</td>
<td>Purification is much easier</td>
</tr>
<tr>
<td>5</td>
<td>Biodiesel purification is by water washing</td>
<td>Biodiesel purification is by decalcification process</td>
</tr>
<tr>
<td>6</td>
<td>Catalyst cannot be recycled</td>
<td>Catalyst can be recycled and reused</td>
</tr>
<tr>
<td>7</td>
<td>Glycerine is pure and needs further purification.</td>
<td>Biodiesel and Glycerine are obtained in pure form.</td>
</tr>
<tr>
<td>8</td>
<td>Process is cheaper</td>
<td>Catalyst synthesis procedures leads to high cost</td>
</tr>
</tbody>
</table>

* ~ * ~ *

**5. HYDROGEN FUEL CELL VEHICLE**

**PROJECT REFERENCE NO.: 39S_B_BE_082**

**COLLEGE**: T. JOHN GROUP OF TECHNOLOGY, BANGALORE  
**BRANCH**: MECHANICAL ENGINEERING  
**GUIDES**: DR. SUJITH PRASAD E.  
**STUDENTS**: MR. VIVEKANANDA M.  
MR. ABHISHEK G. SHETTY  
MR. HARSHA S.  
MR. MAHANTESH MADIWALAR

**INTRODUCTION:**
Hydrogen is going to be the fuel for future. It is the most lightest and most abundant element in the universe. Pure hydrogen gas can extracted from various sources like hydrocarbons, fossil fuels, water etc. The best suitable source to produce hydrogen gas is water which is abundantly available on the earth. Hydrogen from water can be produced by a process called electrolysis which uses electrochemical reaction to separate H2 and O2 molecule from water.

In 1839, the Welsh scientist Sir William Robert Grove took the familiar electrochemical process of electrolysis which uses electricity to produce hydrogen from water and reversed it generating electricity and water from hydrogen. He called his invention a gas voltaic battery.
but today we know it as a hydrogen fuel cell. Much later in the middle of the 20th century the technology was further developed by the inventor Francis Bacon. The technology that these two inventors devised is essential to the operation of a hydrogen car. What makes a hydrogen car possible is a device called a fuel cell which converts hydrogen to electricity giving off only heat and water and water vapour as byproducts. Because it is non-polluting, hydrogen seems to be the ideal fuel for the 21st century. Several hydrogen cars are now in existence which include Chevrolet Equinox, the BMW745h, the Honda FCX, the recently released Toyota Mirai.

**OBJECTIVES:**
- To produce an eco-friendly driving car.
- To make use of freely available resources.
- To find an alternate fuel for automobiles.
- To manufacture it at a lower costs.

**Methodology:**

**ELECTROLYSIS:** Hydrogen gas can be produced by downward displacement reaction through electrolysis of water using electrolyzer with electrodes acting as cathode and anode. Battery can be used as electric source and tap water is used for electrolysis. The hydrogen gas produced is collected and allowed to pass into the fuel cell.

\[ \text{H}_2\text{O}(l) \rightarrow \text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \]

**HYDROGEN FUEL CELL (HFC):** The stored hydrogen gas is made to pass through the HFC at a certain pressure. The Fuel Cell consists of two catalyst coated electrodes. Graphite nanoparticles edged with iodine acts as anode and graphite nanoparticles edged with silver acts as cathode. These two electrodes are separated by a photon exchange membrane. This membrane is prepared by treating cotton sheets with KOH solution and allowing them to dry in acetone. In between these electrodes an electrode separator known as pvc (polyvinylchloride) sheets are provided to prevent direct contact between the electrodes. This fuel cell stack I covered with a scrap metal casing providing two inlet ports for passing hydrogen gas and oxygen gas. The hydrogen gas is passed through the anode which gets oxidized into H+ ions and these ions passes through PEM and gets reacted with O- ions which produced by passing oxygen through cathode. These ions gets reacted through an electro chemical reaction to form water and electricity is obtained. The electricity generated is stored in a battery. This power generated is not sufficient to run a vehicle but can be shown on a voltmeter to prove the working concept of the fuel cell. By passing proper amount of hydrogen gas and oxygen gas at suitable pressure and by using gaskets and still more technological advancements we can run a vehicle.

At anode \[ \text{H}_2(g) \rightarrow 2\text{H}^+ + 2e^- \]

At cathode \[ \frac{1}{2}\text{O}_2 + 2e^- + 2\text{H}^+ \rightarrow \text{H}_2\text{O} \]

**Net cell reaction** \[ \text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{H}_2\text{O}(l) \]

**Expected Outcome of the project:**
Drastic pollution minimization by using eco friendly Hydrogen Fuel Cell Vehicle (HFCV)

**Application of the project:** automobile industries.

* ~ * ~ *
6. ENGINE ANALYSIS AND EMISSION TESTING ON STRAIGHT VEGETABLE OIL (SVO) BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINES

PROJECT REFERENCE NO.: 39S_B_BE_097

COLLEGE: JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING
BRANCH: MECHANICAL ENGINEERING
GUIDES: MR. V. ASHOK, DR. L.K. SREEPATHI
STUDENTS: MR. DARSHAN T. DEVANG
MR. CHETHAN H.
MR. DARSHAN A.B.
MR. POORNA CHANDRA K.

INTRODUCTION: The depleting fossil fuel resources, increases the price of fuel continuously. At one point of time the whole resources may come to end. Keeping this in view many researchers identified various alternative fuels and tested successfully. In the present investigation the Analysis and emission characteristics of single cylinder four stroke direct injection diesel engine using Pongamia pinnata seed oil i.e., as Straight Vegetable Oil (SVO) by avoiding Transesterification process as an alternate fuel is evaluated.

High viscosity is one important difference between Pongamia seed oil and commercial diesel fuel. So, Here Pongamia pinnata seed oil is blended with Petrol at various proportions and finally reached the desired viscosity as that of diesel. The experimental data for various parameters such as Viscosity, Density, Flash and Fire Points, SFC are analyzed before and after blending to desired Percentages. A single cylinder, four stroke, constant speed, air cooled, direct injection diesel engine is used for the experiment.

The Analysis of the engine is done through Visual Inspection, as this engine is tested for 100hrs of running without change in any engine condition, blending ratio or modification in it. and the emissions such as CO, HC, O2, CO2, K, HU is measured using exhaust gas analyzer for initial diesel and blend for every 25hrs of running. Acceptable Viscosity and other parameters were obtained with blends containing 20% of Petrol in Pongamia pinnata seed oil on mass basis.

The pongamia pinnata seed cultivation in India is abundantly done and the availability of pongamia pinnata seeds is also high. The oil obtained by crushing these seeds can be used as an alternate fuel and they are also non edible. pongamia pinnata seed oil is used directly by avoiding Transesterification process i.e. SVO and it is blended with appropriate percentage of petrol in order to meet the properties of diesel fuel, as a substitute fuel for CI engines. The engine Analysis and emission characteristics are acceptable. Also due to the high availability of pongamia seed oil the impact of fossil fuel on Indian economy can be minimized. If mass production of oil is done, it will favour the agricultural sector of our country [1].

Alternate fuels should be easily available at low cost, be environment friendly and fulfill energy security needs without sacrificing engines operational condition [2]. For the developing countries, fuels of bio-origin provide a feasible solution to the twin crises of fossil fuel depletion and environmental degradation. Now bio-fuels are getting a renewed attention.

because of global stress on reduction of greenhouse gases (GHGs) and clean development mechanism (CDM). The fuels of bio-origin may be alcohol, vegetable oils, biomass and bio gas. Some of the fuels can be used directly while others need to be formulated to bring the relevant properties close to the conventional fuels. For diesel engines, a significant research has been directed towards using vegetable oils and their derivatives as fuels [3]. Diesel engines are the most efficient prime movers. From the point of view of protecting global environment and concerns for long-term energy security, it becomes necessary to develop alternative fuels with properties comparable to petroleum based fuels. Unlike rest of the world, India's demand for diesel fuel is roughly six times of gasoline hence seeking alternative to mineral diesel is a natural choice.

Pongamia seed oils have comparable energy density, cetane number, heat of vaporization and stoichiometric air/fuel ratio with mineral diesel. In addition they are bio degradable, non-toxic and have a potential to significantly reduce pollution. Pongamia seed oil and its derivatives in diesel engines, lead to substantial reductions in emissions of sulfur dioxides, hydrocarbons (HC), Harridge unit (HU), light absorption coefficient (K), carbon monoxide (CO), poly aromatic hydrocarbon (PAH), smoke, particulate matter (PM) and noise. Furthermore, contribution of bio fuels to greenhouse effect is insignificant, since carbon dioxide (CO₂) emitted during combustion is recycled in photosynthesis process in plants [4].

Bio fuel are produce locally, which decreases the nation’s dependence upon foreign energy and can employ hundreds or thousands of workers, creating new jobs in rural areas and crop cultivation of biodiesel plants will boost the rural Economy.

**Objectives of the project:**

- Engine Analysis And Emission Testing
- Analyzing the CI engine and its components on using SVO blended with petrol.
- Running the engine for 100 hrs using 80% of SVO +20% petrol on mass basis.
- Experimenting on CI engine by use of straight vegetable oil blended with petrol in order to know the emission is increased or reduced after usage of fuel.
- In order to reduce emission Percentage.

**EXPERIMENTAL METHODOLOGY**

**Block diagram**

```
  Pongamia pinnata
    ↓
  Pongamia pinnata (SVO) oil
    ↓
  Sedimentation and filtration
    ↓
  Testing the Pongamia oil properties, such as viscosity, density, flash and fire points.
    ↓
  Blending the petrol to the pongamia seed oil till it meets the viscosity and other values that of diesel
    ↓
  Dis-assemble the CI engine and analysing the components, parts of CI engine
    ↓
  Assemble the CI engine and running the engine with (80% pongamia seed oil+20% petrol) by mass basis.
    ↓
  Running the engine for 100hrs by using (80% pongamia seed oil+20% petrol) by mass basis blend.
```
Fuel property testing

Viscosity and density measurement formula

- Viscosity is the property of the fluid which measures the resistance to flow.
- Unit: Dynamic viscosity –poise and Kinematic viscosity - centistokes.
- Kinematic Viscosity is the ratio of absolute viscosity to the density and the calculation of the Diesel, SVO and (SVO+PETROL) for various blends are determined by using the Redwoods viscometer. Viscosity of the fluids varies with the temperature.

Formula: Kinematic viscosity: $0.247t-(50/t)$ Cst ($t>100$sec)  
$0.26t – (179/t)$ Cst ($t<100$sec)  
“t” denotes redwood second

- DENSITY: It is the ratio of mass per volume.

Formula: Mass/volume gm/cc  
Weight of the empty 50cc flask, W1 in gm.  
Weight of the (flask with oil), W2 in gm.  
Net weight $W= (W2-W1)/50$ gm/cc.

For 5 Litre Blend (Mass Basis)

[80%] SVO: 4,290.45ml  
[20%] Petrol: 1,366ml

Experimental values of various blends represents the viscosity of various SVO with Petrol blends

<table>
<thead>
<tr>
<th>sl.no</th>
<th>Substance at Room temp</th>
<th>Redwood sec</th>
<th>Kinematic Viscosity cst</th>
<th>Density gm/cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Petrol</td>
<td></td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>2</td>
<td>Diesel</td>
<td>35</td>
<td>3.98</td>
<td>0.82</td>
</tr>
<tr>
<td>3</td>
<td>SVO</td>
<td>202</td>
<td>49.73</td>
<td>0.93</td>
</tr>
<tr>
<td>4</td>
<td>SVO+Petrol (97+3%)</td>
<td>142</td>
<td>34.72</td>
<td>0.93</td>
</tr>
<tr>
<td>5</td>
<td>SVO+Petrol (95+5%)</td>
<td>121</td>
<td>29.47</td>
<td>0.91</td>
</tr>
<tr>
<td>6</td>
<td>SVO+Petrol(90+10%)</td>
<td>88</td>
<td>20.42</td>
<td>0.90</td>
</tr>
<tr>
<td>7</td>
<td>SVO+Petro (85+15%)</td>
<td>69</td>
<td>15.35</td>
<td>0.91</td>
</tr>
<tr>
<td>8</td>
<td>SVO+Petro (80+20%)</td>
<td>54</td>
<td>10.73</td>
<td>0.89</td>
</tr>
<tr>
<td>9</td>
<td>SVO+Petro(75+25%)</td>
<td>44</td>
<td>7.01</td>
<td></td>
</tr>
</tbody>
</table>
Result of viscosity testing – Graph

![Graph showing kinematic viscosity vs blend percentage](image)

Fig 3.9 Variation of viscosity with petrol percentage

Above graph indicates kinematic viscosity v/s blend % (SVO + Petrol). As observed in the Fig. 3.9, viscosity of the blend decreases with increase in the percentage of petrol in the blend. 25 % petrol blend shows a viscosity value of 7cst. However, the 25% mix would have higher chances of back fire in the engine. Hence, 20% petrol blend with SVO was used for further testing.

**Engine Experimental Setup**

Nearly all agricultural tractors pump sets, farm machinery, and transport vehicles use direct injection diesel engines. Keeping the specific features of diesel engines in mind, a typical engine system widely used in the agricultural sector in developing countries has been selected for present experimental investigations. Here present study was carried out to investigate the analysis and emission test of Pongamia oil blended with petrol in a stationary single cylinder diesel engine and to compare it with diesel fuel. The test were conducted on a four stroke, air cooled, direct injection diesel engine having rated power of 7.5kw at a constant speed of 1500rpm (Fig. 4.1). The engine was coupled with water load pump. The specifications of the engine are given in Table 4.1

![Image of engine setup](image)

**Fig 4.1 Engine Setup Used For the Project Work**

**Engine Specification**

<table>
<thead>
<tr>
<th>Valve Timing Operation</th>
<th>Engine Type</th>
<th>Four Strokes, Single Cylinder, direct injection Diesel Engine, air cooled.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore Diameter</td>
<td></td>
<td>102 mm</td>
</tr>
<tr>
<td>Engine Power</td>
<td></td>
<td>10 hp</td>
</tr>
<tr>
<td>RPM</td>
<td></td>
<td>1500 rpm</td>
</tr>
<tr>
<td>Type Of Starting</td>
<td></td>
<td>Crank Starting</td>
</tr>
</tbody>
</table>
• Length of the flywheel = 124.5 cm
• $1 \text{ cm} \cdot \frac{360}{124.5} = 2.89^\circ$

**Valve Timing Measurements Values**

<table>
<thead>
<tr>
<th>Sl no</th>
<th>VALVE OPERATION</th>
<th>ANGLE IN DEGREES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IVO (BTDC)</td>
<td>4.046</td>
</tr>
<tr>
<td>2</td>
<td>IVC (ABDC)</td>
<td>30.63</td>
</tr>
<tr>
<td>3</td>
<td>EVO (BBDC)</td>
<td>29.478</td>
</tr>
<tr>
<td>4</td>
<td>EVO (BTDC)</td>
<td>2.89</td>
</tr>
</tbody>
</table>

**Fig. 4.2 valve time movements**

Valve timing operation is conducted to know the inlet and outlet valve operations during the running period of the engine. The table 4.2 shows the valve opening and closing at certain angle.

**EXHAUST GAS ANALYZER**

Emission testing process is carried out to compare the emission norms of blended fuel (SVO+PETROL) with that of diesel.

The exhaust gas composition was measured using exhaust gas analyzer (I3SIS) as shown in (Fig 5.1)

It measures various gas emissions like carbon dioxide, carbon monoxide, oxygen, Hydrocarbons, and the oxides of nitrogen concentration in the exhaust gas.

**Table 6.1 Exhaust Gas Analyzer Specifications**

<table>
<thead>
<tr>
<th>Measuring quantity</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>0-10%</td>
</tr>
<tr>
<td>CO$_2$</td>
<td>0-20%</td>
</tr>
<tr>
<td>HC</td>
<td>0-20000PPM</td>
</tr>
<tr>
<td>O$_2$</td>
<td>0-22%</td>
</tr>
</tbody>
</table>
ENDURANCE TEST

In the long-term endurance test, the effect of use of (SVO+PETROL blend) and their blends on various engine parts v/s mineral diesel fuel were studied. For this purpose, diesel engines were subjected to constant operating conditions with same blend fuels. The assessment of wear of various parts of diesel-fuelled engines was done in long-term endurance test after dismantling various parts of the engine.

After the completion of Preliminary running in and fuel consumption test, the engines were dismantled completely and examined physically for the conditions of the various critical parts before endurance test was commenced. After physical examination, the dimensions of various moving, vital parts were recorded e.g. cylinder head, cylinder bore/ cylinder liner, piston, piston-rings, gudgeon pin, valves (inlet and exhaust), valve seats (inserts), valve guide, valve springs, big-end bearing, small-end bush, camshaft etc. The engines were re-assembled and mounted on suitable test beds and again run-in for 100 hours. This test was carried out to take care of any misalignments occurring during dismantling and re-assembling of the engine. This test continues until the completion of 100hrs.During the running-in period, none of the critical components listed above were replaced.

Emission test cycle is a protocol contained in an emission standard to allow repeatable and comparable measurement of exhaust emissions for different engines or vehicles. Test cycles specify the specific conditions under which the engine or vehicle is operated during the emission test. There are many different test cycles issued by various national and international governments and working groups. Specified parameters in a test cycle include a range of operating temperature, speed, and load. Ideally these are specified so as to accurately and realistically represent the range of conditions under which the vehicle or engine will be operated in actual use. Because it is impractical to test an engine or vehicle under every possible combination of speed, load, and temperature, this may not actually be the case. Vehicle and engine manufacturers may exploit the limited number of test conditions in the cycle by programming their engine management systems to control emissions to regulated levels at the specific test points contained in the cycle, but create a great deal more pollution under conditions experienced in real operation but not represented in the test cycle. This results in real emissions higher than the standards are supposed to allow, undermining the standards and public health.

Disassembled engine after the endurance test

After the completion of the long term endurance test the engine parts are dis-assembled and it is shown in (Fig 6.1) to check the certain engine parts such as cylinder head, valve seating, piston, fuel injector through visual inspection method to know the changes in the engine parts and to compare with initial condition.
6.2 Results And Discussions

**Fig 6.2. Cylinder Head before endurance Test**
Fig 6.2 shows the photograph of cylinder head before start endurance test. The cylinder head is subjected to initial service to remove the particles adhere to the head. Fig 6.3 shows the photograph of cylinder head after completing the 100 hours test. It has been observed that carbon deposition occurs on the cylinder head due to incomplete combustion. It is observed that, around the valve seat of the cylinder head, higher amount of carbon is deposited.

**Valve Seating**

**Fig 6.4 Valve seating before endurance Test**
**Fig 6.5 Valve seating after endurance Test**
Fig 6.4 shows the photograph of valve seating of the testing engine before endurance test. Upper and inner surface of the seating's are cleaned before subjecting to the experiment. Fig 6.5 shows the photograph of valve seating of the engine after the endurance test. By observing the photograph through visual inspection the carbon content deposition is more on the valve seating. Due to which the valve operation may be blocked or changed.

**Piston Rings**

**Fig 6.6 Piston rings before endurance test**
**Fig 6.7 Piston rings after endurance test**
Fig 6.6 shows the photograph of pistons rings before endurance test. It consists of 3 compression rings and 2 oil rings. During the new pistons rings are subjected to experiment. Surface of the rings are clean.
**Fig 6.7** represents the photograph of piston rings after the endurance test. By observing the photo of piston rings carbon deposition on the rings is lesser compared to other elements. Rings do not undergo any type of the wear.

**Head Gasket**

![Fig 6.8 Head Gasket before endurance test](image1)

![Fig 6.9 Head Gasket after endurance test](image2)

**Fig 6.8** represents the photograph of head gasket before endurance test. The surface of the material is flat and does not contain any type of deposition.

**Fig 6.9** represents the photograph of head gasket after the endurance test. The surface of the gasket contains black carbon patches. The surface does not have any type of wear or damage during the experiment.

**Piston**

![Fig 6.10 Side view of piston before Endurance test](image3)

![Fig 6.11 Side view of piston after Endurance test](image4)

**Fig 6.10** shows the photographs of side view of cleaned piston before the endurance test. Later after 100 hrs endurance test **Fig 6.11** shows the photograph of side view of piston observed that some slightly ware on surface, and no carbon deposited on surface of piston.

**Piston Top view**

![Fig 6.12 Piston top view before Endurance test](image5)

![Fig 6.13 Piston top view after Endurance test](image6)

**Fig 6.12** shows the photographs of top view of piston before endurance test. The top surface contain little black marks observed before subjected to experiment.
**Fig 6.13** shows the photograph of top view of piston after the 100 hrs endurance test. Observed that whole top surface of piston covered by carbon deposition due to incomplete fuel combustion.

**Engine Inlet and Outlet Valves**

![Engine Inlet and Outlet Valves before endurance test](image1)

![Engine Inlet and Outlet Valves after endurance test](image2)

**Engine Inlet and Outlet Valves**

- **Fig 6.14** shows the photograph of inlet and outlet valve before endurance test. Valves are operated by cam action. Bottom and top surface of the valves free from.
- **Fig 6.15** shows the photograph of inlet and outlet valve after the 100 hrs endurance test. From the figure, we can observe that more carbon deposition occurs on the bottom and middle portion of the valves. This may lead to change in valve movements.

**Fuel Injector**

![Fuel Injector before Endurance test](image3)

![Fuel Injector after Endurance test](image4)

**Fuel Injector**

- **Fig 6.16** shows the photographs of fuel injector before endurance test. The injector contains three nozzles to atomize the blended fuel during the combustion period. The surface is clean and does not contain any type of deposition layer before subjecting to the experiment. The tip of the nozzle made up of brass material.
- **Fig 6.17** shows the photographs of fuel injector after the 100 hrs endurance test. As observed that little oil grease substance adhere to the tip of the outer surface of the nozzle, due to thickness of SVO but the tip of nozzle did not blocked.
Emission Test Results And Discussions

Emission Test Results

EMISSION

<table>
<thead>
<tr>
<th>Emission norms</th>
<th>DIESEL</th>
<th>BLEND (25 hrs)</th>
<th>BLEND (50 hrs)</th>
<th>BLEND (75 hrs)</th>
<th>BLEND (100 hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HU (%) (Hartridge unit)</td>
<td>99.99%</td>
<td>47.83</td>
<td>37.32</td>
<td>31.03</td>
<td>25.74</td>
</tr>
<tr>
<td>K (light absorption co-efficient)</td>
<td>21.43</td>
<td>1.514</td>
<td>1.63</td>
<td>1.32</td>
<td>0.692</td>
</tr>
<tr>
<td>CO2 (%)</td>
<td>2.07</td>
<td>3.60</td>
<td>3.53</td>
<td>3.72</td>
<td></td>
</tr>
<tr>
<td>HC (ppm)</td>
<td>373</td>
<td>250</td>
<td>50.23</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>CO (%)</td>
<td>2.07</td>
<td>1.09</td>
<td>0.54</td>
<td>0.316</td>
<td></td>
</tr>
<tr>
<td>O2 (%)</td>
<td>2.07</td>
<td>15.88</td>
<td>16.77</td>
<td>15.10</td>
<td></td>
</tr>
</tbody>
</table>

represents the emission test results of diesel at initial condition and blended fuel (SVO+PETROL) for very 25hrs.

From the table we can observed that blended fuel emission norms are lower compared to diesel fuel because of the lower content of carbon and hydrogen of the blended fuel.

The smoke density parameters such as HU, k units of the blend are lowered when compared to diesel due to uniform combustion rate of the fuel. The HC unit is goes on decreasing due to lower content of carbon and hydrogen. Higher the viscosity of the SVO affects the atomization process resulting in localized rich mixtures of the blend. This should result in higher CO formation. But the oxygen content in the fuel in addition to the air supplied during combustion helps to reduce CO formation. Hence by the above readings the emission percentages are reduced, when compared to the diesel emission reading at initial condition.

OBSERVATION

1. After running for 100hrs, the carbon deposition on the engine parts are visually inspected and carbon deposition is extracted by physically, and amount of carbon content on the engine parts is determined by electronic weighing machine.
Electronic Weighing Machine

- Piston head -2.39 gms
- Outlet valve – 0.44gms
- Inlet valve -0.49gms
- Valve seatings -1.52gms

Expected Outcome of the project:
The outcome of project is useful in deciding
- Use of SVO in CI engines.
- Engine durability can be studied.
- Optimum blend of SVO and petrol with reference to emission levels.
- Effect of using SVO in engine for longer duration.
- Promotion of usage SVO to farmers in their diesel pump sets.
- Emission characteristics
- Economic viability

APPLICATION OF THE PROJECT

- Generators in Small scale industries and institutes can use direct SVO has fuel source
- Domestic usage
- Farmers –use of tiller, water pump set, tractor, which are run by diesel, so by use of the (SVO) they can effectively utilize this.
- About 80% of Indian railways are running with the diesel, hence we can utilize there in large quantity.

Scope for future work: By this project work, we can say that pongamia pinnata oil which is used in blending with petrol in the form of straight vegetable oil, i.e transesterification process is avoided. Hence in future this will help in developing the bio-fuel engines in automobiles in large scale. And also emission is reduce by using SVO.
- It will be very useful to country like ours , because we dependent mostly on railways,
- Then here usage of diesel is more, hence by using these fuels instead of diesel, the country economy increases, and our country will be in top. As these are eco-friendly and non-harmful to humans.

CONCLUSION
The main aim of the present investigation was to reduce the viscosity of Pongamia seed oil (SVO) close to that of conventional fuel to make it suitable for use in single cylinder, air cooled, vertical and direct injection diesel engine and to evaluate the Emission testing of the engine with modified Pongamia seed oil. Significant reduction in viscosity was achieved by blending with Petrol on mass basis. The bio-fuel from SVO is blended with Petrol at varying proportions. It is observed that 20% of petrol blend with SVO blended fuel properties is nearer to that of diesel fuel properties. Emissions from the blends were also acceptable. Bio-fuel use could preserve the environmental air quality by decreasing harmful emissions released by regular diesel fuel. Bio fuel are produce locally, which decreases the nation’s
dependence upon foreign energy and can employ hundreds or thousands of workers, creating new jobs in rural areas and crop cultivation of biodiesel plants will boost the rural economy. Hence they can be used as alternate fuel without any modification, operational difficulties in existing diesel engine.

* ~ * ~ *

7. Performance Study on Straight Vegetable oil (SVO) blended with Petrol as substitute fuel in CI Engine

PROJECT REFERENCE NO.: 39S_B_BE_100

COLLEGE : JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING
BRANCH : MECHANICAL ENGINEERING
GUIDES : MR. V. ASHOK, M. RAMESH
STUDENTS : MR. KARTHIK S.N.
MR. DEVIPRASAD K.
MR. KIRAN KUMAR G.
MR. SOURABH H.R.

Objectives:

a. Extraction of Non Edible Oil from Seeds using Expeller.
b. Sedimentation and filtering of obtained oil.
c. Filtered oil is blended with petrol with percentage of 5%.
d. To do the performance test, SVO is blended with 5% of petrol and mixture of SVO and petrol is added to 90%, 80%, 70%, 60% of diesel. (Ex: SVO+5% of petrol +90% of diesel)
e. Blended oil is tested for Viscosity and density.

Methodology:

The use of SVO (straight vegetable oil) as a fuel substituent in CI engines, this method firstly oil extracted from non edible seeds especially karanja (Pongamia pinnate), the obtained is allowed for sedimentation process. Later the SVO oil is filtered and blended with petrol various percentages 05%. Blended fuel is analysed for physical properties of fuel and then one of blended 5% petrol with SVO is taken for long term endurance test in CI engines. During endurance test engines properties were reported.
FLOW CHART:

Outcome of the project:
The outcome of project is useful in deciding
a. Use of SVO in Diesel engines.
b. Optimum blend of SVO and petrol.
c. Effect of using SVO in engine for longer duration.
d. Promotion of usage SVO to farmers in their diesel pump sets.
e. Biofuel raw material Development.
f. Economic viability.
g. Entrepreneurs can easily involve introducing small scale extraction units in villages.

Conclusion:
- There is no gradual variation in efficiency as percentage of blend increases when it is compared with the standard diesel.
- Density and viscosity increases as blend percentage increases at room temperature.
8. EXPERIMENTAL INVESTIGATION OF GASIFIED VEGETABLE OILS AS ALTERNATIVE FUELS IN SI ENGINES ON ROAD BIKE

PROJECT REFERENCE NO.: 39S_B_BE_012

COLLEGE : RAO BAHAUDUR Y. MAHABALESHWARAPPA ENGINEERING COLLEGE, BELLARY
BRANCH : MECHANICAL ENGINEERING
GUIDES : DR. HIREGOUDAR YERRENNAGOUDARU
STUDENTS : MR. K. VIJAY KUMAR
           MR. K.M. SHIVA KUMAR
           MR. M.D. ZAHID ALI
           MR. LAKSHA NAIK

INTRODUCTION
It is quite common nowadays to learn that every country is in the race to find suitable and affordable alternative fuel options for diesel engine as the present-day diesel fuel reserve is depleting fast. Even though the petrol vehicles are more in population, The research of alternative fuel for petrol (SI) Engines are very less In addition, the price of conventional petrol fuel is sky rocketing due to great demand, exponential increase of vehicles number on road and political turmoil. Therefore, it is an urgent need for India as well to search for an option to run Petrol engine using a fuel other than conventional and petroleum fuels.

Research work on biodiesel reveals that large number of experimental studies of biodiesel, derived from various feed stocks, as fuel for engines used for transportation and or other applications have been carried out all over the world. Application of biodiesel, as a fuel in transportation vehicles, has nowadays become common in almost all oil importing nations, But when we compare population of the domestic vehicles (petrol vehicles) with transportation vehicles (Diesel vehicles), the Population of the domestic vehicles is more hence we have to concentrate and find alternative fuel for petrol vehicles also.

Controlling operational parameters considered to be practically attractive techniques for reducing the level of CO in SI engine, because it involve minimum additional cost and maintenance. A survey of the literature tells us that that the air-fuel ratio is the important parameter which affects the level of CO emission in a spark ignition engine, while other studies show that ignition timing has an appreciable influence on the level of CO emission and on the onset of knock. Today, usually fossil fuels are used for fuel production. The reserves of these fossil-based fuels are being rapidly depleted. Besides that, when these fuels are used in the internal combustion engines, they produce air pollutants such as CO, HC, and particulate matter. Alternative sources of energy are needed in order to replace the non-renewable resources and also improve air quality. There are many investigations on increasing the engine performance and decreasing the concentration of toxic Components in combustion products by using non-petroleum, renewable, sustainable and non-polluting fuels. The high octane ratings and greater heat of evaporation values of alcohols such as ethanol, methanol make them appropriate fuels for high CR engines with high powers. High octane values can permit significant increases in CR. High heats of evaporation cool down
the incoming fuel–air charge and make it denser to promote the power output. The fuels which have high the auto-ignition temperature are ignited at higher temperatures. The auto-ignition temperatures of alcohols are higher of gasoline, which makes it safer for transportation and storage. The heat of evaporation of alcohol is 3 to 5 times higher than that of gasoline, which makes the temperature of the intake manifold lower, and increases the volumetric efficiency. The laminar flame speed of methanol is significantly higher than those of most of the hydrocarbon fuels. High laminar flame speed increases thermal efficiency by completing the combustion earlier which decreases heat losses from the cylinder. Methanol exhaust contains lower concentrations of particulate matters than gasoline exhaust. The molecule of methanol has an oxygen atom that makes the gasoline-methanol blends more oxygenated. Which leads to better combustion of the fuel and decreases carbon monoxide and hydrocarbon emissions. Methanol is an alternative fuel and can be produced from natural gas, biomass, and coal and also municipal solid wastes and sewage. Several studies have been conducted on the use of methanol and methanol-gasoline blends as fuel in the SI (Spark Ignition) engines. These results showed that there was an increase in engine thermal efficiency and decrease in CO emissions when pure ethanol and pure methanol fuels were used and the effects of these fuels on engine performance and exhaust emissions.

We know that the combustion reaction in the internal combustion engine depends on many different variables, one of the most important factors in an efficient combustion reaction is the ability of the reactants, the fuel molecules and the oxidant molecules, to interact with each other. Most fuels used in internal combustion engines are in liquid state, like gasoline, diesel, bio-fuels, and since combustion occurs in the gas phase, achieving a substantially even dispersion of Bio-fuel molecules among oxidant molecules can prove difficult due to the vapor pressure of the liquid. Therefore, an efficient combustion reaction would involve providing for the Bio-fuel molecules to be substantially and evenly dispersed throughout the oxidant molecules, thereby allowing sufficient interactions between the reactants and promoting the combustion reaction. Conventional systems and methods attempt to remedy this problem by increasing the quantity of gas phase fuel molecules by increasing the temperature of the liquid fuel to increase the vapor pressure.

The present invention has been developed in response to the present state and in particular, in response to the problems and needs that have not yet been fully solved by currently available conventional systems. Hence we have developed a special system where the use of bio-fuel in gasified form using convective heat exchanger which works as the heat recovering system. This system pre-atomize the Bio-fuel molecules and they are heated to 200-300°C from engine exhaust gases and they are vaporized and these gases are sent to inlet of the engine.

Here we are using Bio-fuels as 100% Turmeric Leaf oil and blends of Methanol, Turmeric leaf oil with petrol in specially designed system fitted with Hero Honda splendor (+) 100 cc bike. When we come to turmeric leaf oil, Turmeric leaf oil has various chemical compounds that include phellandrene, limonene, zingiberene, curcumene, turmerone, turmerone, turmerone and cineole. It is natural antiseptic. aphrodisiac, anti-arthritis, anti-inflammatory, anti-oxidant, anti-tumoral, bactericidal, diuretic, hypotensive, insecticidal, laxative, rubefacient and digestive stimulant. Turmeric leaf essential oil is viewed as a strong relaxant and balancer. It also has historical applications as an antiseptic and for skin care use against acne and facial hair in women. It has a great role in flavorings for food additives.

It is one of the most important colouring materials of India. The leaf oil yield the orange-red dye. It is much used to impart a yellow colour to cloth. When we come to Methanol, Methanol can be made from a wide array of feedstocks, making it one of the most flexible chemical commodities and energy sources available today. To make methanol, you need first to create synthesis gas, which has carbon monoxide and hydrogen gas as its main components.

While natural gas is most often used in the global economy, methanol has the distinct advantage of ‘polygeneration’ - whereby methanol can be made from any resource that can be converted first into synthesis gas. Through gasification, synthesis gas can be produced
from anything that is or ever was a plant. This includes biomass, agricultural and timber waste, solid municipal waste, and a number of other feedstock. In a typical plant, methanol production is carried out in two steps. The first step is to convert the feedstock natural gas into a synthesis gas stream consisting of CO, CO2, H2O and hydrogen. This is usually accomplished by the catalytic reforming of feed gas and steam. Partial oxidation is another possible route. The second step is the catalytic synthesis of methanol from the synthesis gas. Each of these steps can be carried out in a number of ways and various technologies offer a spectrum of possibilities which may be most suitable for any desired application.

* ~ * ~ *

9. IMPROVEMENTS IN DESIGN AND RE-FABRICATION OF AUTOMATED CLEANING MACHINE FOR PONGAMIA SEEDS

PROJECT REFERENCE NO.: 39S_B_BE_036

COLLEGE : S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA
BRANCH : MECHANICAL ENGINEERING
GUIDES : PROF. SRIDHAR M.E.
STUDENTS : MR. MOHAMMED WASIM AKRAM
            MR. ACHYUTHA K.
            MR. ANAND VITTHAL HALLUR
            MR. SHASHI KIRAN D.T.

INTRODUCTION
This machine is a bio oil seeds cleaning machine, which has two stages of cleaning. 1st stage is for cleaning the lighter impurities like dry leaves, husk, dry sticks, dust particles etc and the 2nd stage of cleaning is for cleaning the heavier impurities like small stones, eroded seeds. This machine is a modification over the earlier seed cleaning machine for pongamia seed. The earlier machine was used to clean only the pongamia seeds, but now the modified multi seeds cleaning machine can clean different bio oil seeds like pongamia, neem, jatropa, mahua.

Modifications done on the machine are

- The blower speed is controlled by an autotransformer
- Implementation of a control valve at the hopper
- Replacing single stage sieve tray into three stage sieve tray.

The modified multi seed cleaning machine consists of a hopper whose capacity is 15kg. The feed rate of seed is controlled by a control valve at the hopper. There is a blower, whose speed is regulated by an autotransformer. For cleaning different bio oil seeds different air velocity is required.
Objectives

1. To study the theory behind the existing seed cleaning machine, analyse & solve the problems associated with existing cleaning processes.
2. To modify the existing seed cleaning machine for pongamia seeds into Multi seed cleaning machine.
3. To regulate blower speed using an auto transformer for cleaning different bio-oil seeds efficiently.
4. To provide a control valve in the Hopper, to control feed rate of bio-oil seeds into the machine.
5. To adopt three stage separator sieve trays for final stage of cleaning.
6. For effective elimination of dust particles, dry sticks, dry leaves & other impurities from the seeds.
7. To reduce the time of efficient cleaning for different bio-oil seeds.

Methodology

1. Study of the old machine and analysing the old machine as a need for improvement.
   
   The components present in this machine are as follows:- Hopper, Duct, Fan, Air Duct Passage, Motor, Shaft, Pulleys, Plummer Block, Bearing, Single stage sieve tray.
   
   • The previous model was only meant for cleaning Pongamia seeds.
   
   • There was no regulation of blower speed.
   
   • There was not a control valve at the hopper, for regulating seed flow rate into the machine.

2. Listing out the Final Requirements

   a) There is Regulation of the blower speed by an auto transformer.

   b) Implementing a control valve at the hopper.

   c) To Convert the single stage sieve tray into a three Stage sieve tray for the effective cleaning of the bio oil seeds.
d) Modified multi seeds cleaning machine

RESULTS

1) Blower speed and voltage required for different seeds

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Seed Name</th>
<th>Air velocity (m/s)</th>
<th>Blower speed (rpm)</th>
<th>Voltage supplied (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Pongamia</td>
<td>28</td>
<td>2140</td>
<td>170</td>
</tr>
<tr>
<td>02</td>
<td>Neem</td>
<td>17</td>
<td>1300</td>
<td>102</td>
</tr>
<tr>
<td>03</td>
<td>Jatropa</td>
<td>25</td>
<td>1910</td>
<td>150</td>
</tr>
<tr>
<td>04</td>
<td>Mahua</td>
<td>22</td>
<td>1680</td>
<td>132</td>
</tr>
</tbody>
</table>

2) Efficiency of cleaning pongamia seeds

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Seeds in kg</th>
<th>Impurities added in gm</th>
<th>Impurities collected in gm</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>03</td>
<td>500</td>
<td>458</td>
<td>92%</td>
</tr>
<tr>
<td>02</td>
<td>06</td>
<td>1000</td>
<td>866</td>
<td>87%</td>
</tr>
<tr>
<td>03</td>
<td>12</td>
<td>2000</td>
<td>1538</td>
<td>77%</td>
</tr>
</tbody>
</table>

3) Efficiency of cleaning neem seeds

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Seeds in kg</th>
<th>Impurities added in gm</th>
<th>Impurities collected in gm</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>01</td>
<td>200</td>
<td>189</td>
<td>95%</td>
</tr>
<tr>
<td>02</td>
<td>02</td>
<td>400</td>
<td>371</td>
<td>93%</td>
</tr>
<tr>
<td>03</td>
<td>03</td>
<td>600</td>
<td>545</td>
<td>91%</td>
</tr>
</tbody>
</table>
Conclusion

The conclusion is that the multi seeds cleaning machine consumes less time than the manual cleaning method employed in our college Bio diesel plant. The efficiency of cleaning is increased, by using a blower with an autotransformer. As the petroleum products are being depleted due to its excessive use, the bio fuel substitutes the conventional fuel. The multi seeds cleaning machine is simple, can be operated by an operator with basic skills. This machine has upgraded technology, which makes use of easy cleaning method.

Multi seed cleaning machine consumes less time than that of the manual hand picking method. We can conclude that the automated cleaning technique is more efficient than the manual method of cleaning. Thus production time and the labour cost is reduced.

Scope For Future Work

Further improvements in cleaning of different seeds can be done by finding air velocity for cleaning different seeds by CFD analysis.

* ~ * ~ *
## List of Projects Proposal received for the sponsorship under 39\textsuperscript{th} Series of SPP – Biofuel Projects

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39S_B_BE_043</td>
<td>PERFORMANCE EVALUATION OF GAS TURBINE ENGINE USING ALTERNATIVE FUELS</td>
<td>AERONAUTICAL AND AUTOMOBILE ENGINEERING</td>
<td>MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_BE_055</td>
<td>UTILIZATION OF OLIAGENOUS HYDROPHYTES FOR PRODUCTION OF BIO-DIESEL</td>
<td>AERONAUTICAL AND AUTOMOBILE ENGINEERING</td>
<td>MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_BE_061</td>
<td>COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A CI ENGINE UNDER VARIOUS BIODIESELS FOR DIFFERENT COMPRESSION RATIOS</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_BE_090</td>
<td>SYNTHESIS OF BIODIESEL FROM MADHUCA INDICA OIL (MI-OIL) BY TRANSESTERIFICATION PROCESS FOR ENGINE PERFORMANCE TEST</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_BE_045</td>
<td>MONITORING THE EFFECT OF THERMAL BARRIER COATING ON BIO-DIESEL FUELLED CI ENGINE THROUGH OIL ANALYSIS</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_BE_083</td>
<td>AN EXPERIMENTAL STUDY ON 4-STROKE DIESEL ENGINE USING DIETHYL ETHER AS AN ALTERNATIVE FUEL</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHLALI, BENGALURU</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_BE_079</td>
<td>OXYHYDROGEN AS A FUEL COMBUSTION ENHANCER</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHLALI, BENGALURU</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_BE_025</td>
<td>REAR WHEEL TADPOLE TRIKE OPERATED BY HYDROGEN FUEL CELL</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_BE_091</td>
<td>PRODUCTION OF MIXED BIODIESEL FROM WASTE VEGETABLE OIL WITH TRASH FOR ENGINE PERFORMANCE TEST</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>---------</td>
<td>---------------------</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_BE_069</td>
<td>LIPID YIELD AND COMPOSITION OF AZOLLA FILICULOIDES AND THE IMPLICATIONS FOR THE PRODUCTION OF BIODIESEL AND EXTRACTION OF NUTRACEUTICALS</td>
<td>BIOTECHNOLOGY</td>
<td>BAPUJI INSTITUTE OF ENGINEERING AND TECHNOLOGY, DAVANGERE</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_BE_033</td>
<td>PRODUCTION OF BIODIESEL FROM PONGAMIA PINNATA BY ENZYMATIC METHOD</td>
<td>BIOTECHNOLOGY</td>
<td>BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOT</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_BE_009</td>
<td>MICROWAVE ASSISTED OPTIMIZATION FOR RELEASING FERMENTABLE SUGAR AND PRODUCTION OF BIOETHANOL FROM COCOA POD SHELLS</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_BE_051</td>
<td>BIOELECTRICITY PRODUCTION THROUGH INTEGRATED BIOGAS AND MICROBIAL FUEL CELL</td>
<td>BIOTECHNOLOGY</td>
<td>DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU</td>
</tr>
<tr>
<td>14</td>
<td>39S_B_BE_010</td>
<td>PRODUCTION OF BIO-BUTANOL FROM SACCHARUM SPONTANEUM</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>15</td>
<td>39S_B_BE_005</td>
<td>DESIGN AND FABRICATION OF ECONOMICALLY VIABLE HYBRID PHOTO-BIOREACTOR (CLOSED BUBBLE COLUMN) PROTOTYPE FOR CULTIVATION OF ELITE MICROALGAE FOR ENHANCED LIPIDS (BIODIESEL) YIELD</td>
<td>BIOTECHNOLOGY</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHALLI, BENGALURU</td>
</tr>
<tr>
<td>16</td>
<td>39S_B_BE_070</td>
<td>PRODUCTION OF ETHANOL FROM SUGARCANE BAGASSE BY ENZYMATIC HYDROLYSIS</td>
<td>BIOTECHNOLOGY</td>
<td>KLE DR.M.S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI</td>
</tr>
<tr>
<td>17</td>
<td>39S_B_BE_071</td>
<td>PRODUCTION OF DROP-IN BIO-BUTANOL AND ITS COMPARISON WITH SECOND GENERATION BIOFUELS</td>
<td>BIOTECHNOLOGY</td>
<td>KLE DR.M.S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI</td>
</tr>
<tr>
<td>18</td>
<td>39S_B_BE_006</td>
<td>PRODUCTION OF CLEAN BIOFUEL FROM MICRO ALGAE</td>
<td>BIOTECHNOLOGY</td>
<td>R.V. COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>19</td>
<td>39S_B_BE_044</td>
<td>GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM JATROPHA CURCAS TO ENHANCE LIPASE ACTIVITY</td>
<td>BIOTECHNOLOGY</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, HUNASAMARANAHALLI, BENGALURU</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>20</td>
<td>39S_B_BE_008</td>
<td>DESIGNING OF BIOREMEDIATION TOOL FOR POLY AROMATIC HYDROCARBON (PAHS) DEGRADATION USING FUNGAL CONSORTIUM</td>
<td>BIOTECHNOLOGY</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>21</td>
<td>39S_B_BE_008</td>
<td>BIOSYNTHESIS OF NANOPARTICLES AND THEIR APPLICATION AS CATALYST IN BIODIESEL PRODUCTION</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>22</td>
<td>39S_B_BE_007</td>
<td>EFFICACY OF MICROWAVE PRETREATMENT METHOD ON DIGESTION OF PONGAMIA PINNATA OIL CAKE</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>23</td>
<td>39S_B_BE_035</td>
<td>SEPARATION OF LIGNOCELLULOSIC FRACTION FROM THE DE-OILED EDIBLE CAKES AND EXTRACTION OF DIETARY FIBRES</td>
<td>BIOTECHNOLOGY</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHALLI, BENGALURU</td>
</tr>
<tr>
<td>24</td>
<td>39S_B_BE_050</td>
<td>SIMAROUBA OIL CAKE: THE SOLID LOW VALUE SUBSTRATE TO PRODUCE LIPASE WITH POTENTIAL APPLICATION IN BIODIESEL EXTRACTION AND TO ASSAY THE TOXICITY OF PHYTOCHEMICAL IN INHIBITION OF LIPASE ACTIVITY</td>
<td>BIOTECHNOLOGY</td>
<td>SAPTHAGIRI COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>25</td>
<td>39S_B_BE_088</td>
<td>DUAL BIOFUEL PRODUCTION FROM MICROALGAE</td>
<td>BIOTECHNOLOGY</td>
<td>SAPTHAGIRI COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>26</td>
<td>39S_B_BE_072</td>
<td>LAB SCALE BIOREFINERY FOR PRODUCTION OF ETHANOL USING FRUIT PULP WASTE</td>
<td>BIOTECHNOLOGY</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>27</td>
<td>39S_B_BE_065</td>
<td>DESIGN OF A NOVAL FIXED BED PHOTOBioreACTOR FOR BIOFUEL PRODUCTION USING DIATOM SPECIES</td>
<td>BIOTECHNOLOGY</td>
<td>SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSORE</td>
</tr>
<tr>
<td>28</td>
<td>39S_B_BE_084</td>
<td>PHUMDIS-A POTENTIAL BIOFUEL</td>
<td>BIOTECHNOLOGY AND MECHANICAL ENGINEERING</td>
<td>BMS COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>29</td>
<td>39S_B_BE_069</td>
<td>STUDIES ON PROCESS OPTIMIZATION OF VARIOUS PARAMETERS FOR PRODUCTION OF BIODIESEL</td>
<td>CHEMICAL ENGINEERING</td>
<td>KLE DR.M.S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>30</td>
<td>39S_B_BE_038</td>
<td>VALUE ADDITION TO NATURALLY AVAILABLE DIATOMACEOUS EARTH (DE) AS CATALYST SUPPORT</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>31</td>
<td>39S_B_BE_003</td>
<td>SYNTHESIS OF BIODIESEL BY TRANSESTERIFICATION REACTIONS USING Mg/AI HYDROTALITE CATALYST WITH DIFFERENT OILS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>32</td>
<td>39S_B_BE_074</td>
<td>SYNTHESIS AND CHARACTERISATION OF NOVEL CATALYST FOR CONVERSION OF CRUDE GLYCEROL DERIVED FROM BIODIESEL TO VALUE-ADDED PRODUCTS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>33</td>
<td>39S_B_BE_040</td>
<td>OPTIMIZATION AND CHARACTERIZATION OF BIO-DIESEL FROM BOMBAX CEIBA OIL</td>
<td>CHEMICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>34</td>
<td>39S_B_BE_073</td>
<td>PRODUCTION OF BIODIESEL FROM MICROALGA CHLORELLA PROTOthECOides GROWN IN MUNICIPAL WASTE WATER</td>
<td>CHEMICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>35</td>
<td>39S_B_BE_029</td>
<td>ARTIFICIAL AUTOMATIC BIO FUEL GENERATION PLANT</td>
<td>ELECTRONICS AND COMMUNICATION</td>
<td>MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING, MOODABIDRI</td>
</tr>
<tr>
<td>36</td>
<td>39S_B_BE_064</td>
<td>AUTOMATION OF INVENTORY CONTROL FOR BIO-DIESEL PLANT</td>
<td>ELECTRONICS AND COMMUNICATION</td>
<td>P.E.S. COLLEGE OF ENGINEERING, MANDYA</td>
</tr>
<tr>
<td>37</td>
<td>39S_B_BE_018</td>
<td>AUTOMATION OF THE GAS VALVE CONTROL IN THE ESTERIFICATION PROCESS OF MANUFACTURING THE BIO-DIESEL</td>
<td>ELECTRONICS AND COMMUNICATION</td>
<td>P.E.S. COLLEGE OF ENGINEERING, MANDYA</td>
</tr>
<tr>
<td>38</td>
<td>39S_B_BE_066</td>
<td>BIODIESEL GENERATION FROM SPENT COFFEE GROUNDS</td>
<td>ENVIRONMENTAL ENGINEERING</td>
<td>SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSORE</td>
</tr>
<tr>
<td>39</td>
<td>39S_B_BE_092</td>
<td>AN EXPERIMENTAL STUDY ON THE EFFECT OF AL2O3 NANO ADDITIVE BLENDED BIO-DIESEL EMULSION FUEL ON THE PERFORMANCE OF 4-S DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>ACS COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>40</td>
<td>39S_B_BE_093</td>
<td>EXPERIMENTAL EVALUATION ON PRODUCTION OF BIOCHAR FROM RAPESEED CAKE</td>
<td>MECHANICAL ENGINEERING</td>
<td>ACS COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>41</td>
<td>39S_B_BE_011</td>
<td>INVESTIGATION OF PROPERTIES OF DIFFERENT BLENDS OF BIODIESEL AND THEIR PERFORMANCE IN A COMPRESSION IGNITION ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>CANARA ENGINEERING COLLEGE, BENJANAPADAVU</td>
</tr>
<tr>
<td>42</td>
<td>39S_B_BE_046</td>
<td>CONVERSION OF BIO-MASS TO BIO-OIL BY RAPID PYROLYSIS USING CIRCULATING FLUIDIZED BED AND CHECK FOR WEIGHT PERCENTAGE OF CARBON, NITROGEN, SULPHUR IN DIFFERENT SAMPLES AS WELL AS CALORIFIC VALUE OF THE BIO-OIL EXTRACTED FOR DIFFERENT SAMPLES</td>
<td>MECHANICAL ENGINEERING</td>
<td>CMR INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>43</td>
<td>39S_B_BE_099</td>
<td>DESIGN AND DEVELOPMENT OF SEED DECORTICATOR FOR SIMAROUBA GLAUCAS SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>CMR INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>44</td>
<td>39S_B_BE_087</td>
<td>GREEN SYNTHESIS OF NANO METAL OXIDE AND THEIR APPLICATION TO REDUCE HARMFUL EMISSION FROM DIESEL ENGINE EXHAUST WITH BIODIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>DON BOSCO INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>45</td>
<td>39S_B_BE_015</td>
<td>DEVELOPMENT AND FABRICATION OF BIODEGRADABLE COMPOSITE</td>
<td>MECHANICAL ENGINEERING</td>
<td>GLOBAL ACADEMY OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>46</td>
<td>39S_B_BE_077</td>
<td>EXPERIMENTAL INVESTIGATION TO STUDY EFFECTS OF EMISSIONS AND ENGINE PERFORMANCE ON MULTI BLEND BIODIESEL FUELLED WITH VCR ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>HIRASUGAR INSTITUTE OF TECHNOLOGY, NIDASOSHI</td>
</tr>
<tr>
<td>47</td>
<td>39S_B_BE_097</td>
<td>ENGINE ANALYSIS AND EMISSION TESTING ON STRAIGHT VEGETABLE OIL (SVO) BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>48</td>
<td>39S_B_BE_100</td>
<td>PERFORMANCE STUDY ON STRAIGHT VEGETABLE OIL BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>49</td>
<td>39S_B_BE_057</td>
<td>PERFORMANCE AND COMBUSTION CHARACTERISTICS OF CI ENGINE OPERATED WITH MIXTURE OF JATROPA, RICE BRAN, AMURA, HONNE BIO DIESEL AND PETROLEUM DIESEL BLENDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>KLE DR.M.S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI</td>
</tr>
<tr>
<td>50</td>
<td>39S_B_BE_067</td>
<td>EXPERIMENTAL ANALYSIS OF PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE USING THE BLENDS OF DSOME BIODIESEL AND JOME BIODIESEL WITH NEAT DIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>KLE’S KLE COLLEGE OF ENGINEERING AND TECHNOLOGY, CHIKODI</td>
</tr>
<tr>
<td>51</td>
<td>39S_B_BE_028</td>
<td>BIOGAS COMPRESSOR FOR CONVERSION OF BIOGAS INTO LIQUID AND BOTTLELING</td>
<td>MECHANICAL ENGINEERING</td>
<td>KLS GOGTE INSTITUTE OF TECHNOLOGY, UDYAMBAG</td>
</tr>
<tr>
<td>52</td>
<td>39S_B_BE_068</td>
<td>EXPERIMENTAL INVESTIGATION OF NEEM AND MAHUA AS A CUTTING FLUID IN DRILLING ON AA6061</td>
<td>MECHANICAL ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>53</td>
<td>39S_B_BE_058</td>
<td>STUDY OF TRIBOLOGICAL CHARACTERISTICS OF AISI-304L WITH NEEM AND MAHUA AS BIO-LUBRICANTS</td>
<td>MECHANICAL ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>54</td>
<td>39S_B_BE_042</td>
<td>EFFECT OF INJECTION TIMING, INJECTOR OPENING PRESSURE ON DIRECT INJECTION DIESEL ENGINE USING DAIRY SCUM BIO-DIESELOIL</td>
<td>MECHANICAL ENGINEERING</td>
<td>A.G.M. RURAL COLLEGE OF ENGINEERING AND TECHNOLOGY, VARUR, HUBLI</td>
</tr>
<tr>
<td>55</td>
<td>39S_B_BE_056</td>
<td>STUDIES ON SUITABILITY OF HONGE SEED CAKE AND WASTE GLYCERIN AS FUEL FOR SMALL-SCALE COMBUSTION UNIT</td>
<td>MECHANICAL ENGINEERING</td>
<td>NAGARJUNA COLLEGE OF ENGINEERING AND TECHNOLOGY, BENGALORE</td>
</tr>
<tr>
<td>56</td>
<td>39S_B_BE_053</td>
<td>STUDIES ON ENHANCEMENT OF COLD FLOW PROPERTIES OF HONGE AND NEEM BIODIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>NAGARJUNA COLLEGE OF ENGINEERING AND TECHNOLOGY, BENGALORE</td>
</tr>
<tr>
<td>57</td>
<td>39S_B_BE_062</td>
<td>PRODUCTION OF BIOFUELS FROM SEMECARPUS ANCARDIUM(BIBA) SEED OIL AND PERFORMANCE STUDY ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>AMRUTA INSTITUTE OF ENGINEERING AND MANAGEMENT SCIENCES</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>58</td>
<td>39S_B_BE_080</td>
<td>DESIGN AND FABRICATION OF SOLAR BIODIESEL REACTOR AND PERFORMANCE STUDIES ON A CI ENGINE WITH DIESEL-BIODIESEL-PENTANOl BLENDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>P.A. COLLEGE OF ENGINEERING, MANGALORE</td>
</tr>
<tr>
<td>59</td>
<td>39S_B_BE_034</td>
<td>LOW COST BIOGAS PURIFICATION SYSTEM FOR APPLICATION OF BIO-GAS AS FUEL FOR AUTOMOBILE ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>P.E.S. COLLEGE OF ENGINEERING, MANDYA</td>
</tr>
<tr>
<td>60</td>
<td>39S_B_BE_013</td>
<td>PERFORMANCE AND EMISSION EVALUATION OF NANO PARTICLE ADDED SIMAROUBA BIODIESEL ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>CANARA ENGINEERING COLLEGE, BENJANAPADAVU</td>
</tr>
<tr>
<td>61</td>
<td>39S_B_BE_012</td>
<td>EXPERIMENTAL INVESTIGATION OF GASIFIED VEGETABLE OILS AS ALTERNATIVE FUELS IN SI ENGINES ON ROAD BIKE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RAO BAHADUR Y. MAHABALESHWARAPPA ENGINEERING COLLEGE, BELLARY</td>
</tr>
<tr>
<td>62</td>
<td>39S_B_BE_060</td>
<td>PERFORMANCE TEST ON CI ENGINE USING THE BIO-DIESEL EXTRACTED FROM TERMINALIA-CATTAPPA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>G.M. INSTITUTE OF TECHNOLOGY, DAVANGERE</td>
</tr>
<tr>
<td>63</td>
<td>39S_B_BE_014</td>
<td>DEVELOPMENT OF TABLE TOP BIOGAS UNIT</td>
<td>MECHANICAL ENGINEERING</td>
<td>GLOBAL ACADEMY OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>64</td>
<td>39S_B_BE_019</td>
<td>DESIGN AND FABRICATION OF BIO SEED CRUSHER MACHINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>65</td>
<td>39S_B_BE_020</td>
<td>CABINET DRIER INTEGRATED WITH BIOMASS</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>66</td>
<td>39S_B_BE_021</td>
<td>BIOMASS BRIQUETTING MACHINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>67</td>
<td>39S_B_BE_022</td>
<td>FABRICATION OF BIO DIESEL DISTILING</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>68</td>
<td>39S_B_BE_023</td>
<td>COST EFFECTIVE AND ENERGY EFFICIENT HOME BIODIESEL PRODUCTION UNIT</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>69</td>
<td>39S_B_BE_004</td>
<td>FUEL OIL EXTRACTION THROUGH PYROLYSIS USING SOLAR ENERGY</td>
<td>MECHANICAL ENGINEERING</td>
<td>MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING, MOODABIDRI</td>
</tr>
<tr>
<td>70</td>
<td>39S_B_BE_036</td>
<td>IMPROVEMENTS IN DESIGN AND REFabRICATION OF AUTOMATED CLEANING MACHINE FOR PONGAMIA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA</td>
</tr>
<tr>
<td>71</td>
<td>39S_B_BE_016</td>
<td>PERFORMANCE AND EMISSION CHARACTERISTICS OF IC ENGINE WITH CHICKEN FAT BIODIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>72</td>
<td>39S_B_BE_017</td>
<td>STUDY ON PERFORMANCE AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE BY USING VEGETABLE OIL BLENDS WITH BIODIESEL AS A BIOFUEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>73</td>
<td>39S_B_BE_085</td>
<td>BIO-ETHANOL PRODUCTION FROM NON-EDIBLE FRUIT RESOURCES ALONG WITH RAGI STRAW AND ITS PARAMETRIC ANALYSIS USING ETHANOL INTERNAL COMBUSTION ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>Sampoorna Institute of Technology and Research (SITAR), Ramanagara</td>
</tr>
<tr>
<td>74</td>
<td>39S_B_BE_086</td>
<td>EXPERIMENTAL INVESTIGATIONS ON PARAMETRIC OPTIMIZATION AND PERFORMANCE EMISSION CHARACTERISTICS OF DI ENGINE USING DIFFERENT BIO-DIESEL ADDITIVE BLENDS WITH DIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>Sampoorna Institute of Technology and Research (SITAR), Ramanagara</td>
</tr>
<tr>
<td>75</td>
<td>39S_B_BE_094</td>
<td>PRODUCTION OF GREEN GAS FROM AGRICULTURAL WASTES AND MODIFICATION OF DIESEL ENGINE FOR ELECTRICITY PRODUCTION BY EMPLOYING ENERGY CONVERSION TECHNOLOGY</td>
<td>MECHANICAL ENGINEERING</td>
<td>Sampoorna Institute of Technology and Research (SITAR), Ramanagara</td>
</tr>
<tr>
<td>76</td>
<td>39S_B_BE_095</td>
<td>PERFORMANCE CHARACTERISTICS OF IC ENGINE FUELLED WITH DIFFERENT BLENDS OF BIO-DIESEL OBTAINED FROM TYRE OIL AND ITS PURIFICATION USING RICE HUSK AS AN ADSORBENT</td>
<td>MECHANICAL ENGINEERING</td>
<td>Sampoorna Institute of Technology and Research (SITAR), Ramanagara</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>77</td>
<td>39S_B_BE_089</td>
<td>REFURBISHMENT OF AN IC ENGINE FOR ETHANOL BLENDED PETROL FUEL AND TESTING ITS PERFORMANCE AND EXHAUST POLLUTANT CHARACTERISTICS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAPTHAGIRI COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>78</td>
<td>39S_B_BE_039</td>
<td>PRODUCTION OF BIODIESEL AND TESTING OF PHYSICO-CHEMICAL PROPERTIES</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>79</td>
<td>39S_B_BE_041</td>
<td>PRODUCTION OF BIODIESEL FROM PALM OIL REFINERY WASTE - SPENT BLEACHING EARTH (SBE) AND STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>80</td>
<td>39S_B_BE_049</td>
<td>PRODUCTION OF DETAILS AND TESTING OF PHYSICOCHEMICAL PROPERTIES</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>81</td>
<td>39S_B_BE_081</td>
<td>ADVANCED ALL SEASON BIOGAS PLANT</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>82</td>
<td>39S_B_BE_024</td>
<td>COMPARISONS OF PERFORMANCE EMISSION TEST USING BIODIESEL FROM SIMAROUBA AND WASTE COOKING OIL IN A C.I. ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>83</td>
<td>39S_B_BE_047</td>
<td>SYNTHESE OF BUTEA MONOSPERMA BIO DIESEL AND STUDY ON PERFORMANCE, COMBUSTION CHARACTERISTICS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>84</td>
<td>39S_B_BE_054</td>
<td>PRODUCTION OF BIODIESEL FROM YELLOW OLEANDER SEED AND PERFORMANCE ANALYSIS ON SINGLE CYLINDER CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>85</td>
<td>39S_B_BE_075</td>
<td>PRODUCTION OF ETHANOL FROM LIGNOCELLULOSIC FEED STOck</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
<tr>
<td>86</td>
<td>39S_B_BE_076</td>
<td>ASSESSMENT OF BIO-OIL PRODUCTION FROM WASTE FISH FAT AND UTILIZATION IN DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>87</td>
<td>39S_B_BE_037</td>
<td>RESEARCH IN BY-PRODUCT UTILIZATION, VALUE ADDITIONS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALORE</td>
</tr>
<tr>
<td>88</td>
<td>39S_B_BE_001</td>
<td>PYROLYSIS DECOMPOSITION OF TAMARIND SEED FOR BIODIESEL PRODUCTION AND PERFORMANCE ANALYSIS ON A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>89</td>
<td>39S_B_BE_006</td>
<td>PRODUCTION OF HYBRID BIODIESEL FROM PONGAMIA AND CASHEW SHELL OIL AND PERFORMANCE EVALUATION IN A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>90</td>
<td>39S_B_BE_026</td>
<td>A COMPARATIVE STUDY ON THE EFFECT OF TiO2 AND Al2O3 NANO PARTICLES ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF BLENDS OF LARD OIL METHYL ESTER (LOME) ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>ST. JOSEPH ENGINEERING COLLEGE, MANGALURU</td>
</tr>
<tr>
<td>91</td>
<td>39S_B_BE_027</td>
<td>EFFECT OF INJECTION PRESSURE ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF WATSE COOKING OIL METHYL ESTER BLENDED WITH DIESEL AND ETHANOL ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>ST. JOSEPH ENGINEERING COLLEGE, MANGALURU</td>
</tr>
<tr>
<td>92</td>
<td>39S_B_BE_082</td>
<td>HYDROGEN FUEL CELL VEHICLE</td>
<td>MECHANICAL ENGINEERING</td>
<td>T. JOHN GROUP OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>93</td>
<td>39S_B_BE_048</td>
<td>PRODUCTION AND OPTIMIZATION OF SIMAROUBA BIODIESEL USING RSM AND PERFORMANCE, COMBUSTION, EMISSION ANALYSIS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>94</td>
<td>39S_B_BE_052</td>
<td>DEVELOPMENT OF DUAL FUEL ENGINE AND ITS PERFORMANCE AND EMISSION ANALYSIS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>95</td>
<td>39S_B_BE_030</td>
<td>PERFORMANCE TESTING AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE WORKING ON LIQUID FUEL PRODUCED FROM HOUSEHOLD PLASTIC WASTE AND ITS BLENDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>96</td>
<td>39S_B_BE_031</td>
<td>INVESTIGATION OF PROPERTIES OF BIODIESEL BLEND WITH 3% PETROL AND ITS INFLUENCE ON PERFORMANCE OF SINGLE CYLINDER FOUR STROKE DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
<tr>
<td>97</td>
<td>39S_B_BE_032</td>
<td>PRODUCTION AND PURIFICATION OF LIQUID FUEL BY HOUSEHOLD PLASTIC WASTE FOR IC ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
<tr>
<td>98</td>
<td>39S_B_BE_063</td>
<td>PRODUCTION AND PURIFICATION OF RAW BIOGAS AS A FUEL IN SI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
<tr>
<td>99</td>
<td>39S_B_BE_078</td>
<td>PREPARATION OF BIODIESEL FROM WASTE VEGETABLE OIL AND ANALYSIS OF ITS PERFORMANCE AND EMISSION CHARACTERISTICS IN DIESEL ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>PES INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>100</td>
<td>39S_B_BE_002</td>
<td>EXPERIMENTAL INVESTIGATION OF MANGO SEED OIL BLENDED WITH ETHANOL IN LOW HEAT REJECTION DIESEL ENGINE AND ITS PERFORMANCE AND EMISSION EVALUATION</td>
<td>MECHANICAL ENGINEERING</td>
<td>RAO BAHADUR Y. MAHABALESHWARAPPA ENGINEERING COLLEGE, BELLARY</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project Code</td>
<td>Title</td>
<td>Discipline</td>
<td>Institute/University</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MTech_005</td>
<td>ISOLATION AND CHARACTERIZATION OF ENDOPHYTES FROM PONGAMIA PINNATA SEED FOR BIOFUEL PRODUCTION</td>
<td>BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING</td>
<td>SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MTech_004</td>
<td>ULTRASOUND ASSISTED SYNTHESIS OF BIODIESEL FROM WASTE COOKING OIL BY USING METAL OXIDE CATALYST</td>
<td>CHEMICAL ENGINEERING</td>
<td>MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MTech_007</td>
<td>UTILIZATION OF AGRICULTURAL RESIDUES/BY-PRODUCTS FOR HEAT GENERATION WITH CARBON-DIOXIDE CAPTURE IN FLUIDIZED BED COMBUSTORS</td>
<td>CHEMICAL ENGINEERING</td>
<td>NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA (NITK), MANGALORE</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MTech_015</td>
<td>VALIDATION OF CST DESIGN 3-STAGE CONTINUOUS BIOREACTOR FOR SEWAGE FED LAKE RESTORATION ALONG WITH ALGAL BIOMASS RECOVERY FOR BIOFUEL PRODUCTION</td>
<td>ENVIRONMENTAL ENGINEERING</td>
<td>BMS COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MTech_011</td>
<td>EXPERIMENTAL INVESTIGATION ON USE OF PREHEATED NEEM-OIL BIO-DIESEL IN DI DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>JSS ACADEMY OF TECHNICAL EDUCATION, BENGALORE</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MTech_014</td>
<td>CONTROLLED FLOW CAVITATION TECHNOLOGY FOR BIODIESEL PRODUCTION FROM USED FRYING OIL AND PERFORMANCE TESTING IN A ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>P.A. COLLEGE OF ENGINEERING, MANGALORE</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_MTech_012</td>
<td>DESIGN AND DEVELOPMENT OF AN EFFICIENT OIL EXPELLER</td>
<td>MECHANICAL ENGINEERING</td>
<td>R.V. COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_MTech_013</td>
<td>EFFECT OF BIODIESEL ON CORROSION OF AUTOMOBILE PARTS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_MTech_002</td>
<td>OPTIMIZATION OF REACTION PARAMETERS FOR WATERMELON BIODIESEL PRODUCTION USING TAGUCHI METHOD AND PERFORMANCE TEST ON A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>Sl. No</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_MTech_001</td>
<td>PRODUCTION AND CHARACTERIZATION OF BIODIESEL FROM SPENT COFFEE POWDER AND PERFORMANCE TEST IN A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_MTech_003</td>
<td>STUDY ON EFFECT OF ADDITION OF COBALT OXIDE NANO PARTICLES ON PERFORMANCE AND EMISSION OF A DIESEL ENGINE FUELED WITH SIMAROUBA BIODIESEL BLENDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_MTech_006</td>
<td>HETEROGENEOUS CATALYSED PROCESS OPTIMIZATION FOR BIODIESEL PRODUCTION FROM BONBAX CEIBA SEED VIA MICROWAVE ASSISTED BIODIESEL PRODUCTION TECHNOLOGY</td>
<td>THERMAL POWER ENERGY</td>
<td>VISVESWARAYA TECHNOLOGICAL UNIVERSITY, MYSORE</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_MTech_008</td>
<td>DEVELOPMENT AND PERFORMANCE EVALUATION OF BIOGAS DIGESTER FILLED WITH MULTIPLE FEED STOCKS</td>
<td>THERMAL POWER ENGINEERING</td>
<td>VISVESWARAYA TECHNOLOGICAL UNIVERSITY, MYSORE</td>
</tr>
<tr>
<td>14</td>
<td>39S_B_MTech_009</td>
<td>DESIGN AND DEVELOPMENT AND PERFORMANCE EVALUATION OF LABORATORY SCALE UPDRAFT GASIFIER FOR GASIFICATION OF RICE HUSK</td>
<td>THERMAL POWER ENGINEERING</td>
<td>VISVESWARAYA TECHNOLOGICAL UNIVERSITY, MYSORE</td>
</tr>
<tr>
<td>15</td>
<td>39S_B_MTech_010</td>
<td>STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A DIESEL ENGINE FUELED WITH BLENDS OF NEEM AND SEMAROUBA</td>
<td>THERMAL SCIENCE AND ENERGY SYSTEM</td>
<td>AMRITA SCHOOL OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MSC_001</td>
<td>STUDY OF BIOMASS VALORIZATION TO PRODUCE DROP-IN FUELS</td>
<td>APPLIED CHEMISTRY</td>
<td>MANGALORE UNIVERSITY, MANGALAGANGOTHRI</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MSC_005</td>
<td>EVALUATION OF BIOPESTICIDE PROPERTIES OF AZADIRACHTA INDICA SEED CAKE</td>
<td>BIOCHEMISTRY</td>
<td>MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN, BENGALURU</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MSC_015</td>
<td>BIODIESEL PRODUCTION FROM SILKWORM PUPAE OIL</td>
<td>BIOCHEMISTRY</td>
<td>INDIAN ACADEMY DEGREE COLLEGE, BENGALURU</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MSC_013</td>
<td>ENHANCEMENT OF BIOETHANOL PRODUCTION BY IMMOBILIZING OF HYDROLYTIC ENZYMES AND MARKERS ASSISTED ANALYSIS BY RAPD METHODE OF AMMORPHOPHALUS SPEICES</td>
<td>BIOTECHNOLOGY</td>
<td>GARDEN CITY COLLEGE OF SCIENCE AND MANAGEMENT STUDIES, BANGALURU</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MSC_009</td>
<td>COMPARITIVE STUDY ON THE EFFECT OF DESIGNED LOW-COST IONIC LIQUID ON PRETREATMENT OF THREE LIGNOCELLULOSIC BIOMASS AND THE OPTIMIZATION OF RECOVERY TECHNIQUE OF IONIC LIQUID</td>
<td>BIOTECHNOLOGY</td>
<td>GARDEN CITY COLLEGE OF SCIENCE AND MANAGEMENT STUDIES, BANGALURU</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MSC_010</td>
<td>SUSTAINABLE APPROACH FOR BIOFUEL PRODUCTION FROM POND REEDS AND REJUVENATION OF THE POND ECOSYSTEM</td>
<td>BIOTECHNOLOGY</td>
<td>GARDEN CITY COLLEGE OF SCIENCE AND MANAGEMENT STUDIES, BANGALURU</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_MSC_007</td>
<td>ISOLATION SCREENING AND CHARACTERIZATION OF LIPASE PRODUCERS USING NON-EDIBLE DE-OILED SEED CAKE AS A SUBSTRATE</td>
<td>BIOTECHNOLOGY</td>
<td>GULBARGA UNIVERSITY, KALABURGI</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_MSC_008</td>
<td>BIOCONVERSION OF BIODIESEL DERIVED CRUDE GLYCEROL TO POLYHYDROXYALKANOTES / POLYHYDROXYBUTRATR (PHA/PHB)</td>
<td>BIOTECHNOLOGY</td>
<td>GULBARGA UNIVERSITY, KALABURGI</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_MSC_021</td>
<td>MICROALGAE CULTIVATION USING URBAN WASTE WATER FOR ENHANCED BIOMASS AND LIPID PRODUCTION ALONG WITH REDUCED EUTROPHICATION</td>
<td>BIOTECHNOLOGY</td>
<td>INDIAN ACADEMY DEGREE COLLEGE, BENGALURU</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_MSC_003</td>
<td>CHEMICAL NUTRIENT ANALYSIS OF VERMICOMPOST PRODUCED USING PONGAMIA PINNATA SEED CAKE AND ITS EFFECT ON THE GROWTH OF PONGAMIA PINNATA</td>
<td>BIOTECHNOLOGY</td>
<td>M.S.RAMAIH COLLEGE OF ARTS, SCIENCE AND COMMERCE, BANGALORE</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_MSC_023</td>
<td>GENETIC ANALYSIS OF THE VARIATION AMONG THE TRAITS OF THE WILD TYPE PONGAMIA TREES PLANTED IN BANGALORE CITY IN COMPARISON WITH THOSE OF THAT OF THE CANDIDATE PLUS PONGAMIA SPECIES THROUGH PROTIEN MARKER ASSAY TEST AND IMPROVING THE CROP VARIETY BY GRAFTING TECHNOLOGY FOR BETTER YIELD OF PONGAMIA SEEDS</td>
<td>BIOTECHNOLOGY</td>
<td>M.S.RAMAIH COLLEGE OF ARTS, SCIENCE AND COMMERCE, BANGALORE</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_MSC_006</td>
<td>AN INVESTIGATION INTO OPTIMAL BIODIESEL PRODUCTION FROM NON-EDIBLE OIL USING MICROBIAL LIPASE AND EVALUATION OF PHYSICO-CHEMICAL PARAMETERS</td>
<td>BIOTECHNOLOGY</td>
<td>MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN, BENGALURU</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_MSC_002</td>
<td>INVESTIGATION ON MICROPROPAGATION OF JATROPHA CURCAS FOR THE PRODUCTION OF ELITE HIGH OIL YIELDING GENOTYPES</td>
<td>BIOTECHNOLOGY</td>
<td>REVA INSTITUTE OF SCIENCE AND MANAGEMENT, YELAHANKA</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>14</td>
<td>39S_B_MSC_017</td>
<td>SYNTHESIS AND CHARACTERIZATION OF BIOFUEL SYNTHESISED FROM MANILKARA ZAPOTA</td>
<td>CHEMISTRY</td>
<td>MANGALORE UNIVERSITY, MANGALAGANGOTHRI</td>
</tr>
<tr>
<td>15</td>
<td>39S_B_MSC_011</td>
<td>TOBACCO-A PLATFORM FOR EFFICIENT BIOFUEL PRODUCTION: PRETREATMENT TO CELLULOLYSIS OF LIGNOCELLULOSIC BIOMASS OF TOBACCO LEAF</td>
<td>CHEMISTRY AND BIOCHEMISTRY</td>
<td>INDIAN ACADEMY DEGREE COLLEGE, BENGALURU</td>
</tr>
<tr>
<td>16</td>
<td>39S_B_MSC_018</td>
<td>CONVERSION OF WASTE COOKING OIL INTO BIO-DIESEL AND STUDY OF ITS FUEL EFFICIENCY</td>
<td>CHEMISTRY AND BIOSCIENCES</td>
<td>MANGALORE UNIVERSITY, MANGALAGANGOTHRI</td>
</tr>
<tr>
<td>17</td>
<td>39S_B_MSC_014</td>
<td>PRODUCTION OF BIODIESEL FROM OLEAGINOUS FUNGI</td>
<td>MICROBIOLOGY</td>
<td>DAVANGERE UNIVERSITY, DAVANGERE</td>
</tr>
<tr>
<td>18</td>
<td>39S_B_MSC_019</td>
<td>ISOLATION OF CELLULOLYTIC MICROBES AND ROLE OF MICROBES IN BIODEGRADATION OF INVASIVE WEED SPECIES FOR ETHANOL PRODUCTION</td>
<td>MICROBIOLOGY</td>
<td>DAYANANDA SAGAR INSTITUTIONS, BANGALORE</td>
</tr>
<tr>
<td>19</td>
<td>39S_B_MSC_022</td>
<td>COFFE PULP AND ARECA NUT HUSK - A POTENTIAL SOURCE OF CELLULOSIC FEED STOCK FOR BIOETHANOL PRODUCTION USING MICROBIAL CONSORTIA</td>
<td>MICROBIOLOGY</td>
<td>DAYANANDA SAGAR INSTITUTIONS, BANGALORE</td>
</tr>
<tr>
<td>20</td>
<td>39S_B_MSC_012</td>
<td>BIOFUEL PRODUCTION FROM ARSENIC REMOVAL ALGAE</td>
<td>MICROBIOLOGY</td>
<td>MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BANGALORE</td>
</tr>
<tr>
<td>21</td>
<td>39S_B_MSC_004</td>
<td>MICROBIAL PRODUCTION OF BIOETHANOL FROM CAROB PODS</td>
<td>MICROBIOLOGY</td>
<td>MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BANGALORE</td>
</tr>
<tr>
<td>22</td>
<td>39S_B_MSC_020</td>
<td>ASSESSMENT OF CARBON SEQUESTRATION POTENTIAL OF SELECTED BIOFUEL SPECIES PLANTATION IN KODAGU DISTRICT</td>
<td>NATURAL RESOURCE MANAGEMENT (NMR)</td>
<td>COLLEGE OF FORESTRY, PONNAMPET</td>
</tr>
<tr>
<td>23</td>
<td>39S_B_MSC_016</td>
<td>HETEROGENEOUS CATALYSED PROCESS OPTIMIZATION FOR BIODIESEL PRODUCTION FROM BONBAX CEIBA SEED VIA MICROWAVE ASSISTED BIODIESEL PRODUCTION TECHNOLOGY</td>
<td>THERMAL POWER ENERGY</td>
<td>VISVESVARAYA TECHNOLOGICAL UNIVERSITY, MYSURE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MBA_004</td>
<td>FINANCIAL AND ECONOMIC ASSESSMENT OF BIODIESEL PRODUCTION AND USE IN BANGALORE</td>
<td>MANAGEMENT STUDIES</td>
<td>M.S. RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MBA_003</td>
<td>A FEASIBILITY STUDY ON BIO DIESEL FUEL</td>
<td>MANAGEMENT STUDIES</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, BANGALURU</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MBA_002</td>
<td>FEASIBILITY STUDY ON ESTABLISHING BIODIESEL PLANT</td>
<td>MANAGEMENT STUDIES</td>
<td>PES UNIVERSITY, BANGALURU</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MBA_001</td>
<td>A STUDY ON COST ANALYSIS OF PROCUREMENT AND PROCESSING OF NON-EDIBLE OIL SEEDS</td>
<td>MASTER OF BUSINESS ADMINISTRATION</td>
<td>SESHADRIPURAM INSTITUTE OF MANAGEMENT STUDIES, YELAHANKA</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MBA_006</td>
<td>A STUDY ON TRAINING NEED ASSESSMENT FOR THE FARMERS WITH REFERENCE TO EXPERT FARMING PRACTICES OF JATROPHA BASED BIO-FUEL IN KARNATAKA</td>
<td>MANAGEMENT STUDIES</td>
<td>SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MBA_005</td>
<td>A STUDY ON THE CULTIVATION OF JATROPHA FOR BIOFUEL PRODUCTION AND ITS LIVELIHOOD EFFECT ON SMALL SCALE FARMERS IN KARNATAKA</td>
<td>MANAGEMENT STUDIES</td>
<td>SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
</tbody>
</table>
### List of Projects for Selected for Sponsorship under 39th Series of SPP – Biofuel Projects

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39S_B_BE_061</td>
<td>COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A CI ENGINE UNDER VARIOUS BIODIESELS FOR DIFFERENT COMPRESSION RATIOS</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_BE_090</td>
<td>SYNTHESIS OF BIODIESEL FROM MADHUCA INDICA OIL (MI-OIL) BY TRANSESTERIFICATION PROCESS FOR ENGINE PERFORMANCE TEST</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_BE_083</td>
<td>AN EXPERIMENTAL STUDY ON 4-STROKE DIESEL ENGINE USING DIETHYL ETHER AS AN ALTERNATIVE FUEL</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHALLI, BENGALURU</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_BE_025</td>
<td>REAR WHEEL TADPOLE TRIKE OPERATED BY HYDROGEN FUEL CELL</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_BE_009</td>
<td>MICROWAVE ASSISTED OPTIMIZATION FOR RELEASING FERMENTABLE SUGAR AND PRODUCTION OF BIOETHANOL FROM COCOA POD SHELLS</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_BE_051</td>
<td>BIOELECTRICITY PRODUCTION THROUGH INTEGRATED BIOGASS AND MICROBIAL FUEL CELL</td>
<td>BIOTECHNOLOGY</td>
<td>DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_BE_010</td>
<td>PRODUCTION OF BIO-BUTANOL FROM SACCHARUM SPONTANEUM</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_BE_005</td>
<td>DESIGN AND FABRICATION OF ECONOMICALLY Viable HYBRID PHOTO-BIOREACTOR (CLOSED BUBBLE COLUMN) Prototype for CULTIVATION OF ELITE MICROALGAE FOR ENHANCED LIPIDS (BIODIESEL) YIELD</td>
<td>BIOTECHNOLOGY</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHALLI, BENGALURU</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_BE_006</td>
<td>PRODUCTION OF CLEAN BIOFUEL FROM MICRO ALGAE</td>
<td>BIOTECHNOLOGY</td>
<td>R.V. COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>Sl. No</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_BE_044</td>
<td>GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM JATROPHA CURCAS TO ENHANCE LIPASE ACTIVITY</td>
<td>BIOTECHNOLOGY</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, HUNASAMARANAHALLI, BENGALURU</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_BE_098</td>
<td>DESIGNING OF BIOREMEDIATION TOOL FOR POLY AROMATIC HYDROCARBON (PAHS) DEGRADATION USING FUNGAL CONSORTIUM</td>
<td>BIOTECHNOLOGY</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_BE_008</td>
<td>BIOSYNTHESIS OF NANOPARTICLES AND THEIR APPLICATION AS CATALYST IN BIODIESEL PRODUCTION</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_BE_050</td>
<td>SIMAROUBA OIL CAKE: THE SOLID LOW VALUE SUBSTRATE TO PRODUCE LIPASE WITH POTENTIAL APPLICATION IN BIODIESEL EXTRACTION AND TO ASSAY THE TOXICITY OF PHYTOCHEMICAL IN INHIBITION OF LIPASE ACTIVITY</td>
<td>BIOTECHNOLOGY</td>
<td>SAPTHAGIRI COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>14</td>
<td>39S_B_BE_088</td>
<td>DUAL BIOFUEL PRODUCTION FROM MICROALGAE</td>
<td>BIOTECHNOLOGY</td>
<td>SAPTHAGIRI COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>15</td>
<td>39S_B_BE_003</td>
<td>SYNTHESIS OF BIODIESEL BY TRANSESTERIFICATION REACTIONS USING MG/AI HYDROTALITE CATALYST WITH DIFFERENT OILS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>16</td>
<td>39S_B_BE_074</td>
<td>SYNTHESIS AND CHARACTERISATION OF NOVEL CATALYST FOR CONVERSION OF CRUDE GLYCEROL DERIVED FROM BIODIESEL TO VALUE-ADDED PRODUCTS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>17</td>
<td>39S_B_BE_064</td>
<td>AUTOMATION OF INVENTORY CONTROL FOR BIO-DIESEL PLANT</td>
<td>ELECTRONICS AND COMMUNICATION</td>
<td>P.E.S. COLLEGE OF ENGINEERING, MANDYA</td>
</tr>
<tr>
<td>18</td>
<td>39S_B_BE_099</td>
<td>DESIGN AND DEVELOPMENT OF SEED DECORTICATOR FOR SIMAROUBA GLAUCA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>CMR INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>19</td>
<td>39S_B_BE_097</td>
<td>ENGINE ANALYSIS AND EMISSION TESTING ON STRAIGHT VEGETABLE OIL (SVO) BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>20</td>
<td>39S_B_BE_100</td>
<td>PERFORMANCE STUDY ON STRAIGHT VEGETABLE OIL BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>21</td>
<td>39S_B_BE_058</td>
<td>STUDY OF TRIBOLOGICAL CHARACTERISTICS OF AISI-304L WITH NEEM AND MAHUA AS BIO-LUBRICANTS</td>
<td>MECHANICAL ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>22</td>
<td>39S_B_BE_042</td>
<td>EFFECT OF INJECTION TIMING, INJECTOR OPENING PRESSURE ON DIRECT INJECTION DIESEL ENGINE USING DAIRY SCUM BIO-DIESELOIL</td>
<td>MECHANICAL ENGINEERING</td>
<td>A.G.M. RURAL COLLEGE OF ENGINEERING AND TECHNOLOGY, VARUR, HUBLI</td>
</tr>
<tr>
<td>23</td>
<td>39S_B_BE_062</td>
<td>PRODUCTION OF BIOFUELS FROM SEMECARPUS ANCARDIUM(BIBA) SEED OIL AND PERFORMANCE STUDY ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>AMRUTA INSTITUTE OF ENGINEERING AND MANAGEMENT SCIENCES</td>
</tr>
<tr>
<td>24</td>
<td>39S_B_BE_034</td>
<td>LOW COST BIOGAS PURIFICATION SYSTEM FOR APPLICATION OF BIO-GAS AS FUEL FOR AUTOMOBILE ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>P.E.S. COLLEGE OF ENGINEERING, MANDYA</td>
</tr>
<tr>
<td>25</td>
<td>39S_B_BE_013</td>
<td>PERFORMANCE AND EMISSION EVALUATION OF NANO PARTICLE ADDED SIMAROUBA BIODIESEL ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>CANARA ENGINEERING COLLEGE, BENJANAPADAVU</td>
</tr>
<tr>
<td>26</td>
<td>39S_B_BE_012</td>
<td>EXPERIMENTAL INVESTIGATION OF GASIFIED VEGETABLE OILS AS ALTERNATIVE FUELS IN SI ENGINES ON ROAD BIKE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RAO BAHADUR Y. MAHABALESHWARAPPA ENGINEERING COLLEGE, BELLARY</td>
</tr>
<tr>
<td>27</td>
<td>39S_B_BE_060</td>
<td>PERFORMANCE TEST ON CI ENGINE USING THE BIO-DIESEL EXTRACTED FROM TERMINALIA-CATTAPPA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>G.M. INSTITUTE OF TECHNOLOGY, DAVANGERE</td>
</tr>
<tr>
<td>28</td>
<td>39S_B_BE_014</td>
<td>DEVELOPMENT OF TABLE TOP BIOGAS UNIT</td>
<td>MECHANICAL ENGINEERING</td>
<td>GLOBAL ACADEMY OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>29</td>
<td>39S_B_BE_004</td>
<td>FUEL OIL EXTRACTION THROUGH PYROLYSIS USING SOLAR ENERGY</td>
<td>MECHANICAL ENGINEERING</td>
<td>MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING, MOODABIDRI</td>
</tr>
<tr>
<td>30</td>
<td>39S_B_BE_036</td>
<td>IMPROVEMENTS IN DESIGN AND REFACTRICATION OF AUTOMATED CLEANING MACHINE FOR PONGAMIA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA</td>
</tr>
<tr>
<td>31</td>
<td>39S_B_BE_016</td>
<td>PERFORMANCE AND EMISSION CHARACTERISTICS OF IC ENGINE WITH CHICKEN FAT BIODIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>32</td>
<td>39S_B_BE_017</td>
<td>STUDY ON PERFORMANCE AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE BY USING VEGETABLE OIL BLENDS WITH BIODIESEL AS A BIOFUEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>33</td>
<td>39S_B_BE_024</td>
<td>COMPARISONS OF PERFORMANCE EMISSION TEST USING BIODIESEL FROM SIMAROUBA AND WASTE COOKING OIL IN A C.I. ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>34</td>
<td>39S_B_BE_047</td>
<td>SYNTHESIS OF BUTEA MONOSPERMA BIO DIESEL AND STUDY ON PERFORMANCE, COMBUSTION CHARACTERISTICS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>35</td>
<td>39S_B_BE_054</td>
<td>PRODUCTION OF BIODIESEL FROM YELLOW OLEANDER SEED AND PERFORMANCE ANALYSIS ON SINGLE CYLINDER CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>36</td>
<td>39S_B_BE_075</td>
<td>PRODUCTION OF ETHANOL FROM LIGNOCELLULOSIC FEED STOCK</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
<tr>
<td>37</td>
<td>39S_B_BE_076</td>
<td>ASSESSMENT OF BIO-OIL PRODUCTION FROM WASTE FISH FAT AND UTILIZATION IN DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
</tbody>
</table>
### Biofuel Projects Compendium: 2015-16

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>39S_B_BE_082</td>
<td>HYDROGEN FUEL CELL VEHICLE</td>
<td>MECHANICAL ENGINEERING</td>
<td>T. JOHN GROUP OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>39</td>
<td>39S_B_BE_048</td>
<td>PRODUCTION AND OPTIMIZATION OF SIMAROUBA BIODIESEL USING RSM AND PERFORMANCE, COMBUSTION, EMISSION ANALYSIS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>40</td>
<td>39S_B_BE_052</td>
<td>DEVELOPMENT OF DUAL FUEL ENGINE AND ITS PERFORMANCE AND EMISSION ANALYSIS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>41</td>
<td>39S_B_BE_032</td>
<td>PRODUCTION AND PURIFICATION OF LIQUID FUEL BY HOUSEHOLD PLASTIC WASTE FOR IC ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39S_B_MTech_004</td>
<td>ULTRASOUND ASSISTED SYNTHESIS OF BIODIESEL FROM WASTE COOKING OIL BY USING METAL OXIDE CATALYST</td>
<td>CHEMICAL ENGINEERING</td>
<td>MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MTech_015</td>
<td>VALIDATION OF CST DESIGN 3-STAGE CONTINUOUS BIOREACTOR FOR SEWAGE FED LAKE RESTORATION ALONG WITH ALGAL BIOMASS RECOVERY FOR BIOFUEL PRODUCTION</td>
<td>ENVIRONMENTAL ENGINEERING</td>
<td>BMS COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MTech_011</td>
<td>EXPERIMENTAL INVESTIGATION ON USE OF PREHEATED NEEM-OIL BIO-</td>
<td>MECHANICAL</td>
<td>JSS ACADEMY OF TECHNICAL EDUCATION,</td>
</tr>
</tbody>
</table>

**M.Tech Projects**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>39S_B_MTech_014</td>
<td>CONTROLLED FLOW CAVITATION TECHNOLOGY FOR BIODIESEL PRODUCTION FROM USED FRYING OIL AND PERFORMANCE TESTING IN A ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>P.A. COLLEGE OF ENGINEERING, MANGALORE</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MTech_012</td>
<td>DESIGN AND DEVELOPMENT OF AN EFFICIENT OIL EXPPELLER</td>
<td>MECHANICAL ENGINEERING</td>
<td>R.V. COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MTech_001</td>
<td>PRODUCTION AND CHARACTERIZATION OF BIODIESEL FROM SPENT COFFEE POWDER AND PERFORMANCE TEST IN A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_MTech_003</td>
<td>STUDY ON EFFECT OF ADDITION OF COBALT OXIDE NANO PARTICLES ON PERFORMANCE AND EMISSION OF A DIESEL ENGINE FUELED WITH SIMAROUBA BIODIESEL BLENDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SRI VENKATESWARA COLLEGE OF TECHNOLOGY, BENGALURU</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_MTech_006</td>
<td>HETEROGENEOUS CATALYSED PROCESS OPTIMIZATION FOR BIODIESEL PRODUCTION FROM BONBAX CEIBA SEED VIA MICROWAVE ASSISTED BIODIESEL PRODUCTION TECHNOLOGY</td>
<td>THERMAL POWER ENERGY</td>
<td>VISVESWARAYA TECHNOLOGICAL UNIVERSITY, MYSORE</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_MTech_010</td>
<td>STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A DIESEL ENGINE FUELLED WITH BLENDS OF NEEM AND SEMAROUBA</td>
<td>THERMAL SCIENCE AND ENERGY SYSTEM</td>
<td>AMRITA SCHOOL OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MSC_005</td>
<td>EVALUATION OF BIOPESTICIDE PROPERTIES OF AZADIRACHTA INDICA SEED CAKE</td>
<td>BIOCHEMISTRY</td>
<td>MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN, BENGALURU</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MSC_013</td>
<td>ENHANCEMENT OF BIOETHANOL PRODUCTION BY IMMOBILIZING OF HYDROLYTIC ENZYMES AND MARKERS ASSISTED ANALYSIS BY RAPID METHODE OF AMMORPHOPHALUS SPEICES</td>
<td>BIOTECHNOLOGY</td>
<td>GARDEN CITY COLLEGE OF SCIENCE AND MANAGEMENT STUDIES, BANGALURU</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MSC_007</td>
<td>ISOLATION SCREENING AND CHARACTERIZATION OF LIPASE PRODUCERS USING NON-EDIBLE DE-OILED SEED CAKE AS A SUBSTRATE</td>
<td>BIOTECHNOLOGY</td>
<td>GULBARGA UNIVERSITY, KALABURGI</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MSC_008</td>
<td>BIOCONVERSION OF BIODIESEL DERIVED CRUDE GLYCEROL TO POLYHYDROXYALKANOTES / POLYHYDROXYBUTRATE (PHA/PHB)</td>
<td>BIOTECHNOLOGY</td>
<td>GULBARGA UNIVERSITY, KALABURGI</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MSC_021</td>
<td>MICROALGAE CULTIVATION USING URBAN WASTE WATER FOR ENHANCED BIOMASS AND LIPID PRODUCTION ALONG WITH REDUCED EUTROPHICATION</td>
<td>BIOTECHNOLOGY</td>
<td>INDIAN ACADEMY DEGREE COLLEGE, BENGALURU</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MSC_003</td>
<td>CHEMICAL NUTRIENT ANALYSIS OF VERMICOMPOST PRODUCED USING PONGAMIA PINNATA SEED CAKE AND ITS EFFECT ON THE GROWTH OF PONGAMIA PINNATA</td>
<td>BIOTECHNOLOGY</td>
<td>M.S.RAMAIAH COLLEGE OF ARTS, SCIENCE AND COMMERCE, BANGALORE</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_MSC_023</td>
<td>GENETIC ANALYSIS OF THE VARIATION AMONG THE TRAITS OF THE WILD TYPE PONGAMIA TREES PLANTED IN BANGALORE CITY IN COMPARISON WITH THOSE OF THAT OF THE CANDIDATE PLUS PONGAMIA SPECIES THROUGH PROTIEN MARKER ASSAY TEST AND IMPROVING THE CROP VARIETY BY GRAFTING TECHNOLOGY FOR BETTER YIELD OF PONGAMIA SEEDS</td>
<td>BIOTECHNOLOGY</td>
<td>M.S.RAMAIAH COLLEGE OF ARTS, SCIENCE AND COMMERCE, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_MSC_006</td>
<td>AN INVESTIGATION INTO OPTIMAL BIODIESEL PRODUCTION FROM NON-EDIBLE OIL USING MICROBIAL LIPASE AND EVALUATION OF PHYSICO-CHEMICAL PARAMETERS</td>
<td>BIOTECHNOLOGY</td>
<td>MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN, BENGALURU</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_MSC_014</td>
<td>PRODUCTION OF BIODIESEL FROM OLEAGINOUS FUNGI</td>
<td>MICROBIOLOGY</td>
<td>DAVANGERE UNIVERSITY, DAVANGERE</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_MSC_019</td>
<td>ISOLATION OF CELLULOLYTIC MICROBES AND ROLE OF MICROBES IN BIODEGRADATION OF INVASIVE WEED SPECIES FOR ETHANOL PRODUCTION</td>
<td>MICROBIOLOGY</td>
<td>DAYANANDA SAGAR INSTITUTIONS, BANGALORE</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_MSC_022</td>
<td>COFFE PULP AND ARECA NUT HUSK - A POTENTIAL SOURCE OF CELLULOSIC FEED STOCK FOR BIOETHANOL PRODUCTION USING MICROBIAL CONSORTIA</td>
<td>MICROBIOLOGY</td>
<td>DAYANANDA SAGAR INSTITUTIONS, BANGALORE</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_MSC_012</td>
<td>BIOFUEL PRODUCTION FROM ARSENIC REMOVAL ALGAE</td>
<td>MICROBIOLOGY</td>
<td>MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BANGALORE</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_MSC_004</td>
<td>MICROBIAL PRODUCTION OF BIOETHANOL FROM CAROB PODS</td>
<td>MICROBIOLOGY</td>
<td>MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>Degree</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MBA_004</td>
<td>FINANCIAL AND ECONOMIC ASSESSMENT OF BIODIESEL PRODUCTION AND USE IN BANGALORE</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MBA_002</td>
<td>FEASIBILITY STUDY ON ESTABLISHING BIODIESEL PLANT</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MBA_003</td>
<td>A FEASIBILITY STUDY ON BIO DIESEL FUEL</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MBA_001</td>
<td>A STUDY ON COST ANALYSIS OF PROCUREMENT AND PROCESSING OF NON-EDIBLE OIL SEEDS</td>
<td>MASTER OF BUSINESS ADMINISTRATION</td>
<td>MBA</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MBA_006</td>
<td>A STUDY ON TRAINING NEED ASSESSMENT FOR THE FARMERS WITH REFERENCE TO EXPERT FARMING PRACTICES OF JATROPHA BASED BIO-FUEL IN KARNATAKA</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
</tbody>
</table>
### List of Projects for Selected for Final Seminar and Exhibition held at BLDE Association’s Vachana Pitamaha Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura (Bijapur), on 19th and 20th August 2016

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39S_B_BE_042</td>
<td>EFFECT OF INJECTION TIMING, INJECTOR OPENING PRESSURE ON DIRECT INJECTION DIESEL ENGINE USING DAIRY SCUM BIO-DIESEL OIL</td>
<td>MECHANICAL ENGINEERING</td>
<td>A.G.M. RURAL COLLEGE OF ENGINEERING AND TECHNOLOGY, VARUR, HUBLI</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_BE_062</td>
<td>PRODUCTION OF BIOFUELS FROM SEMECARPUS ANCARDIUM(BIBA) SEED OIL AND PERFORMANCE STUDY ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>AMRUTA INSTITUTE OF ENGINEERING AND MANAGEMENT SCIENCES</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_BE_013</td>
<td>PERFORMANCE AND EMISSION EVALUATION OF NANO PARTICLE ADDED SIMAROUBA BIODIESEL ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>CANARA ENGINEERING COLLEGE, BENJANAPADAVU</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_BE_060</td>
<td>PERFORMANCE TEST ON CI ENGINE USING THE BIO-DIESEL EXTRACTED FROM TERMINALIA-CATTAPPA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>G.M. INSTITUTE OF TECHNOLOGY, DAVANGERE</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_BE_014</td>
<td>DEVELOPMENT OF TABLE TOP BIOGAS UNIT</td>
<td>MECHANICAL ENGINEERING</td>
<td>GLOBAL ACADEMY OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_BE_003</td>
<td>SYNTHESIS OF BIODIESEL BY TRANSESTERIFICATION REACTIONS USING HETEROGENEOUS BASE CATALYST WITH DIFFERENT OILS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_BE_074</td>
<td>SYNTHESIS AND CHARACTERISATION OF NOVEL CATALYST FOR CONVERSION OF CRUDE GLYCEROL DERIVED FROM BIODIESEL TO VALUE-ADDED PRODUCTS</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.S.RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_BE_061</td>
<td>COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A CI ENGINE UNDER VARIOUS BIODIESELS FOR DIFFERENT COMPRESSION RATIOS</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>MALNAD COLLEGE OF ENGINEERING, HASSAN</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_BE_004</td>
<td>FUEL OIL EXTRACTION THROUGH PYROLYSIS USING SOLAR ENERGY</td>
<td>MECHANICAL ENGINEERING</td>
<td>MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING, MOODABIDRI</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>10</td>
<td>39S_B_BE_009</td>
<td>MICROWAVE ASSISTED OPTIMIZATION FOR RELEASING FERMENTABLE SUGAR AND PRODUCTION OF BIOETHANOL FROM COCOA POD SHELLS</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>11</td>
<td>39S_B_BE_010</td>
<td>PRODUCTION OF BIO-BUTANOL FROM SACCHARUM SPONTANEUM</td>
<td>BIOTECHNOLOGY</td>
<td>N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE</td>
</tr>
<tr>
<td>12</td>
<td>39S_B_BE_005</td>
<td>DESIGN AND FABRICATION OF ECONOMICALLY VIABLE HYBRID PHOTO-BIOREACTOR (CLOSED BUBBLE COLUMN) PROTOTYPE FOR CULTIVATION OF ELITE MICROALGAE FOR ENHANCED LIPIDS (BIODIESEL) YIELD</td>
<td>BIOTECHNOLOGY</td>
<td>NEW HORIZON COLLEGE OF ENGINEERING, MARATHAHALLI, BENGALURU</td>
</tr>
<tr>
<td>13</td>
<td>39S_B_BE_006</td>
<td>PRODUCTION OF CLEAN BIOFUEL FROM MICRO ALGAE</td>
<td>BIOTECHNOLOGY</td>
<td>R.V. COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>14</td>
<td>39S_B_BE_016</td>
<td>PERFORMANCE AND EMISSION CHARACTERISTICS OF IC ENGINE WITH CHICKEN FAT BIODIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>15</td>
<td>39S_B_BE_017</td>
<td>PERFORMANCE TEST ON 4-STROKE DIESEL ENGINE BY USING PONGAMIA AND VEGETABLE OIL AS A BIO-FUEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>REVA INSTITUTE OF TECHNOLOGY AND MANAGEMENT KATTIGENAHALLI, YELAHANKA, BENGALURU</td>
</tr>
<tr>
<td>16</td>
<td>39S_B_BE_024</td>
<td>COMPARISONS OF PERFORMANCE EMISSION TEST USING BIODIESEL FROM SIMAROUBA AND WASTE COOKING OIL IN A C.I. ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>RURAL ENGINEERING COLLEGE HULKOTI, GADAG</td>
</tr>
<tr>
<td>17</td>
<td>39S_B_BE_075</td>
<td>PRODUCTION OF ETHANOL FROM LIGNOCELLULOSIC FEED STOCK</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
<tr>
<td>18</td>
<td>39S_B_BE_076</td>
<td>ASSESSMENT OF BIO-OIL PRODUCTION FROM WASTE FISH FAT AND UTILIZATION IN DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALORE</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>NAME OF THE COLLEGE</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>19</td>
<td>39S_B_BE_048</td>
<td>PRODUCTION AND OPTIMIZATION OF SIMAROUBA BIODIESEL USING RSM AND PERFORMANCE, COMBUSTION, EMISSION ANALYSIS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>20</td>
<td>39S_B_BE_052</td>
<td>DEVELOPMENT OF DUAL FUEL ENGINE AND ITS PERFORMANCE AND EMISSION ANALYSIS</td>
<td>MECHANICAL ENGINEERING</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>21</td>
<td>39S_B_BE_044</td>
<td>GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM JATROPHA CURCAS TO ENHANCE LIPASE ACTIVITY</td>
<td>BIOTECHNOLOGY</td>
<td>SIR M VISVESVARAYA INSTITUTE OF TECHNOLOGY, HUNASAMARANAHALLI, BENGALURU</td>
</tr>
<tr>
<td>22</td>
<td>39S_B_BE_090</td>
<td>SYNTHESIS OF BIODIESEL FROM MADHUCA INDICA OIL (MI-OIL) BY TRANSESTERIFICATION PROCESS FOR ENGINE PERFORMANCE TEST</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>23</td>
<td>39S_B_BE_098</td>
<td>DESIGNING OF BIOREMEDIATION TOOL FOR POLY AROMATIC HYDROCARBON (PAHS) DEGRADATION USING FUNGAL CONSORTIUM</td>
<td>BIOTECHNOLOGY</td>
<td>THE OXFORD COLLEGE OF ENGINEERING, BANGALORE</td>
</tr>
<tr>
<td>24</td>
<td>39S_B_BE_032</td>
<td>PRODUCTION AND PURIFICATION OF LIQUID FUEL BY HOUSEHOLD PLASTIC WASTE FOR IC ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>VSM INSTITUTE OF TECHNOLOGY, NIPANI</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>Degree</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MTech_015</td>
<td>VALIDATION OF CST DESIGN 3-STAGE CONTINUOUS BIOREACTOR FOR SEWAGE FED LAKE RESTORATION ALONG WITH ALGAL BIOMASS RECOVERY FOR BIOFUEL PRODUCTION</td>
<td>ENVIRONMENTAL ENGINEERING</td>
<td>M.Tech</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MTech_004</td>
<td>ULTRASOUND ASSISTED SYNTHESIS OF BIODIESEL FROM WASTE COOKING OIL BY USING METAL OXIDE CATALYST</td>
<td>CHEMICAL ENGINEERING</td>
<td>M.Tech</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MTech_001</td>
<td>PRODUCTION AND CHARACTERIZATION OF BIODIESEL FROM SPENT COFFEE POWDER AND PERFORMANCE TEST IN A DIESEL ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>M.Tech</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MTech_006</td>
<td>HETEROGENEOUS CATALYSED PROCESS OPTIMIZATION FOR BIODIESEL PRODUCTION FROM BONBAX CEIBA SEED VIA MICROWAVE ASSISTED BIODIESEL PRODUCTION TECHNOLOGY</td>
<td>THERMAL POWER ENERGY</td>
<td>M.Tech</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MTech_010</td>
<td>STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF A DIESEL ENGINE FUELED WITH BLENDS OF NEEM AND SEMAROUBA</td>
<td>THERMAL SCIENCE AND ENERGY SYSTEM</td>
<td>M.Tech</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>Degree</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MSC_022</td>
<td>COFFE PULP AND ARECA NUT HUSK - A POTENTIAL SOURCE OF CELLULOSIC FEED STOCK FOR BIOETHANOL PRODUCTION USING MICROBIAL CONSORTIA</td>
<td>MICROBIOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MSC_013</td>
<td>ENHANCEMENT OF BIOETHANOL PRODUCTION BY IMMOBILIZING OF HYDROLYTIC ENZYMES AND MARKERS ASSISTED ANALYSIS BY RAPD METHODE OF AMMORPHOPHALUS SPEICES</td>
<td>BIOTECHNOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MSC_007</td>
<td>ISOLATION SCREENING AND CHARACTERIZATION OF LIPASE PRODUCERS USING NON-EDITABLE DE-OILED SEED CAKE AS A SUBSTRATE</td>
<td>BIOTECHNOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MSC_008</td>
<td>BIOCONVERSION OF BIODIESEL DERIVED CRUDE GLYCEROL TO POLYHYDROXYALKANOTES / POLYHYDROXYBUTRATE (PHA/PHB)</td>
<td>BIOTECHNOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MSC_021</td>
<td>MICROALGAE CULTIVATION USING URBAN WASTE WATER FOR ENHANCED BIOMASS AND LIPID PRODUCTION ALONG WITH REDUCED EUTEOPHICATION</td>
<td>BIOTECHNOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_MSC_003</td>
<td>CHEMICAL NUTRIENT ANALYSIS OF VERMICOMPOST PRODUCED USING PONGAMIA PINNATA SEED CAKE AND ITS EFFECT ON THE GROWTH OF PONGAMIA PINNATA</td>
<td>BIOTECHNOLOGY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_MSC_005</td>
<td>EVALUATION OF BIOPESTICIDE PROPERTIES OF AZADIRACTHA INDICA SEED CAKE</td>
<td>BIOCHEMISTRY</td>
<td>M.Sc</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Project proposal Ref. No.</td>
<td>TITLE OF THE PROJECT</td>
<td>BRANCH</td>
<td>Degree</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>39S_B_MBA_004</td>
<td>FINANCIAL AND ECONOMIC ASSESSMENT OF BIODIESEL PRODUCTION AND USE IN BANGALORE</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_MBA_002</td>
<td>FEASIBILITY STUDY ON ESTABLISHING BIODIESEL PLANT</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_MBA_003</td>
<td>A FEASIBILITY STUDY ON BIO DIESEL FUEL</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_MBA_001</td>
<td>A STUDY ON COST ANALYSIS OF PROCUREMENT AND PROCESSING OF NON-EDIBLE OIL SEEDS</td>
<td>MASTER OF BUSINESS ADMINISTRATION</td>
<td>MBA</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_MBA_006</td>
<td>A STUDY ON TRAINING NEED ASSESSMENT FOR THE FARMERS WITH REFERENCE TO EXPERT FARMING PRACTICES OF JATROPHA BASED BIO-FUEL IN KARNATAKA</td>
<td>MANAGEMENT STUDIES</td>
<td>MBA</td>
</tr>
</tbody>
</table>
# Biofuel B.E. Projects Selected for Final EXHIBITION

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Project proposal Ref. No.</th>
<th>TITLE OF THE PROJECT</th>
<th>BRANCH</th>
<th>Degree</th>
<th>NAME OF THE COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39S_B_BE_099</td>
<td>DESIGN AND DEVELOPMENT OF SEED DECORTICATOR FOR SIMAROUBA GLAUCAGE SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>CMR INSTITUTE OF TECHNOLOGY, BANGALORE</td>
</tr>
<tr>
<td>2</td>
<td>39S_B_BE_051</td>
<td>BIOELECTRICITY PRODUCTION THROUGH INTEGRATED BIOGAS AND MICROBIAL FUEL CELL</td>
<td>BIOTECHNOLOGY</td>
<td>BE</td>
<td>DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU</td>
</tr>
<tr>
<td>3</td>
<td>39S_B_BE_097</td>
<td>ENGINE ANALYSIS AND EMISSION TESTING ON STRAIGHT VEGETABLE OIL (SVO) BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINES</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>4</td>
<td>39S_B_BE_100</td>
<td>PERFORMANCE STUDY ON STRAIGHT VEGETABLE OIL BLENDED WITH PETROL AS SUBSTITUTE FUEL IN CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA</td>
</tr>
<tr>
<td>5</td>
<td>39S_B_BE_012</td>
<td>EXPERIMENTAL INVESTIGATION OF GASIFIED VEGETABLE OILS AS ALTERNATIVE FUELS IN SI ENGINES ON ROAD BIKE</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>RAO BAHADUR Y. MAHABALESHWARAPPA ENGINEERING COLLEGE, BELLARY</td>
</tr>
<tr>
<td>6</td>
<td>39S_B_BE_036</td>
<td>IMPROVEMENTS IN DESIGN AND REFABRICATION OF AUTOMATED CLEANING MACHINE FOR PONGAMIA SEEDS</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA</td>
</tr>
<tr>
<td>7</td>
<td>39S_B_BE_047</td>
<td>SYNTHESIS OF BUTEA MONOSPERMA BIO DIESEL AND STUDY ON PERFORMANCE, COMBUSTION CHARACTERISTICS ON CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>8</td>
<td>39S_B_BE_054</td>
<td>PRODUCTION OF BIODIESEL FROM YELLOW OLEANDER SEED AND PERFORMANCE ANALYSIS ON SINGLE CYLINDER CI ENGINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR</td>
</tr>
<tr>
<td>9</td>
<td>39S_B_BE_082</td>
<td>HYDROGEN FUEL CELL VEHICLE</td>
<td>MECHANICAL ENGINEERING</td>
<td>BE</td>
<td>T. JOHN GROUP OF TECHNOLOGY, BANGALORE</td>
</tr>
</tbody>
</table>