STUDENT PROJECT PROGRAMME : 2017 - 18

BIOFUEL PROJECTS

Compendium of
41st Series SPP : Biofuel Projects

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

Supported by
KARNATAKA STATE BIOENERGY DEVELOPMENT BOARD
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FOREWORD

It has always been an interesting feature to learn more and more about the recent developments in the field of Bioenergy as the country progresses towards a fully developed nation. The recent trend in Bioenergy indicates that it has the potential to replace the fossil fuel to a larger extent thereby reducing the burden on exchequer in the import of crude oil. This has also led to wider scope for Research and Development in the area of Biofuels and Bioenergy. Further, Innovation and Technology are needed for self-reliance in the energy sector which could be sector wise based on the exploitation of natural resources that are renewable. Developing renewable energy technologies is a multi-disciplinary effort and requires a well-planned impetus for growth.

In this context, it gives me immense pleasure to learn that Karnataka State Council for Science and Technology (KSCST) had taken the lead, in its earlier stages, to focus on decentralized energy systems through community biogas for power generation. In its efforts to promulgate the green energy technologies in rural Karnataka, KSCST has always been in the forefront in providing solutions to the decentralized energy requirements in the State through S&T interventions. The approach is sector wise when it comes to identifying appropriate S&T interventions, hence KSCST, has created the right platform for young researchers to come out with the right solution. One of the major strategy in this regard has been the implementation of Student Project Programme (SPP) during 1977 which encouraged the student community in the engineering institutions to take up innovative projects that would give realistic solutions for the problems faced in, not only renewable energy sector, but all those sectors which impact the socio-economic development of rural population.

KSCST has executed energy-based projects in association with Indian Institute of Science and successfully implemented them in the field from time to time. Community biogas plants, smokeless and fuel-efficient wood stoves and popularization of domestic solar water heaters, are some of the important energy devices designed and developed by KSCST and disseminated.

In continuation of its effort for developing renewable energy KSCST has collaborated with Karnataka State Bioenergy Development Board (KSBDB), Government of Karnataka and set up the Biofuel Cell 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.

Since inception of Biofuel Cell, KSBDB has come forward for funding the projects on biofuel and bio energy related projects. Under the 41st series 154 project proposals were received, 87 projects were sanctioned out of which 62 (BE – 43, MTech – 01, MSc – 12 and MBA - 06) projects have been selected for final seminar and exhibition.

We also have the pleasant task of arranging the State Level Seminar and Exhibition. This compendium of biofuel projects compiled under the 41st series will be released on the occasion of the State level Seminar and Exhibition being held on 10th and 11th August 2018 at BIET Davangere. I hope these endeavours would inspire the creative minds of young talented students to work towards clean and green energy. I take this opportunity to thank KSBDB for their constant support and encouragement. I also thank BIET, Davangere for hosting this important event of KSCST.

Prof. S. Subramanian
Secretary, KSCST
ABOUT KSCST

Located in the prestigious campus of Indian Institute of Science, Karnataka State Council for Science and Technology (KSCST) has been pioneering in providing solutions to the problems that require immediate attention through S&T interventions. Established in 1975, 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 focus has always been in the Energy, Agriculture, Water, Housing, Waste management, Health and Education sectors. 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 especially suitable for the application of Science and Technology;

❖ To prepare Science and Technology plans relevant to the development needs of the State;

❖ To advise the government on such other matters as relevant to the application of Science and Technology to the problems of Karnataka State.

To identify research areas of major concerns in sectors like Housing, Energy, Water supply, Ecology and Environment, Industries and Rural employment KSCST has networked with several institutions and governmental agencies for effective implementation.

KSCST has taken lead in the renewable energy sector by becoming the first to popularize Solar Water Heaters and Wind Energy Projects by conducting wind potential survey in the State which has culminated into major solar and wind energy projects in the State.

Another major programme of the Council is the Natural Resources Data Management System (NRDMS) programme which has been assisting the district administration and Planning by using the latest GIS and Remote Sensing based planning tools through its 30 district centres established in the premises of Zilla Panchayaths.

Rainwater Harvesting is one of the important programmes of the Council. Council has 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.
objectives of the Council has been to improve the quality of education in engineering and Science 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 for last four decades and has become a flagship programme of the Council. Many projects, sponsored in this programme, deal with technology applications relevant to the needs of State. Since its inception in 1978, the Council has supported more than 9,500 projects under this programme including 350 projects under Biofuels and Bioenergy sector.

This is the 41st series of SPP (2017-18) and it is for the seventh time in the series of SPP (35th Series onwards) that the Biofuel projects have been supported and sponsored for the students of final year BE, MTech, MSc and MBA.

This year (2017-18) 87 Biofuel/Bioenergy projects have been supported by Karnataka State Bioenergy Development Board (KSBDB) and 62 projects have been selected for the State level Seminar and Exhibition to be held at Bapuji Institute of Engineering and Technology (BIET), Davangere. This compendium provides 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. All the Projects are going to be presented by the students at the State level Seminar and Exhibition before a panel of experts and awards and certificates will be presented to the best projects during the valedictory function.

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The State government constituted the Biofuel Task Force during September 2008 for effective planning and implementation of the biofuel program in the state. The Task force was entrusted with the responsibility of advising the Government and to create an enabling atmosphere in the State. Further, the task force also drafted the State Biofuel policy which was approved by the State Government and also adopted by the Central Government. Based on the recommendation of this task force and the work carried out indicated 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 programs in 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 Bio-ethanol production from agro waste and its applications
9. Setting up information and Demonstration centers for creating awareness and promoting biodiesel usage in rural areas.
11. Programmes for value addition and usage of value added products in rural areas.
12. Establishment of clonal orchards in different regions across the State.
13. Encouraging various research activities in the entire Biofuel value chain involving Universities and research organization.

KSBDB launched several programmes such as “Bardu Bangara” & “Hasiru Honnu” for producing seedlings for raising of Biofuel species for establishing plantation and also for the community to grow in the marginal land. The large-scale planting requires supply of the feed stock 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 several clonal orchards have been established for different species. 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.

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.
KSBDB has set up Bioenergy, Research, Information and Demonstration Centres (BRIDC) in all the 33 districts of the State to provide information on biofuel for students, scientists, entrepreneurs, farmers, biofuel cultivators, researchers and general public. The BRIDC centres provide information of harvesting, processing, marketing, value addition and serve as a role model. BRIDC centres are functioning with an installed pilot plant capacity of hundred litres per day. The responsibilities of the information and Demonstration Centres are to meet the needs of all stake holders in biofuel development. The BRIDC Centres shall endeavour to contribute to the socio-economic development of the nation by demonstrating the entire Biofuel value chain.

To ensure effective implementation, 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).

KSBDB recognised the activities of KSCST in the energy sector and showed a keen interest in its projects and programme, considering the potential of research and training in the field of Bioenergy and Biofuel. KSBDB and KSCST collaborated to setup Biofuel Cell in KSCST. The aim was to promote R&D in the Biofuel area through SPP and also to organize workshops and training to students, faculties and officials.

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 graduate’s students to take up biofuels as their academic project has received a tremendous response from many colleges and Universities across Karnataka. The support from KSBDB came during the 35th series of SPP where in 31 projects were sponsored. So far KSBDB has supported more than 350 Engineering and Science projects till date. Under the 41st series of SPP, KSBDB has supported 87 projects. Out of 87 projects, 62 projects (43-B.E., 01-M.Tech, 12-MSc and 06-MBA) were selected during the mid-term evaluation held at Sri Venkateswara College of Engineering (SVCE), Bengaluru for the final seminar and exhibition to be held at Bapuji Institute of Engineering and Technology (BIET), Davangere.

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ACKNOWLEDGEMENT

This compendium of Biofuel Projects is a compilation of the works carried out by the students of the final semester B.E., M.Tech, MSc and MBA whose project were sponsored by KSCST and selected for the State level Seminar and Exhibition to be held at Bapuj Institute of Engineering and Technology (BIET), Davangere. Although under the 41st Series 87 projects were sponsored but during the midterm evaluation only 62 projects were selected for the final Seminar and Exhibition.

We place on record our sincere gratitude and appreciation for Karnataka State Bioenergy Development Board with a special mention to Prof. Basavaraj Ramnal, former Hon’ble Chairman of the KSBDB and Shri. V. Yashavanth, IAS, former Managing Director, KSBDB for their constant guidance and encouragement for Biofuel Projects and its activities. We are also thankful to Smt. K. M. Jaanaki, IAS, for her support in Biofuel activities in our State.

The exercise of compiling the compendium involves several activities including the framework for the booklet to be published and printed. This effort requires all the valuable support of the decision makers, staff and team members of the project. Although, we may fall short of words to express our gratitude to all those who have sincerely contributed to this publication, but we are privileged to express our gratitude to one and all.

We sincerely express our gratitude to Prof. S. Subramanian, Secretary, KSCST, for his wholehearted encouragement and support for our efforts in completing the SPP Biofuel Projects of 41st Series.

This compendium consists of synopsis of 62 projects selected for the final Seminar & Exhibition of SPP out of the 87 projects sanctioned. These projects were scrutinized before sanction of support and evaluated for the selection to final Seminar and Exhibition by the Working Group Members consisting of

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

In order to prepare this book, it is essential to coordinate with all the students of the selected projects and get their feedback in the form of synopsis which is then compiled as a compendium. We are thankful to Shri. K. N. Venkatesh, Project Engineer and Programme Co-ordinator SPP, Ms. G. P. Prayanya, Project Associate, Biofuel Cell and Mr. Nagarjun M. G., Project Associate, Biofuel Cell. We also thank all the staffs of KSCST who have directly or indirectly helped us in completing this compendium.

(Dr. S.G. Sreekanteswara Swamy) (S. N. Sondur)
SYNOPSIS OF B.E. SEMINAR PROJECTS

COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF FOUR STROKE GASOLINE ENGINE UNDER THE VARIOUS BLENDS WITH BIO LUBRICANTS

Project Reference No.: 41S_B_BE_021

COLLEGE : MALNAD COLLEGE OF ENGINEERING, HASSAN
BRANCH : DEPARTMENT OF AUTOMOBILE ENGINEERING
GUIDE : Dr. Y. M. SHASHIDHARA
STUDENTS : Mr. ASHOKA G U
            Mr. LINGARAJU G H
            Mr. MADHURAJ J
            Mr. SACHIN M

Three vegetable oils such as Pongamia oil, Neem oil, and Coconut oil are selected for the formulation of bio lubricants due to their higher mono saturation composition in their fatty acid composition. Primarily, the structure of these oils is chemically modified through transesterification using methanol to obtain their methyl esters, Methyl ester of Pongamia oil (MEPO), Methyl ester of Neem oil (MENO) and Methyl ester of Coconut oil (MECO). Further, to improve thermal and oxidative stability, all the three methyl esters are transesterified with Trimethylpropane (TMP) to form their TMP ester. The obtained Pongamia Trimethylolpropane ester (PTMPE), Neem Trimethylolpropane ester (NTMPE) and Coconut Trimethylolpropane ester (CTMPE) are washed with ethyl acetate and distillation is done to obtain bio lubricant base oil for engine lube oil application.

Experiments are conducted on a vertical single cylinder air cooled four stroke gasoline Honda engine developing 1.5 kW at 4500 rpm, under different blends of mineral oil and three bio-lubricants. The engine is coupled to an electric generator for varying the load.

It is observed that, the fuel consumption drops by about 5 % under NTMPE20-MO80 mode of operation, about 15% decrease in PTMPE40-MO60 and about 30 % decrease under CTMPE20-MO80 mode of operation compared to mineral oil mode of operation.

The brake thermal efficiency is increased by about 6% under NTMPE20-MO80 mode of operation, about 12% increase under PTMPE40-MO60 and about 35% increase under compared to mineral oil mode of operation respectively. Further, it is observed that the mechanical efficiency is also high under the blend, CTMPE20-MO80 compared to mineral oil lubrication mode of operation.

The engine emits about 2%, 3 % and 9% lower Carbon monoxide under NTMPE 20-MO 80, PTMPE 40-MO 60 and CTMPE 20-MO 80 respectively compared to mineral oil lubrication mode of engine operation. Further, the engine exhales about 2%, 9% and 4% lower unburnt hydrocarbon under NTMPE 20-MO 80, PTMPE 40-MO 60 and CTMPE 20-MO 80 respectively compared to mineral oil lubrication mode of engine operation.

The experimental results reveal that the blend, CTMPE20-MO 80 is found to be the potential alternative for the conventional mineral oil in terms of performance and emission characteristics.

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PRODUCTION OF MYCODYESELM FROM COST EFFECTIVE HYDROCARBONS OF ENDOPHYTIC FUNGAL SPECIES OF PONGAMIA AND JATROPHA

Project Reference No.: 41S_B_BE_013

COLLEGE: DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU
BRANCH: DEPARTMENT OF BIOTECHNOLOGY
GUIDE: Dr. GOVINDAPPA M
STUDENTS: MS. ZOYA NOORAIN
            MS. ARCHANA T

Introduction: According to the present global scenario, the availability of the fuel such as diesel is decreasing rapidly with increase in demand. This fuel is non-renewable source of energy. Due to the depletion of this non-renewable fuel, finding new renewable fuel sources that can be a clean alternative for fossil fuels has gained importance in almost all parts of the world. The non-toxic, biodegradable, clean burning, lower emission and green alternative for diesel can be biodiesel. Mycodiesel is the new and innovative technology to produce Bio-diesel in an effective way. Thus, Mycodiesel is the production of Bio-diesel from the effective hydrocarbons, which are produced by the endophytic fungal species of the diesel plant seeds, namely, Pongamia and Jatropha seeds. On inoculating the pongamia and jatropha seeds into the media, the fungi grown on it produces volatile hydrocarbons, which in turn produces biodiesel by transesterification. *Pongamia pinnata* is a rapidly growing and economically important evergreen tree. The seeds of Pongamia tree are used increasingly as feedstock for biodiesel production and this Oil-yielding crop plant is important for economic growth of the biodiesel. *Jatropha curcas* is a species of flowering plant. The oil produced by the Jatropha seeds can be processed to produce a high-quality biodiesel that can be used in a diesel car.

Keywords: Mycodiesel, Bio-diesel, hydrocarbons, Pongamia, Jatropha, hydrocarbons, transesterification.

Objectives:
1. To isolate, characterize and mass culture of endophytic fungal species from Jatropha curcas and Pongamia pinnata.
2. To produce and characterize mycodiesel from endophytic fungus from TLC, GC-MS etc.
3. Production of biodiesel from endophytic fungi through the process of transesterification.
4. Development of an innovative technology for the conversion of endophytic fungal hydrocarbons into biodiesel.

Methodology:
Results and Conclusion:

➢ The Mycodiese was obtained from Aspergillus niger and Aspergillus tamarii of Jatropha curcas and Pongamia pinnata by Transesterification.
➢ Various tests like GC-MS, TLC, FTIR, 'H-NMR, UV Visible Spectrophotometry, Raman Spectroscopy was performed on the Mycodiesel produced by the hydrocarbons from the endophytic fungal species of Jatropha curcas and Pongamia pinnata seeds.
➢ Therefore the Mycodiesel obtained from the endophytic fungal species by Transesterification was found to consist of the similar structural and functional compounds and similar oil properties as that of the standard diesel.
➢ The results of Mycodiesel obtained from these tests were similar to the result of the standard diesel. Results of Mycodiesel obtained from Aspergillus tamarii of Jatropha curcas are shown below.

❖ Jatropha curcas (Aspergillus tamarii)

Future Scope: Myco-diesel is a safe alternative fuel to replace traditional petroleum diesel which can be developed further. It acts like petroleum diesel, but it produces less air pollution, comes from the renewable sources. It is also biodegradable, clean burning, lower emission, non-toxic, and safe fuel. It is safer for the environment, therefore producing biodiesel fuels can help create local economic revitalization and local environmental benefits. The global market for biodiesel is expected to increase in the next ten years. The use of oil seeds such as Pongamia pinnata and Jatropha curcas for obtaining the mycodiesel has the potential to provide an environmentally acceptable fuel.
Considering the increasing prices and environmental aspects of fossil fuels especially diesel fuel, mycodiesel can be used as an alternative fuel for diesel.

BIOFUEL PRODUCTION USING INNOVATION AND COST-EFFECTIVE BIOREACTOR FROM MICROALGAE AND PVA BY HYDROTHERMAL LIQUEFACTION TECHNOLOGY (AT LOW TEMPERATURE)

Project Reference No.: 41S_B_BE_014

COLLEGE : DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU
BRANCH : DEPARTMENT OF BIOTECHNOLOGY
GUIDE : MRS. MANASA V ANAND
STUDENTS : MS. VAISHNAVI CONETI
           MS. SHREYA JAYYAM

Keywords: Microalgae; Hydrothermal Liquefaction Technology; Bioreactor; Renewable Energy; Alternative fuel

Introduction:
- Biofuels productions from microalgae received wide attention recently and have high potential to replace fossil fuels.
- Microalgae have high growth rate and is able to develop maximum of 70% of lipid content within their cells depending on species.
- Research into algae for the mass-production of oil focuses mainly on their less complex structure, fast growth rates, and high oil-content.
- Micro algal conversion into biofuel can be carried out by numerous techniques, one of which is hydrothermal liquefaction technology. Hydrothermal liquefaction technology is the thermochemical conversion of wet biomass into bio-crude or bio-oil at high temperature and pressure conditions.
- Here we focus on conversion of biomass into biofuel at low temperatures of about 80-120˚C.
- Hydrothermal liquefaction technology can be carried out in a bioreactor specially designed to maintain optimum temperature and pressure conditions.
- The bioreactors used to carry out this experimentation work are- PSM mini reactor which has the ability to maintain temperatures up to 250˚C and also has a special ability to maintain vacuum. Enerzi microwave reactor which uses microwaves as a heating source and can maintain temperatures up to 900˚C.
- Apart from the above two reactors, a conventional reactor was developed to maintain the desired low temperatures and work was carried out in the same.
- The Biofuel produced is further characterized and analyzed, and its properties like flash point, calorific value, density and viscosity is addressed.
- Flash point test is carried out to find the lowest temperature at which vapors’ of the biofuel produced will ignite, when given an ignition source.
- Calorific value test is carried out to find out the energy contained in the biofuel produced, determined by measuring the heat produced by complete combustion of a specified quantity of it.
- The density and viscosity are very important properties of the fuel engine. Viscosity affects the atomization of the fuel and is majorly affected by the density of the biofuel.

Objectives
- Extraction of crude oil by hydrothermal liquefaction of PVA and microalgal sources at low temperatures at lab scale.
➢ To develop a reactor for scale up of biofuel production that can provide low temperature and pressure conditions.
➢ To improve the characteristic properties of the biofuel (flash point, calorific value, viscosity, density).
➢ To develop a biofilm using PVA, Algae & lignocellulosic sources as an application for packaging.

Methodology:

- Microalgae was cultured in BG-11 medium
- Powdered microalgae along with PVA were blended together at different concentrations.
- The above mixtures were subjected to hydrothermal liquefaction technology at low temperature and pressure conditions.
- Hydrothermal liquefaction was performed in a bioreactor designed to cater the low temperatures required for our experimentation work.
- Three different reactors were used to perform hydrothermal liquefaction technology.
- A conventional reactor was designed at DSCE which could provide low temperatures and low pressure, the samples were subjected to the bioreactor and the heating source in this reactor was steam from boiling water.
- PSM mini reactor and Enerzi microwave reactor at TERI was used. PSM mini reactor is a conventional reactor which can provide temperatures up to 250˚C and Enerzi microwave reactor can provide temperatures up to 900˚C where the heat source is from microwaves.
- After subjecting the samples to hydrothermal liquefaction, the layers were separated and were further processed.
- The biofuel produced was subjected to fuel characterization tests such as flammability test, flash point test, calorific value test and density.

![Conventional reactor at DSCE](image1)

Fig. 01: Conventional reactor at DSCE

![PSM mini reactor](image2)

Fig. 02: PSM mini reactor

![Enerzi microwave reactor](image3)

Fig. 03: Enerzi microwave reactor

![Flammability test](image4)

Fig. 05: Flammability test
Results:

1. **Flammability of PVA**: Various concentrations of PVA at temperatures ranging from 70-90°C was analysed and it was noticed that the product was flammable for 10 Wt. % and 15 Wt % concentration of PVA at a temperature of 80°C. The product showed negative results at a concentration of 20 Wt % of PVA due to high viscosity. It is difficult to test the flammability when the product is highly viscous.

2. **Flash point analysis of the flammable samples**: The best result was analysed at a temperature of 76°C. The flash point of the biofuel produced from algae was much higher than that of conventional diesel (54–96 °C). It is much safer than conventional diesel because it decreases the chance of fire hazards by many folds.

3. **Calorific value of the flammable samples**: The change in the calorific value of the fuel was observed with the changing proportion of microalgae and PVA. With the increase of the proportion of microalgae the increase in calorific value was observed.

4. **Density of the flammable samples**: The density was found to increase due to the addition of PVA. To reduce the density, the concentration of PVA was maintained at 5wt%.

**Conclusion**: Cellulose was extracted from biomass (microalgae) and it was used for the hydrothermal liquefaction for the conversion of biomass into biofuel. Since, the process Hydrothermal Liquefaction Technology is a mimic of the natural geological process, the process requires the supply of high temperature and pressure but it was also found that continuous supply of low temperatures (80°C–120°C) for a certain interval of time could also lead to the production of biofuels. Hence, microalgae, water and PVA (which helps in donating hydrogen and carbon for the reaction) were subjected to low pressure and low temperature. After subsequent processing of these raw materials biocrude was obtained and it was found that the flash point obtained was very high, which helps in the safe storage of the biofuel.

Future perspectives

- To develop a reactor that can be fully automated and provide higher vessel capacity.
- Data analyses like cetane number, Carbon content and Sulphur content for the biofuel.
- To increase the calorific value of the biofuel obtained.
- To reduce the production cost of the biofuel formed.
- To reduce the viscosity of the biofuel obtained.
- To scale up the biofuel production process.

**PRODUCTION OF BIOFUEL AND BIOSORPTION OF HEAVY METALS BY MICROALGAE USING INDUSTRIAL WASTE WATER**

Project Reference No.: 41S_B_BE_018

**COLLEGE**: G.M. INSTITUTE OF TECHNOLOGY, DAVANGERE
**BRANCH**: DEPARTMENT OF BIOTECHNOLOGY
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**Abstract**: The removal of heavy metals from the waste water is necessary because it starts accumulating in the food web. Many techniques have been emerged to remove heavy metals. The biomass has huge advantageous over conventional methods. The biomass is further directed into transesterification to produce bio fuel. Algal biomass is highly productive feedstock with great potential in biofuel industry.
Scope / Objectives of the project:

- Cultivation of microalgae using industrial waste water.
- Biosorption of heavy metals using microalgae.
- Characterisation of biomass.
- Production and characterisation of bioethanol.

Methodology:

1. **COLLECTION OF WASTE WATER:** Industrial waste water is collected from nearby industry in Davangere district and it is used for the growth of selected Microalgae.

2. **SELECTION OF MICROALGAE:** Algal species selected on the basis of lipid productivity, growth conditions and other characteristics.

3. **CULTIVATION OF MICROALGAE:** A Photobioreactor is a closed system that contain biologically active environment which is sustained with light, energy, heat and nutrients. It allows the better control of conditions surrounding the cultivation of microorganisms.

4. **BIOSORPTION OF HEAVY METALS:** Industrial waste water contains many heavy metals. As these toxic chemicals may enter to food chain will cause severe disasters to human beings, aquatic and non-aquatic species. This present work aimed to reduce the effect of biosorption of locally available heavy metals released by industrial waste water using algae culture.

5. **PRODUCTION OF BIOFUEL:** Algae are an ideal feedstock for the production of bio fuel. The technique has been formulated to maximize the algal productivity using industrial waste water. Oil extraction from algae is done by solvent extraction because solvent used can be recycled; reducing processing cost. Hexane is used for oil extraction. The extracted oil is trans esterified to methyl ester by sodium methoxide.

6. **BIOFUEL CHARACTERISATION:** The final product of methyl ester identified with the help of thin layer chromatography (TLC) and analyzed for kinematic viscosity, specific gravity, carbon residue.

Outcome of the project: Microalgae biomass provides a number of potential and advantages over conventional biomass – it can be cultivated in waste water, stagnant water, contaminated water or sea water. These can be used to consume the heavy metals present in these sources and produce bio fuel which can further be used to derive bio energy. They can reduce the production of greenhouse gases intern reducing global warming and can also result in efficient treatment of waste water.

Microalgae are cultivated in photo bioreactor, dried out in sun. This can enhance the over drain measurement of greenhouse horticulture. It can absorb considerable amount of heavy metals from cultivation media simultaneously producing bio ethanol.

Application of the project: Using algae species for treating wastewater have the ability to sustain growth of algae that produce oil/fats which can be used for biodiesel productions. Therefore, the algae provide dual benefit of wastewater treatments and oil productions. The industrial production of bio fuel using algae is alternative fuel for transport system. the bio fuel known to be environment friendly and it can replace the toxic products and experimental study on adsorbent would be quite useful in developing appropriate technologies for the removals of heavy metals ions from industrial/ domestic effluent.

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**PROCESS DEVELOPMENT FOR THE PRODUCTION OF BIOETHANOL USING COFFEE BERRY PULP IN LAB SCALE AND BIOREACTOR**

Project Reference No.: 41S_B_BE_063

**COLLEGE:** N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE
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Key words: Bioethanol, Acid Hydrolysis, Coffee pulp, Arabica, Robusta, Pre-treatment Optimization

Introduction: Biomass represents one of the most promising sources of energy and chemicals for future generations on the basis that biomass can be utilized without depleting reserves; therefore, it represents a renewable energy source. Lignocellulosic materials are more reliable and promising feedstock for the fermentative biofuels production once the reducing sugars are recovered from its complex structure such as cellulose and hemicellulose. Agricultural residues can be used as a biomass for the production of bioethanol. Biofuels fermentation with the raw waste is more energy intensive and low yield process. Thus, pre-treatment must be carried out to make the process viable and sustainable. Pre-treatment using acid promises more sugar recovery. A number of pre-treatment methods have been developed for improving hydrolysis of lignocellulosic biomaterials. In the current study coffee pulp were hydrolyzed with H$_2$SO$_4$ to release sugars.

Objectives:
1. To optimize pre-treatment process for Robusta and Arabica dried coffee pulp with mucilage.
2. To produce ethanol using optimised process parameters in lab scale.
3. To produce ethanol using optimised process parameters in bioreactor.

Methodology:
a. Materials: Robusta and Arabica coffee pulp, 100 ml conical flasks, DNSA reagent, Autoclave, Centrifuge, pH meter, Visible Spectrophotometer, Hot air oven, Sulfuric Acid, Weighing balance

Methods:

Processing of Raw Materials:
Dried coffee pulp with mucilage of two species Robusta and Arabica was collected from coffee estate of Chikkamagaluru. All these pulp with mucilage was dried in hot air oven at 60°C for 24 hours. The dried pulp with mucilage was powdered in mixer and the powdered pulp was sieved using Tyler mesh #10 to obtain particles of uniform size. The powder was stored in air tight container in refrigerator for further use.

Autoclave Assisted Hydrolysis
Autoclave assisted hydrolysis was performed by weighing 5g (initially for preliminary studies) of powdered pulp with mucilage in a conical flask, this was treated with 1% (v/v) H$_2$SO$_4$ solution, mixed well using glass rod to obtain uniform solution, this was autoclaved for 20 min (initially for preliminary studies) then the solution was centrifuged for 10 min at 8000 rpm. Further hydrolysate was neutralized to pH 7 using 5N NaOH. The released reducing sugar was estimated by DNSA method (Miller 1959). OFAT analysis was performed to identify the significant factors among acid concentration (%v/v), autoclave time (min) and weight (g).

Optimization of Pre-Treatment of Robusta And Arabica Coffee Pulp With Mucilage

Selection of Significant Parameters and Their Levels by OFAT
Pre-treatment of Robusta and Arabica Coffee Pulp was carried out by autoclave assisted sulfuric acid hydrolysis. The OFAT approach was adopted to select the significant factors and its range for pre-treatment process (Table 1). The factors at which maximum reducing sugars released were chosen as the centre point values for central composite design (CCD) to enhance the pre-treatment process by RSM.

Table 1: Selected factors and their range for OFAT studies of pulp hydrolysis for Robusta and Arabica.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Notation</th>
<th>Range of value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H$_2$SO$_4$ Concentration (%v/v)</td>
<td>X$_1$</td>
<td>0.5 -10</td>
</tr>
<tr>
<td>Weight (%w/v)</td>
<td>X$_2$</td>
<td>2-16</td>
</tr>
<tr>
<td>Time</td>
<td>X$_3$</td>
<td>5-90</td>
</tr>
</tbody>
</table>

Central Composite Design
The factors (X$_1$, X$_2$, and X$_3$) exhibiting significant effect during OFAT studies were chosen and their levels were optimized for maximum extraction of reducing sugars as response (Y) using central composite design (CCD) for autoclave based sulfuric acid hydrolysis. CCD was designed for RSM optimization by software with three factors and five levels (Table 2) and it consisted of 20 experimental runs. The data of pre-treatment studies obtained was subjected to analysis by using analysis of variance (ANOVA) using the same software. The optimization experiments were carried out for Robusta and Arabica.
Table 2: Significant factors and their coded levels for hydrolysis of Robusta and Arabica pulp by acid hydrolysis optimized by CCD

<table>
<thead>
<tr>
<th>Factors</th>
<th>Notations</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{H}_2\text{SO}_4$ Concentration (%v/v)</td>
<td>$X_1$</td>
<td>-0.16 0.5 1 1.5 1.84</td>
</tr>
<tr>
<td>Weight (%w/v)</td>
<td>$X_2$</td>
<td>1.64 3 5 7 8.36</td>
</tr>
<tr>
<td>Time (min)</td>
<td>$X_3$</td>
<td>23.18 30 40 50 56.82</td>
</tr>
</tbody>
</table>

Validation of the Second Order Polynomial Model: The second order polynomial model obtained from RSM was validated. The experimental output was then compared to the values predicted by the second order model obtained from CCD, to find out the goodness of fit of the model.

Results and conclusion:
1. Optimization of pre-treatment process was carried out.
2. Optimized conditions for Robusta coffee pulp were found to be 1 (%v/v) of $\text{H}_2\text{SO}_4$, 8.36(%w/v) of wt. of biomass at 48.4 min hydrolysis time yielding reducing sugar concentration of 17.45g/L.
3. Optimized conditions for Arabica coffee pulp were found to be 1 (%v/v) of $\text{H}_2\text{SO}_4$, 7(%w/v) of wt. of biomass at 36.31 min hydrolysis time yielding reducing sugar concentration of 14.31g/L.

Scope for future work: According to Bio-Fuel Mission 2018, for 2017-2018 supply year, over 139.5 crore litres of ethanol has been assured. “This will help us to achieve 4% blending”. By 2022 the blending should be 10% as per the present Prime minister. Since there is demand for ethanol our work can contribute for its production.

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GLYCEROL AS A FEED STOCK FOR MICROBIAL LIPID PRODUCTION

Project Reference No.: 41S_B_BE_103

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KEYWORDS: Aspergillus ochraceus, Pongamia seed cake, Phospho-vanillin method, Gravimetric analysis

INTRODUCTION: The use of renewable and clean energy sources have gained predominant attention as an alternative to fossil fuel derived diesel. One such example is biodiesel. However, conventional biodiesel production from plant sources comes with limitations necessitating the search for alternate sources. Currently, there is an increasing interest in obtaining microbial oils from oleaginous microorganisms for biodiesel production. Microbial lipids or single cell oils, produced by oleaginous microorganisms such as algae, fungi and bacteria, are one such promising source. Glycerol, a colorless, odorless, viscous, nontoxic liquid, is among the most promising raw materials for lipid production because it is the inexpensive residue of biodiesel production. Cultivation of oleaginous microorganisms in glycerol is attracting great interest since glycerol acts as the carbon source for microbial growth and lipid production.

OBJECTIVES:
The objectives of the present study are:
1) To study the bio-oil producing capacity of Aspergillus ochraceus when cultivated on a glycerol-based media.
2) To estimate the biomass and lipid production of the fungus when grown on different unconventional media.
3) To optimize the culture conditions for maximum laboratory scale lipid production.
METHODOLOGY:

Materials:
Raw material- Pongamia seed cake
Strain- Aspergillus ochraceus
Media-
   i) Pure 6% glycerol
   ii) Glycerol hydrolysate of Pongamia seed cake
   iii) Acid hydrolysate of Pongamia seed cake combined with pure 6% glycerol
   iv) Aqueous hydrolysate of Pongamia seed cake
Control media- Potato dextrose broth

Fig 1: A. ochraceus colonies on solid culture.  Fig 2: Broth culture of A. ochraceus

ANALYTICAL METHODS

• Cell disruption (Homogenization)
• Biomass estimation (Gravimetric analysis)
• Lipid estimation (Phospho-vanillin method)

Procedure:
• Pure cultures of Aspergillus ochraceus were cultured in different media such as pure glycerol (6%, v/v), glycerol hydrolysate of Pongamia seed cake, acid hydrolysate of Pongamia seed cake combined with 6% pure glycerol, as well as aqueous hydrolysate of Pongamia seed cake. Growth curves obtained in these media were compared with that obtained when cultured in Potato Dextrose Broth (PDB) media used as control.
• For each media used, determination of biomass was done gravimetrically and lipid estimation was performed using phospho-vanillin method.
• Culture conditions such as glycerol concentration, substrate concentration, incubation time were varied during the study to determine the optimum conditions for bio-oil production.

RESULTS:
CONCLUSIONS:

- Among different percentages of glycerol tested, 6% glycerol media yielded the better biomass and lipid yields.
- When different concentrations of seed cake were chosen for glycerol hydrolysis, it was seen that media containing 2.5% seed cake gave best results.
- Comparative study of the growth of *A. ochraceus* in different media revealed that the biomass and lipid production was highest in the glycerol hydrolysate media with biomass and lipid yields of 14.98 g/L and 2.693 g/L, respectively.
- The maximum lipid yield was produced at 96th hour of incubation period.

FUTURE SCOPE

- Optimization of additional culture parameters to maximize microbial lipid production.

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A COUPLED PROCESS INTEGRATING HEAVY METAL BIOREMEDIATION AND BIODIESEL PRODUCTION USING OLEAGINOUS MICROALGAE

**Project Reference No.: 41S_B_BE_067**

**COLLEGE:** NEW HORIZON COLLEGE OF ENGINEERING, BENGALURU  
**BRANCH:** DEPARTMENT OF BIOTECHNOLOGY  
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**STUDENTS:**  
Ms. CHAITHANYA LAKSHMI  
Ms. HANNA ABDUL HAKEEM  
Ms. SHIVALI MUTHAPPA B

**Keywords:** Microalgae, Lipids, Biofuels, Heavy metals, Arsenic, Wastewater, Bioremediation, Photobioreactor,

**Introduction:** Heavy metals disembogue into water bodies have led to the loss of aquatic life, bioaccumulation and magnification of toxins in the food chain. Removal of heavy metals from the water sources is critical as they are not biodegradable by higher animal kingdom and abolish the self-purification ability of aquatic bodies leading to toxic water supply. Excess consumption of fossil fuels and the inability of mankind to replace it back to the environment have brought us to the edge of power source. Not only has it depleted sources but also created an imbalance. Soaring oil prices along with concerns of climate change have driven us to utilize sustainable alternative energy sources. Hence, the need for a sustainable, reliable and environment friendly solution to replace the use of harmful fuels and simultaneously detoxify water bodies. The bioremediation of heavy metals and simultaneous production of biofuels using microalgae has proved to meet both end of the problem.

**Objectives**

I. A hybrid approach integrating heavy metal bioremediation and biodiesel production using oleaginous microalgae.

II. New updated design of photobioreactor which supports for higher surface area and blue LED light source.
Methodology

I. Materials

i) Source collection - Sterile bottle, Gloves, pH Strips, Lab Coat, Para film, thermometer.

ii) Culturing media – BBM (Bolds Basal Media) for fresh water, MBM (Modified Bristol’s Media) for marine water.

iii) Reagents - 70% Ethanol, Lugol’s solution, Canola oil, Phosphovanillin reagent, Leuco Crystal Violet.

iv) Glassware - Conical flask, Measuring cylinder, Funnel, Glass rod, Beakers, Pipettes, Petri plates, Slides, Cover slips.

Results

I. Culture growth and Subculture in BBM & MBM Media

Fig. 3: Mother culture

Fig. 4: Subculture

Fig. 5: Subculture

II. Microscopic characteristics (Light microscopy)

Fig. 6: Varthur Sample

Fig. 7: Halasur Sample

Fig. 8: Vagator Sample

Fig. 9: Anjuna Sample

III. Scanning Electron Microscopy (SEM)

Fig. 10: Vagator beach sample

Fig. 11: Varthur Lake sample

IV. Pilot Scale-up in Photobioreactor

Fig. 12: Photobioreactor process for Varthur and Vagator samples in waste water

Fig. 13: Photobioreactor process with LED light source
V. **Lipid Estimation**  
*Quantitative estimation by Sulpho Phosphovanillin method*  

![Graph showing lipid content before and after process](Image)

**Fig.14: Graph for Lipid content in Varthur lake Sample**  
**Fig.15: Graph for Lipid content in Vagator beach Sample**

VI. **Heavy metal (Arsenic) estimation**  
*Leuco Crystal Violet method:* Arsenic Bioremediation was observed to be **64.42%** in Varthur lake sample inoculated wastewater and **48.07%** in Vagator beach sample inoculated wastewater.

![Graph showing arsenic content](Image)

**Fig. 16: Graph for Arsenic content in Varthur Lake and Vagator beach samples**

**Conclusions**

I. Tests like SEM analysis and 18S RNA Sequencing confirmed the presence of micro algae on both freshwater and marine water bodies.

II. The optimisation results showed best results in undiluted samples of Varthur Lake, Bangalore and 1:1 diluted sample of Vagator beach, Goa.

III. Lipid estimation results - **5 Fold increase** for Varthur (freshwater) sample  
**11 Fold increase** for Vagator (Marine) sample

IV. Heavy metal (Arsenic) estimation results -  
Wastewater with Varthur lake sample - **64.42%** bioremediation  
Wastewater with Vagator sample - **48.07%** bioremediation

**Scope for Future Work**

I. The resulting oleaginous microalgal biomass can be exploited for biofuel synthesis.

II. Specialized microalgae can be used in wastewater treatment plants to accumulate lipids and for the bioremediation of the wastewater.

PRODUCTION OF BACTERIAL CELLULOSE FROM SEWAGE AND ITS USE IN POWER GENERATION THROUGH ENZYMATIC FUEL CELL FORMULATION

Project Reference No.: 41S_B_BE_081

COLLEGE: R.V. COLLEGE OF ENGINEERING, BENGALURU  
BRANCH: DEPARTMENT OF BIOTECHNOLOGY  
GUIDE: Dr. LINGAYYA HIREMATH & Dr. S. SATHYANARAYANA

KSCST: SFP-41ST SERIES: BIOFUEL PROJECTS COMPRENDIUM: 2017-18
STUDENTS: Ms. AISHWARYA BHAT  
Ms. ALYSIA M MARTINS  
Ms. BRINDA V

Introduction: While cellulose is a basic structural material of most plants, it is also produced by bacteria. Bacterial, or microbial, cellulose has different properties from plant cellulose and is characterized by high purity, strength, mold ability and increased water holding ability. In natural habitats, the majority of bacteria synthesize extracellular polysaccharides, such as cellulose, which form protective envelopes around the cells. The enhanced mechanical properties of BC occur due to the uniform, continuous and Nano-scale network of cellulosic fibres. These properties are affected by various factors, such as the culture conditions, the microorganism and the fermentation media employed. Bacterial cellulose (BC) is a versatile biopolymer with better material properties, such as purity, high degree of porosity, relative high permeability to liquid and gases, high water-uptake capacity, tensile strength and ultrafine network. Bacterial cellulose forms a layer at the interface between the media and the air surface thus causing the harvest to become a less tedious process.

Objectives

- Growth of bacterial cellulose isolated from *Acetobacter xylinum*, *Pseudomonas sp* and *Rhizobium* in waste water and its characterization.
- Construction of bacterial cellulose Multiwalled Carbon Nanotubes composites.
- Design of fuel cell in waste sludge with the formation of anode/cathode by enzyme immobilized composites and quantification of power generation.

Methodology

1. Isolation of *Acetobacter xylinum* and production of bacterial cellulose
   - *Acetobacter xylinum*, the cellulose producing bacteria is isolated from rotten pear by serial dilution method using HS media.
   - The bacterial cellulose is grown in waste sludge gotten from the pretreated kitchen waste and subsequently harvested for preparation of composite.
2. Production of Bacterial Cellulose/multiwalled carbon nanotubes composite and immobilization of enzymes for formation of electrodes.
   - The bacterial cellulose fibers are cross linked with the carbon nanotubes magnetically stirred and the enzymes laccase and glucose oxidase immobilized by injection.
3. Design of the biofuel cell using characterized waste sludge as the electrolyte, with regeneration of bacterial cellulose.
   - The electrodes are treated and are inserted into the electrolyte which is waste water. The waste water is characterized before and after the assembly of the fuel cell. The salt bridge is created using a Nafion membrane and is connected to a voltmeter.
4. Quantification of Power generation
   - The salt bridge is connected to a voltmeter and ammeter to calculate the power generation. It is connected to an amplifier in order to reduce noise and quantify usable power on a small scale.

Conclusion:

1. The successful isolation of bacteria from local sources produced very little bacterial cellulose to allow it to undergo further mechanical and chemical tests.
2. The bacterial cellulose was produced by acetobacter and rhizobium and not by pseudomonas sp. even after mutation by UV.
3. Rhizobium grew better when isolated by bleaching methodology and the cellulose was produced when the flask was static as compared to the shake flask.
4. The layer formed in the acetobacter flask was thicker as compared to the rhizobium flask though the cellulose produced by the acetobacter divided into strands upon filtration.
5. The *Acetobacter* cellulose was less compact and while the rhizobium cellulose produced was very thin and flimsy and crystallized on drying.
6. The biochemical tests revealed that the acetobacter and the pseudomonas broke down the dextrose into sucrose and fructose and most of the sugar was not utilized as compared to rhizobium which completely utilized the sugar.

7. The protein produced in the rhizobium was relatively lesser than pseudomonas and acetobacter was higher compared to both of them.

8. Thus, the media in which the media is to be grown must be optimized to increase the sugar content in YMA media and reduce the sugar content in HS media.

9. The amount of citric acid utilized by rhizobium was maximum as compared to both A. xylinum and Pseudomonas sp. while the utilization of citric acid was higher in A. xylinum than Pseudomonas sp.

10. Bacterial Cellulose/Multiwalled carbon nanotubes composite were prepared.

11. Enzymes were successfully immobilized on to the bacterial cellulose multiwalled Nanocomposites to create an electrode.

12. The power generation setup was made and the output was measured.

Future Scope: Due to the depleting petroleum source it is imperative that researchers consider looking for alternative sources of energy. Biofuel cells, as new sources of energy without any pollution are suitable replacements of traditional fossil fuels. Because of the promise of sustainable energy generation from different substrates such as organic wastes, research has been intensified in this field in the last few years. Bacterial cellulose is biopolymer and can be used to generate by power by forming a matrix with nanoparticles and treated to become an electrode. Using a naturally produced compound such as cellulose, by a cost-effective manner of having bacteria produce them is efficient and does not use any non-renewable materials. The possibilities are endless and since power can be generated using waste water, there is an opportunity for waste management and a chance to treat the waste water and make it useable. The power output generated is quite low but with more research and further refinements to the process it is possible to make this fuel cell fully functional and use it as a fully-fledged mechanism to generate power.

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DESIGN AND LAB SCALE ULTRASONIC BATCH REACTOR FOR THE PRODUCTION OF BIODIESEL FROM THE SLAUGHTER WASTE

Project Reference No.: 41S_B_BE_076

COLLEGE : SAPTHAGIRI COLLEGE OF ENGINEERING, BENGALURU
BRANCH : DEPARTMENT OF BIOTECHNOLOGY
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STUDENTS : Ms. NIRANJANA S.
            Ms. VANI VISWANATHAN

Introduction: Biodiesel is one of the renewable and clean burning fuels, which can be used in diesel engines. Biodiesel can be generated from feedstock and non-feedstock using the transesterification process. A consistent supply of feedstock is being faced as a major challenge because of their higher cost and depletion of resources. The utilization of inexpensive feedstock (such as waste cooking oils, non-edible oils, waste water from dairy, Slaughter) appears as an attractive option since it would improve the economic feasibility of biodiesel production.

One of the difficulties faced in the current technology for biodiesel production is the requirement for rigorous mixing of catalyst with the feedstock and non-feedstock oil in the reactor. The use of ultrasound is one of the tool to mix liquids that tend to separate. In biodiesel production, adequate mixing is required to create sufficient contact between the oil and alcohol, especially at the beginning of the reaction. Ultrasonic waves cause intense mixing so that the reaction can proceed at a much faster rate. Ultrasound transfers energy into fluid and creates violent vibrations, which form cavitation bubbles. As the bubbles burst, a sudden contraction of the fluid occurs, and the ingredients are mixed
in the area of the bubbles. Such a high-energy action in liquid can considerably increase the reactivity of the reactant mixture and shorten the reaction time without involving elevated temperatures. Based on the above findings, this research is devoted to the utilization of oil from the slaughter waste and to assess the use of ultrasound waves in batch reactor for effective transesterification reaction for biodiesel production

**Objectives:**
Collection of Slaughter waste
Extraction of oil from the Slaughter waste
Qualitative analysis of oil obtained from slaughter house waste
Transesterification of oil to biodiesel using ultrasound waves in batch reactor
Qualitative analysis of biodiesel by Gas chromatography

**Experimental conditions and Procedures**

**Collection of Raw material:** The slaughterhouse waste has collected from the nearest slaughter house stalls and stored in deep freezer at -20°C till sufficient quantity was available

**Solvent Extraction of fat/oil from slaughterhouse waste:** To maximize the yield, methanol at a fat-to-solvent ratio of 1:10 (w/v) will be used. The mixture will be stirred for 2 h and the extraction procedure was repeated three times to ensure that the oil was extracted completely. The resultant oil is filtered/centrifuged and decanted to remove the suspended particles. The processed fat was stored in air tight opaque plastic jars to prevent oxidation and it used for further qualitative analysis.

**Qualitative analysis of oil obtained from slaughterhouse waste**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Slaughter waste(gm)</th>
<th>Oil obtained(ml)</th>
<th>Iodine number</th>
<th>Acid number</th>
<th>Saponification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>50</td>
<td>2.5</td>
<td>8</td>
<td>0.1</td>
<td>103.53</td>
</tr>
<tr>
<td>Sample 2</td>
<td>50</td>
<td>2.7</td>
<td>9.24</td>
<td>0.02</td>
<td>120.464</td>
</tr>
<tr>
<td>Sample 3</td>
<td>50</td>
<td>3</td>
<td>8.58</td>
<td>0.02</td>
<td>123.46</td>
</tr>
</tbody>
</table>

**EXPERIMENTAL SET UP:**

**Purification of Biodiesel:**

After the reaction, the methanol excess will evaporated then, the ester and glycerol layers will allowed to separate in a separator funnel, and the ethyl esters layer will purified. During separation the hydrophilic and denser glycerine migrates to the bottom of the mixture creating a separate layer, while the less dense biodiesel stays on top together with the unconverted oil.

**Qualitative analysis of biodiesel:**

In order to record the progress of the transesterification reaction the fatty acid methyl esters of biodiesel will be analysed by gas chromatography (GC).
CHEMICAL AND ENZYMATIC CONVERSION OF BIOGLYCEROL TO ACETINS

Project Reference No.: 41S_B_BE_027

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MS. NIDHI R HERLE

Keywords used in the synopsis: Esterification, mixed oxide, lipase, conversion, acetins

Introduction: Exhaustion of renewable fuel sources has forced researchers to look for more viable options and this search has led to the establishment of the biodiesel sector. One advantage of biodiesel production is that of by-product glycerol being formed, the separation and purification processes which are complex and uneconomical. Various chemical processes are available to utilize the excess impure glycerol, namely carboxylation, condensation, esterification, etc., and convert it to value-added products thereby increasing the overall efficiency of production and eliminating the problems involved with handling of the by-product.

This present study deals with the chemical catalytic and enzymatic conversion of glycerol to acetins through the process of esterification. It also involves optimization of the reaction conditions to explore the viability of both types of catalysts involved in the reaction.

Objectives:

- Survey of existing methods for glycerol conversion to acetins (mono, di and triacetin), application of acetins and selection of chemical catalyst and enzyme
- Preparation of mixed oxide heterogeneous catalysts such as CeO$_2$-ZrO$_2$ and SO$_4^{2-}$/CeO$_2$-ZrO$_2$
- Evaluate the performance of prepared mixed oxide catalysts and Lipase enzyme procured from three different sources (Lipase I, II and III) for the selected reaction by study of effect various parameters on the reaction

Methodology:

- Catalyst Preparation: Combustion method was used to synthesize the mixed oxide catalysts using the metal nitrates as oxidizers and urea as the reducing fuel.
- Batch Experimentation: The esterification reaction between glycerol and acetic acid was carried out in a three-necked or two-necked round bottom flask equipped with a magnetic stirrer, a thermometer, a condenser and a PID controller to control the reaction temperature.
- Product Analysis: The samples collected at regular intervals were analyzed by Gas Chromatography (Mayura Analytical LLP Model 1100). The products mono, di and triacetin were identified and their retention times determined from GC analysis by utilizing the pre-determined calibration data of known pure compounds.

Results and Conclusions: The glycerol esterification reaction was studied with the help of chemical catalysts and enzymes for the synthesis of acetins. The CeO$_2$-ZrO$_2$ catalysts were synthesized by the combustion process. The esterification of glycerol with acetic acid over synthesized metal oxide catalysts CeO$_2$-ZrO$_2$, SO$_4^{2-}$/CeO$_2$-ZrO$_2$ and Lipase enzymes was carried out. The influence of different parameters such as glycerol to acetic acid molar ratio, catalyst loading and temperature were studied and the process conditions were optimized. It was found that the conversion of glycerol for both sulphated and unsulphated chemical catalysts increased with the molar ratio of glycerol to acetic acid till 1:10, catalyst loading of 5 wt% and temperature of 100°C. Hence the optimized conditions were found to be at a molar ratio of glycerol to acetic acid as 1:10, catalyst loading of 5 wt% and reaction temperature of 100°C. For SO$_4^{2-}$/CeO$_2$-ZrO$_2$, the glycerol conversion at the optimized conditions was observed to be 98.4%. Unsulphated CeO$_2$-ZrO$_2$ exhibited glycerol conversion of 95.6%, thereby proving that the sulphated catalysts provide better yield.
In comparison of the three different Lipase enzyme, experimental results confirmed that the Lipase I better aided the glycerol esterification reaction. Lipase I showed a glycerol conversion of 98.97% at 70°C for catalyst loading of 5 wt%, molar ratio of 1:10 and reaction time of 108hrs.

The method of effectively utilizing the combustion-synthesized catalysts and commercially obtained Lipase enzymes for glycerol esterification produce valuable products that find applications in a wide range of industries. Thus, a viable strategy has been proposed for effective utilization of glycerol that has the potential to be scaled up to commercial production.

Scope for future work:
- Effect of other parameters such as pH and agitator speed could be studied
- Impregnating the catalyst over a support to increase the surface area could prove beneficial
- Synthesis of catalysts using other methods such as wet precipitation and gel combustion may be carried out
- Scaling up of the process to an industrial level will result in effective utilization of glycerol and ultimately lead to increased biodiesel production

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**CATALYTIC CONVERSION OF GLYCEROL TO OXYGENATED FUEL ADDITIVE (SOLKETAL) USING HETEROPOLYACID**

Project Reference No.: 41S_B_BE_028

**COLLEGE**: RAMAIAH INSTITUTE OF TECHNOLOGY, BENGALURU
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**STUDENTS**: Mr. SUDARSHA N C S
               Ms. NAVITHA R
               Mr. KIRAN D SHETTY
               Mr. RAKESH KUMAR S

**Introduction:**
In recent years, due to the increased biodiesel production, glycerol, its by-product is also gaining significance importance. Various useful reactions are studied to convert glycerol into value-added products. Ketolization of glycerol is one among them and the products obtained is solketal, which have wide range of applications especially as fuel additives. The present work deals with the study of ketolization of biodiesel derived glycerol with acetone over synthesized Phospho Molybdic Acid (PMA) solid acid catalyst. The solid acid catalyst was prepared by co-precipitation method and was modified by addition of Cerium Nitrate ions. Both the modified and unmodified catalyst was characterized by means of XRD, BET surface area, FTIR and the results were compared. From the characterization result, it was found that the addition of cerium nitrate significantly enhanced the surface acidity of heteropolyacid catalyst. Interestingly, the PMA solid acid showed higher surface area and acidity as well. The cerium exchanged PMA was applied for ketolization of glycerol and acetone. The reaction was studied for different temperatures, different mole ratio of glycerol to acetone and varying amount of catalyst. The results showed that cerium exchanged PMA catalysts are the promising heterogeneous catalysts for ketolization of glycerol. The kinetic model was developed to determine the reaction rate constants and the activation energies.

**keywords**- Glycerol, acetone, ketolization, Cerium exchanged Phospho Molybdic Acid

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PILOT PLANT STUDY FOR SUSTAINABLE ENERGY GENERATION IN SEPTIC TANK USING BIO-FUEL CELL

Project Reference No.: 41S_B_BE_042

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Ms. MEGHANA G B
Ms. NIRUSHA S A
Mr. RAJESH M B

Introduction: In the recent decades, the consumption of energy around the globe has been increased exponentially. This excessive consumption of energy sources usage of non-renewable energy sources i.e. Fossil fuels, nuclear sources etc. Fossil fuels account for over 90% of the world’s total energy resources. The main sources of fossil fuel are; coal, 16%; natural gas 29%; petroleum 36% and nuclear 9%. Renewable energy accounts for only 10% of the total energy consumption. At this consumption rate, it will lead to energy crisis and it will affect the natural resources. For example, usage of fossil fuels negatively influences the nature owing to the emission of CO2 which eventually leads to global warming and atmospheric pollution.

In the search of economic prosperity, too much emphasis has been placed on conventional energy, mostly powered by fossil fuels that create serious environmental and social costs. Local air pollution, regional acid deposition and global climate change are only some of these costs which we all must pay now or in the future regardless of our local address.

Objectives:
• To design a suitable septic tank system for prototype.
• Design of anodic and cathodic chamber for Bio-fuel cell.
• Design and fabrication of electrode system for prototype.
• To regulate output current for household utility.

Methodology:
• Modification in design for conventional septic tank.
• Moulding of panels with Cement-Mortar and glass fibre incorporations.
• Ion exchange membrane window.
• Fabrication of Scaled down proto type septic tank fabrication.
• Improving energy production rate by electrode design.
• Fabrication of Cathode and Anode Electrodes for bio fuel cell.
• Anodic cathodic chambers in the existing septic tank.
• Electrical connections with Voltage booster.
• Power generation and demonstration.
• Voltage boosters for tapped energy

Conclusion:
• Micro Bio-Fuel Cells is promising new technology for generation of electrical energy from the septic tank. This technology involves aerobic and anaerobic micro-organisms to generate H+ ions and to generate DC voltage through bio-logical process contained within the Micro Bio-Fuel Cell reactor.
• The pilot plant scale, gives an idea for the alternative design’s to suit’s for the existing septic tank.
• In the alterations an aerobic tank is to be added, on the existing septic tank in which proper aeration condition shall be established to get more energy tapping.
• The DC voltage generated with respect to tank is depends of breeding of microbes in the septic tank.
• In the prototype the DC voltage has got increased with respect to time with available feed and the voltages is made consistent with periodic feeding.
• In the case of septic tank, the feeding is regular from the residence that will make the consistent energy tapping.
• Voltage booster that will make the tapped current for the residential purpose.

Scope for future studies:

• The present pilot scale was established as one single cell having multiple anode and multiple cathode. Due to this less voltage was tapped and is boosted.
• A modified design is required to have multiple cell to tap higher voltages.
• Based on the modified design a prototype further study is required.

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WASTE TO ENERGY WITH A BIO GAS UNIT

Project Reference No.: 41S_B_BE_100

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BRANCH : DEPARTMENT OF CIVIL ENGINEERING
GUIDE : DR. S.G. JOSHI
STUDENTS : MR. AKASH DHAWALE
           Mr. MURIGEPPA SHASHIDHAR SHAHAPURKAR
           Mr. ABHISHEK M. HULAGADDI
           Mr. MANJUNATH GADDI

INTRODUCTION: The conventional energy resources are continuously registering a diminishing balance with the population explosion and industrialization taking place all around the world. India is the second largest in the world in the statistics of population and considered to be sixth in the consumption of energy. In the view of existence of large gap between the requirements of the population and the availability of the conventional source of energy there is need for the development of a sustainable resource-based alternative for the energy resource.

The conventional energy resources are the natural resources like coal, oil and gas. With rapid developments taking place in the industrial sector the need for energy is also increasing constantly. It has become inevitable to supplement the exhaustible resources to cater to the needs of the future generations effectively. Fortunately, INDIA is gifted with large amount of sustainable non-conventional energy resources like solar power, Wind and Biogas along with small hydro power. These resources are natural, cost free, available abundantly and readily usable for the generation of energy in different forms. Moreover, these are pollution free and hence produce clean energy.

Kitchen wastes are organic in nature which is easily biodegradable. They are a potential raw material for biogas production. Generally, Kitchen waste is treated as waste and thrown which acts as the key factor for the pollution. The pollution leads to number of diseases which affect human health. Energy production from waste is becoming more popular these days. It has mainly two direct advantages. One, the disposal waste is reduced as it is utilized. Another, energy is generated. Traditional biogas plant such as fixed dome or floating drum made of concrete or other materials are generally below the ground. The scarcity of land in urban areas has made it nearly impossible for the local people to install the biogas plant. Use of biogas plant (above ground) using kitchen wastes seem to decrease the problem arising from scarcity of LPG.

Objectives:

1. To study current solid waste management and technology practices at HDMC.
2. To design and set up a lab scale Biogas unit.
3. To analyse the Biogas and compost produced and their utilization.

Methodology:

1. Field survey: A detailed field survey was carried out in our college campus to know source of organic waste generated.
   Hostel mess produces around average 90 kg.
   Canteen around 30 kg and Fast food centre around 15 kg.
2. Installation of Anaerobic digester: A 120 litre plastic water storage drum was used as anaerobic digester. Materials: Plastic drum, PVC pipes, plastic ball valves, rubber pipe, M seal, PVC cap, plastic elbow
3. Waste feeding: Organic waste at the rate of 1.7 kg/day was fed to the digester. Large pieces of vegetables found in the waste were manually shredded.
4. Gas storage: The Biogas produced was stored in the ball.
5. Gas analysis: Biogas produced was qualitatively and quantitatively analysed.

Results and Conclusions:
1. Biogas unit has been successfully fabricated and installed at the college campus. Anaerobic digester of 120 litre capacity installed.
2. Kitchen waste has been successfully converted into Biogas.
3. Our study shows that kitchen waste has a potential to be used as a feed material for production of Biogas which is an unconventional source of energy.
4. From the observations it is seen that 60.41% waste has been converted into useful compost.
5. Observation showed that actual gas production rate was 0.002 m³ which is less than the expected rate 0.011 m³.

Scope for future work: virtual unlimited: In production of Biogas through anaerobic digestion, animal excreta, human excreta and other agricultural wastes are used. The existing as well as future energy demands of the rural areas can be completed by biogas technology. Biogas is plentiful and is available from sources such as landfills, wastewater treatment facilities, and animal and agricultural waste. If fully utilized, the yield from existing organic waste streams could satisfy about 20 percent of current natural gas use. Biogas feedstock may also soon be farmed economically. Work is already underway to develop low cost dedicated energy crops such as a source of biogas production. Future energy crops could make the potential availability.

NUMERICAL INVESTIGATION OF KIRLOSKAR DIESEL ENGINE USING CALOPHYLLUM INOPHYLLUM AS A BIODIESEL

Project Reference No.: 41S_B_BE_087

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STUDENTS : Ms. SONU D. K.
Ms. NAVYASHREE H.S.
Ms. AYESHA BASEER
**Introduction:** Most modern searches are directed to alternative fuels because the buffer stock from the petroleum oils reduces with time and the fossil fuels are worst impact on environmental pollution. Biodiesel is derived from oil crops is a potentially renewable and carbon neutral alternative to petroleum fuels. In present work, Calophyllum inophyllum seeds were used to produce biodiesel. Transesterification process has been used to produce Calophyllum Inophyllum Methyl Ester (CIME) from raw Calophyllum oil. Once the biodiesel is produced, Kirloskar engine performance test is carried experimentally. Then the numerical analysis is carried which includes modelling and analysis. Modelling is done using CATIA V5 and analysis is done through ANSYS FLUENT 18.1. Numerical results are compared with that of experimental ones.

**OBJECTIVES:** The main objective of the present work is to conduct the performance, Combustion and emission test on single cylinder, four stroke cycle, direct injection kirloskar diesel engine fuelled blend of CIME B20 and experimental results were compared with those of CFD results. Following are the detailed objective of present work.

- To Conduct transesterification process to extract biodiesel from Calophyllum inophyllum raw oil.
- To Conduct property test for Calophyllum Inophyllum Methyl Ester (CIME).
- To Conduct performance test, Combustion Characteristics and Emission characteristics for CIME.
- The CFD simulation involves running the engine on Biodiesel fuels for four strokes and their effect on in-cylinder air motion were studied effectively and are analyzed with captured velocity, pressure and temperature distributions in the cylinder during all the four reciprocating strokes of the engine at discrete crank angles.
- Investigation of time history for spray of fuel to engine cylinder at different crank angle and combustion characteristics has done through CFD combustion analysis.
- Comparing numerical results with experimental results.
- To list the advantages of biodiesel over diesel

**METHODOLOGY:**

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**Fig 3: Experimental methods**

**Table 1: Properties of selected fuel**
RESULTS AND DISCUSSION:

PERFORMANCE CHARACTERISTICS: Diesel, Injection Opening Pressure=200bar, C.R=17.5

The variation of Brake Specific Fuel consumption (BSFC) for different loads is shown in Fig 4 for IOP of 200 bar respectively. As shown in Fig.4, it is clearly observed that BSFC is decreasing as load is increased because Percentage of fuel required to operate the engine is less than the percentage increase in brake power due to relatively less portion of the heat losses at higher loads. A BSFC value for different loads of B20 is nearer to diesel value.

The variation of Brake Thermal Efficiency (BThE) for different loads is shown in Fig.5 for IOP 200bar respectively. As shown in Fig.5 it is clearly observed that BThE is increases as the load increases. This was due to reduction in heat loss and increase in power with increase in load.

EMISSION GRAPHS FOR IOP-200 BAR: The experiments were conducted on a direct injection compression ignition engine for various loads and various blends of biodiesels. Analysis of emission characteristics like carbon monoxide, hydrocarbon, oxide of nitrogen and carbon dioxide.

Fig. 4: BSFC vs Load, IOP=200bar for diesel and CIME 20

Fig. 5: BThE vs Load, IOP=200bar for diesel and CIME 20

Fig. 6: Variations of CO vs Load, IOP=200bar

Fig. 7: Variations of HC vs Load, IOP=200bar
Carbon Monoxide (CO): It is observed from Fig.6 that CO emission reduces with CIME blend 20; this is because the quantity of oxygen increases to form CO into CO₂ will cause lesser CO emissions.

Hydrocarbons (HC): Hydrocarbon emission slightly increases significantly with increase in load because of better combustion of fuel at higher load as shown in Fig.7. It is observed that decrease in HC emission with CIME 20 due to complete combustion of fuel. Higher temperature of burnt gases in biodiesel fuel helps in preventing condensation of higher hydrocarbon reducing unburnt HC. The higher cetane number of biodiesel results decrease in HC emission due to shorter ignition delay.

NOx emissions: From the Fig.8 the observation is that NOx emissions increase linearly with increase in load. First NOx emissions are a direct function of engine loading. This is expected because with increasing load, the temperature of the combustion chamber increases and NOx formation is a strongly temperature dependent phenomenon. Second important observation is that the NOx emissions in the case of bio diesel fuel are higher by approximately 2 to 3 percent.

Carbon dioxide (CO₂): The observation from the Fig.9 is that CO₂ emission increases with increase in load. The observed trend is that more fuel burned at higher injection pressures to convert more carbon into CO₂. Decreases CO₂ emission is found for biodiesel when compared to diesel at higher load. Also emission levels of CO₂ for various blends and diesel. Test measurements reveals that the CO₂ emission for CIME 20 blend was less as compared to diesel at all loads. The rising trend of CO₂ emission with load is due to the higher fuel entry as the load increases. Biofuels contain lower carbon content as compared to diesel and hence the CO₂ emission is comparatively lower.

COMBUSTION CHARACTERISTICS GRAPHS FOR IOP 200BAr: Fig 10 and 12 shows the variation of cylinder pressure with respect to crank angle for full load condition. It is evident from the graph that as load on engine is increased the cylinder pressure increases. The maximum cylinder pressure is 78bar for diesel. Fig 11 shows the heat release rate with respect to crank angle for full load. It clearly shows that with increase in load heat release rate spreads on both sides, i.e., before and after the injection of fuel. Heat release rate is 275 J/degCA at full load condition. The B20 blend fuel has 77bar cylinder pressure and heat release rate 275 J/degCA. Therefore, it is equal.
4 EXPERIMENTAL PRESSURE RESULT OF DIESEL AND BIODIESEL (CIME B-20).

Table 6.3: Pressure result of diesel

<table>
<thead>
<tr>
<th>FUEL</th>
<th>PRESSURE (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIESEL</td>
<td>78</td>
</tr>
<tr>
<td>BIODIESEL(B20)</td>
<td>77</td>
</tr>
</tbody>
</table>

COMPUTATIONAL FLUID DYNAMICS (CFD)

Intake Manifold design

**Fig 14:** Combustion geometry using CATIA

**Fig 15:** Meshing details of IC engine with Manifold

- Total No of elements = 0.4 millions at TD
- Total No of elements = 1 millions at BDC
- Total No of elements = 1 millions at BDC

**COMBUSTION ANALYSIS:** Internal combustion engine; more specifically, it is a compression ignition engine, in which the fuel is ignited solely by the high temperature created by compression of the air-fuel mixture, rather than by a separate source of ignition, such as a fuel injector, as is the case in the IC engine. The engine operates using the diesel cycle. In very cold weather, diesel fuel thickens and increases in viscosity and forms wax crystals or a gel. This can make it difficult for the fuel injector to get fuel into the cylinder in an effective manner, making cold weather starts difficult at times, though recent advances in diesel fuel technology have made these difficulties rare. A commonly applied advance is to electrically heat the fuel filter and fuel lines. In combustion, fuel and air are located in the segregated region in the unburned zone, their mixing is continuously. The newly mixed reactants are transferred into the mixed region where they are consumed by combustion. The combustion products are finally passed into the burned zone. The liquid fuel, usually injected at high velocity as one or more jets through small orifices.
or nozzles in the injector tip, atomizes into small drops and penetrates into the combustion chamber. The fuel vaporizes and mixes with the high-temperature high-pressure cylinder air. Since the air temperature and pressure are above the fuel's ignition point, spontaneous ignition of portions of the already-mixed fuel and air occurs after a delay period of a few crank angle degrees. The cylinder pressure increases as combustion of the fuel-air mixture occurs. The consequent compression of the unburned portion of the charge shortens the delay before ignition for the fuel and air which has mixed to within combustible limits, which then burns rapidly. It also reduces the evaporation time of the remaining liquid fuel. Injection continues until the desired amount of fuel has entered the cylinder. Atomization, vaporization, fuel-air mixing, and combustion continue until essentially all the fuel has passed through each process. In addition, mixing of the air remaining in the cylinder with burning and already burned gases continues throughout the combustion and expansion processes. In diesel engines, only air is sent into the combustion chamber during suction. This air is compressed during the compression stroke and towards the end of compression stroke. Fuel is injected by the fuel injection system into the cylinder - just before the desired start of combustion. Fuel spray from the injector in the combustion chamber. The temperature distribution inside the combustion chamber is nearer to the cylinder wall. The temperature is more compared to other position of the combustion chamber.

Fig 24: Temperature contour suction stroke(Diesel)  
Fig 25: Temperature contour for compression stroke(DIESEL)

Fig 26: Temperature contour for power stroke(Diesel)  
Fig 27: Temperature contour for exhaust stroke(Diesel)

From the Fig.24 to Fig.27 shows the static temperatures contours it is observed that that the temperature of fluid inside the combustion chamber increases with increasing of crank angle. It is an interesting result that temperature of two sides of a wall was almost equal to each other. Nevertheless, crank angle is effective parameters on this value. Combustion produces a rise in pressure and temperature as the energy contained in the fuel is released and the chemical reaction is completed. The fuel combustion produces a spike in pressure and temperature as the energy contained in the fuel is released, with the production of exhaust gases. Some of the energy is radiated and convicted to the cylinder walls, cylinder head, piston and the valves and is lost. Most of the energy goes into the power stroke, where the exhaust gases expand under high pressure and push the piston down to the bottom center position. A thermodynamic energy balance shows that the energy produced due to combustion is used for work done due to expansion, while the thermal losses includes heat losses through the walls and the enthalpy of the exhaust gases at high temperature. During the subsequent exhaust stroke, the exhaust gases are pushed out through the exhaust valves, which start opening towards the end of the power stroke. This process involves formation of a high speed, high temperature jet in the gap between the exhaust valves and ports.
As the result, the initial vapor clouds are of almost stoichometric fuel/air ratio in the centre. The initial flame occurs from the centre of the vapor clouds. The early stages of combustion have certain characteristics of premixed burning.

The spray and flame reaches the edge of piston bowl very quickly. Liquid droplets accumulate near the wall and are expected to form wall film. This stage of combustion is more controlled by mixing and could be even more precisely simulated when a more detailed wall film model is employed.

Fig 28: Temperature contour for suction stroke (Biodiesel)

Fig 29: Temperature contour for compression stroke (Biodiesel)

Fig 30: Temperature contour for power stroke (Biodiesel)

Fig 31: Temperature contour for exhaust stroke (Biodiesel)

CONCLUSION: A four-stroke water cooled single cylinder direct injection diesel engine was run successfully using calophyllum inophyllum biodiesel and its blend (B20) as fuel. The performance and emission characteristics have been analyzed. The following conclusions are made with respect to the experimental results.

- The calophyllum inophyllum oil can be successfully converted into CIME through transesterification process.
- The properties of CIME blends such as viscosity, density, calorific value & flash and fire point are compared with diesel and are found to be nearer to diesel. Therefore CIME can be used as an alternate fuel for diesel.
- The injection pressure has significant role on the engine performance. Increase in injection pressure causes better atomization of fuel.
- Due to higher density & lower calorific value of biodiesel, brake thermal efficiency of the fuel blend is slightly lower compared to diesel and Brake specific fuel consumption are slightly higher for these blends.
- On the basis of the above conclusion, it is recommended that B20 fuel blend can be efficiently used in diesel engine at injection pressure of 200bar.
- The emission such as CO, HC and CO$_2$ are lower than the diesel but the NOx emission for biodiesel increases with increasing the loads. Sulphur content is not there in CIME, so no sulphur emissions.
- Computational fluid dynamics package and simulations carried out for CIME biodiesel fuelled operation. Compression stroke plays a key role in controlling the pressure and temperature of the air mixture in the combustion chamber. Numerical results obtained also indicate that the incoming air initially follows the cylinder head to a greater extent. CFD can be used as a useful tool to fix the parameters related to engine performance.
A STUDY ON DIESEL ENGINE USING USED COOKING OIL WITH BIOTIC ADDITIVE

Project Reference No.: 41S_B_BE_065

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STUDENTS: Mr. SRIRAM SRINIVASAN
Mr. RANGDALE ANANDARAO RAAJKUMAR

KEY WORDS: bio-diesel, esterification, biotic additive, emissions, used cooking oil, performance, cow urine.

INTRODUCTION: Bio-diesel is a fuel obtained from biotic compounds containing higher fat content. In this work, the bio-diesel is obtained from the trans-esterification of used cooking oil (sunflower oil). The bio-diesel so obtained after processing is blended with diesel obtained from crude oil distillation and along with a biotic additive which is cow urine. Various works have been done in reference to bio-diesel and its blends with diesel or additives added to it such as methanol or ethanol. In this work, we have put to use a novel idea that adds a water base additive to the blends to know the improvements in the emissions characteristics preceded by the engine performance. Previous works with blends prepared from diesel and used cooking oil have indicated that the emissions have reduced drastically in areas of NOx and COx. This is a very significant aspect pertaining to the modern world when global temperatures are on the rise and pollution is posing a very serious threat to both health of living beings as well as the planet. The engine performance has also increased (CI engine). The bio-diesel has properties similar to that of diesel which include flash and fire point, viscosity, calorific value is slightly lower for the bio-diesel compared to diesel counterpart. Because of these similarities it is convenient to use the bio-diesel in the engines. The idea to use cow urine originated with the various Government initiatives which include Panchakavya and other organic pesticides and fertilizers. The urine as known has higher uric acid and other minerals which add to the reduction of the emissions.

OBJECTIVES: The rising cost of fuels and complimentary depletion of crude oil reserves will drastically affect our lifestyle. Hence before such incident occurs it is safe to keep an alternate plan B. We cannot just change all vehicles to electric over-night nor is the technology so advanced. In order to progress slowly we have to give the world the next best plan to crude oil which is less harmful, non-exhausting and can be used until cleaner sources of energy have been placed extensively. Hence this project tries to establish such a fuel which can be used in diesel engines as an alternative to diesel. Hence the objective of this project would be to find the best blend of diesel, bio-diesel and biotic additive so that the engine performance improves along with reduction in the emissions. So preceding this objective would be the best way to prepare bio-diesel in a cost effective way so that this fuel can smoothly transition its way into the fuel industry. This project also through s light on the effect the biotic additive has left in the diesel. We have come to know from experiments that the additive has improved efficiency and also decreased emissions but the reason has been investigated in this project. The team along with the project would also in future investigate into ways through which wide spread implementation of this fuel would be possible.

METHODOLOGY: The project started with the in-house preparation of bio-diesel from used cooking oil by the process of esterification. The obtained bio-diesel was less viscous and less dense compared to cooking oil. The diesel was then mixed with cooking oil and a bio-tic additive which being cow urine. Various blends of the above mixtures where made on the mass basis and the chemical characteristics were tested which include flash and fire point, calorific value, viscosity. The performance characteristics were tested on a CI engine and its brake power, mechanical efficiency and fuel consumption were analysed. In parallel to this we also undertook emission tests of the exhaust gases to determine the percentage of harmful hydrocarbons and other pollutants. This project has been performed to find a perfect blend of the bio-diesel which can be used in the diesel engine as fuel. The cooking oil filtered to remove impurities. The impurities originate due to their usage of cooking oil in the kitchen. These oils will have higher viscosity and hence should be esterified to obtain the bio-diesel. The purified cooking oil is used in the preparation of the blends. The blend proportions are of 10DWCO, 20DWCO, 30DWCO, 40DWCO, 50DWCO, 10DWCOA, 20DWCOA, 30DWCOA.
40DWCOA and 50 DWCOA. The different blends of 10DWCO, 20DWCO, 30DWCO, 40DWCO and 50DWCO with additive as well as without additive are prepared on the volume basis. Here 10DWCO is a mixture of 10% of waste cooking oil with 90% of diesel. Similarly, 10DWCOA is a mixture of 10% esterified waste cooking oil and 90% of diesel with 10% of cow urine. The biodiesel blends are prepared on the volume basis. The blends are prepared for net content 1 litre. Firstly, trans-esterification process is done by mixing NaOH and methanol. Then slowly the purified cooking oil is added and stirred in a mechanical stirrer at a temperature of 50 – 60°C for 2 hours. The same procedure is followed for the production of bio-diesel with additive but during trans-esterification process. 20% of additive is added the esterified oil and methoxide and stirred for about 5 – 6 hours and then kept for settling. After settling, the upper part liquid is separated and used for the blend preparation. The same procedure is carried out again and again to obtain cleaner biodiesel.

SYNTHESIS OF COMPARITIVE ANALYSIS OF PONGAMIA OIL BIO LUBRICANT

Project Reference No.: 41S_B_BE_040

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STUDENTS : Mr. RAHUL V.
            Mr. SHARATH M
            Mr. NIRANJAN S
            Mr. PRAKASHA

Objectives: The present work is aimed with the following objectives

➢ To develop the lubricant from Pongamia oil by adding ZDDP and Benzoic acid as an additive.
➢ To study the variation of the following tribological characteristics of Pongamia oil with different percentage of additives.
• Density.
• Kinematic viscosity.
➢ To study the comparison between the lubricants for the test conducted.

Methodology:

1. Selection of vegetable oil.
2. Selection of additives.
3. Blending of base oil with additive.
5. Viscosity test using Canon Penske viscometer.
6. Comparison between the lubricants.

RESULTS AND DISCUSSION:

Density test results
Density test results of Pongamia oil blended with ZDDP and Benzoic acid additive.

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Wt%</th>
<th>PONGAMMIA OIL WITH ZDDP</th>
<th>PONGAMMIA OIL WITH BENZOIC ACID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.924</td>
<td>0.924</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.917</td>
<td>0.935</td>
</tr>
</tbody>
</table>
Density vs wt% of ZDDP

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Weight Percentage of ZDDP</th>
<th>Time taken in Min</th>
<th>Kinematic Viscosity in (cSt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trial</td>
<td>Average</td>
</tr>
<tr>
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<td>0</td>
<td>44.29</td>
<td>44.23</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>6</td>
<td>3</td>
<td>42.81</td>
<td>42.56</td>
</tr>
</tbody>
</table>

Viscosity test results of Pongamia oil blended with ZDDP additive.

Viscosity test results of Pongamia oil blended with Benzoic acid additive.

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Weight Percentage of Benzoic acid</th>
<th>Time taken in Min</th>
<th>Kinematic Viscosity in (cSt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trial</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>44.26</td>
<td>44.42</td>
</tr>
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<td>55.57</td>
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<tr>
<td>6</td>
<td>3</td>
<td>60.11</td>
<td>60.23</td>
</tr>
</tbody>
</table>
viscosities of Pongamia oil blended with different percentage of ZDDP and Benzoic acid additive by using Cannon-Fenske viscometer as explained in section 3.5. During the test, two trials have been carried out for each samples and repeatability of results have been observed in each trial as shown in Table. This indicates the accuracy of the test. The kinematic viscosity of mineral oil SAE20w40 was found to be 115.142 cSt. As compared to the viscosity of mineral oil SAE20w40, the viscosity of Pongamia base oil as well as both the additive added oils is observed to be too low.

Figure shows the variation of kinematic viscosity with addition of different percentage of ZDDP and Benzoic acid additive. As seen from this figure, the kinematic viscosity decreases up to 2wt% addition of ZDDP and further increase in wt% of ZDDP increases the kinematic viscosity whereas for Benzoic acid it increases with wt%. With the addition of ZDDP up to 2 wt % the newly developed oil creates a boundary film which forms on the surface of the viscometer. The film formed by ZDDP acts as a friction reducer showing that ZDDP additive in the right amount is beneficial. At higher concentration the excess ZDDP adversely effects on the boundary film formation. Since Zinc is present in the ZDDP, it forms a film on the surfaces of viscometer. With the increase of weight percentage of the ZDDP, more film is formed. This condition may be contributed to the increase of the viscosity due to the excess of the metal present in the oil. This results into the significant increment of kinematic viscosity of oil with addition of more than 2wt % ZDDP.

CONCLUSION:
Based on the experimental results, the following conclusions are drawn,
1. The density, kinematic viscosity of Pongamia base oil reduces with addition of ZDDP additive up to its 2 wt %.
2. The density, kinematic viscosity of Pongamia base oil increases with addition of Benzoic acid additive.
3. The density of Pongamia base oil as well as additive added Pongamia oils is more than the density of mineral oil SAE20w40 irrespective of weight percentage of ZDDP and Benzoic acid additive. However, addition of 2wt% of ZDDP to Pongamia oil results in density closer to SAE20w40 oil.
4. As compared to the viscosity of mineral oil SAE20w40, the viscosity of Pongamia base oil as well as the additive added oils is observed to be too low. Lower viscosity was obtained at 2wt% of ZDDP blended with Pongamia oil whereas. The viscosity of Benzoic acid blended bio lubricant is increasing with increase in wt% concentration.
5. Finally, the addition of 2wt% of ZDDP to Pongamia oil can contribute to reduce the global demand of petroleum based lubricants for the applications where reduced density, kinematic viscosity.

~*~*~*~
PRODUCTION OF BIOETHANOL FROM WASTE CASHEW APPLE AND USE OF BIOETHANOL AS FUEL FOR IC ENGINE

Project Reference No.: 41S_B_BE_086

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            Mr. MANJIT SHET DESSAI
            Mr. PRABHAV PHAL GAONKAR
            Mr. AKSHAY USAPKAR

Introduction: Cashew apple, a product which is abundantly available in the country every year and much of it is wasted. Cashew apple could be an excellent source of bio-fuel, the objective of this study is the effective utilization of cashew apple for Bio-ethanol production. It is estimated that 22–25 lakh tones of cashew apple fruits are available in the country. Most of the fruits are at present wasted and practically not utilized by the industry in any of the cashew growing states in India except Goa where it is used in the preparation of alcoholic beverages.

In today's world we are facing difficulties like the decrease in resources of fossil fuel. The use of fossil fuel also leads to increase in emission of greenhouse gas which leads to global warming. In order to overcome this problem bioethanol can be produced from renewable resources like biomass which can help us to overcome both above problems. Bioethanol is bio fuel produced sugar rich biomass. The bioethanol can be produced using various sources such as cashew apple, potatoes, sugarcane, and bagasse. There are three steps to produce bioethanol from raw material: they are 1) Hydrolysis 2) Fermentation 3) Distillation
1) In hydrolysis process starch is converted to fermentable monosaccharide sugar.
2) In fermentation process the sugar is converted into ethanol.
3) Distillation process involves separating the ethanol by which concentration is increased.

Mainly it is separated from the water. The produced fuel can be used as alternate fuel or can be blended with petroleum and used as additive. Biomass feedstock such as wheat, barley, rice, corn and sugarcane are sources from which bioethanol can be produced. But they are sources of food so they cannot be used for production of bioethanol. Sources such as cashew apple, sugarcane bagasse are used for production of ethanol.

Key words: Bioethanol blends, Single cylinder 4 stroke engine, Emission test analyzer.

Objective:

1. To create awareness among the public regarding alternative fuel for IC engine due to depletion of petrol and diesel fuels.
2. Usage of the waste product into useful fuel.
3. Utilization of produced bioethanol from cashew apple to the engine fuel.
5. Bioethanol is highly volatile liquid, easily combustible and less engine emission.

Methodology: Bioethanol fuel is produced by crushing, fermentation, distillation, double distillation and triple distillation process.
Cashew apple is crushed using cashew apple crusher. Cashew apple crusher separates cashew juice from cashew apple then sends it for fermentation. First, the juice is collected in a tank and left undisturbed for two days. During this process froth is formed and the top surface and bubbling action takes place. Once the bubbling action starts, fermentation begins. After the end of the second day of fermentation, the fermented juice is transferred into a distillation tank. Distillation unit consists of copper vessel, furnace, condensing unit, and collecting tank. First juice is transferred into the copper vessel while heat is supplied from the bottom by burning wood. At around 84 degrees, the ethanol vaporizes and moves towards the condenser unit. The condensation unit consists of a pipe that passes through a water tank. The water from the water tank extracts heat from the ethanol vapor and converts it into liquid ethanol. This liquid ethanol is then collected in the collecting tank. Distilled ethanol is then further distilled in order to increase the concentration of ethanol while removing water concentration. The distilled ethanol is transferred into a round bottom flask. Fractionating column is then attached to the round bottom flask and condenser. Thermometer is used to measure the temperature inside the fractionating column.

**Results and Conclusion:** Ethanol blends prepared by mixing of Bioethanol with Petrol fuel in the proportion E5, E10, E15 & E20. Engine tests are done on a single cylinder 4-stroke vehicle (hero hunk). Exhaust gas emission test carried out in AVL444 DIGAS gas analyser to determine CO, HC and CO2 gases for each blend. The two-wheeler bike was made to run on a constant speed of 50 KMPH and using a trip meter, the distance travelled for 1 litre of each fuel and therefore the average distance for each litre of fuel were noted down.

Ethanol has lower energy content than petrol; hence more ethanol in petrol will increase fuel consumption and thereby decrease efficiency. Figure (c) shows that petrol gives maximum mileage of 62 kmpl. As the content of ethanol increases in petrol fuel consumption increases and mileage decreases. Consumption of blend E20 is faster among all other used blends.
blends and therefore mileage decreases to 32 kmpl. Figure (a) and (b) shows emission if use ethanol blends around 60% emission reduction.

**Conclusion:** Ethanol can be blended with petrol and used as fuel. Blends burn much cleaner compared to petrol. When E5, E10, E15 and E20 blend are used, emission of exhaust gases decreases considerably compared to petrol. But as the ethanol content increases in blends, fuel gets consumed faster and heat generated in combustion chamber increases. Which result in high engine temperature which also affects the efficiency of engine. Among fuels E5 and E10 gives more satisfactory result. Heat generated in E5 and E10 is slightly higher than petrol and Consumption is also higher than petrol but emission for E5 and E10 are lower than that of petrol around 60%. With the use of blends E5 and E10 blends, without any modification in current engine, can help to reduce emission and use of blends can also reduce import burden of fuels.

**Future scope**

1. To blend bioethanol and diesel fuel with different percentages.
2. To run engine with 100% ethanol without modifications in engine.
3. To produce bioethanol from sugarcane, corn, etc. and compare bioethanol produced from cashew apple.
4. To do chemical analysis of Bioethanol and Bioethanol blends.
5. To evaluate the waste product.

**PRODUCTION OF BIODIESEL FROM NON-EDIBLE OIL AND INVESTIGATING ITS SUITABILITY FOR IC ENGINE APPLICATION**

**Project Reference No.: 41S_B_BE_010**

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MR RAJDEEP SINGH  
MR. KAMALAKAR  
MR. SACHIN

**KEYWORDS:** Calophyllum-Inophyllum oil, Esterification, Transesterification, Calorific value, Viscosity, Density, Mechanical efficiency, Brake thermal efficiency, specific fuel consumption, Indicated mean effective pressure.

**INTRODUCTION:** Industrial development and economy of any country is mainly depends on its energy resources. In view of rapid industrialization and explosive growth of vehicles for transportation, demand for energy is increasing at rapid rate. It is observed that major portion of energy need is fulfilled by petroleum product among various fraction of petroleum products, demand for diesel is increasing many folds due to extensive use of compression ignition engines for various industrial applications. It is observed that the petroleum products are concentrated over some parts of the world and majority of countries import petroleum products for their needs. This puts heavy financial burden on their economy. Also, combustion of these petroleum products in internal combustion engine cause environmental pollution due to emission of carbon dioxide to atmosphere. To solve the problems of scarcity of energy and pollution, it is required to investigate some alternative fuel for petroleum products which can be produced indigenously and can cause less pollution. Among various alternatives, vegetable oil-based fuels can be used due to their properties very close to that of diesel and can be prepared from plant species which can be grown on dry or semi-arid land.

Use of straight vegetable oils of IC engine application results in inferior performance and combustion characteristics due to their higher viscosity. To reduce the viscosity of vegetable oils-based fuels different methods can be adopted. This experimental work describes the findings of experiments conducted on a diesel engine to investigate its performance of punnai (Calophyllum Inophyllum) oil. The oil obtained from non-edible seed oil is used to find out the performance.
OBJECTIVES:

- To produce biodiesel by transesterification process and also to find the best process to get maximum yield of biodiesel by varying heating process settling time, chemical content for the process.
- To investigate the performance and combustion characteristics of diesel engine using punnai bio diesel and blends. The performance characteristics like brake power (BP), indicated power (IP), brake thermal efficiency ($\eta_{bth}$), mechanical efficiency ($\eta_{mech}$), etc.

METHODOLOGY:

FFA TEST

- Prepare N/10 solution by taking 2gm of NaOH and put 500ml of distilled water and mix it properly (to prepare a NaOH).
- Take 10gm of raw oil and put 50ml of Isopropyl and heat the oil up to 60°C and cool it up to ½ an hour and put 2-3 drops of phenolphthalein in the cooled oil and titrate it against N/10 solution.
- After getting the titration value we have the standard formula for finding the FFA (free fatty acid) i.e.
  \[
  \text{FFA} = \frac{28.2 \times (\text{normality of NaOH}) \times \text{titration value}}{\text{Weight of oil}}
  \]
- After getting the titration value from standard chart, if it is above 4 means need to go for esterification.
- If the value of FFA is less than 4 means go for Transesterification. The value of FFA is optimized.

After EEA test the transesterification of the oil is carried out to obtained biodiesel.

ENGINE PERFORMANCE:

The Engine chosen to carry out experimentation is a single cylinder, four stroke, vertical, water cooled, direct injection computerized Kirloskar make IC Engine. This engine can withstand higher pressures encountered and also is used extensively in agriculture and industrial sectors. Therefore, this engine is selected for carrying experiments.

A computerized engine setup consisting of a computer loaded with the engine compatible software (IC ENGINE SOFT) is connected to the engine electronically to different units like the dynamometer, pressure sensor, temperature sensor, Rota meters, fuel, air level indicators is used to analyze all the data accumulated during the process of experimentation.

The experiment is conducted under varying load of 0, 3, 6, 9, 12, 15 and 18 with injection pressure of 200 bar. Firstly the normal diesel engine is run with diesel fuel under variable load conditions. The readings are always recorded after the engine attains stability of operation after 4-5 minutes of running. Then the punnai oil and punnai biodiesel is used in place of diesel at different loads. The performance parameter such as Brake Thermal Efficiency ($\eta_{bth}$), Indicated Thermal Efficiency ($\eta_{ITH}$), Brake Specific Fuel Consumption (BSFC), and Mechanical Efficiency ($\eta_{mech}$).

RESULTS AND CONCLUSION:

Based on the experimental investigations, the following conclusions are drawn.

- The calorific value of PB100 is 39563.15 KJ/Kg, PB10 44878 KJ/Kg, PB20 42792.66 KJ/Kg, PB30 40443 KJ/Kg which is lower than that of diesel (45379 KJ/Kg).
- The specific gravity of PB100 is 0.86 and for which is higher than that of diesel.
- The Calophyllum Inophyllum (punnai) Bio Diesel and Bio Oil fuel is more viscous compared to diesel.
- Specific Fuel consumption is near to the values of diesel.
- Break thermal efficiency of Calophyllum Inophyllum (punnai) bio diesel is slightly high when compared with diesel (BTHE of Diesel and PB100 are 22.81% and 26.44% respectively).
- The exhaust temperature of Calophyllum Inophyllum (punnai) biodiesel and Calophyllum Inophyllum (punnai) bio oil at full load are higher than diesel due to incomplete combustion because of higher viscosity.

With these above conclusions we can state that Calophyllum Inophyllum (punnai) bio diesel and its blends can be used as an alternative fuel to run the diesel engine without any modifications which gives better efficiency with reduction in air pollution.

SCOPE OF THE FUTURE WORK: The work done in this investigation can be extended to
Investigation on effect of various engine variables such as inlet opening pressure, fuel injection timing, and compression ratio (IOP, FIT and CR.) with best performing fuel.

Experiments should be conducted based on design of experiment approach.

Optimization of Combination of Best fuel (Blend) and engine variables.

Blends of punnai oil with suitable solvent preferably any other agricultural produce (like ethanol, butanol etc) or diesel also can be done to enhance the performance.

DESIGN AND FABRICATION OF BIODIESEL FILTER

Project Reference No.: 41S_B_BE_094

COLLEGE : JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA
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GUIDE : Mr. RAVIKUMAR B.N. & Mr. CHETHAN S. G.
STUDENTS : Mr. GOWTHAM S
            Mr. MOHAMMED INZAMAM
            Mr. KIRAN CHANDRA O.
            Mr. ROOPESH KUMAR JHA

Diesel fuel plays an important role in the industrial economy of any country. These fuels run a major part of the transport sector and their demand is increasing steadily, requiring an alternative fuel which is technically feasible, economically competitive, environmentally acceptable and readily available. BIODIESEL helps in saving the environment in many ways. It produces lower emissions and is more energy efficient when compared to mineral diesel. Biodiesel helps in the reduction of greenhouse emissions, biodegradation and pollution.

**Biodiesel Filtration:** Biodiesel tends to dissolve the natural fuel “tar” deposits coating the inside of diesel tanks, piping, and hoses. The dissolved deposits are carried to fuel filters, causing shortened fuel filter life. Most biodiesels have a low “interfacial tension”. This means that water easily disperses and dissolves in the fuel. Low interfacial tension greatly reduces water separation efficiency for all types of water separators and coalescences. Removal of water from a fuel system is necessary for proper engine performance. A larger filter adds more filtration media surface area, which lowers the flow velocity going to each square inch of the media. This extends filter life and increases water removal efficiency. When specifying a new biodiesel fuel system, de-rate fuel filter flow by 50% and install on the vacuum side of any pumps, where possible. Pure biodiesel has high cloud and pour points, necessitating the use of electric and/or coolant heaters in cold weather. Lower percentage blends (B20) act more like standard diesel fuel, but some lower fuel blends have been known to cause problems. Pour point suppressants and biocides are necessary for reliable operation. A coolant heat exchanger is required to heat the fuel in extreme cold weather conditions.

Biodiesel is known to attack certain synthetic rubber compounds, making them swell and soften, or the opposite, shrink and harden. Seals subject to biodiesel exposure are generally replaced at the same time as the replacement filter. Filtration can be used in several steps during the biodiesel production process. The use of filtration depends on the used feedstock. The use of filtration during biodiesel production can be divided in two steps the pre-treatment of the crude oil and the purifying of the crude biodiesel.

**Pump Filters:** This type of filter is used when high rate of filtration is required. There are a large variety of pump filters used in liquid transfer & spraying systems. The main function of a pump filters is to “separate” large and small particles from the liquid before it enters key components in the system such as certain types of pumps, meters and storage tanks or truck tanks. Suction pumps can be located inside or outside the reservoir. External pumps are easy to service and often include an indicator to show when the filter starts bypassing. The indicator can be as simple as a vacuum gauge or it might be a vacuum-operated electrical output to a warning light or controller. Return-line filters should have integral
bypass check valves. If the filter becomes loaded, return oil needs a flow path to tank until it is convenient to change the filter. Without a bypass, the filter element may collapse, or the element housing or seal may rupture.

Objectives:

- To design and fabricate automated filtering system for biodiesel purification
- To obtain high quality biodiesel
- To overcome problem of blockages while using in engines
- Removal of residual matters
- Comparative study of biodiesel with and without filtration.

3D rendering of expected fabricated filtering unit

OPTIMIZATION OF PERFORMANCE CHARACTERISTICS OF DI DIESEL ENGINE WITH BLENDS OF HONNE (CALLOPHYLLUM INOPHYLLUM LINN) BIODIESEL AND PURE DIESEL

Project Reference No.: 41S_B_BE_047

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STUDENTS: MR. MUDASI S. K.
           MR. MALLANAGOUDA PATIL
           MR. BASAVRAJ GOUDAR
           MR. OMKAR B

Keywords: SurHonne Oil (Callophyllum Inophyllum Linn), Biodeisel, Desirability Function Analysis.

Introduction: India is a country which heavily imports petroleum products from other countries. This has imposed burden on economy of the country. To address this issue, there is large importance given to bio diesel, which also improve farmers revenue in agricultural based country like India. Apart from this an increasing the demand for fossil fuel has been a critical problem for us. The natural resource of fossil fuel is dwindling day by day. Biodiesel that may be called natural fuel may be a good source in future. In this direction, our project aims to carry out Optimization of Performance Characteristics of DI Diesel Engine with Blends of Honne (Callophyllum Inophyllum Linn) Bio-Diesel and Pure Diesel. In this project, Biodiesel is produced from non edible oil Honne (Callophyllum Inophyllum Linn) and is tested in diesel engine with blends of 20%, 40% and 60% of biodiesel and pure diesel for performance characteristics. Further, Optimization is carried out using Desirability Function Analysis (DFA). Optimization of the
process is, special feature of this work apart from conventional approach of carrying out analysis by experimentation. Blends, Load and BP, BSFC, BTE, HSU are the input and output variables considered in this work respectively. It is found that B40% and load 6 kg are found to be optimal process parameters.

Objectives:
1. To conduct the performance analysis of blends of biodiesel.
3. Determination of optimized process parameters.

Methodology:
1. Problem definition.
2. Identifying the appropriate orthogonal array based on number of factors and levels.
4. Conduction of the experiment as per the orthogonal array.
5. Performance of optimization by Taguchi-desirability function approach.
6. Determination of optimized process parameters.
7. Conclusion and documentation.

Result and conclusion:
Formula: larger the better for desirability analysis

Formula for determining Composite desirability value
\[ D_n = \left( d_1^{w_1}d_2^{w_2} \ldots d_n^{w_n} \right)^{1/w} \]

Table: Experimental Results and Evaluated results of desirability function

<table>
<thead>
<tr>
<th>EXP NO</th>
<th>Blend (%)</th>
<th>Load (kg)</th>
<th>Experimental Results</th>
<th>Individual desirability</th>
<th>Composite desirability</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>BP (kw)</td>
<td>BSFC (kg/Kwh)</td>
<td>BTE (%)</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
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<td>2.43</td>
<td>0.3415</td>
<td>26.26</td>
</tr>
</tbody>
</table>

From table evaluated results of desirability function values are considered to construct response table

Table: Response table for the composite desirability

<table>
<thead>
<tr>
<th>Process parameters</th>
<th>Average composite desirability</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Blends</td>
<td>0.2915</td>
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<tr>
<td>Loads</td>
<td>0.2650</td>
</tr>
</tbody>
</table>
From the above table the blend B40 with the load 6 kg is found to be optimal parameter.

**Scope for future work:** The carried-out work is restricted to performance analysis of DI diesel engine with blends of Honne (Callophyllum Inophyllum Linn) biodiesel and pure diesel. Depending on the feasibility, use of ethanol as an additive agent may be considered in future.

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**ECOTOXICITY AND BIODEGRADABILITY STUDIES OF NEEM OIL BASED METAL CUTTING FLUID**

*Project Reference No.: 41S_B_BE_019*

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Mr. VISHWESWAR NADIG

**INTRODUCTION:** Vegetable oil is other highly alternative substitute for mineral oil due to its renewable, environmentally friendly, relatively non-toxic and readily biodegradable properties. Toxicity is the degree to which a chemical substance or a particular mixture of substance can damage an organism. Toxicity can be measured by its effect on the target. Because individuals have different levels of response to the same dose of a toxic substance, a pollution measure of toxicity is often used which relates the probability of an outcome for a given individual in pollution. One such measure is LC50. Aquatic toxicity refers to the effects of a compound to organisms living in the water and is usually determined on organisms representing the three trophic levels, i.e. vertebrates (fish), invertebrates (crustaceans as *Daphnia* spp.) and plants (algae).

Neem oil is practically non-toxic to birds, mammals, bees and plants. Neem oil is slightly toxic to fish and other aquatic organisms. Azadirachtin, a component of neem oil is moderately toxic to fish and other aquatic animals.

**Objective:**  
1. To study the toxicity of neem oil based metal cutting fluids on fishes.  
2. To study the biodegradability of neem oil based metal cutting fluids.

**Methodology:**  
1. Oil formulation is carried out.  
2. Acute fish toxicity of neem oil based metal cutting fluid is measured by following OECD 203 (Organization for Economic Co-operation and Development) test method for acute fish toxicity test.  
3. The mortality rate of fishes is found out using LC50 (Lethal Concentration 50) where calculation for the concentration at which 50% of fishes are killed.
4. Toxicity level of the oil is studied comparing with mineral oil.  
5. BOD (biological oxygen demand) and COD (chemical oxygen demand) of oils is evaluated.

**Results and conclusion:**  
1. Biological oxygen demand for the test sample of neem of 500ml is 25200 mg/L.  
2. Chemical oxygen demand for the test sample of neem of 500 ml is 281598.4 mg/L.  
3. LC50 is obtained at 660 ml concentration which means that beyond this concentration neem oil is toxic according to OECD 203.

**Future scope:** Similar to above research, toxicity of non-edible oils can be found out which can be used as an alternative for mineral oil as a metal cutting fluid.

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KSCST: SPP-41ST SERIES: BIOFUEL PROJECTS COMPENDIUM: 2017-18 45
PERFORMANCE AND EMISSION CHARACTERISTICS STUDIES OF CI ENGINE USING GRAPHENE AND ALUMINIUM OXIDE NANO PARTICLES BLENDED DAIRY WASTE SCUM BIO DIESEL AND EFFECT OF INJECTION PRESSURE AND THREE AND FIVE HOLE OF NOZZLE COMBUSTION PROCESS

Project Reference No.: 41S_B_BE_057

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Mr. PAVAN
Mr. NELSON RODRIGUS
Mr. PRESTON CYRIL QUADRAS

Keywords: Nanoparticles, Biodiesel, Ultrasonication, Fuels.

Introduction: To improve engine performance and reduce output emissions, some studies have focused on the addition of nanoparticles to biodiesel fuels. Such technique was thought to have positive impacts on the combustion characteristics of the biodiesel fuels. The reason for such effects was related to the fact that nanoparticles have a high surface to volume ratio and could act as a catalyst in the combustion zone as well as was confirmed to have a significant possibility of emissions reduction. Such nano-additives also improve the radiative mass transfer properties, reduce ignition delay and improve the ignition temperature of the fuel in the combustion zone. Correspondingly, the previous experimental studies have been conducted with the addition of nano-additives to biodiesel and diesel fuels to enhance the fuel properties and engine performance, as well as to decrease the engine emissions.

Nanoparticles have generally higher surface energy due to their larger surface area. Hence they tend to agglomerate to form a micro sized particle and start to sediment. Stability of the suspensions is a crucial issue for both scientific research and practical applications.

Objectives:
- To prepare nano-bio-diesel fuel blend using Probe type ultrasonicator.
- To study the performance of blended biodiesel using single cylinder Diesel Engine.
- To study the Emission characteristics of blended biodiesel.
- To reduce the use of fossil fuels which are depleting now a days.

Methodology: The Dairy waste is collected and filtered. Oil extracted whose FFA has to be found it obtained more than 4% hence one stage of acid esterification was carried out to bring it below the 4%. Acid esterification has done 1 L of oil mix with 200ml (20%) of methanol with the addition of 25ml (2%) conc. sulfuric acid reaction was kept at 60°C and 90 min time with the Batch reactor. After the esterification the traces of FFA, acid content and methanol ratio collected at the top, which has to be separated. Further processing has been done by using base Transesterification for 1 L of acid esterified oil mixed with methoxide solution contain 240 ml of methanol and 7g of NaOH pellets (base catalyst). The solution is maintained at a temperature of 65°C on the batch reactor for 90 min of time. The solution is washed to remove soaps and residual catalyst. The washing of Biodiesel is continued till the bottom layer of separating funnel found to be like water. This achieved by washing at least 15 times. The solution taken out from the separating flask should be dried for complete evaporation of water content at 100°C.

Alumina blends preparation: Weigh the Alumina to a predetermined mass fraction of 50 ppm. About 2-3ml of isopropyl 2-propanol is taken in a beaker and weighed Alumina are added to it and is ultrasonicated for 30 minutes using ultrasonic bath. The surfactant is taken 4 to 5 times the weight of alumina and is dissolved in 3ml De-Mineralised (DM) water. The dissolved surfactant is added to above alumina solution. The mixture is again ultrasonicated for another 30 minutes. Now the above mixture is added to blended biodiesel and once again it is ultrasonicated for uniform dispersion 1 hour and further stirring is done using magnetic homogenizer for 1 hour.

Graphene blends preparation: The graphene is weighed to a predetermined mass fraction of 50 ppm. About 2-3ml of isopropyl 2-propanol is taken in a beaker and grapheme are added to it and is ultrasonicated for 30 minutes using ultrasonic bath. The surfactant is taken 4 to 5 times the weight of the grapheme and is dissolved in 3ml De-Mineralised (DM) water. The dissolved
surfactant is added to above graphene solution. Again the mixture is ultrasonicated for another 30 minutes. Now the above mixture is added to blended biodiesel and it is ultrasonicated for 1 hour and further stirring is done using magnetic homogenizer for 1 hour.

**Alumina+Graphene blends preparation**

Fig1: Alumina Blend  
Fig 2: Graphene Blend  
Fig: Graphene+Alumina blend  

The Alumina and the Graphene mixtures are weighed to a predetermined mass fraction of 50 ppm, i.e. 25 ppm of Alumina and 25 ppm of graphene. About 2-3ml of isopropyl 2-propanol is taken in a beaker and weighed Alumina and graphene are added to it and is ultrasonicated for 30 minutes using ultrasonic bath. The surfactant is taken 4 to 5 times the weight of blended solution and is dissolved in 3ml De-Mineralised (DM) water. The dissolved surfactant is added to this mixture. The mixture is again ultrasonicated for another 30 minutes. Now the above mixture is added to blended biodiesel and once again it is ultrasonicated for uniform dispersion 1 hour and further stirring is done using magnetic homogenizer for 1 hour.

**Results and conclusions:** The results obtained by Performance and Emission test are as follows:

![SFC vs Load](chart1.png)

It is observed that graphene and Al₂O₃+Graphene blended biodiesel shows a considerable decrease of SFC in comparison other two blended biodiesel fuel, Al₂O₃ blended biodiesel shows increase of SFC at 20-50% load and decrease at 50-100% load. The decrease in SFC can be due to the positive effects of nanoparticles on physical properties of the fuel and reduction of ignition delay period. Corresponding to load, the specific fuel consumption decreases with the dosing of Al₂O₃.

![Smoke vs Load](chart2.png)

Smoke for B20 is higher compared to that of B20+Al₂O₃ and Graphene blended fuel. However Smoke were marginally lower for the B20+Al₂O₃+GRAPHENE, this could be due to higher catalytic activity and improved combustion characteristics. The smoke for
Al₂O₃ Blended fuel increases from 0-50% of load and decreases suddenly from 50-75% of load and further increases from 75-100% of load.

**Scope for future work:** The present study is being done on B-20 Blend further study can done on different combination of blends by modifying the present Diesel engine. Nano particles can be added in different proportions to increase the performance and decrease the emission characteristics of the diesel engine.

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**DESIGN AND FABRICATION OF MACHINE TO CONVERT PLASTIC INTO OIL AND GASEOUS FUEL PRODUCTION**

Project Reference No.: 41S_B_BE_007

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

**BRANCH:** DEPARTMENT OF MECHANICAL ENGINEERING

**GUIDE:** Prof. LAKSHMANA NAIK & Dr. M. S. GANESHA PRASAD

**STUDENTS:**
- Mr. SITAL KUMAR SAH
- Mr. SANDEEP CHAUDHARY
- Mr. SURAJ TIMILSINA
- Mr. NISCHAL BHATTARAI

**KEYWORD:** - Pyrolysis, Plastic Waste, Flash Point, Fire Point, Viscosity, Reactor, catalytic cracking, fractional distillation.

**INTRODUCTION:** - Plastic was invented by Alexander Parkes in 1860. Plastics have become a crucible part in today’s world. Due to their light weight, durability, design flexibility, they are excessively used in industry as well as household and other fields. The demand for plastic is increasing day by day which now pose a tremendous threat to the environment. The study focuses on the design and fabrication of machine to convert plastic into oil and gaseous fuel production as an effort in finding environment-friendly means of waste recycling by means of pyrolysis. It is an alternative solution to increasing problem of waste disposal. Pyrolysis runs without oxygen and in high temperature of about 250°C for which reactor is fabricated to provide the required temperature for the reaction. The waste plastics are subjected to depolymerisation, pyrolysis, and fractional distillation to obtain different value-added fuels such as petrol, kerosene, and diesel. Our Project deals with the extraction of oil from the waste plastics termed as plastic pyrolysed oil which can be marketed at much cheaper rates compared to that present in the market. As we know that both Plastics and Petroleum derived fuels are Hydrocarbons that contain the elements of Carbon & Hydrogen. Pyrolysis process becomes an option of waste-to-energy technology to deliver bio-fuel to replace fossil fuel. The advantage of the pyrolysis process is its ability to handle unsort and dirty plastic. The pre-treatment of the material is easy. Plastic is needed to be sorted and dried. Pyrolysis is also nontoxic or non-environmental harmful emission unlike incineration.

**OBJECTIVES:**
- To build up the reason for the improvement and execution of waste plastics reusing with the use of environmentally sound technologies (EST). To advance asset protection and ozone depleting substances
- To create awareness on plastic waste and its possible reuse for conversion into diesel or fuel.
- To reduce the dependency on fossil fuels, thereby contributing to the economic growth of the country.
- 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 in to 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.
METHODOLOGY:

**Material:** Mild steel, Plastic, Nichrome (Ni-80%, Cr-20%), Glass wool, K-type thermocouple, leather gasket, round bottom flask.

**Methods:**

1. **Collection and segregation of plastic** - The plastic waste is collected from different sources such as household, hotels, market etc. and separated on the basis of their types.
2. **Feeding** - The waste plastic is collected, cleaned and fed into reactor through feeder and feeder inlet is closed.
3. **Heating** - Heat the product of reactor inside by using suitable heating source.
4. **Condensing** - The plastic get evaporated at high temperature, this vapour is condensed to atmospheric temperature by using tube condenser.
5. **Liquid collection** - Outcoming product from the condenser is collected at liquid collector.
6. **Distillation** - The collected oil is further distilled to get gaseous and other products.
7. **Testing** - The oil sample is finally taken to laboratories for testing its properties like density, calorific value, flash point, fire point, viscosity, etc. The test is carried out for different samples before coming to final result.

![Fig 1 CAD Assembled view of setup](image1)
![Fig 2 experimental setup](image2)
RESULTS AND DISCUSSION: -

Flash Point: - Flash point is obtained at temperature 28°C.

Fire point: - At 32°C temperature the fire point is obtained.

Density: - Density of fuel at different temperature was measured by a standard 50ml flask.

Weight of the empty 50ml flask ($W_1$) = 39gm

Weight of the flask with oil ($W_2$) = 77gm

Weight of the oil ($W$) = $W_2 - W_1$ = 77-39 = 38 gm

Density of oil ($\rho$) = \[
\frac{\text{Weight of oil}}{\text{volume of oil}} = \frac{38 \times 1000}{50} = 760 \text{ Kg/m}^3
\]

Kinematic Viscosity ($\gamma$):- Viscosity is an important property of fuel. It is fluid’s resistance to the flow at a given temperature.

1. Calculate the viscosity of the fuel.

\[
(\gamma) = (0.26 \times t - \frac{188}{47}) \times 10^{-6}
\]

Where $t$ = Time taken for collection of ml oil in seconds = 47 sec

\[
\gamma = (0.26 \times 47 - \frac{188}{47}) \times 10^{-6}
\]

= $8.22 \times 10^{-6}$ m$^2$/s

Calorific value: - Calorific value of fuel is the quantity of heat produced by its combustion at constant pressure and under normal condition. The calorific value of plastic pyrolysis is 47532.740326 KJ/KG
## Comparison of Properties of Plastic with Diesel and Petrol:

<table>
<thead>
<tr>
<th>Sl. NO.</th>
<th>Properties</th>
<th>Plastic Oil</th>
<th>Petrol</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density (Kg/m$^3$)</td>
<td>760</td>
<td>740</td>
<td>832</td>
</tr>
<tr>
<td>2</td>
<td>Calorific value (KJ/Kg)</td>
<td>47528.55</td>
<td>45800</td>
<td>45500</td>
</tr>
<tr>
<td>3</td>
<td>Kinematic viscosity (m$^2$/s) @ 40°C</td>
<td>$8.22 \times 10^{-6}$</td>
<td>-</td>
<td>$2.5 \times 10^{-6}$</td>
</tr>
<tr>
<td>4</td>
<td>Flash Point (°C)</td>
<td>28</td>
<td>29</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>Fire Point (°C)</td>
<td>32</td>
<td>33</td>
<td>55</td>
</tr>
</tbody>
</table>

### Advantage:
1. The waste plastic is converted into fuels having high calorific value.
2. It solves the problem of disposal and management of waste plastic by converting them into alternative source of energy.
3. Burning of plastic produces toxic gases like nitrogen dioxide, sulfur oxides, dioxins and other harmful gases. Plastic pyrolysis process produces minimum hazardous gases. Hence, the process helps to control environmental pollution.
4. The process is environment friendly.
5. It promotes environmental protection. When people realise that waste plastic can be converted into fuel they won’t dump plastic unnecessarily.
6. Plastic fuel can act as an alternate fuel to diesel, petrol, kerosene, etc.
7. Plastic fuel can be used as good source of heat in sugar industry, brick industry, and steel industry.
8. Plastic pyrolysis fuel is cheaper than other fuels.

### Limitations:
1. Plastic pyrolysis fuel cannot use directly in engine.
2. Initial cost of machine is high.
3. Fractional distillation process is complicated.
4. Identification of type of plastic is difficult.
5. The process is time consuming.

### Application of Project & Future Work:
1. It can be used as alternate source of fuel in diesel engines.
2. It can be used as a fuel in diesel generators.
3. It can be used for heating in sugar industry, steel industry, etc.
4. It can be used for heating boilers.
CONCLUSION: Plastic bears a major threat to the current scenario and the environment. Millions of tonnes of plastics are produced on the daily basis and only few percentage of the waste plastic are being successfully recycled. Since, plastic takes long years to decompose, some alternative to plastic should be developed. Also, the world is facing the problem of shortage of petroleum. Therefore, conversion of waste plastic into fuel can provide a better solution to the disposal problem of waste plastic as well as act as an alternative to fossil fuel. From the experiments and trials, we also found that by using pyrolysis method we were able to get recover 80-85% oil for polypropylene plastic (Type-5). However, the output varies depending on the type of plastic used. Also, the plastic fuel showed properties similar to that of diesel fuel. Hence, we can conclude that pyrolysis of plastic into fuel can solve both the problem of plastic waste management as well as shortage of fossil fuel if plant is set up at the commercial level.

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IMPROVISATION ON PHYSICAL AND COMBUSTION PROPERTIES OF FUEL BRIQUETTE FROM PONGAMIA AND GLYCERIN MIXING DIFFERENT BINDERS

Project Reference No.: 41S_B_BE_008

COLLEGE: NEW HORIZON COLLEGE OF ENGINEERING, BENGALURU
BRANCH: DEPARTMENT OF MECHANICAL ENGINEERING
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STUDENTS: Mr. ARJUN YADAV
Mr. MANOJ RATNA BHUSAL
Mr. RANJAN JAISWAL
Mr. HARISH

Introduction: Nowadays as there is a shortage of energy source like wood, coal, natural gases, kerosene, diesel, petrol etc. And day by day the prices of these fuels are going high, leading to demand of alternative energy source. Fuel briquette can be a step of staircase in the path of alternative and renewable energy source. Fuel Briquettes are a fast-growing product in India since it is easy to use, ecofriendly, economical and can be produced in bulk quantity to fulfil the alternative source of fuel. Biomass briquettes are made utilizing agricultural wastes such as sugarcane straw, coffee husk, rice husk, groundnut shells etc., forestry wastes such as leaves, dry woods etc. and industrial wastes such as saw dust, molasses, charcoal etc. Bio mass Briquettes have wide application in domestic and industrial purposes.

Therefore, in present work Fuel briquettes were produced using pongamia pod shells and waste glycerine mixing different Binders such as coffee husk, saw dust, charcoal etc. such that the low-density waste is converted into high density biomass fuels to obtain highest calorific value fuel briquette. Earlier research has shown that they can be used in daily life or people can be attracted towards fuel briquette instead of wood or coal, only if they are economically efficient or are of lower cost compared to wood and coal and can give the required heat or energy i.e higher CV compared to wood or coal or other sources that is to be replaced by fuel briquettes. Hence in our project we have tried to get maximum calorific value using the solid wastages which are available free of cost for respective farmers or they are very cheaper compared to traditional fuels.

OBJECTIVE:
The objectives of the current project are:

1. To Test a fuel Briquette for different proportions of Pongamia Pod shells, Glycerin and different binders of selected different shapes which are with and without holes for varied Grain size
2. Study Physical and Thermal properties of the produced Briquette
3. Designing and Fabrication of simple Briquette maker (Hand Briquette press) which can be home made by using waste wood blocks of broken wooden chairs, tables etc. This requires no electricity consumption and process is simple.
4. This experimental study to become a ready reckoner for the consumer to choose best fuel Briquette and researchers to further research on various compositions of Bio waste and Binders.
METHODOLOGY: Below are the following steps involved in producing of fuel Briquettes:

1. Raw material such as Pongamia pod shells, saw dust etc. stored at dry condition
2. Crushing of dried Raw materials to powder form
3. Preparation of mixture with proper mixing proportions of powdered raw material and binders
4. Mixture in powder form is added to Briquette Hand press and pressed for long time with greater force. The process involved in Briquette making is as shown in figure below.
5. Remove the Briquette and subjected to drying
6. Briquettes are tested for physical and thermal properties as shown in Sample Table 1. Percentage ratio of mixtures added and binders will be decided during experimentation

RESULT:

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Moisture Content (%)</th>
<th>Ash Content (%)</th>
<th>Density (Kg/m^3)</th>
<th>Calorific Value (Cal/Gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.42</td>
<td>8</td>
<td>908.42</td>
<td>4990</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>7</td>
<td>1022.92</td>
<td>5046</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>6.5</td>
<td>1092.11</td>
<td>5240</td>
</tr>
<tr>
<td>4</td>
<td>6.92</td>
<td>8.25</td>
<td>1244.855</td>
<td>5497</td>
</tr>
</tbody>
</table>

CONCLUSION: The fuel briquette that we have made is giving us higher CV and is improvised value, but till now we have only tested for different mixture composition, as of now our sample-4 has given us the highest CV, now using the same proportion of mixture as in sample-4, we have to try with different shapes of moulds and check for the improvement in properties.
ABSTRACT: Biofuels from renewable sources like vegetable oils, animal fats etc. are seriously evaluated as an alternative to fossil fuels. The intended application of biofuels has been replacement of petroleum diesel. However, due to higher viscosities, these fuels are transesterified to produce fatty acid alkyl esters or biodiesel for engine applications. The major feedstocks recognized for biodiesel production in India are Jatropha, Karanja etc. However, the failure of National Biodiesel Mission to realize 20% blending by 2012 indicated an urgent need to assess the potential of other potential feedstocks. In this context, the present work deals with an underutilized vegetable oil known as “Shorea robusta” or Sal seed oil” as a potential feedstock for biodiesel production which can significantly increase the feedstock availability. The production potential of this oil seed is a gigantic 1.5 million tons a year and the geo-climatic penetration of the plant is sub-continental with special presence in Odisha, Chhattisgarh and Madhya Pradesh. In the present work, pressure filtered Sal seed oil was transesterified with 1:9 oil to methanol molar ratio, 0.95% by weight of catalyst (potassium hydroxide), 65°C reaction temperature and 450 rpm agitation speed leading to an ester yield of 96.8%. The results of physico-chemical properties indicated that kinematic viscosity, density, heating values of the Sal oil methyl ester (SOME) was well within the ASTM/EN standard limits.

OBJECTIVE:
- A production potential of Sal Seed oil is very promising.
- Sal Seed Oil is unexplored biodiesel feedstock which is abundantly found in India.
- Extraction of oil from Sal Seeds
- To study the transesterification of Sal seed oil using various amount of catalyst taking part in the reaction.
- The biodiesel obtained is subjected to various studies like density, viscosity and flame test.
- To study and improve the performance characteristics of single cylinder four stroke diesel engine.
- To study and improve the combustion benefits of single cylinder four stroke diesel engine.
- To compare performance and combustion characteristics using different blends ratio of Sal seed oil and Diesel as primary fuel

METHODOLOGY: Biodiesel is normally produced by the transesterification process in which the triglyceride of the Sal seed oil is converted into fatty acid alkyl esters and glycerol in presence of a catalyst. The most commonly used alcohol is methanol to produce methyl esters. It is generally referred as fatty acid methyl esters (FAME) [14]. The general scheme of the transesterification reaction for FAME is presented in equation (1.1), where R is a mixture of fatty acid chains the free fatty acid contents of the sal seed oil was as low as 0.42% leading to a simple and one stage transesterification process to produce sal seed oil methyl ester (SOME) or sal biodiesel. Various process parameters for the transesterification stage were 1:9 oil to methanol molar ratio, 65°C reaction temperature, 450 rpm agitation speed, 0.5% by weight of the catalyst (potassium hydroxide) and a reaction time of 60 minutes. The ester yield was more than 96%. Fig.3 shows the SOME after water washing.
PROPERTIES PARAMETER:
- It may be observed that a marginal reduction in density was realized after neat sal oil was transesterified to produce SOME.
- Although, SOME showed 3.96% higher density than mineral diesel, but it was still well within the ISO 12185 standard limit of 0.86-0.89 g/cc.
- Meanwhile, viscosity of the neat oil was reduced drastically from 157 mm²/sec to nearly 5.8 mm²/sec after transesterification.
- The maximum yield of SOME is observed around 96% at 60°C temperature, 450rpm and about 90min reaction time.

CONCLUSION:
- The production of biodiesel through optimization techniques of non-edible oils have considerably brought down the cost of biodiesel.
- In the present study, production of biodiesel was performed using Shorea robusta oils that are potentially available in the central and South Eastern part of India. In the present study, a single stage transesterification process and then a comprehensive physicochemical characterisation was carried out.
- The initiative taken in the present research work to explore sal or Shorea Robust as a biodiesel feedstock is a small step in the right direction.
- It was found that most of the properties of biodiesel follow the standard specified by ASTM D 6751. RSM proved to be a powerful tool for the optimization of biodiesel production.

EXPERIMENTAL INVESTIGATION ON PERFORMANCE & EMISSION CHARACTERISTICS USING POULTRY WASTE BIODIESEL AND ADDITIVES IN CI ENGINE

Project Reference No.: 41S_B_BE_046

COLLEGE : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT, MANGALURU
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STUDENTS : Mr. MOHAMMED SAFUVAN C A
           Mr. MOHAMED SHAHBAZ ABDUL SHUKOOR
           Mr. MOHAMMED SUHAIL

Keywords: Poultry waste, Biodiesel, Nano particle, Combustion

Introduction: In terms of environmental hazards, biodiesel is more adaptable as compared to fossil fuel due to the reason such as it forms low carbon and smoke emissions which are the main components responsible for greenhouse effect & global warming. The demand for broiler chicken has been increased drastically all over the world in the last
decade. A person gives more preference to the chicken meat rather than the red meat of beef or pork due to increasing health consciousness. Broiler chicken has become the cheapest source of animal protein in many parts of the world.

In Kerala, a small state of India, it is estimated that about 5.4 lakh broiler chickens are slaughtered daily which results in production of 360 tons of broiler waste per day. These wastes are disposed of in uninhabited areas or in water bodies which leads to ground and surface water pollution, extremely unpleasant odor and health hazards raised by careless breeding of micro-organisms, parasites, house flies and stray dogs. This raises a catastrophic threat to the environment and results in major health hazards. Among the different bio-secure and sanitary disposal methods, rendering is an excellent way to recycle a troublesome waste material into a good feed ingredient. The final products obtained are carcass meal & rendered chicken oil. Carcass meal can be used as pet and fish feed ingredient rather than that it can also be used as a bio-fertilizer. The rendered chicken oil which has high amount of free fatty acid content does not have much commercial value at present condition.

Thus, Conversion of these rendered chicken oil into biodiesel may open new aspects for generating wealth from waste besides controlling the major disorder of environmental pollution.

Nano particles are those particles which vary in dimensions from 1 to 100 nanometres. Nanoparticles have a wide range of applications. Intensive research is being carried out in the field of nanoparticles because of their potential benefits in biomedical and mechanical fields. Nanoparticles behave has solid surfactants and are capable of aligning themselves at water oil interface. Ball mill process is one of the most preferred processes for the preparation of nanoparticles. The particle size is determined using scanning electron microscope. The ultrasonic is the device used for the dispersion of the additive in fuel. They have the property of stabilizing emulsions and their addition does not affect the density of the final product. Cerium oxide is a rare element. It has a dual valence state and excellent catalytic activity. Cerium oxide when added in different dosing levels improves the performance and efficiency of the engine.

Cerium oxide has the ability to catalyze combustion reactions, by donating oxygen atoms from its lattice structure. This catalytic activity is dependent on surface area, amongst other things, so using nanoparticles can offer distinct advantages over bulk material or larger particles. Adding cerium oxide nanoparticles to fuel can help decomposition of unburnt hydrocarbons and soot, reducing the amount of these pollutants emitted in the exhaust and reducing the amount of fuel used. It has also been shown that cerium oxide decreases the pressure in the combustion chamber, which reduces the production of NOx and makes combustion reactions more efficient.

Objective:
1. To produce an alternative fuel which is biodegradable, nontoxic and eco-friendly
2. To conduct various performance test on obtained biodiesel blends.
3. To conduct emission test on obtained biodiesel blends.
4. To understand the effect of cerium oxide nanoparticles on performance and emission of biodiesel blend

Methodology:
1. Collection of Poultry waste and boiling at 100 degree Celsius or above
2. Collecting the fat or oil from top of water and store it in a container
3. Transesterification process is carried out to remove glycerine as it may affect the performance & emission characteristics of the biodiesel

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Units</th>
<th>Results</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Density</td>
<td>g/ml</td>
<td>0.880 @ 15°C</td>
<td>IS: 1448 (P 32)</td>
</tr>
<tr>
<td>2.</td>
<td>Gross Calorific Value</td>
<td>Cal/g</td>
<td>6649.0</td>
<td>IS: 1448 (P 6)</td>
</tr>
<tr>
<td>3.</td>
<td>Flash point (open cup)</td>
<td>°C</td>
<td>158</td>
<td>IS: 1448 (P 66)</td>
</tr>
<tr>
<td>4.</td>
<td>Kinematic viscosity @ 40°C</td>
<td>cSt</td>
<td>4.4</td>
<td>IS: 1448 (P 25)</td>
</tr>
<tr>
<td>5.</td>
<td>Fire point</td>
<td>°C</td>
<td>178</td>
<td>IS: 1448 (P 66)</td>
</tr>
</tbody>
</table>

4. Preparation of B20 (20% Biofuel+ 80% Diesel) blend
5. Addition of cerium oxide to B20 blend

Table 2: Different blends of Biodiesel

<table>
<thead>
<tr>
<th>Blend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B20</td>
<td>20% of bio-fuel and 80% of conventional diesel</td>
</tr>
<tr>
<td>B20 10ppm</td>
<td>B20 and 10ppm of additives</td>
</tr>
<tr>
<td>B20 20ppm</td>
<td>B20 and 20ppm of additives</td>
</tr>
<tr>
<td>B20 30ppm</td>
<td>B20 and 30ppm of additives</td>
</tr>
</tbody>
</table>

Table 3: Properties of Cerium Oxide

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS Number</td>
<td>1306-38-3</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>172.11 g/mol</td>
</tr>
<tr>
<td>Linear Formula</td>
<td>CeO$_2$</td>
</tr>
<tr>
<td>Empirical Formula</td>
<td>CeO$_2$</td>
</tr>
<tr>
<td>Particle size</td>
<td>&lt;25 nm</td>
</tr>
<tr>
<td>Density</td>
<td>7.13 g/mL at 25°C</td>
</tr>
<tr>
<td>Color</td>
<td>Pale yellow</td>
</tr>
<tr>
<td>Melting Point</td>
<td>2400 °C</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>3500°C</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>Insoluble</td>
</tr>
</tbody>
</table>

6. Experimentation is carried to determine the performance and emission characteristics of B20 blend with cerium oxide additives.

Table 4: Specification of Engine

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine make</td>
<td>Kirloskar</td>
</tr>
<tr>
<td>No. of Stroke</td>
<td>4</td>
</tr>
<tr>
<td>No. of Cylinder</td>
<td>1</td>
</tr>
<tr>
<td>Fuel</td>
<td>Diesel</td>
</tr>
<tr>
<td>Stroke length</td>
<td>110 mm</td>
</tr>
<tr>
<td>Compression Ratio</td>
<td>16.5:1</td>
</tr>
<tr>
<td>Loading</td>
<td>Eddy current dynamometer</td>
</tr>
<tr>
<td>Capacity</td>
<td>3.5 kw</td>
</tr>
<tr>
<td>Cylinder Bore</td>
<td>80 mm</td>
</tr>
<tr>
<td>Cylinder Capacity</td>
<td>553 cc</td>
</tr>
<tr>
<td>Cooling</td>
<td>Water Cooled</td>
</tr>
</tbody>
</table>

Results and Conclusions:

- Utilization of poultry waste can be done by converting it into biodiesel. Its low operating cost in biodiesel production make this study a promising one for possible green technological applications.
- The rendered chicken oil could be converted to good quality biodiesel by alkali catalysed transesterification of triglycerides.
- Use of Cerium oxide additive in diesel/biodiesel blends resulted in improved performance characteristics. Improved combustion stability, reduced deposit buildup, shorter ignition delay, better heat release rate is observed with the additives.
- Cerium oxide additives significantly decrease the emission characteristics such as CO, HC, and NOx compared B20 blend without additives.
- Chicken oil methyl ester blended with diesel fuel could be used as an alternative fuel in conventional diesel engines without any major modifications and it improves mechanical efficiency, brake thermal efficiency, and decreases smoke emissions by reducing pollution and mitigating climatic changes.
Scope for future work:
1. By varying different blends and volume of nano particles can be tested.
2. Testing can be done on 4-cylinder engine to understand the emission and performance characteristics better.

INVESTIGATIONS ON PERFORMANCE AND POLLUTION LEVEL ON N-BUTANOL BLENDED PETROL FUELED IC ENGINE (10% TO 50% BLENDING)

Project Reference No.: 41S_B_BE_062

ABSTRACT: N-Butanol or n-butyl alcohol is a primary alcohol with a 4-carbon structure and the chemical formula C₄H₉OH. Now-a-days air pollution is becoming a serious problem in many urban cities and it can have a serious effect on the environment. Although experimental studies have shown that alcohol fuels burn cleaner than gasoline and produce lesser emission there is scarce information regarding the comparison among the alcohol fuels as gasoline additive in spark-ignited engines. Experimental investigations are planned both on performance and pollution levels of exhaust gas emissions. N-butanol is to be added to unleaded gasoline by mass percent of 10% to 50% and then will be tested in a four-stroke SI engine.

OBJECTIVES:
1. To reduce atmospheric pollution by decreasing emission levels of petrol engines by using n-butanol blended petrol.
2. To study the reduction in emissions of butanol blended fuel (Studying pollutant elements such as CO, CO₂, NOₓ, HC).
3. To test the performance of petrol engines by the use of n-butanol blended petrol with various parameters, to reduce the consumption of petrol and to find alternatives for depleting fossil fuel reserves.

METHODOLOGY FOR EXECUTING THE PROJECT: Purchasing and refurbishing a petrol engine and to fix it rigidly on a base frame and set up a prony brake dynamometer to test its performance. Next prepare blended fuel of petrol with n-butanol using a centrifuge from 10% to 50% blends in steps of 10% and conduct the performance test of petrol engine using blended petrol fuel in comparison with unblended petrol fuel and check the emission levels of the exhaust gases when different blends of n-butanol with petrol in comparison with unblended petrol fuel and evaluate optimum blending levels.

EXPECTED OUTCOME OF THE PROJECT: Study the performance of petrol engine with the use of n-butanol blended petrol fuel. Reduced emission of pollutants in exhaust gases by the use of n-butanol blended petrol fuel. A comparative study of the changes in performance of the engine is run on butanol blended petrol and unblended petrol. Changes in performance parameters and pollution levels compared to 100% petrol fuelled engine.

WORK CARRIED OUT: For evaluation of exhaust and performance characteristics N-Butanol blends up to 50% ratios in 10% increments N10, N20, N30, N40 and N50 are prepared in bio technology department laboratory. 200ml of each blend was prepared and then the engine was run on petrol until it ran stable. After that the performance of the engine i.e. brake power, brake specific fuel consumption (bsfc), brake thermal efficiency, brake mean effective pressure were evaluated. The engine was tested at a constant speed of 420 rpm with varying loads from 0 kg with steps of 2 kg up to 10 kg. The engine was loaded using a rope brake dynamometer setup. Emission characteristics test for the engine with all Blends was done in a government certified test center for biofuel research in Vemana Institute of Technology using an “Automotive Emission Analyzer (QRO-401 Series)” and CO, CO₂, HC, O₂ and NOₓ levels were determined.
RESULTS: PERFORMANCE TEST ANALYSIS: As analysed from the graph we infer that unblended petrol has the best BSFC at 2kg load and 10% and 40% Blends have the closest BSFC and is the best alternatives to Petrol at 2kg load. And 50% blend has the best efficiency at 6kg load. The 40% and 30% Blends have the next highest efficiencies and is the best alternatives to 50% blend at 6kg load. Theoretically this might be due to the presence of a higher percentage of oxygen content in the butanol.

EMISSION TEST ANALYSIS: With no load condition 30% blend is the best because there are significant reductions in the emissions of HC, CO and NOx. And with 4 kg load 20% blend is the best because there are significant reductions in the emissions of HC, CO, CO2 and NOx.

CONCLUSION: N-butanol is a green fuel which can be produced by bio methods using agro based products such as corn and anaerobic chemical reactions. Nowadays, the increase in emission of the automobile is a serious concern to humanity. Several regulations have been laid by the government to keep pollution levels in check. This creates need for alternate methods for reduction in emission such as using alcohol fuel blends. In future, necessary steps need to be taken by the government to make n-butanol fuels available at lower prices, support and improve the production method of N-butanol. More investigations are needed to study upto 100% N-butanol blends in petrol engine.

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STUDY OF CALOPHYLLUM INOPHYLLUM BIODIESEL AND PERFORMANCE ON CI ENGINE USING COMBINATION OF BIOETHANOL, BIODIESEL, DIESEL AND ITS FEASIBILITY STUDY USING NATURAL AND SYNTHETIC ANTIOXIDANT

Project Reference No.: 41S_B_BE_034

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ABSTRACT: Calophyllum Inophyllum (Sura Honne) oil, which is non edible could be used as a source for biodiesel Esterification in India and it is available in abundant quantities in western Ghats of India. The present Research work examines the suitability of Calophyllum Inophyllum as a promising feed stock for biodiesel production and its application in diesel engine operation. The Calophyllum biodiesel can reduce the dependency of petroleum imports to a certain extent. The Calophyllum Inophyllum methyl ester and its blends are used in engine testing. The experimental parameters such as break thermal efficiency, break fuel consumption, CO2, CO and NOx emissions are evaluated and results are compared with conventional fuel. It is observed that Calophyllum Inophyllum biodiesel has low NOx emissions.

INTRODUCTION: Energy is considered as a basic factor for economic growth, social improvement and human welfare. There are limited reserves of the fossil fuels and the world has already faced the energy crisis of seventies concerning uncertainties in their supply. Fossil fuels are currently the dominant global source of CO2 emissions and their combustion is stronger threat to clean environment.

BIO-DIESEL: Bio-Diesel isn't the general vegetable oil and isn't protected to swallow. Be that as it may, biodiesel is viewed as biodegradable, so it is thought to be substantially less destructive to the earth if spilled. Biodiesel additionally has been appeared to create bring down fumes emanations than consistent fuel. The best thing about biodiesel is that it is produced using plants and creatures, which are sustainable resources.

ADVANTAGES:
1. It is produced using inexhaustible assets.
2. It delivers less contamination contrasted with diesel motors.
3. It is naturally degradable and lessens peril of defilement of soil.
4. It contains no sulphur, component in charge of corrosive rain.
5. Engines last longer when utilizing it.
6. It produces 78% less carbon dioxide than ordinary diesel fuel.
7. NOx emissions are very less.

**DISADVANTAGES:**
1. It can be used in only diesel-powered engines.
2. The availability of seeds is seasonal.

**Engine test results:**
The experiments were conducted on a Kirloskar, single cylinder four stroke water cooled CI engine, keeping compression ratio of 17.5:1 as constant for various loads and various blends of biodiesel. Analysis of performance parameters and emission characteristics like brake thermal efficiency, unburnt hydrocarbon, carbon monoxide, carbon dioxide, NOx are evaluated.

The following conclusions are drawn from this investigation.
1. More brake thermal efficiency is obtained for diesel fuel compared to the other blends used.
2. NOx emission by the Calophyllum Inophyllum biodiesel is very less.
3. The maximum pressure is obtained for diesel fuel and next being B20.
4. The CO emission for diesel fuel is less when compared to other biodiesel blends. This could be due to complete combustion of diesel fuel inside the cylinder, lower viscosity and lower density.
5. Improved Storing capacity of produced Diesel using Synthetic and Natural Antioxidants with different concentration.

**PERFORMANCE ANALYSIS OF CI ENGINE FUELED WITH TURMERIC LEAF OIL ASSISTED BY MAGNETIC FUEL ENERGIZER**

Project Reference No.: 41S_B_BE_031

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Mr. PRADEEPKUMAR R NAiK

**Keywords:** Alternate fuel, biodiesel, diesel engine, magnetic fuel energizer, performance, turmeric leaf oil.

**Introduction:** Rudolf Diesel completely trusted that the use of a biomass fuel to be the genuine eventual fate of his motor. He needed to give agriculturists the chance to create their own particular fuel. Biodiesel can be expressed as a fuel that is comprised of a mono alkyl ester of a long chain of unsaturated fats that are gotten either from vegetable oil or creature fat. Vegetable oils have great start quality as they have since quite a while ago anchored structures which are not expanded. Conversely, the higher synthesis of oxygen content, carbon buildup and bigger atomic mass influences the warming to estimation of biodiesels essentially lower than diesel. They have higher blaze point and are around 10% denser than diesel, making them safe to store. Their poor unpredictability because of higher consistency is in charge of their lower cetane numbers. Further, biodiesels are biodegradable and lessen the CO₂ cycle. Likewise, they don't contain sulfur and any cancer-causing agents, in this manner they are not hurtful to living creatures. Most powers for inward burning motors are fluid, however fluid fills don't combust until the point when they are vaporized and blended with air. Most emanations from engine vehicles comprise of unburned hydrocarbon, carbon monoxide, and oxides of nitrogen. Unburned hydrocarbon and oxides of nitrogen respond in the environment and make brown haze. Oxides of nitrogen are additionally poisonous. For the most part, powers for inward ignition motor are compound of
particles. Every particle comprises of various molecules made up of number of core and electrons. Attractive developments as of now exist in their atoms and in this manner, in them as of now have positive and negative electrical charges. Be that as it may, these particles have not been realigned, the fuel isn’t effectively interlocked with oxygen amid ignition, the fuel atom or hydrocarbon chains must be ionized and realigned. The ionization and realignment is accomplished through the use of attractive field made by 'Magnetizer'. The ionization fuel likewise breaks down the carbon develop in carburetor, planes, fuel injector and ignition chamber, subsequently keeping the motors clear condition.

Objectives:
- Instead of using non-renewable sources like petrol, diesel we are using renewable source i.e., Turmeric Leaf Oil.
- Magnetizer is particularly effective for improving the combustion efficiency of fuel.
- Evaluation of biofuel properties.
- Evaluation of performance and emission characteristics of biofuel in diesel engine.
- By using Magnetizer, combustion efficiency of fuel will be tested.

Methodology:
Preparation of Turmeric Leaf Biodiesel
Biodiesel can be produced from vegetables oil, animal oil or fats and waste oils. The main route to produce biodiesel from fats and oil is base catalyzed transesterification of oil.

**Transesterification Process:** The steps involved in the trans-esterification process are as follows: It consists of two methods. They are:

I. Single Phase Method
II. Double Phase Method

1. **Free fatty acid:** Weigh about 4 grams of NaOH using weighing machine. Measure 1 litre of distilled water into one litre standard flask. Using a glass rod to break the NaOH flakes and dissolve it by constant and uniform stirring. Take 25ml of 0.1N NaOH solution prepared transfer into a clean and dry burette. Take 50ml of Isopropyl alcohol in a clean and dry 250ml conical flask and then add 10gm of parent oil to flask. Add few drops of NaOH solution to the above flask and shake well. Heat the above mixture to about 60°C. Titrate against 0.1N NaOH from the burette.

2. **Mixing of alcohol and catalyst:** A specified amount of methanol is added with a measured quantity of NaOH which acts as catalyst, into a flask.

3. **Reaction:** This mixture is then added into a closed reaction vessel and the respective oil is added and heated to 60-80°C. This reaction converts the fats into the esters. Once in a while, an additional measure of fuel can be included request to guarantee finish transformation of fats to esters.

4. **Separation of biodiesel and glycerin:** After the completion of reaction, two products exist: biodiesel and glycerin. The quantity of glycerin varies as per the kind and quantity of vegetable oil.

5. **Removal of alcohol:** The mixture of biodiesel and glycerin is heated up to 60°C, thus producing the steams, which separates the amount of glycerol from the mixture. The methanol is sufficiently dry in order to recirculate it back into the reaction.

6. **Glycerin neutralization:** The glycerin byproduct contains unwanted quantity of catalyst and soap and needs to be neutralized with an acid.

7. **Methyl ester water wash:** This is the final phase which ensures the complete removal of unwanted contents from the biodiesel, so as to make it compatible with the diesel engine.
The single-phase method is used when the free fatty acids (FFA) amount in oil is below 4%. This involves a measured amount of alcohol as methanol and the catalyst NaOH and the mixture is heated and maintained at 65°C. If fatty acids is greater than 4%, double phase method is used. It involves mixture of H$_2$SO$_4$ and methanol to be taken and added and supplied to esterification process first and then it is heated and maintained at 65-80°C. This is then passed onto and previous process is carried out.

**Experimental Method:** Experiment is done on single cylinder, 4 stroke, water cooled with eddy current dynamometer loading computerized diesel engine. It is used for evaluation of performance characteristics of Turmeric leaf biodiesel blend with diesel which can be used as an alternative fuel. Fuel supply is assisted by external device called as Magnetic fuel energizer. The performance of turmeric leaf biodiesel with magnetizer and without magnetizer at different loads are evaluated.

**Installation of Magnetic Fuel Energizer:**
In this experiment we installed the fuel energizer on inlet pipe of diesel engine as shown in Fig.2 to get maximum effect.

![Fig a: Fuel Line with 1 Magnetic fuel Energizer](image1)
![Fig b : Fuel Line with 2 Magnetic fuel Energizer](image2)

**Results and Conclusions:**

Table 1: Comparison of Properties of Turmeric Leaf Biodiesel blends with diesel:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Diesel</th>
<th>B100</th>
<th>B10</th>
<th>B20</th>
<th>B30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/mm$^3$)</td>
<td>0.842</td>
<td>0.850</td>
<td>0.825</td>
<td>0.828</td>
<td>0.830</td>
</tr>
<tr>
<td>Kinematic Viscosity (mm$^2$/s) at 40°C</td>
<td>2.5</td>
<td>1.058</td>
<td>2.152</td>
<td>2.042</td>
<td>1.913</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>70</td>
<td>55</td>
<td>65</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Fire point (°C)</td>
<td>78</td>
<td>60</td>
<td>70</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Calorific value (MJ/Kg)</td>
<td>44000</td>
<td>33050.41</td>
<td>41612.54</td>
<td>42361.72</td>
<td>43431.90</td>
</tr>
</tbody>
</table>

![BRAKE POWER V/S LOAD](image3)

**Fig. 3: Variation of Brake power with load**
The variation of brake power with load for different fuels is presented in the figure 3. In this graph brake power is increased with increased in load. The maximum brake power is found in Diesel as compared to other blend fuels.
Figure 6: Variation of Brake Thermal efficiency with Load

The variation of brake thermal efficiency with load for different loads is presented in figure 6. In all cases, brake thermal efficiency is increased with increase in load. This was due to reduction in heat loss and increase in power with increase in load. The maximum brake thermal efficiency obtained is for B20, B10 and is higher than that of diesel. The brake thermal efficiency obtained for B30, B30 with 1 Magnetizer and B30 with 2 Magnetizer is less than diesel. This lower brake thermal efficiency obtained could be due to increase in fuel consumption when compared to B10 and B20.

Figure 7: Variation of Indicated Thermal efficiency with Load

The variation of Indicated thermal efficiency with load for different fuels is presented in figure 7. In all cases, indicated thermal efficiency is increased and decreased with an increase in load. This was due to reduction in heat loss and increase in power with increase in load. The maximum indicated thermal efficiency obtained is for B20, B10 and is higher than that of diesel. The indicated thermal efficiency obtained for B30, B30 with 1 Magnetizer and B30 with 2 Magnetizer is less than diesel. This lower indicated thermal efficiency obtained could be due to increase in fuel consumption as compared to B20 and B10.

CONCLUSION:

With the obtained results for experimentation following conclusion can be drawn: Turmeric leaf oil with B10 and B20 blend has shown highest indicated thermal efficiency as compared to other blends. Turmeric leaf oil with B30 blend has shown less specific fuel consumption for the same output during part and full load. Addition of 2 magnetizer with B30 blend has improved the brake power due to efficient combustion process. Blend B30 with 2 magnetizer has performed well during part load and full load condition. Turmeric leaf oil has emerged as one alternate fuel for diesel with optimum B30 blend with 2 magnetizer.

Scope for future work: This project was carried out on a single cylinder engine for which satisfactory results were obtained. Results with multi cylinder engine fuelled by conditioned oils can be carried out and compared with that of single cylinder engine performance characteristics. Different types of biodiesel blends can be used for the same experimental set up. More number of Magnetic fuel energizer can be used for the same experimental set up.
INTRODUCTION: Considering where the world stands today we can see that energy is one of the biggest factors responsible for growth of nations. Nations with superior energy resources develop faster than those with lesser resources. This growth has led to soaring energy demands which are met directly or indirectly largely by fossil fuels. The present situation is such that the energy produced is not enough to meet the demand. Also, the energy sector only caters to the needs of the developed and the underdeveloped regions do not have access to conventional energy sources.

In order to attain energy security, the world needs to turn towards alternative fuel sources like biofuels. Over the last 25 years the world has seen a considerable growth in the use of alternative fuels. A good example is ethanol which is mixed with regular petroleum fuels and used in car engines. Another example is biodiesel produce from vegetable oil. Biodiesel has become a very popular solution over the last decade with a variety of sources available for its production.

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 no commercial value and is currently disposed of as a solid waste or in some cases used as fertilizer. Due to high organic material content and the presence of compounds such as caffeine, tannins and polyphenols which can have negative effects on the environment and result in the release of greenhouse gases in to the atmosphere. Thus, the disposal of spent coffee powder should be properly managed. As per the preliminary experiments conducted spent coffee powder consists of 20% oil content in it, which can be converted to biodiesel by the method of transesterification.

OBJECTIVES OF THE PROJECT

➢ To extract oil from waste coffee powder using solvent extraction method.
➢ To use various solvents like Hexane, Acetone, Methanol, Ethanol, Kerosene in extraction process and to select the best solvent based on yield of oil and cost of production.
➢ To produce biofuel from the obtained oil by the method of transesterification.
➢ To blend the produced Biofuel with Diesel in various proportions (B10, B20, B30, etc.,)
➢ To find out the properties of various blends (B0, B10, B20, B30, B40 etc.,) like Specific gravity, Flash point, Fire point, Viscosity, Calorific value etc.,
➢ To test the produced biodiesel and its blends in a Diesel engine.
➢ To study the effect of addition of Titanium oxide Nano particles in various proportions to bio-fuel blends on efficiency and emissions of the engine.

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 titrating the oil against NaOH solution using iso-propyl alcohol with phenolphthalein indicator. 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 and alkali base process 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 washed and 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 (B0, B10, B20, B30, etc...). The properties of the produced fuel like Specific gravity, Flash point, Fire 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.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watermelon seeds Soxhlet Extractor</td>
<td>Transesterification &amp; washing of Methyl Esters</td>
</tr>
<tr>
<td>Methanol recovery from Distillation process</td>
<td>Pensky Martin Apparatus to find Flash Point</td>
</tr>
<tr>
<td></td>
<td>Ostwald Viscometer</td>
</tr>
<tr>
<td></td>
<td>Hydrometer to find Density</td>
</tr>
<tr>
<td></td>
<td>4-S Single cylinder CI Engine</td>
</tr>
</tbody>
</table>

**RESULTS AND CONCLUSIONS:**

(i) **Characterization of SCP biodiesel blends**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Range</th>
<th>Diesel</th>
<th>B100</th>
<th>B10</th>
<th>B20</th>
<th>B30</th>
<th>B20 (250 ppm)</th>
<th>B20 (500 ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point (˚C)</td>
<td>ASTM D93</td>
<td>&gt; 130</td>
<td>64</td>
<td>135</td>
<td>68</td>
<td>77</td>
<td>80</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>Kinematic Viscosity (cst)</td>
<td>ASTM D445</td>
<td>1.9-6.0</td>
<td>1.764</td>
<td>3.85</td>
<td>2.03</td>
<td>2.13</td>
<td>2.57</td>
<td>1.79</td>
<td>1.8</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>ASTM D4052</td>
<td>870-900</td>
<td>850</td>
<td>875</td>
<td>855</td>
<td>857</td>
<td>861</td>
<td>0.90</td>
<td>0.91</td>
</tr>
<tr>
<td>Calorific Value (kJ/kgK)</td>
<td>ASTM D240</td>
<td>---</td>
<td>43800</td>
<td>33790</td>
<td>40994</td>
<td>37278</td>
<td>35537</td>
<td>42174</td>
<td>42876</td>
</tr>
<tr>
<td>Ash (% w/w)</td>
<td>IS: 1448 (P4)</td>
<td>0.5 max</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
</tbody>
</table>
Table: Properties of SCP Biodiesel & Blends

(ii) Performance and Emission Characteristics.

The results of the experimentation can be briefed as:

➢ The measured properties of produced methyl ester (kinematic viscosity, flash point, fire point) met the ASTM D6751 biodiesel standards.
➢ Spent coffee powder oil biodiesel can be used as an alternative fuel in existing diesel engine without modification of basic engine.
➢ It is observed that the brake thermal efficiency of B20 and B30 blends almost matches with diesel. Further it can be observed that addition of titanium oxide Nano particles of 250 PPM to B20 blend increases the efficiency up to 0.85%.
➢ Brake specific fuel consumption of B20 and B30 biodiesel blends almost matches with diesel.
➢ NOx emission biodiesel blends increased up to 5% at full load for B20 and B30 blends compared to diesel. Addition of nanoparticles increased the NOx emissions.
➢ HC emission reduced up to 20% for B20 at full load compared to diesel. Further addition of 250 PPM nanoparticles reduced HC emissions by 14.28%. There was a net HC reduction in 34.37% for 250 PPM as compared to that of Diesel.
➢ Emission of CO was considerably reduced as the load increased for biodiesel blends compared to diesel. With the addition of 250 PPM Nano particles there was a net reduction of 50% CO emission at full load as compared to that of Diesel.
SCOPE FOR FUTURE WORK:
The present work is an experimental study on production of biodiesel and performance characteristics of direct injection compression ignition engine using the mixture of spent coffee seed biodiesel as fuel at different proportions with injection pressure of 200 bar and compression ratios like 17.5, under various loads. Further work can be done in the following areas.

➢ A study of performance and emission of the engine with the biodiesel blends can be carried out by varying the injection pressure. By optimizing the injection pressure better BTE can be achieved.
➢ The performance and emission characteristics of the engine with variation of compression ratio of the engine can be studied for all blends.
➢ Experimentation can be carried out on multi cylinder engines to study the behaviour of these fuels to ascertain the usage in the practical engines.
➢ Performance and emission tests with biodiesel blends can be carried out in an adiabatic engine. Approximately one third of the heat released by the combustion of the diesel engine is dissipated to the cooling medium. If this can be reduced by thermally insulating the piston crown, cylinder liner and cylinder head, the gases in cylinder will become much hotter and hence more work can be extracted from them. This is the concept of adiabatic engine, which will improve the performance of the engine and emissions may be reduced.
➢ Preheated fuel can be used in order to get the reduction in viscosity which will result in similar characteristics to that of diesel.
➢ Performance evaluation of all these blends can be carried out for different injection timings to optimize injection timing for best performance and minimum emission characteristics.

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PERFORMANCE CHARACTERISTICS OF METHANOL (CH3OH) EXTRACTED FROM ATMOSPHERIC CO2

Project Reference No.: 41S_B_BE_084

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           Mr RAVIKIRAN N S
           Mr SHANKAR R
           Mr BINUBALACHANDRAN

Introduction:
• As we all know due to rapid increase in consumption of conventional energy sources, the fuel resources are depleting continuously.
• So as a solution to this problem researches were carried on alternate forms of energy sources that is the non-conventional energy sources and to extract energy from them.
• Methanol is an alternative, renewable, environmentally and economically attractive fuel, considered to be one of the most favorable alternative fuels to conventional fossil-based fuels.
• The work represents an important step that could lead to a future "methanol economy," in which fuel and energy storage are primarily based on methanol.

Objectives:
• The process removes harmful CO2 from the atmosphere, and the methanol can be used as an alternative fuel to gasoline.
• Conversion of carbon-dioxide into methanol by hydrogenation, using catalyst.
• Testing performance characteristics by blending methanol with petrol in a SI engine test rig.
• To increase the performance of the engine to achieve better power and emission characteristics without altering the engine design.
Methodology:

CO₂ sequestration process

- To obtain CO₂ from atmosphere we used quick lime (calcium oxide). CaO in crystalline form was exposed to engine’s exhaust gas to obtain CaCO₃ and its activeness and stability was checked with Atomic Absorption spectroscopy.
- Now using CaCO₃ with hydrochloric acid in Kipp's apparatus we obtain CO₂ gas.

\[
\text{CaO} + \text{CO}_2 = \text{CaCO}_3
\]
\[
\text{CaCO}_3 + 2\text{HCl} = \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2
\]

Catalyst preparation

- The name of the catalysts prepared were copper-zirconium oxide-zinc oxide (Cu-ZrO₂-ZnO), copper zirconium oxide (Cu-ZrO₂).
- The composition of Cu-ZrO₂-ZnO is 45:45:10 & Cu-ZrO₂:30:70.
- Aqueous solution of Zirconyl Nitrate and Sodium Hydroxide was prepared.
- Aqueous solution of Sodium hydroxide and Zinc sulphate was prepared.
- Aqueous solution of Copper Nitrate and Sodium Hydroxide was prepared.
- The liquid was stirred up to 15 min's until dark blue gel was obtained.
- The solution was filtered using glass filter and dried at NTP.
- The dried element was heated to 348K upto 15Hrs for Cu-ZrO₂-ZnO, 403K upto 15Hrs for Cu-ZrO₂ and then powdered to 70 micro-meter.
- Calcination process was done @623K for 3Hrs.
- The resultant Catalysts were obtained.

Hydrogenation of Gaseous CO₂ to CH₃OH

The pressure was maintained at 3 atmospheres (3.03 bar).

- The catalyst tube was loaded with 0.5gm of catalyst, measuring around 6mm length.
- The end of the catalyst in the tube were closed with glass wool.
- The loaded catalyst tube and the reactor bed setup were connected and the temperature of 550K and pressure of 3 atmospheres were maintained.
- The obtained CO₂ gas was connected to the pressure regulator and H₂ inlet manifold.
- Then the mixture of CO₂ and H₂ gas was passed through the catalytic chamber.
- Obtained gas was passed to the gas analyser and the water was condensed to the condenser tube.
- When the gas was passed to the gas analyser methanol gas was detected.
- The conversion % of CO₂ to methanol using Cu-ZrO₂-ZnO was 13% & Cu-ZrO₂ was 10.75%.

Performance test of petrol and petrol blend using SI engine test rig

- The calorific value of the petrol (43000kJ/JkgK) and the blended fuel (38093kJ/JkgK) were analyzed in the laboratory.
- Petrol-methanol blends were done as follows
  - 90% petrol and 10% methanol (675ml petrol+75ml methanol)
  - 85% petrol and 15% methanol (637.5ml petrol+112.5ml methanol)
  - 80% petrol and 20% methanol (600ml petrol+150ml methanol)
- Then the values were tabulated for no load and full load conditions under constant speed.
- The performance characteristics of petrol sample was calculated for the same no load and full load conditions.
- The results were compared with the original fuel characteristic values.
- Emission of CO₂ was noted down for different fuel blends.
- Plots were drawn and results were obtained.

Results and discussion:

- CO₂ extraction process from limestone and calcium carbonate had a yield rate of 42% i.e. 50ml for 120gm of CaCO₃ used.
- The yield rate of CO₂ obtained was quite amazing & successful since the CO₂ comes out as a bi-product.
- Using industrial setup and promoters in the reaction of CO₂ extraction process the CO₂ yield can be increased.
Hydrogenation reaction didn’t provide satisfactory conversion results but the results obtained were better when compared to the previously conducted experiments by chemical analysts.

The results of hydrogenation were analyzed experimentally by gas chromatographs.

Emission characteristic table:

**Conclusion:**

- CO\(_2\) gas was obtained with a yield of 42% using Kipp's apparatus.
- The catalysts used (Cu-ZrO\(_2\)-ZnO, Cu-ZrO\(_2\)) were economical & has good thermal stability to withstand high pressure.
- CO\(_2\) conversion to methanol was found to be 13% max and min of 10.75%.
- The methanol conversion rate was good for Cu-ZrO\(_2\)-ZnO (13%).
- The methanol selectivity was 64% for Cu-ZrO\(_2\)-ZnO.
- As methanol % increases in petrol, efficiency increases, specific fuel consumption increases.
- The efficiency was max for the 15% blend when compared to other blends.
- CO\(_2\) and CO emission decreases with increase in blend percentage.
- The 20% fuel blend has the least CO\(_2\) and CO emission in comparison.

<table>
<thead>
<tr>
<th>LOAD(N)</th>
<th>CO(%)</th>
<th>CO(_2)(%)</th>
<th>NOx(ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blends (%)</td>
<td>Blends (%)</td>
<td>Blends (%)</td>
</tr>
<tr>
<td>0</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>0.12</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td>9.81</td>
<td>0.13</td>
<td>0.11</td>
<td>0.15</td>
</tr>
<tr>
<td>19.62</td>
<td>0.13</td>
<td>0.06</td>
<td>0.19</td>
</tr>
<tr>
<td>29.43</td>
<td>0.35</td>
<td>0.02</td>
<td>0.17</td>
</tr>
</tbody>
</table>

EFFECT OF INJECTION PRESSURE ON PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE FUELED WITH MIXED ESTERIFIED OIL BLENDS DERIVED FROM DAIRY SCUM AND FRIED OIL

**Project Reference No.:** 41S_B_BE_083

**COLLEGE:** VIVEKANANDA INSTITUTE OF TECHNOLOGY, BENGALURU

**BRANCH:** DEPARTMENT OF MECHANICAL ENGINEERING

**GUIDE:** Mr. MANJUNATHA R

**STUDENTS:**
- Mr. PRAVEEN H
- Mr. MOHAN KUMAR J
- Mr. KIRAN KUMAR K N
- Mr. NAGARJUN M

**INTRODUCTION:** Alternative fuel derived from vegetable oil and animal fat have increasingly important due to decreasing petroleum resources and increase in pollution problems. Bio-diesel is a cleaner fuel than petroleum diesel and an exact substitute for existing compression engines. Biodiesel has received much attention in the past decade due to its ability to replace fossil fuels, which are likely to run out within a century. Annual production of milk in India is 150 million tons per year. In large dairies while cleaning the equipments, the residual butter and related fats which are washed and get collected in effluent treatment plant as a scum. Scum is a less dense floating solid mass usually formed by a mixture fat, lipids, proteins, packing materials etc. This scum is collected in tanks by skimming. Most of the dairies dispose this scum in solid waste disposal site. Waste scum was collected from effluent area and scum oil is extracted from it. Scum oil transestrified to produce SOME, which have fuel properties similar to diesel.

Waste cooking oil refers to the used vegetable oil obtained from cooking food. Repeated frying for preparation of food makes the edible vegetable oil no longer suitable for consumption due to high free fatty acid (FFA) content. Waste oil
has many disposal problems like water and soil pollution, human health concern and disturbance to the aquatic ecosystem, so rather than disposing it and harming the environment, it can be used as an effective and cost-efficient feedstock for Biodiesel production as it is readily available.

**OBJECTIVES:**
- Baseline survey for the collection of samples of Dairy Scum and Fried oil from different locations for the production of Oil to Bio-diesel.
- Scum oil methyl ester (SOME) and Fried Oil methyl ester (FOME) will be produced by employing transesterification process and the properties of SOME will be analysed which will be further comparable with ASTM biodiesel standards.
- Characterization of Bio-diesel for its physical, chemical & biological properties by standardizing various technical parameters along with low cost transesterification process.
- Procurement of Test Rig to test the Performance of the CI engine fuelled with mixed esterified oil blends derived from dairy scum and fried oil.

**METHODOLOGY:** Initially, the bio oil has extracted from the Milk scum & Fried oil. Then these esterified oils were subjected to transesterification process. In transesterification, 100ml of oil has taken in round bottom flask. 0.6gms NaOH & 20ml of Methanol dissolved in the esterified oil by stirring. Then the flask has kept on magnetic stirrer & using magnetic bit the mixture has stirred about 30min without heating. Then switch on the heater & heat the mixture for 60 min with the temperature maintaining between 500C - 600C. After this pour the mixture into the separating funnel & the mixture has allowed to settle by gravity in a separating funnel overnight. Then Glycerol has separated, the Methyl ester has collected & collected Methyl ester is heated upto 900C to evaporate the Methanol if present. The important fuel properties like specific gravity, calorific value, viscosity, flash point and fire point of diesel, SOME and FOME has been determined. Then the Performance of the CI engine for different blends of B10, B20 & B30 has been evaluated with varied injection pressure of 180bar, 200bar & 220bar. Finally, the results have been tabulated.

**RESULTS AND CONCLUSIONS:** The diesel engine performed satisfactorily on biodiesel fuel without any engine modification. 2. The Brake thermal efficiency increased with increase in Brake power for all the blends. B20 found to be the optimum blend which has shown percentage increase in brake thermal efficiency higher than diesel at injection pressure of 220bar. 3. BSFC decreases with increasing BP up to 2 KW. BSFC for B20 blend is less than all the other blends for all operating conditions and less than diesel at injection pressure of 220bar. 4. The NOx emission for blend B10 is lower than diesel. All other blends show much higher difference than diesel. 5. Most of the major exhaust pollutants like Hydrocarbons, Carbon-monoxide reduced with the use of Biodiesel. B20 & B30 shows the low HC & CO emission at injection pressure of 200bar compared to diesel.

**SCOPE FOR FUTURE WORK:** No work is complete without mentioning its drawback. In this present study, an attempt has been made to give the alternative for diesel by using esterified Scum oil & Fried oil blended with the diesel fuel. In this work, up to 30% of the Scum oil & Fried oil has blended with diesel. Further, the experiment can be conducted by varying blending ratio & more blends of fuel can be brought under investigation. Other bio resources which is having good fuel characteristics can be investigated by adopting the same procedure.

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SYNOPSIS OF M.TECH SEMINAR PROJECTS

PERFORMANCE ENHANCEMENT OF FOUR STROKE CI ENGINE FUELED WITH DIESEL, WCO BIODIESEL AND ETHANOL BLENDS WITH INCLUSION OF NANO ADDITIVES

Project Reference No.: 41S_B_MTech_009

COLLEGE: N.M.A.M. INSTITUTE OF TECHNOLOGY, NITTE
BRANCH: DEPARTMENT OF MECHANICAL ENGINEERING
GUIDE: Dr. NARASIMHA K BAILKERI & Mr. SANTHOSHPOOJARY
STUDENTS: Mr. AVINASH KALLURAYA M.

Keywords: Waste cooking oil biodiesel, Ethanol, Nano Additives

INTRODUCTION: World economy is depends on the petroleum resources, which are non-renewable sources. These resources are depleting day by day. The increasing industrialization together with modernization of the world has led to a huge increase in the demand and subsequent consumption of the fuel. The transportation sector across the world entirely depends on the fuels which are derived from crude oil petroleum. The transportation industry contributes to twenty percent of carbon dioxide to the atmosphere. Hence in this scenario, immediate demand has been created to replace the fossil fuels by alternative fuels for automotive engines. Diesel engines are widely used in transportation sector because of higher thermal efficiency than gasoline engines. But these fossil fuels are very hazardous and emit pollutants. Hence there is an urge for renewable and environmental friendly alternative fuel. In this perspective a detailed literature review has been conducted and it has been found that very few researchers have focused on the influence of Nano additives with Ethanol and Biodiesel blends on the performance and emission characteristics of CI engines. The stability analysis of biodiesel, ethanol and diesel blends and performance testing of CI engine with these stable blends has been done by one of the researcher and this work has been taken as the prime reference for the present work.

OBJECTIVES: Biodiesel is the key solution for an alternative fuel, and also environmental pollution. Waste cooking oil (WCO), which is left after cooking food, is best feedstock for Biodiesel production through Transesterification. Also, Ethanol is blended to the biodiesel which will improve the efficiency. Nano additives are added to the fuel blends for further enhancement of the engine performance. Optimizing the combination of Diesel, Biodiesel, Ethanol and Nano additives to achieve improved engine performance and lower emission levels is the main objective of this project work.

METHODOLOGY: A VCR diesel engine is used in the experimentation to evaluate the engine performance with the available blends. The experiments have been conducted in a single cylinder, water cooled, constant speed, four stroke, variable compression ratio diesel engine test rig. Loading is done electrically by eddy current dynamometer which is connected to the engine. Necessary instruments and sensors are fitted to the engine to measure fuel consumption, injection pressure, exhaust gas temperature etc. Conducting an extensive experiment with Diesel, WCO Biodiesel and Ethanol blends with Nano additives (Aluminium oxide and Cerium Oxide) at different load conditions. In the first stage, the experiment have been conducted with neat diesel, then checking of the stability of different blends of diesel, WCO biodiesel and ethanol blends, experiments are repeated. In the second stage entire set of experiments have been repeated with addition of Nano particles. The dispersion of Aluminium oxide and Cerium oxide is done by the instrument called Sonicator, which works under the principle of ultra sound wave. The stability check has been carried out for different quantity of nano particles like 10,20,30 ppm. The performance parameters like Break thermal efficiency, Specific fuel consumption, and emission parameters like CO, UBHC, NOx, and Smoke opacity are to be compared with that of first set of experiments. Finally, an optimum combination of Diesel, WCO Biodiesel and Ethanol blends with Nano additives will be found with respect to improved engine performance and reduced emission level.

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SYNOPSIS OF M.SC. SEMINAR PROJECTS

BIO-CAPSULE FORMATION FOR BIOETHANOL PRODUCTION FROM AGROWASTE

Project Reference No.: 41S_B_MSC_004

COLLEGE: JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, BN ROAD, MYSURU
BRANCH: DEPARTMENT OF BIOCHEMISTRY
GUIDE: Dr. LATHA B. V.
STUDENTS: Ms. ACHALA P VASISHT
Ms. AMRUTHA S M
Mr. BHASKER V
Mr. GOWTHAM D K

Keywords used in the synopsis: Biocapsule, cellulolytic fungi, yeast, saccharification, fermentation, bioethanol

Introduction: Bioethanol has attracted worldwide attention because of its potential use as an alternative automotive fuel. Depletion and exhaustion of feedstock from natural and non-renewable sources lead for the search of sustainable, renewable, cheap, and environmentally friendly solutions to resource depletion. So there is a special interest in exploitation of the energy available in lignocellulosic biomasses to produce bioethanol by microbial fermentation by suitable process technology. Co-cultures of filamentous fungi and yeasts have received little attention, except in the case of rice wine fermentation and traditional fermented Asian foods. Natural and spontaneous co-immobilization of the yeast Saccharomyces cerevisiae and the filamentous fungus Aspergillus flavus and Penicillium chrysogenum without the need for an external support or a chemical binder to produce “biocapsule” of the fungus immobilizing the yeast can be achieved. The spontaneous co-immobilization was forced under appropriate conditions to obtain capsules with walls composed of mycelium and entrapping yeast cells, these walls enclosed an inner space partially occupied by yeast cells that are either free or associated to hyphae to form a cluster. In these cellulolytic enzymes excreted by the filamentous fungi hydrolyze the complex lignocellulosic substrate into simple sugars which can be assimilated by yeast for fermentation to produce bioethanol (simultaneous saccharification and fermentation). Biocapsule are known to be stable, can be reused and are resistant to infections. Pellet morphology greatly reduces the viscosity of the medium, which enhances mass transfer rates and also reduces costs for aeration, stirring and cooling in industrial processes.

Objectives
1. To formulate biocapsule pellet from cellulolytic fungi and Saccharomyces cerevisiae.
2. To study the efficiency of the immobilized and free cells towards hydrolysis of lignocellulosic biomass and bioethanol production.

To optimize the conditions favorable for biocapsule formation.

Methodology:

i. Isolation of cellulolytic fungi
Trichoderma, Rhizopus, Penicillium chrysogenum, Fusarium oxysporum having cellulolytic activity were isolated from soil and identified by morphological characteristics. Aspergillus flavus MTCC 10938 and Saccharomyces cerevisiae MTCC 170 were procured from IMTECH, Chandigarh.

ii. Bio-capsule formulation
Cellulolytic fungus and the yeast (Saccharomyces cerevisiae) were cocultured in primary Liaox media where glucose is replaced by xylose as carbon source and in Zhou media with glucose as carbon source separately for five days in shake flask with agitation rate of 140 rpm. The pellet formed were grown in secondary media containing sucrose and yeast nitrogen base for the growth of yeast for two days. To optimize the condition that favours the formation of biocapsule different agitation rates (100 rpm, 140 rpm and 160 rpm) and different types of media were carried out.

Shake flask co-culturing of fungi and yeast
iii. **Lignocellulosic hydrolysate**  
Mild acid hydrolysis of lignocellulosic agrowaste (corn cob, vegetable peel) was carried out. A dilute sulfuric acid hydrolysate of corn cob and vegetable peel with pH 1.8 was treated with calcium carbonate until the pH reached 5.5. A precipitate consisting mainly of calcium sulphate was then removed by centrifugation. The amount of reducing sugars present in the hydrolysate was estimated by phenol sulphuric acid method.

iv. **Saccharification and fermentation**  
The biocapsules that are formed was inoculated into the acid hydrolysed lignocellulosic agrowaste (serves as carbon source, whereas the media is supplemented with trace metal ions and salts). Simultaneous saccharification and fermentation was carried out for five days. Bioethanol formed was separated by distillation and estimated by potassium dichromate method.

**Results and Conclusions:**

- Pellet growth of fungus was achieved except for *Rhizopus* and *Fusarium*. Pelletization was more favourable in *Penicillium chrysogenum* and *Aspergillus flavus*. A simple medium containing calcium carbonate with xylose as carbon source was found to induce pelletization with very high reproducibility. The size of the biocapsules formed by *Aspergillus flavus* increased when grown in the secondary media.
- The possibility of immobilization of yeasts inside the fungal pellet was examined by compound microscope with lactophenol staining. The Liaox media is favourable for the formation of biocapsule than the Zhou and Yang media. Out of three agitation rates 140 rpm is favourable for the formation of pellet.

**Table 1: Morphology of the biocapsule formed by different fungi**

<table>
<thead>
<tr>
<th>Fungi</th>
<th>Pellet formation in Primary media</th>
<th>Diameter of the pellet in primary media (cm)</th>
<th>Diameter of the pellet in secondary media (cm)</th>
<th>Morphology of the pellet (biocapsule)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichoderma</td>
<td>Positive</td>
<td>&lt;0.5 cm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rhizopus</td>
<td>Negative</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Aspergillus flavus</td>
<td>Positive</td>
<td>&lt;0.5 cm</td>
<td>≥0.5 cm</td>
<td>Smooth cottony</td>
</tr>
<tr>
<td>Penicillium chrysogenum</td>
<td>Positive</td>
<td>&lt;0.5 cm</td>
<td>≥0.5 cm</td>
<td>Slightly hard</td>
</tr>
<tr>
<td>Fusarium</td>
<td>Negative</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
• The reducing sugar content of acid hydrolyzed corn cob and vegetable peel was found to be 34.3mg/g and 23.5mg/g respectively. The reducing sugar content was increased to 46.4mg/g and 37.3mg/g in corn cob and vegetable peel respectively when the acid hydrolysed samples were incubated with Aspergillus flavus and Penicillium chrysogenum. This indicates the cellulolytic activity of the fungus.

• Simultaneous saccharification and fermentation of acid hydrolysed agrowaste by biocapsule formed by Aspergillus niger yield 16% bioethanol in corn cob as carbon source and 10% bioethanol in vegetable peel as carbon source. Whereas biocapsule formed by Penicillium chrysogenum yield 8% bioethanol in corn cob as carbon source and 4.3% bioethanol in vegetable peel as carbon source.

• Since both saccharification and fermentation occurs simultaneously the total time is reduced and efficiency is increased.

Scope for future work: Industrially important fungi can be grown in the form of pellet which reduces the viscosity and enhances the mass transfer rates in the culture broth. The pellet can be easily harvested, recycled and its morphology directs it to specific metabolites. Considering the high practical significance of the yeast S.Cerevisiae, its potential use in a naturally auto-immobilised form opens new solutions for fermentation. The method not only provides a simple, convenient, inexpensive alternate technique which affords yeast reuse. Although further studies are required to confirm the results obtained, interaction effects between many factors influencing pelletization has to be carried out. The interaction between the fungi and the yeast has to be studied by different microscopic techniques.

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**STRAIN IMPROVEMENT OF PENICILLIUM SPECIES FOR THE HIGH YIELD PRODUCTION OF EXTRACELLULAR LIPASE**

**Project Reference No.: 41S_B_MSC_023**

**INTRODUCTION:** Lipases (triacylglycerol ester hydrolases, E.C. 3.1.1.3) are the extensive enzymes that are involved in hydrolysis of triglycerides into diglycerides, monoglycerides and fatty acids. These enzymes have emanated as one of the prominent biocatalysts with proven potential for contributing to the multibillion worldwide enzyme markets. Lipases...
are capable to catalyze various reactions such as esterification, transesterification reactions and resolutions of chiral substrates. Lipases finds lot of commercial applications in various industries such as in paper and agrochemical industry, in food Industry for flavour enhancement in cheese development, ester production in pharmaceuticals, cosmetics and in oil industry.

Lipases are reported from different sources like plants, animals, fungi, bacteria and yeast. Among these fungal lipases are of great concern for large scale production. These lipases are being used extensively due to their low cost of extraction, thermal and pH stability, group substrate specificity, and action in organic solvents. Species belonging to Aspergillus spp., Rhizopus spp., Mucor spp. and Penicillium spp. are considered to be good producer of commercially important enzymes. Using fungal species, oil cakes have been reported to be good substrate for economical enzyme production. In view of the above facts, there is a great urge to explore thermostable and alkali resistant lipases for various industrial uses. The proposed project aims to improvise the production of lipase from Penicillium species by inducing mutation in the organism, further purifying and characterizing the lipase enzyme.

**Objective**

- To induce mutation by using both physical and chemical mutagenic agent.
- To compare the lipase enzyme activity survival mutants and wild type *Penicillium* strain.
- To purify lipase obtained from high yield producing survival mutants and biochemical characterisation of purified lipase enzyme.
- To determine the molecular mass of purified enzyme.

**Methodology:**

**UV Irradiation:** The spores from the completely sporulated slant will be scrapped off into 5 ml of sterile water. The spore suspension will be serially diluted up to $10^{-5}$ dilution. A 0.1 ml quantity of spore suspension will be poured aseptically on the medium contained in Petri plates. The suspension was uniformly distributed using a sterile spreader. The spore suspension was exposed to UV light, will be carried out in lamina air flow. The exposure times will be 60, 120, 180, 240 and 300 s. each UV exposed spore suspension will be stored overnight to avoid photo reactivation. The plates were incubated for 5 days at 28°C and the numbers of colonies in each plate will be counted. Mutated strains will be screened for lipase production using rhodamine agar.

**Ethidium Bromide (ETBr) induced mutation:** The spores from the completely sporulated slants will be scrapped off in to 5 ml of sterile water. The spore suspension will be serially diluted up to $10^{-5}$ dilution. Diluted suspension was aliquoted into different test tube and treated with different concentration of ETBr for different time. At the end of incubation time 0.1 ml of ETBr treated spore suspension will be spread on plates. The plates were incubated for 5 days at 28°C and Mutated strains will be screened for lipase production using rhodamine agar.

**Conditions for submerged production of extracellular lipase:** A nutritive medium of a following composition (g dm-3): olive oil- 10, yeast extract- 5, peptone- 20, MgSO₄.7H₂O- 0.5, ZnSO₄.7H₂O- 0.4, FeSO₄.7H₂O- 1 and MnSO₄- 0.2, pH 7.0 will be used for the submerged lipase production. The nutritive medium will be sterilized at 121°C for 15 min. The cultivation will be carried out in 300 cm₃ Erlenmeyer flasks, containing 30 cm₃ nutritive medium on a rotary shaker at 220 rpm, 30°C for 120 h. The nutritive medium will be inoculated with 1% spore inoculum. After the cultivation, the fungal biomass will be separated through filtration and the cell free cultural broth was used as crude enzyme.

**Lipase assay:** The lipase activity was measured using modified titrimetric method as described by Borkar et al. [2]. The reaction mixture contains 10 ml of olive oil containing 1% (v/v) tween-80, 4ml of 0.1M sodium phosphate buffer (pH 7.0),500μL of 2% calcium chloride and 1ml of enzyme. The total contents were incubated at 37 °C in water bath for 20 mins with frequent shaking for every 5 min intervals. The Reaction was terminated by the addition of 20ml of acetone:ethanol mixture (1:1 v/v). The reaction mixture was titrated against 0.1N NaOH. The lipase activity was calculated using the following formula:

\[
\text{Lipase activity} = \frac{(\text{Test-Control}) \times \text{Normality of NaOH}}{\text{Incubation Time (min)}}.
\]

Blank samples will be run in the same way by adding acetone/ethanol solution before the addition of the crude enzyme sample.
**Unit Activity**: One unit of lipase activity was defined as the amount of enzyme liberating one Micro mole of fatty acid per minute under standard assay conditions.

**Partial purification**: The crude lipase obtained will be subjected to protein fractionation by 80% ammonium sulphate saturation. The pellet was collected by centrifuging at 10,000 rpm for 20 min at 4°C, dissolved in 50 mM phosphate buffer (pH -8.0) & dialysed against 10 Mm Tris-HCl buffer (pH-8.0) for 24 hours, with three changes of buffer. The dialyzed enzymatic fraction will be used for protein estimation and enzyme immobilization studies.

**Purification of enzyme**: Sepharose gel permeation column chromatography gel matrix will be allowed to swell in 0.1M sodium phosphate buffer pH 7.0 and then packed on to a glass column (30 X0.8cm).the gel matrix is equilibrated with 0.1M sodium phosphate buffer pH 7.0. The ammonium sulphate fractionated sample will be loaded to the column and protein will be eluted with buffer. Fractions of 2ml were collected and the absorbance in each fraction was measured at 280nm and also checked for enzyme activity

**Biochemical characterisation of enzyme**: Several enzyme kinetic parameters like Optimum pH, Optimum temperature, $K_{m}$ and $V_{max}$ will be accessed. Amino acid sequence analysis of purified enzyme will be carried out by LC-MS analysis.

**Molecular mass determination**: The column eluted fraction that exhibits the lipase activity will be subjected for SDS PAGE analysis along with standard protein markers to access the molecular mass of the lipase enzyme

**RESULT AND DISCUSSION:**

**SUB CULTURING**
The *Penicillium* species when further subculture on MRBA media & Rhodamine media. The fungal culture grown on rhodamine shows orange fluorescent zones around colonies

**MORPHOLOGICAL AND MICROSCOPIC EXAMINATION OF Penicillium SPECIES**
- Green colored fungal colony possessed a white border along its boundary.
- Based on the Manual of Soil Fungi identification by Gilman, under 40X magnification, as *Penicillium* species.

**INTRACELLULAR ND EXTRACELLULAR ACTIVITY OF Penicillium GROWN ON LIQUID MEDIA** The lipase activity was of penicillum grown on liquid media was found to be 1.2 and 0.6 IU/ml/min extracellularly and intracellular respectively
The spores were subjected to both physical and chemical mutation and the survival mutants will be screened for lipase production using rhodamine agar and further carry out biochemical assay of the enzyme.

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**BIOETHANOL PRODUCTION FROM AGRO WASTE (PIGEON PEA STALK) USING SOLID STATE FERMENTATION**

Project Reference No.: 41S_B_MSC_018

**COLLEGE**: DEPARTMENT OF BIOTECHNOLOGY, GULBARGA UNIVERSITY

**BRANCH**: DEPARTMENT OF BIOTECHNOLOGY

**GUIDE**: PROF. RAMESH LONDONKAR

**STUDENTS**: Ms. KIRTI

Ms. MEENAKSHI S C

**Introduction**: Due to rapid growth in population and industrialization, there is an increase in transportation facility worldwide as result ethanol demand is increasing continuously. Conventional crops such as corn and sugarcane are unable to meet the global demand of bioethanol production due to their primary value of food and feed. Agricultural wastes are cost effective, renewable and abundant. The aim of work is to produce bioethanol from stalks of Pigeon pea. In Karnataka, there is large amount of these agro waste produced every year and burned without any use. We can use as biomass for bioethanol production. Therefore, lignocellulosic substances such as agricultural wastes are attractive feedstocks for bioethanol production.

**Objective**

- Extraction of Reducing Sugar and xylo-oligosaccharide from agro waste (*Pigeon pea stalk*)
- Screening and isolation of yeast
- Bioethanol Production using solid state fermentation

1) **Extraction of Reducing Sugar and xylo-oligosaccharide from agro waste (*Pigeon pea stalk*)**

Pigeon pea was collected from Gulbarga district. The sample was sun dry, break into small pieces and converted into 2mm size. The collected waste was then subjected to preliminary treatment (Alkalination & Steam).

2). **Screening and isolation of yeast**

Isolation of yeast from specific source by Yeast grown on YPD (Yeast Peptone Dextrose) media @ 30deg C at PH 5.

3). **Bio ethanol Production using solid state fermentation**

The Fermentation reaction was carried out for maintaining standard condition, done optimisation to check whether yeast consume reducing sugar more or pentoses. The reaction is set for 30, 40 deg C at various PH (5,6,7) for 3 days. Prepare standard curve for ethanol and find out ethanol conc. after purification.

The reducing sugar and pentoses both can be used together for ethanol production. The obtained reducing sugar and pentoses sugar conc. were **1.025gm/500ml & 0.5gm/500ml**. This is only possible by using biological enzymatic pretreatment. The resultant substrate can used for making 2-3% ethanol.
The work is carried out by referring previous work done with some modification in methodologies.

Scope of Future Work: After by applying different pretreatment methods on agrowaste, we can utilize this wasted agrowaste for ethanol production. This is more ecofriendly because there is no food source used. The ethanol produced from this agrowaste is 2-3% in lab scale. Then go for pilot scale 4-5% and later for industrial scale 7-8% by treat with different pretreatment methods using solid state fermentation. This helps in increases the utilization of wastes for economic use and improves the biofuel production resources.

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**BIO-ETHANOL PRODUCTION FROM FINGER MILLET (RAGI) HUSK BY DIFFERENT PRETREATMENT METHODS, SIMULTANEOUS SACCHARIFICATION AND FERMENTATION**

Project Reference No.: 41S_B_MSC_016

**COLLEGE** : DEPARTMENT OF MICROBIOLOGY AND BIOTECHNOLOGY, BENGALURU UNIVERSITY  
**BRANCH** : DEPARTMENT OF BIOTECHNOLOGY  
**GUIDE** : Dr. S.T. GIRISHA & Mr. MANJUNATHA S. S.  
**STUDENTS** : Ms. HEMALATHA M.  
Ms. HARIKA K.  
Mr. KUNAL SARMAH

**Introduction:** Energy consumption has surged over the past century as the world population has rapidly increased. The depletion of fossil energy resources and concern over CO$_2$ emission have further shifted the global trend towards developing a new and consistent bio-based resources. Biofuel is a high priority alternative energy source because of rapid depletion of fossil fuel and other environmental issues. (Scheidel & Sorman, 2012). This instigated an attention to produce bio fuels from renewable resources, Ethanol productions from cellulosic materials offer a solution to some of the recent environmental, economic, and energy problems facing worldwide. Nationally, energy costs are on the rise and forecasts of petroleum supply disruptions are once again making news (Srivastava et al., 2014) Finger millet husk is a by-product derived at the time of harvesting of finger millet crop. Finger millet husk is the major agro waste in south India especially in Karnataka, which is cultivated around 7.0-8.0 lakh hectares per year. Which produce large amount of husk which is not used for any purpose at present except for using as a manure, as in many regions burning is the main practice. According to Umakantha (2007), Tumkur district covers an area of 175115 ha., followed by Bangalore Rural 146944 ha., Hassan 115582 ha., Kolar 100903 ha., and Mysore 79533 ha. The bioethanol production involves saccharification for breakdown of cellulose to monosaccharides and conversion to ethanol by the process of fermentation.

**Objectives:**
- Collection of samples from different district of Karnataka.
- Estimation of total sugar, reducing sugar,
- Applying different pretreatment methods.
- Production of bioethanol.
- Qualitative and quantitative analysis of bioethanol.

**Materials and methods:**

**Sample collection:** Finger millet husk collected from 4 different districts of Karnataka namely, Kolar, Bengaluru rural, Tumkur, Hassan. Samples were chopped, sieved, washed and dried, stored for the further use.

**Analysis of samples:** All the 4 samples were estimated for, Reducing sugar by DNS method (Miller, 1972), Total sugar by phenol H$_2$SO$_4$ method, Cellulose contents by Updegroff (1969) method.
**Organisms used:** The *Cellulomonas fumi* which is reported for the production of cellulase enzyme is procured from NCIM pune (NCIM 5015) cultured on LB media for the saccharification of husk. The yeast required for the fermentation is isolated from musk melon using YEPDA media.

**Saccharification and fermentation:** To evaluate the best pre-treatment methods different pretreatments was carried out (physical, chemical and enzymatic) according to Rawinder et al., (2017). Followed by simultaneous saccharification and fermentation was done according to Cassells et al., (2017). The raw and pretreated lignocellulosic feedstocks were analyzed using Fourier transform infrared spectroscopy (Kim et al., 2013)

**Qualitative and quantitative analysis of bioethanol:** Determination of ethanol content was done by spectrophotometric method (Caputi et al 1968). Quantitative analysis of bioethanol was done by GC (Mushimiyimana et al., 2016).

**Results:**

**Collected samples**

![Raw finger millet husk collected from Kolar, Bengaluru rural, Tumakur and Hassan districts.](image)

![Chopped, sieved, washed and dried finger millet husk.](image)

**Analysis of samples**

The reducing sugar was found to be highest in Tumakur sample (63.80 µg/ml), lowest in kolar sample (45.20 µg/ml). Total sugar content is maximum in Tumakur sample (19.60 µg/ml), minimum in Hassan sample (9.10µg/ml) and the cellulose content is more in Bengaluru rural sample (150.00 µg/ml), less in Tumakur sample (95.00 µg/ml).

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>sample</th>
<th>Reducing sugar (µg/ml)</th>
<th>Total sugar (µg/ml)</th>
<th>Cellulose (µg/ml)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Kolar</td>
<td>45.20</td>
<td>12.30</td>
<td>135.00</td>
</tr>
<tr>
<td>2</td>
<td>Bengaluru rural</td>
<td>47.30</td>
<td>17.20</td>
<td>150.00</td>
</tr>
<tr>
<td>3</td>
<td>Tumakur</td>
<td>63.80</td>
<td>19.60</td>
<td>95.00</td>
</tr>
<tr>
<td>4</td>
<td>Hassan</td>
<td>59.00</td>
<td>9.10</td>
<td>110.00</td>
</tr>
</tbody>
</table>

**FTIR analysis**

![Physical treated](image)

![Acid treated](image)
The FTIR analysis of the Finger millet husk (Tumakur sample) after Saccharification and filtration shows the Region of 1000 – 1200 cm⁻¹, which is commonly used to study the fine structural characteristics of cellulose. The spectra of regenerated cellulose from the ionic liquids and untreated ragi husk are presented.

GC analysis:

<table>
<thead>
<tr>
<th>Saccharification method</th>
<th>% of ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>physical</td>
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</tr>
<tr>
<td>acid</td>
<td>3.9</td>
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<tr>
<td>alkali</td>
<td>3.6</td>
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<tr>
<td>enzymatic</td>
<td>5.1</td>
</tr>
</tbody>
</table>

The GC analysis confirms that the amount of ethanol was highest in enzymatic treated sample (5.1%), followed by Acid treated (3.9 %), alkali treated (3.6 %) and physical treated (3.0%).

Outcome of the project: One of the largest agro waste in Karnataka is finger millet husk it can be utilized for the production of bioethanol. Pretreatment of finger millet husk will be a potential option for bioethanol production in the future. Pretreatment strategies help to increase the accessibility of enzymes to the cellulose to convert it into sugars, enzymatic pre-treated (*Cellulomonas fumi*) was the best suited method. The GC analysis confirms that the amount of ethanol was highest in enzymatic treated sample (5.1%), followed by Acid treated (3.9 %), alkali treated (3.6 %) and physical treated (3.0%). The result indicates that enzymatic treated is best suited for ethanol production. As in many regions burning is the main practice. If this huge amount of husk is used by industry as a raw material for bioethanol production it will be helpful.

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GENETIC VARIATION ANALYSIS OF MICROALGAL SPECIES UNDER NUTRIENT STRESS THROUGH MARKER ASSISTANCE FOR POTENTIAL BIOFUEL SOURCE

Project Reference No.: 41S_B_MSC_005

COLLEGE : INDIAN ACADEMY DEGREE COLLEGE-AUTONOMOUS, BENGALURU
BRANCH : DEPARTMENT OF BIOTECHNOLOGY
GUIDE : Dr. SIBI G & MR. SUDHAKAR MALLA
STUDENTS : Mr. SAYANTAN CHOUDHURY
            Mr. GOPAL KRISHNA MAJI
            Mr. PRASHANTH R
            Mr. SHOAIB HAMID

Background: Algae have long been recognized as a promising resource for biotechnological applications, such as a source of nutritional supplements like omega-3 fatty acids or carotenoids, or as a feedstock for biofuel generation. Although microalgal biofuels hold great promise, considerable challenges exist for their commercialization. Among the
research efforts required to make microalgal biofuels cost-effective and sustainable include optimizing culturing conditions for microalgal biomass and biofuel production. The composition of microalgal biomass (such as biofuel-related lipids and carbohydrates) varies with the environmental conditions. Nitrogen is critical for protein biosynthesis. However, under nitrogen-limiting conditions, most of the carbon fixed in photosynthesis is used to synthesize lipids or carbohydrates, instead of proteins. Nitrogen is considered to be the most important nutrient affecting lipid metabolism in microalgae. The patterns of genetic variation and population structure are very important to the ecology and evolution research, allowing greater understanding into the transmission of genes from generation to generation. Nile red is a lipid-soluble fluorescent dye employed for determination of lipid content in different groups of microorganisms.

**Objective**
- To identify the genetic variability among microalgal strains grown under nutrient stress for potential biofuel sources.

**Methodology**

**Isolation and Identification of Algae**

Algal blooms were collected from fresh water lakes in and around Bangalore by following the standard protocols.

<table>
<thead>
<tr>
<th>Sample point</th>
<th>Latitude/longitude coordinates</th>
</tr>
</thead>
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<tr>
<td>Bellandur lake</td>
<td>12°56'11.1&quot;N  77°40'04.2&quot;E</td>
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<tr>
<td>Benninganahalli lake</td>
<td>12°59'50.4&quot;N  77°39'55.6&quot;E</td>
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<td>Madiwala Lake</td>
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<td>Ulsoor lake</td>
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<tr>
<td>Sankey Tank</td>
<td>13°00'34.6&quot;N  77°34'26.7&quot;E</td>
</tr>
<tr>
<td>Hebbal Lake</td>
<td>13°02'50.3&quot;N  77°35'08.0&quot;E</td>
</tr>
</tbody>
</table>

**DNA extraction**: Microalgal cells were harvested from a culture by centrifugation and the total DNA was isolated using NucleoSpin® Microbial DNA Column. The quality of isolated DNA was evaluated on 1.0% agarose gel.

**Polymerase chain reaction**: Amplification of the 18S rDNA region was conducted in a PCR reaction mixture with forward primer NS1 (5'-GTAGTCATATGCTTGTCTC-3') and reverse primer NS4 (5' - CTTCCGTCAATTCTTTAAG - 3'). Forward and reverse DNA sequencing reaction of PCR amplicon was carried out with NS1 and NS4 primers using BDT v3.1 Cycle sequencing kit on ABI 3730xl Genetic Analyser.

**Sequencing**: The purified DNA was sequenced at Eurofins, Bangalore. Nucleotide sequences were determined by automated sequence analysis using a Perkin Elmer/ABI Prism 3130 four capillary based DNA sequencer (Perkin Elmer, Foster City, CA) and analysed using ABI Sequencing Analysis 5.3.1 software.

**Phylogenetic analysis**: The 18s rRNA sequences obtained were compared against sequences in the GenBank nucleotide collection through the Basic Local Alignment Search Tool (BLAST) available on the National Center for Biotechnology Information (NCBI) website (www.ncbi.nlm.nih.gov/).

**Nutrient Stress**: In order to determine the genetic variations that lead to lipid production by the microalgae, nutrient stress was selected. Two sets of experiments were carried out in which Bristol’s medium as a control and Bristol’s medium without nitrogen source was used for experiments.

**Specific Growth Rate**: Specific growth rate (µ) of the microalgae was calculated according to the following formula.

\[
\mu = \frac{\ln \left( \frac{N_t}{N_0} \right)}{T_t - T_0}
\]

Where, \(N_t\) and \(N_0\) are the dry cell weight concentration (g L\(^{-1}\)) at the end (\(T_t\)) and start (\(T_0\)) of log phase respectively.

**Biomass Concentration**: Biomass (g L\(^{-1}\)) of microalgae was determined by measuring the optical density of samples at 600 nm (OD\(_{600}\)) using UV-Vis spectrophotometer and the biomass yield was calculated from the following equation.

Biomass yield (g/l) = \((B_t - B_0) \times \text{Volume of culture}\)

Where \(B_t\) is the biomass concentration at the end of cultivation period (\(T_t\)) and \(B_0\) is the initial biomass concentration at the beginning of the cultivation period (\(T_0\)).
Total Lipid estimation: Lipid extraction from dried algal cells were carried out by chloroform:methanol extraction method (Folch et al., 1956). The total lipid content of dry weight was calculated using the following Equation.
Lipid content (%) = \(\frac{m_2 - m_0}{m_1} \times 100\)
Where \(m_1\) is the weight of the dried algal cells, \(m_0\) is the weight of the empty new screw cap tube and \(m_2\) is the weight of the new screw cap tube with the dried lipid.

Confocal microscopy: The distribution of intracellular neutral lipid bodies in microalgal stained cells was studied by confocal microscopy. After staining with Nile red, the slides were prepared using 10% glycerin (v/v) and observed under confocal microscope (Confocal Zeiss LSM880) equipped with Airyscan.

Results and Conclusion

The appearance of microalgae under microscope revealed that the major isolates belong to the genera *Chlorella, Oscillatoria, Anabaena, Cladophora, Chlorococcum* and *Oedogonium*. The amplification of 18S rRNA genes with the primers NS1 and NS4 resulted in 1300 bp fragments visualized in gel electrophoresis (Fig-1).

Fig-1: PCR product of the microalgal DNA

Nucleic acid sequences of the 18S rDNA genes were compared with those available in the GenBank database using NCBI/BLAST to search for related sequences. All of the determined sequences corresponded to known species with a high sequence similarity. According to BLAST analysis of corresponding sequences, it was indicated that microalgae strain was closely related to *Chlorococcopsis minuta* based on sequence similarities (Fig-2).

Fig-2: Dendrogram constructed by the Neighbor-joining method
The biomass yield and total lipid content was determined from wild (non-stress) and nutrient stress undergone (nitrogen limitation) Chlorococcopsis minuta to know the genetic variations. The results revealed that biomass content was higher in non-stressed microalgae (N+ media) with a yield of 12.1 g L⁻¹ whereas the total lipid content was 7.2% (Fig-3). In the case of microalgae grown in nutrient under stressed conditions (N- media), the biomass content was lower with the yield of 8.4 g L⁻¹ however there was a 62.5% increase in the total lipid content (11.7%). The genetic variations that lead to the production of neutral lipids were confirmed under the confocal microscopy where the higher amount of lipid droplets were observed in nutrient stressed microalgae (Fig-4). The findings suggest lipid productivity by microalgae under stress conditions could be used as a marker to determine the genetic variations and assist in selecting potential strains for biofuel production.

Fig-4: Lipid content of non-stressed and nutrient stressed microalgae under confocal microscope

Scope for Future Work: The scope for future research involves identification of nitrogen assimilation-associated genes and their expression under nutrient stress (nitrogen starvation) conditions. The findings would provide foundation for regulating microalgal lipid production through manipulation of the nitrogen assimilation-associated genes.

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ISOLATION AND CHARACTERIZATION OF KARANJIN FROM PONGAMIA SEED CAKE FOR INSECTICIDAL ACTIVITY

Project Reference No.: 41S_B_MSC_010

COLLEGE : MAHARANI LAKSHMI AMMANNI COLLEGE FOR WOMEN, BENGALURU
BRANCH : DEPARTMENT OF BIOTECHNOLOGY
GUIDE : Dr. BABITHA B. & DR. MEDHINI N.
STUDENTS : MS. CHAITALI CHANDRASHEKHAR PATHARE
           MS. SNEHAL SHIVAJI APKE
           MS. VALLARI DIVAKAR KAMATH
           MS. NIDHI UPADHYAY
ABSTRACT: *Pongamia pinnata* seed cake contains karanjin, a bioactive molecule with important biological activity. The present investigation was carried on isolation and characterization of Karanjin from *Pongamia* seed cake and determining the insecticidal activity against *Helicoverpa armigera*, cotton boll worm. The seed cake collected from GKVK was subjected to liquid-liquid extraction with methanol. The extract obtained was further characterized by TLC and confirmed by HPLC method. Different concentrations of karanjin extract 1%, 0.5%, 0.1%, 0.05% were subjected to insecticidal activity against third instar larvae of *Helicoverpa armigera*. The mortality count i.e., Lethal Concentration of 50% larval mortality (LC 50) was determined.

INTRODUCTION: *Pongamia pinnata* popularly known as Karanj, is a medium sized glabrous avenue tree grown in all parts of India, particularly in Tamil Nadu, Andhra Pradesh and Karnataka. The seed contains 27-39% oil, 20–30% protein and a group of furano-flavonoids that constitutes 5-6% by weight of the oil. The seeds contain on average 28-30% oil. The cake is bitter and pungent in taste, is used as manure, fungicide and insecticide. The seed cake contains a number of toxic and unpalatable components, including the furan flavones- karanjin and pongamol, and other polyphenolic compounds and a unique aminoacid glabrin. Owing to toxic characteristics of Karanjin, insecticidal activity can be studied. The present work was carried on testing the insecticidal activity of Karanjin on *Helicoverpa armigera*, a cotton boll worm whose larvae feeds on wide range of cultivated crops.

OBJECTIVES

- Extraction, isolation and characterization of the active component, Karanjin from *Pongamia* seed cake.
- Efficacy of Karanjin tested at different concentrations against cotton bollworm, *Helicoverpa armigera*.
- Determination of Mortality Count by analysing Lethal concentration of 50 % larval mortality (LC50).

METHODOLOGY

- Collection of Pongamia seed cake from Biofuel Information & Demonstration center (BIDC), GKVK, Bengaluru.
- 25g of Pongamia seed cake dried properly and grinded into a fine powder.
- Powder was transferred into a thimble and extracted for 12 hrs using freshly distilled 200ml methanol by soxhalation method.
- Extract was concentrated using Rota-Evaporator.

Isolation and characterization of Karanjin:

- The concentrate was further purified by preparative TLC on silica gel using Toluene:Ethyl acetate (7:3) solvent.
- HPLC was performed at 300 nm using methanol:water (80:20) solvent mixture with flow rate 1ml/min.

Biological Assay:

- Concentrations of the test sample were prepared as 1%, 0.5%, 0.1%, and 0.05 %.
- Synthetic diet was prepared as per Nagarkatti and Prakash.
- For insecticidal studies, *H.armigera* larvae (3rd instar) were subjected to 1 ml of each concentration of the extract by spraying and larvae were allowed to feed on diet. Untreated controls were maintained simultaneously. The vials were kept at 27°C.
- Mortality count after 24 hrs was noted. Lethal concentration of 50 % larval mortality (LC50), for each sample was calculated.

RESULT: Successful extraction of karanjin was achieved by liquid-liquid extraction with methanol. The extract obtained was further purified by TLC and confirmed by HPLC with standard karanjin. The insect larvae of 3rd instar was successfully reared by feeding with synthetic diet. The biological assay for toxicity studies on *Helicoverpa* larvae was determined and the expected results were estimated for LC50.

CONCLUSION: The protocol developed in the present study deals with a simple and efficient method for isolation of Karanjin from *Pongamia* seed cake. The insecticidal activity of Karanjin against *Helicoverpa* larvae showed that Karanjin is a potent bioinsecticide. Further studies are required to standardize the protocol with different stages of *Helicoverpa* larvae and establish them as a broad spectrum bioinsecticide. Hence, Karanjin can serve as a major means to control this pest.

~*~*~*~
EFFECTIVE COMPOSTING OF BIOWASTE AND PONGAMIA PINNATA CAKE USING TRICHODERMA

Project Reference No.: 41S_B_MSC_015

COLLEGE: SAHYADRI SCIENCE COLLEGE, SHIVAMOGGA
BRANCH: DEPARTMENT OF BIOTECHNOLOGY
GUIDE: Dr. L.K. SREEPATHI & Dr. B.T. PRABHAKAR
STUDENTS: Mr. VARUN M.
           Mr. RAKESH M. H.

OBJECTIVES
1) To prepare vermicompost using biowaste (kitchen waste, food waste, green waste etc)
2) To assess the effect of seed cake of Pongamia pinnata plant seeds on vermiculture.
3) To study the seed cake vermicompost chemical properties.
4) To evaluate the vermicompost on growth of finger millet and T.harzianum

MATERIALS AND METHOD
Collection of Materials: Kitchen waste was used with garden waste containing leaves were collected form the Jawaharlal Nehru National College of Engineering (JNNCE) campus, Shivamogga. Kitchen waste like vegetables peel, fruit peel from the college hostel, about 5 kg of waste collected and stored in a polythene bag. leaf waste such as dry leaves, wet leaves were collected from the campus trees. dry leaves collected approximately 3kg and stored in polythene bags. Wet leaves also collected approximately 3kg and it is also stored in polythene bags paper waste collected approximately 1kg from Biodeisel department, JNNCE and stored in polythene bags(June, 2017).
Earthworms were procured from JNNCE, Shivamogga.
Pre-decompostion: Plastic bins of 50x30x14 cm were filled with kitchen waste, garden waste, and shredded paper in an appropriate amount as shown in Table 1 and manure composition kept for pre-decomposition for 18 days These wastes are weighed for 1kg and 100 grams of earthworms (Eisenia fetida) were inoculated.
Composting: Holes were made at the bottom of the plastic bins and bedding was made using soil. The bedding surface was layered with kitchen waste on which 100grams of earthworms were inoculated followed by leaf waste, paper waste, and gunny bag on top.
Visualized the moisture content of the bin (50%-60%) by sprinkling the water at regular intervals of time. After that every 4-5 days vermicompost was collected from the top of the bin and sieved it by using the wire mesh and stored in a polythene bag.
Analysis of compost: After 35 days when compost was formed, the vermiculture efficiency was analysed by counting a number of worms in each bin after compost formation.
The chemical analysis Nitrogen, Phosphorous, Potassium, Sulphur and Sodium was done. Nitrogen estimation was done by auto-analyser. All micronutrients estimation was done by atomic absorption and titration method. The estimation was done by SLN BIOTECH, Dharwad. Among six tested composts, compost sample-3 has shown highest percentage of NPK, and hence considered for further experiment.
Preparation Seed cake of Pongamia pinnata seeds: The seeds of Pongamia pinnata were collected from the rural areas of shimoga district (December, 2017). And then seeds were stored in gunny bag, after that the seeds were blended using expellers. After blending two products were obtained, one was pongamia oil and another product was Pongamia pinnata seeds chips. The pongamia oil was utilized to manufacturing of bio diesel and pongamia chips were further blended on expellers which converted as Pongamia seed cake.
Addition of Pongamia seed cake to compost and study of earthworm servivalence: The pongamia cake was added in a different concentration to the compost in a different range of 10, 20, 30, 40, 50% and then anti-helminthic activity of pongamia cake was carried out.
100 grams of compost was taken in 6 plastic cups (150ml). 1st cup contains 90 grams of compost and 10 grams of pongamia cake. 2nd cup contains 80 grams of compost and 20 grams pongamia cake. 3rd cup contains 70 grams of pongamia cake.
compost and 30 grams of pongamia cake. 4th cup contains 60 grams of compost and 40 grams of pongamia cake. 5th cup contains 50 grams of compost and 50 grams of pongamia cake. 6th cup contains 95 grams of compost and 5 grams of pongamia cake. After that 6 to 7 earth worms were introduced to each cup and earthworm servivalene. According to the result of earthworm servialience 6th sample was considered for the further experiment and the chemical analysis of the 6th sample by SLN BIOTECH, Dharwad

Plant growth analysis: Fingler millet (Ragi) plant growth analysis was done by analysing the plant height, root length and shoot length statistically. 3 plastic trays were taken and added soil to it. The soil was around 3/4th level of the tray. Moisture content of the soil was maintained around 30-40%. For each tray added 50 seeds of Ragi, then added compost to each tray. For 1st tray added only compost, for 2nd tray added compost with 5% pongamia pinnata seed cake, for 3rd tray added commercially available compost. For all the trays daily sprinkling the water. After one and half month estimate the ragi plant height and length of the root, shoot.

Effect of compost on growth of Trichoderma harzianum: Analysis of enhancement of Trichoderma harzianum growth by using 5% seed cake mixed compost was carried out. Five autoclavable polypropylene bags were taken and filled with 100 grams of 5% seed cake mixed compost to each bag and another five bags were filled only compost(100grams) without Pongamia cake as control. The bags were allowed to cool down to room temperature prior to inoculation. 2.5 mL of spore suspension, prepared by harvesting the spores from 1 week old culture of T. harzianum in sterile distilled water (10^8– 10^10/mL spore concentration), was injected into the autoclaved bags. The pore in the bag was sealed with sterile cellophane tape and incubated at room temperature (25–30 °C). After 15 days of growth, the colonized composts were dried at 35 °C and ground to powder using a laboratory blender.

Calculation of colony forming units
The estimation of colony forming units (cfu) of T. harzianum in different formulations was done by suspending 1g of dried product prepared on compost by serially diluting the powder and finally plated on fresh Trichoderma selected medium (Elad et al., 1981). The plates were incubated at 25 to 27 °C. There were three replicates for each plate. The population counts of T. harzianum in composts were repeated at every 30 days interval and continued up to 60 days. During storage period, the powdered formulations were stored in sealed polythene bags at room temperature (25–30 °C).

RESULTS AND DISCUSSION:

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Treatment</th>
<th>Concentration in grams</th>
<th>Time taken for death (in Min.)</th>
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<tbody>
<tr>
<td>1</td>
<td>Control (albendazol)</td>
<td>10</td>
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</tr>
<tr>
<td>2</td>
<td>P. pinnata seedcake in compost</td>
<td>10</td>
<td>25.26</td>
</tr>
<tr>
<td>3</td>
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<td>20</td>
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<table>
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<th>Sl.No</th>
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<th>Concentration in grams</th>
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</tbody>
</table>
The earthworms improve the fertility of soil in different ways and, therefore, they are of utmost importance in agriculture. Actually, the burrowing and soil feeding habits of earthworms make the soil porous which permit both aeration and quick absorption of water. It also permits easy and deep penetration of the plant roots. They also reduce the alkalinity and acidity of the soil to provide better conditions for plant growth. After their death and decomposition, they increase the organic constituents of the soil. Thus, the earthworms make the soil fertile to a great extent. Thus, these

**Plant growth analysis**

During plant growth analysis it was observed that there was a better growth in the 5% seedcake plants than in the only compost plants. However, results also showed that chemical fertilizers induced the plant growth significantly compared to compost with 5% seed cake. Worms are also known as natural ploughmen or tillers of the soil. (Howard, A. et al, 1940).

**Enhancement of macro and micronutrients of compost by adding different amount of seed cake:**

According to the 5% seed cake is suitable for the activity of earthworms so it was mixed with compost and again tested for macro and micronutrients. Results of chemical analysis were showed in the Table 4.3.

**Chemical analysis of compost mixed with 5% seed cake of P. pinnata seeds.**

<table>
<thead>
<tr>
<th>N %</th>
<th>P %</th>
<th>K %</th>
<th>S %</th>
<th>Na %</th>
<th>Ca %</th>
<th>Mg %</th>
<th>Zn ppm</th>
<th>Fe ppm</th>
<th>Mn ppm</th>
<th>Cu ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.32</td>
<td>0.0791</td>
<td>0.275</td>
<td>0.054</td>
<td>0.09</td>
<td>2.625</td>
<td>1.44</td>
<td>45.83</td>
<td>6143.2</td>
<td>681.9</td>
<td>3.0125</td>
</tr>
</tbody>
</table>

Results clearly indicates that there is significant improvement in the macro and micronutrients concentration. There is a large number of elements in nature out of which sixteen are important for the proper growth and development of crop plants. Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Potash, Calcium, Magnesium and Sulfur are called macro or major nutrients and required in comparatively large amounts. Iron, Copper, Zinc, Boron, Molybdenum, Manganese and Chloride are the micro or minor nutrients which required in smaller quantities for vegetative and reproductive growth of crop plants. C, H and O contribute the 85-90% of the total plant content. N gives dark-green colour to crop plants and it increases the vegetative growth of crop plants. It is most important for preparation of starch in leaves and production of amino acids. P is the constituent of certain nucleic acids, phosphatides, chromosomes and coenzymes.

During plant growth analysis it was observed that there was a better growth in the 5% seedcake plants than in the only compost plants. However, results also showed that chemical fertilizers induced the plant growth significantly compared to compost with 5% seed cake.
Effect of compost on growth of *T. harzianum*: The effect of compost with 5% seed cake on the growth of *T. harzianum* is presented in Table 4.5. Evidently the population density after 60 days was highest (23x10^6 cfu/g) and lowest on 15th day (11 x10^6 cfu/g). Results are on par with the compost without seed cake.

**Growth of *T. harzianum* on Table 4.5: Effect of**

The antagonistic fungus *Trichoderma harzianum* is widely recognized as a potential biocontrol agent against several soilborne plant pathogens. *Trichoderma* is a very effective biological mean for plant disease management especially the soil born. It is a free-living fungus which is common in soil and root ecosystems. It is highly interactive in root, soil and foliar environments. It reduces growth, survival or infections caused by pathogens by different mechanisms like competition, antibiosis, mycoparasitism, hyphal interactions, and enzyme secretion.

**CONCLUSION:** We here by conclude that *Pongamia* cake mixed compost is a very effective compost in terms of nutrients quality and also in growth parameters tested in field trials. It is a eco-friendly compost and increases the fertility of the soil. It does not cause any harmful effect on environment in case any over use.

<table>
<thead>
<tr>
<th>Colony forming units (cfu)</th>
<th>Days</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost with 5% Seed cake</td>
<td>11x10^6 cfu/g</td>
<td>16x10^6 cfu/g</td>
<td>19 x10^6 cfu/g</td>
<td>23x 10^6 cfu/g</td>
<td></td>
</tr>
<tr>
<td>Compost without seed cake</td>
<td>10 x10^6 cfu/g</td>
<td>12 x10^6 cfu/g</td>
<td>13 x10^6 cfu/g</td>
<td>12 x10^6 cfu/g</td>
<td></td>
</tr>
</tbody>
</table>

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**EFFICACY OF PONGAMIA OIL BASED SOAP AGAINST CONVENTIONAL SOAPS WITH RESPECT TO ANTIBACTERIAL ACTIVITY TO ENCOURAGE HYGIENE PRACTICE AMONG RURAL FOLK**

Project Reference No.: 41S_B_MSC_017

**COLLEGE**: DEPARTMENT OF MICROBIOLOGY, DAVANGERE UNIVERSITY
**BRANCH**: DEPARTMENT OF LIFE SCIENCES
**GUIDE**: PROF. GAYATHRI DEVARAJA
**STUDENTS**: Mr. SANDEEPA E.
Mr. JAVALI UMESH
Mr. SUNIL KS

**INTRODUCTION**: *Pongamia pinnata* is a fast-growing leguminous tree with potential for high oil seed production and the added benefit of the ability to grow on marginal lands. More recently, the effectiveness of *P. pinnata* as a source of biomedicines has been reported, specifically as both an antimicrobial agent and therapeutic agent targeting specifically bringing about microbial growth inhibition. *Pongamia pinnata* used for anti-inflammatory, anti-oxidant, anti- diarrhoeal, anti-ulcer, antibacterial. Its oil is a source of biodiesel. It has also alternative source of energy, which is renewable, safe and non-pollutant. The Pongamia oil-based soaps are used to kill or inhibit the pathogenic organisms present on human hand. Pongamia oil-based soaps like, 5% glycerol containing Pongamia oil-based soap, 90% glycerol containing Pongamia oil-based soap, chirantana soap have been used in the present study.

**OBJECTIVES:**
1. Isolation of bacteria from hands before soap water treatment on random basis among rural folk.
3. Optimization of pongamia oil (time and concentration) based soap to use as disinfectant.
METHODOLOGY:
Sample Collection: Sterile cotton wool swabs were soaked in 0.85% physiological saline solution was used to collect sample from human subjects (from Tholahunse, Kurki villages, near Davangere University).
Isolation of bacteria: The collected sample were spread plated on different selective culture media including, MacConkey agar, EMB agar, Bismuth sulphate agar incubated at 37 °C for 24 to 48 hours. And isolated colonies were then identified by microscopic view, Gram staining and various biochemical tests. The isolated colonies were streaked on nutrient agar slants and pure culture was maintained.
Antibacterial bacterial activity against selected pathogens: A total of three potential human pathogenic bacterial strains capable of transmitting infection through hand to mouth route like E.coli, Staphylococcus aureus, Salmonella, were isolated on selective medium from hand wash treatment.

Well diffusion assay: This method is employed to observe whether the bacteria are inhibited by the particular concentration of soap, or not. By using this method we can find out the least inhibitory concentration of soap for particular bacteria.
Testing the anti-microbial activity of various concentration of different soaps against bacterial culture.
To determine the antimicrobial activity of the pongamia oil based soap against potential bacterial isolates (E. coli, Salmonella, Staphylococcus aureus) were incubated in nutrient broth at 37°C for 24 hours. The Mueller Hinton Agar medium was prepared and autoclaved (121°C/15 min), then poured onto sterile petri plates allowed to solidify. The agar plates were inoculated by spread plate method with 0.1ml of 24 hour broth culture of pathogenic bacteria (bacterial cultures like E.coli, Staphylococcus aureus, Salmonella). In each plates atleast 4 wells with diameter of 6 to 8 mm wells made using sterile cork borer were dug, a volume 100µL of each soap solutions at desired concentration was introduced into each wells. And plates incubated at 37°C for 24 hours and the results were observed in diameter of the zone of inhibition was measured in millimetre.

Turbidity Analysis: This method is based upon comparison of intensity of light scattered by the sample under defined conditions with the intensity of light scattered by the solution. The higher intensity of scattered light, higher is the turbidity. Nutrient broth was prepared and 9 ml of broth was pipetted out into each test tube then inoculated each tube with 100µL of inoculum like E.coli, S. aureus, Salmonella, and incubated at 37°C for 24 hours. After incubation various concentration of different soaps (50 mg, 100 mg, 150 mg) were added, immediately incubated the all test tubes and time interval of 5 min, 10 min, 15 min, optical density (OD) at 590nm readings were recorded and results were tabulated (Bhat et al., 2011).

RESULTS AND DISCUSSION: A total of three human pathogenic bacteria isolated from different human subjects by hand wash method, using selective media like EMB agar, Bismuth sulphate agar, MacConkey agar, and Nutrient agar.
Antibacterial activity against the isolated pathogens: The effect of soap on growth of different species of bacteria was measured by presence/ absence of clear inhibition zones by using well diffusion method. For each bacterium it was varied and the zone of inhibition was greater at maximum concentration while it was minimum at lower concentration. E.coli and Salmonella showed no clear zone formation but 90% glycerol containing pongamia soap shows the inhibition compared to the other soaps. Staphylococcus aureus was shown to be inhibited by all soaps, showing maximum zone of inhibition.

Turbidity analysis method: The growth of pathogenic bacterial isolates in the broth medium with varied concentrations of soaps was determined by turbidity analysis method and optical density was showed variation. The minimum turbidity was recorded in pongamia based oil soaps and maximum turbidity was recorded in conventional soaps. In all tested bacteria maximum optical density was recorded at lower concentration of soaps and except few where the minimum value was recorded at high concentration of soaps.
The antimicrobial activity of some soaps and found that as the concentration of soap increases the intensity of inhibition of bacterial growth also increase. The minimum inhibitory concentration of soaps (90% glycerol containing pongamia oil based soap) for Salmonella and E.coli are 50mg, 100mg, and 150 mg respectively. The pongamia oil based soap and 90% glycerol containing pongamia oil based soap have good antibacterial activity to against some pathogenic organisms such as multi drug resistant pathogens such as Staphylococcus aureus. It has been proved by our experimental study, that the antibacterial soaps kill the bacteria at a specific concentration; they also have bacteriostatic activity and can inhibit the growth of the bacteria. This study suggests that selection of soaps should depend on to the working environment. The soap should have good ingredients which have the ability to kill bacteria but not to damage body tissues. Health care workers should use soaps according to criteria of Health and Hygiene. In this way many immuno-compromised or low immunity patients can be protected from transfer of pathogenic or opportunistic pathogens. This area of research requires attention of scientists and people from soap industry, because quality of
soaps is very important as they are the need of every home. Pongamia oil based soap used for antibacterial activity study has shown 80% of reduction of microbiota when compared initial microbial load when examined at field study and followed by survey. This will give a clear indication to promote Pongamia cultivation and along with primary biofuel production, production of soaps makes the effort of sustainable development of technology and popularisation of pongamia based soap.

Outcome of the project:
➢ Spread of awareness to control possible disease-causing bacteria, particularly of own intestinal origin since hand to mouth microbial transmission could prevent 80% of disease transmission.
➢ Encouragement to rural folk to grow more pongamia trees for biofuel production, pongamia oil production and preparation of soaps and use them effectively.

Applications of the project
➢ Health: Maintenance of personal hygiene avoids number of infectious disease
➢ Agriculture: Encouragement to grow pongamia trees for water conservation and biofuel / oil / soap production.
➢ Societal: Particularly to women folk, encouragement to become self-employed.

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EFFECT OF TRANSPIRATION ON BIOFUEL PRODUCTION AND EVALUATE THE RATE OF CARBON SEQUESTRATION IN ORYZA SATIVA L. WITH ANABAENA

Project Reference No.: 41S_B_MSC_011

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BRANCH : DEPARTMENT OF LIFE SCIENCES
GUIDE : Dr. MADHU MALLESHAPPA
STUDENTS : Ms. ASHWINI GOVEKAR
            Mr. LOVKESH SHARMA

Scope / Objectives of the project:
1. To understand transpiration phenomenon in Oryza sativa L. (Rice), known biofuel producing plants.
2. To let plants adapt at various environmental conditions.
3. To allow a symbiotic relationship between said plant (in optimum environmental condition) and an algae to trap carbon dioxide.

Methodology:
• Potometer
• Cobalt chloride paper
• Absorb-transpirometer to find T/A (transpiration and absorption ratio)

Measuring transpiration rate in varying parameters of:
• pH, Temperature, Salt concentration.

Formation of symbiotic association between Oryza sativa L. and Anabaena
Anabaena was isolated obtaining samples from Rice field on BG-11 Medium.

Carbon sequestration: By using 30 KV JEOL JSM6060LV scanning electron microscope coupled with an Oxford Instruments ISIS energy-dispersive X-ray spectroscopy microanalysis system (SEM-EDX).-pending
**Observation/Results:**
Rice plants were adapted to adverse conditions.
Understanding how transpiration affects biofuel production.
At optimum temperature, they form symbiotic relationship with supplied Anabena to trap carbon dioxide.

**Application of the Project:**
1. **Industry:** It is economical, as unnecessary amount of water wastage is saved.
2. **Health:** Helps in the management of Respiratory diseases.
   We can avoid harmful gases emitted by synthetic fuels.
3. **Agriculture:** Once, we identify how to decrease transpiration, the need to use huge amount of water during biofuel production will decrease. Thus, it will be economical.
4. **Disaster Management:** Management of Pollution using Biofuels.
5. **Societal:** This is one initiative to save on the water consumption during biofuel production.

**Education / Academics:** Awareness about Biofuels, their contribution in the field of health, industry, Disaster management and minimal usage of fossil fuels.

**Conclusion:**
- Transpiration rate in rice plant was calculated and it was 0.5 H2O M²s⁻¹
- Complete transpiration rate using Cobalt chloride 17.5 minutes
- The plant was adapted in a way that it can survive in harsh conditions without altering its transpiration rate.
- This would help decrease water usage and save water.
- Transpiration affects biofuel production.
- At optimum temperature, they form symbiotic relationship with supplied Anabena to trap carbon dioxide.
BIOETHANOL PRODUCTION PROCESS OPTIMIZATION FROM CITRUS SPS SEED OIL AND ITS CHARACTERIZATION

Project Reference No.: 41S_B_MSC_024

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BRANCH: DEPARTMENT OF LIFE SCIENCES
GUIDE: Dr. SHARANGOUDA J. PATIL & Dr. SADASHIV S.O.
STUDENTS: Ms. PUJA KUMARI
Ms. ARNABI MUKHERJEE
Ms. TEJESHWANI P.

Introduction: Ethanol is an alternative fuel derived from biologically renewable resources. Society has been searching for better sources of sustainable energy for many years. Because of limited access to petroleum-based fuels, rising of fossil fuel costs and its consequences on emission of greenhouse gases, the struggle to maintain a green planet has become more challenging over time. In recent years, energy consumption and global carbon intensity have increased worldwide, reinvigorating worries about potential depletion of fossil fuel. Demand of the energy increases with the increase of the world population and urbanization and thus, development of bioenergy as an alternative energy might help to reduce these problems. Bioenergy can be defined as energy obtained from Biomass, which is the biodegradable fraction of products, waste and residues from agriculture like vegetables and animal origin, forestry and related industries and also, from the biodegradable fraction of industrial and municipal waste. Different forms of bioenergy can be produced from a wide range of biomass sources, for example, agricultural residues. Many researchers have produced the biodiesel from nonedible oil, which include Jatropha (Jatropha curcas) oil, Karanja or Honge (Pongamia pinnata/glabra) seed oil, Polanga (Calophyllum inophyllum) seed oil, rubber (Hevea brasiliensis) seed oil, mahua (Madhuca indica) oil, tobacco (Nicotiana tabacum) seed oil, bitter almond (Prunus dulcis) oil, castor (Ricinus communis) seed oil, okra (Hibiscus esculentus) seed oil, Kusum (Schleichera trijuga) oil, Simarouba (Simarouba glauca), milo (Thespesia populnea) seed oil, milk thistle (Silybum marianum) seed oil, Sugar apple (Annona squamosa) seed oil and wild safflower (Carthamus oxyacantha Bieb) seed oil. In the production process of biodiesel, the effects of process parameters such as alcohol to oil molar ratio, catalyst concentration, reaction time, and reaction temperature have been studied and optimized. The fuel properties of produced biodiesel have been investigated and compared with the standard specifications for assessing their feasibility to substitute the petroleum fuels. However there are many other nonedible oils for which process parameters are not being optimized. One among them is Citrus Sps seed oil.

Objectives
To evaluate the bioethanol properties of Citrus sps seed oil extract.
To elucidate and purify the Citrus sps seed oil extract by chromatography.
To determine the Fatty Acid Composition of Citrus sps seed oil.
To characterization of produced bioethanol of Citrus sps seed oil extract.
To evaluate the purity of produced bioethanol compound of Citrus sps seed oil extract.

Methodology:
Collection of Citrus sps seeds: The Citrus sps seeds were collected from various locations of juice centers and households from Bangalore as an agrowaste, shade dried and further subjected to solvent extraction.
Oil Extraction: The collected seeds were dried and crushed in a mechanical expeller. For complete extraction of oil, the seeds were passed four times through the expeller. The pure oil is allowed to settle for 48 hours and after that oil is stored in an airtight container to avoid oxidation.
Fatty Acid Composition of Citrus sps Seed Oil: The vegetable oil extracted from a plant is composed of triglyceride, which is an ester derived from three fatty acids and one glycerol.
The transesterification reaction was carried out in a laboratory scale batch reactor equipped with thermometer and condenser; the heating and stirring were done with a hot plate magnetic stirrer system. In each set of experiment 50 g of oil was heated to the predefined temperature and after attainment of predefined temperature the mixture of catalyst and methanol was transferred to reactor and all the predefined sets of transesterification reaction conditions were measured from this point for each set of experiment. Stoichiometrically 3 : 1 molar ratio of alcohol to oil is needed for completion of transesterification reaction, but many researchers reported that biodiesel yield is maximum with excess molar ratio of alcohol to oil. Hence in the present investigation, in each set of experiment, 6 : 1 molar ratio of alcohol to oil and constant stirrer speed were maintained.

After the completion of predefined set of transesterification reaction conditions, the reaction mixture was transferred into a separating funnel left for 60 minutes to separate into biodiesel and glycerol. The lower layer of glycerol was removed and the upper layer of crude biodiesel is washed several times with hot water at 50°C to remove the impurities, such as residual catalyst, methanol, soap, and glycerol. The removal of impurities was confirmed by measuring the pH of water. The biodiesel was dried by heating it to a temperature of 110°C and allowed overnight for evaporation and cooling. The final product was weighed to determine the biodiesel yield.

Analytical and Test Methods: The mean molecular weight, saponification number (SN), iodine value (IV), and cetane number (CN) was determined from the fatty acid composition of oil.

The fuel properties of Citrus sps seed oil (CSSO) and Citrus sps seed biodiesel (CSSBD) was determined as per the ASTM standards.

Outcome of the project: The yield of the oil extracted from three different solvent system, found potent only in petroleum ether (45ml/100gm) compared to ethanol (15ml/100gm) and methanol (35ml/100gm) extraction and also in colour and consistency of the oil.

Further oil of petroleum ether extract of Citrus Sps seeds were used for analytical analytical and spectroscopic study. The crude oil assessed to know their fatty acid composition by GCMS analysis and found very promising components to represent as biodiesel properties.

The oil produced was refined through degumming, neutralization and bleaching process using local adsorbent (activated clay). The characterization analysis revealed that tested parameters, which include specific gravity, refractive index, acid value, saponification value and iodine value for both crude and refined Citrus Sps seed oil produced, were within the ASTM standard specifications. In fact the iodine value obtained (73.3) for the refined oil indicates that the oil could certainly be used as bioethanol, and depending upon viscosity can also used as lubricant, hydraulic break fluid and protecting coatings for machineries.

The Citrus Sps seed oil was converted into biodiesel successfully by transesterification process.

(1) The Citrus Sps seed oil was converted in to as biodiesel by single stage base-catalyzed transesterification process without any pretreatment as the FFA content is may found to be less than 1%.

(2) The optimized process parameters are catalyst concentration of 0.5 w/w %, reaction time of 75 minutes and reaction temperature of 60°C with alcohol to oil molar ratio of 6 : 1, and constant stirrer speed.

(3) The physical and chemical properties of biodiesel produced was found to be close to those of diesel fuel and also they meet the ASTM standard specifications for biodiesel.

The process parameters such as catalyst concentration, reaction time, and reaction temperature were optimized for the production of citrus seed biodiesel (CSBD). The biodiesel yield of 90.05% was noticed at optimal process parameters. The fuel properties of biodiesel produced were found to be close to that of diesel fuel and also they meet the specifications of ASTM standards.

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PRODUCTION OF BIOETHANOL FROM AGRO WASTES

Project Reference No.: 41S_B_MSC_019

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BRANCH: DEPARTMENT OF MICROBIOLOGY
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STUDENTS: Mr. SIDDESH H. M.
          Mr. DANISH N NALBAND and Ms. KAVYA D. C.

KEYWORDS: Sugarcane bagasse, Aspergillus niger, Saccharomyces cerevisiae, Bioethanol, GC-MS Method.

INTRODUCTION: Bioenergy is energy derived from biofuels, biofuels are fuels such as bioethanol and Biodiesel produced directly or indirectly from organic materials including plant (Agro wastes) and also animal waste. Bioethanol is one of the most promising alternative biofuels. Ethanol has been frequently used for the blended gasoline in concentration ranges 10-85 % (v/v). Sugarcane bagasse and corn feedstock, are the main source of ethanol. Bioethanol is most important alcohol can be produced by converting the sugar content of any starchy material into alcohol with the evolution of carbon dioxide (CO2) under controlled environmental conditions. Other benefits come from using bioethanol as biofuel: it is totally biodegradable and Sulphur free and the products from its incomplete oxidation (acetic acid and acetaldehyde) are less toxic in comparison to other alcohols. The microorganisms chosen for alcoholic fermentation are usually yeasts, mainly belonging to Saccharomyces genus. The preferred characteristics for industrial bioethanol production are: high ethanol yield; high ethanol tolerance; high ethanol productivity (>5.0 g/L/h); aptitude to grow in simple, inexpensive, and undiluted media; aptitude to grow in presence of inhibitors, at low pH, or high temperature. The temperature is a fundamental parameter of the fermentation process. In India, bioethanol is mostly produced from sugarcane molasses which is a waste by-product obtained after the removal of sucrose from the sugarcane juice for sugar production. Hence the present study was aimed at production of bioethanol using various agro wastes as substrates.

OBJECTIVES:
- Isolation of substrate hydrolyzing enzyme producing microorganisms and selection of substrates.
- Standardization and optimization of media for scale up of bioethanol.
- Determination of bioethanol Production and quantification by GC-MS.

METHODOLOGY:
Preparation and pre-treatment of substrate: Sugarcane bagasse, as agro wastes were collected from different regions of our davangere then washed and dried. Pre-treatment of the sample was carried out by 1% NaOH for a period of 2 hours (Ali et al., 2011).

Microorganisms and maintaining the culture: Soil samples were collected from near davangere university, Tholahunase, Davangere is used (for Saacarification). The soil samples were collected at a depth of 10 -20 cm in the fields in sterile air tight containers and transported to the laboratory. Then that soil was screen for the potent microorganisms to hydrolyze substrate. The predomnant fungal culture will isolate and identified by preparing a wet mount using lacto phenol cotton blue.

Use of ferment medium and Saccharomyces cerevisiae: The fermentation media was use 0.2% yeast extract, 0.2% (NH4) NO3, 0.1% MgSO4.7 H2O, 0.2% KH2PO4 and 5 gm. of each substrate are dissolved in 100ml distilled water and then flasks were sterilized by autoclaved at 121°C for 20 minute and then add 5 % (V/V) inoculum of Aspergillus niger and 10% (W/V) Saccharomyces cerevisiae ( Baker yeast) and pH was adjusted to 5.5 and fermentation was carried out for 10 days in rotary shaker at 120pm, after 10 days of incubation, the broth was centrifuged at 6000rpm for 10 minute, the supernatant was collected and fed in to a simple distillation column. (Gendy et al., 2013)
Reducing sugars estimation: (Somyogi method) Somyogi in 1952 estimated reducing sugars of the sample with glucose as standard. 100mg of sugar bagasse was taken and sugars were extracted with hot 80% ethanol twice (5ml each time) supernatant was collected and evaporated keeping it on a water bath at 80°C and then 10 ml of water was added to dissolve the sugars and followed the procedure as Aliquots of 0.2, 0.4, 0.6, 0.8, 1.0 ml of the working standard solution (1mg/1ml) was pipetted out into a series of test tubes. Volume of standard and sample tubes were made to 2ml with distilled water. One tube set as blank and adds 1ml of alkaline copper tartrate reagent was added in each tube. And then all tubes were placed in boiling water bath for 10 min. Then the tubes were cooled and 1ml of arsenomolybdic acid reagent was added to each tube. The optical densities of standard and test samples were measured at 660nm and a graph was plotted.

Protein determination: The Bradford protein assay which was described by the Bradford and this technique is faster and sensitive than any other protein assay method (Bradford s, 1976). The protein content of all the substrates was determined with bovine serum albumin as standard. It is a simple procedure for the determination of protein concentration in the given sugar bagasse sample solution. The Bradford protein assay which was described by the Bradford and this technique is faster and sensitive than any other protein assay method (Bradford s, 1976). Aliquots of 0.2, 0.4, 0.6, 0.8, 1.0 ml of the working standard solution (1mg/1ml) was pipetted out into a series of test tubes. Volumes of standard & sample tubes were made up to 3ml with phosphate buffer. Add 5ml of Bradford reagent to each tube and then kept all the tubes for incubation at room temperature for 30min. Then the tubes were cooled and then optical densities of the standard and test samples were measured at 595nm.

Optimization of fermenting media such as different pH and different incubation time for bioethanol production: The chemically pre- treated substrates were used for all experiments. In order to optimize bioethanol production the “Substrates were taken in different variations,(5g, 6g, 7g, 8g, 10g) and different incubation time ( 2 days, 4 days, 6days, 8days, 10 days ) and different pH ( 3.5, 4.5, 5.5, and 6.5, 7.5) (Duhan et al., 2013).

Separation of ethanol from water mixtures by distillation method: To separate a mixture of alcohol (ethanol) and water mixture, we can use a process known as fractional distillation. This technique relies on the fact that the compounds in the mixture have different boiling points, since ethanol boils at a lower temperature (78.5°C) than water; the alcohol vaporizes while most of the water remains liquid, At this point, we have competed distillation.

Determination of Ethanol: Ethanol was estimated by Potassium dichromate method. (Caputi et al., 1968). According to the potassium dichromate method, ethanol was estimated by taking different concentrations of ethanol (2- 10%) was prepared using deionized water, 2ml of each ethanol solution was taken and the volume was adjusted to 50ml using deionized water in a volumetric flask. Further, this solution was transferred to a round bottom distillation flask. Distillates was carried out at 55°C using a small distillation unit until 15ml of the distillate was taken, 1.85 ml of distillate was taken in a separate set of test tubes. 3.12 ml of freshly prepared chromic acid was added and 1.25ml of distilled water was added. The test tubes were incubated at 50°C for 30 min. the test tubes were cooled to room temperature and the color developed was observed in a UV -Visible spectrophotometer at 660nm against a reagent blank. A standard graph was plotted against concentration of ethanol vs optical density. Alcohol concentration in sugar bagasse was estimated by following the same protocol and using the standard graph of ethanol. (Caputi et al., 1968).

Quantification by GC-MS Method: Gas chromatography (GC) is a common type of chromatography used in analytical chemistry for separating and analyzing compounds that can be vaporized without decomposition. The comparison of retention times is what gives GC its analytical usefulness. Mass spectroscopy is a powerful analytical technique used to quantify known materials, to identify unknown compounds within a sample, and to elucidate the structure and chemical properties of different molecules. The basic principle involved in the mass spectrometer generates multiple ions from the sample under investigation, it then separates them according to their specific mass to charge ratio (m/z), and then records the relative abundance of each ion type.

RESULTS AND DISCUSSION:
The sugar released, from sugarcane bagasse as substrate, maximum amount of sugars were released from sugar bagasse is 1150µg/ml before the substrate is undergoing for fermentation for production of bioethanol but after 10 days of fermentation, it is almost of about 600µg/ml of sugar released by sugar cane bagasse, which is estimated
by somyogi method, this showed that the sugar is being fermented by the help of the microorganism yeast for the production of bioethanol.

The utilization of the protein from sugar bagasse can be of immense importance for bioethanol production. Protein content of sugar bagasse obtained before undergoing for fermentation was found to be 600µg/ml respectively without addition of microorganism. Then the protein content after fermentation with the addition of A. niger and yeast result in gradually increased variation among protein content was found to be 1090µg/ml of sugar bagasse which enhanced the biomass production for bioethanol production. And the concentrations were mentioned in graphical representation. A niger produce cellulolytic and lignin lytic enzymes at the initial stage of composting process and making the substrate available for biodegradation.

The unknown concentration of bioethanol produced by sugar bagasse, by optimized all conditions of ferment broth was found to be 6.81 %( v/v) in 50ml ferment broth after 10 days of incubation.

The unknown concentration of bioethanol produced by sugar bagasse, by optimized at different substrate concentration like 2.5g, 3.0g, 3.5g, 4.0g, 5.0g/ 50 ml of ferment broth was found to be 2.5g/50ml showed the highest amount of bioethanol produced of about 5.9%(V/V) because this substrate concentration favours Saccharomyces cerevisiae which converts the sugar present in the medium to ethanol. With the increase in the concentration of Substrate, the time required for the completion of fermentation decreased dramatically.

The unknown concentration of bioethanol produced by sugar bagasse, by optimized at different pH like 3.5, 4.5, 5.5, 6.5, 7.5 was found to be pH 5.5 showed the highest amount of bioethanol produced of about 6.3%(V/V) because this pH favours Saccharomyces cerevisiae which converts the sugar present in the medium to ethanol and also provides acidic condition which prevents the bacterial contamination during fermentation. As the pH decreases, the fermenting broth became more acidic, thus changing the metabolic activities of the yeast for increased ethanol production.

The unknown concentration of bioethanol produced by sugar bagasse, by optimized at different incubation time like 2days, 4days, 6days, 8days, 10 days of ferment broth was found to be 10 days showed the highest amount of bioethanol produced of about 6.91%(V/V). Because these 10 days of incubation time, the depletion of sugar was very rapid, this phase was believed to be the exponential phase which was the period of rapid cell multiplication indicated by active fermentation. Increases with the increasing number of days while sugar concentration decreases.

This shows the sugar is being fermented by the help of the microorganism yeast for the production of ethanol.

Quantification of bioethanol by GC-MS Method.

A Gas chromatography was used in the quantitative analysis of ethanol in the all fermentation media. Bioethanol obtained from sugarcane bagasse by potassium dichromate method was found to be 6.81 %( v/v) and confirmed by Gas chromatography which yielded 9.99 % (v/v) the Retention time (min) was 20.08 as shown in below chart the peak 207 shows highest ethanol concentration.

Chart for the estimation of glucose by Somoyogi method:
The chart for the estimation of protein by Bradford’s method:

Before fermentation               After fermentation

The chart for the general ethanol production

Substrate Concentration          Different pH

Different Incubation time

The chart for the Quantification of bioethanol by GC-MS Method

CONCLUSION: The result of this study shows that agricultural waste namely sugarcane bagasse, known to contain sugar is good substrates for ethanol production. Therefore the findings of this work suggest that ethanol can be
produced from agricultural wastes rather than allowing it to contribute a nuisance to the environment. Therefore, there should be the development of an environmentally friendly, pre-treatment procedure highly effective enzyme system for conversion of pre-treated waste to fermentable sugars. Effective microorganism to convert multiple sugars to ethanol. The use of alternate sources for the production of ethanol has been found to be economical and effective. This process of utilizing the solid waste those are very rich in cellulose, hemicellulose and lignin, gives rise to zero waste generation techniques. The maximum ethanol obtained from sugar cane bagasse was 6.8 % (v/v) at 10th day. And the fermentation extract confirms the presence of ethanol which is quantified by potassium dichromate method. According to the policy statement, ethanol production for blending with fuel in 2017-18 will be around 150 crore liters, resulting in foreign exchange savings up to Rs 4,000 crore. The production of biofuels is expected to control the carbon dioxide emissions by 20,000 tons.

**SCOPE FOR FUTURE WORK:** Bioethanol offers great benefits for safeguarding the environment, boosting the rural economy and ensuring fuel security. Bioethanol production process successful at industrial scale with reduction in capital and operation cost.

**PHOTOGRAPHS OF BIOETHANOL**

PRODUCTION OF BIOETHANOL FROM COFFEE PULP WASTE USING SACCHAROMYCES CEREVISIAE

**Project Reference No.: 41S_B_MSC_007**

**COLLEGE:** MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BENGALURU

**BRANCH:** DEPARTMENT OF MICROBIOLOGY

**GUIDE:** Dr. VISHWANATHA.T

**STUDENTS:**
- Ms. HARSHITHA M.
- Ms. NAVYA A.
- Ms. CHAITRA M.

**INTRODUCTION:** Coffee is one of the most consumed beverages in the world and is the second most traded commodity after oil. During the coffee processing, we obtain the following waste: pulp, mucilage, coffee husk, etc. For
every two tons of coffee produced one ton of coffee pulp is obtained. It is possible to utilize coffee pulp waste to produce energy. Fermentation is one of the most important processes for agro waste reuse producing clean fuels. Bioethanol is produced from biological waste by alcohol fermentation of simple sugars present in coffee pulp waste. The fermentation is carried out by using yeast (*Saccharomyces cerevisiae*). It tolerates a wide range of pH which makes it fermentation less susceptible to contamination than bacteria. It also tolerates ethanol better than other ethanol producing microorganisms.

The advantages of bioethanol over fossil fuels are: they are clean, renewable, have a more complete combustion and less waste in general. The use of agrowaste as an alternative can also reduce the environmental impacts arising from dumping of the waste directly to the nearby rivers could also contribute to the solution of fossil fuel replacement.

**OBJECTIVES**

1. Isolation of *Saccharomyces* species
2. Collection and pretreatment of coffee pulp waste
3. Screening of isolated organism for ethanol production
4. Production and distillation of ethanol

**METHODOLOGY**

1. **Isolation of *Saccharomyces* species:**
   The sugar cane was collected and its scrapings was plated on yeast isolation agar medium (soluble starch-5g, yeastextract-5g, K2HPO4-1.2g, MgSo4-0.5g, agar-20g, distilledwater-1000ml, pH-3-3.5, chloramphinicol-70mg). and were incubated at room temperature for 48 hours. The colonies appeared will be further identified on the basis of colony characteristics and microscopic features. The colonies showing standard characters will be picked up and subcultured for further studies.

2. **Collection and pretreatment of coffee pulp waste:**
   The coffee pulp waste will be collected from chikkamagaluru district and finely powdered. The powdered coffee pulp was hydrolyzed with dilute sulfuric acid (H2SO4) at different concentrations. (1-5% H2SO4) in order to break down the cellulose and hemicelluloses into simple sugars.

3. **Screening of isolated organism for ethanol production:**
   *Saccharomyces* species will be screened its alcohol producing ability, quantitative estimation of ethanol by alcoholometry method.

4. **Production and distillation of ethanol:**
   The coffee pulp extracts will be used as a fermentation medium for the biosynthesis of ethanol. The coffee pulp extract was inoculated with *Saccharomyces* species. After inoculation flasks were incubated at 37°C for 3-7 days. At the end of fermentation, the alcohol shall be recovered by distillation process. (Note:we will be characterizing the coffee pulp waste and also collecting strain from NCIM, Pune. Once it comes, we will compare the strain with our isolated wild strain. The fermentation kinetics will be studied for the biosynthesis of ethanol is pH, temperature and inoculums size optimized for the maximum yield).

**RESULTS AND CONCLUSION:** The maximum sugar content was obtained by the hydrolysis of coffee pulp waste was 9.5%, which was hydrolysed with distilled water. The specific gravity of ethanol produced was 0.9758, which corresponds to 18.23% of ethanol.

**SCOPE FOR FUTURE WORK:** Biofuels are catalyzing the attention of researchers due to the big potential in reducing the dependence of crude oil together with the possible reduction in the pollution associated with the combustion process. Bioethanol has been recognized as a potential alternative to petroleum derive transportation fuel and cooking fuel.

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SYNOPSIS OF MBA SEMINAR PROJECTS

A STUDY ON COMMERCIALIZATION OF BIODIESEL IN BANGALURU CITY

Project Reference No.: 41S_B_MBA_001

COLLEGE : RAMAIAH INSTITUTE OF TECHNOLOGY, BENGALURU
BRANCH : DEPARTMENT OF MANAGEMENT STUDIES
GUIDE : Prof. SANTHOSH KUMAR.S
STUDENTS : Mr. GAURAV DHAMA
            Mr. CHANDAN M
            Ms. PATIL BHAVANA

INTRODUCTION: There are various sources of non-harmful fuel such as Bio-diesels, which can be obtained from diverse vegetable oils and animal fats. Its primary advantage is that, it is being one of the most renewable forms of fuels currently available and it is also non-toxic and biodegradable in nature.

STATEMENT OF THE PROBLEM: India is expected to be the one of the fastest growing markets for the product as the demand for diesel driven vehicles in the region is increasing at a significant pace. The government initiative to boost green fuel and government of India has also planned to blend 5% biodiesel by 2022 which is anticipated to propel the growth over the projected period.

There are numerous number of biodiesel producers across the major economies, however, the production capacity is unable to meet the surging demand for the product which decreases the competitive rivalry owing to high demand-supply gap. The existing manufacturers are expected to invest to enlarge production capacities and expand geographical reach in order to strengthen their market presence.

OBJECTIVES:
- To identify the consumption units of biodiesel in Bangalore city.
- To determine the demand for biodiesel in Bangalore city.

RESEARCH METHODOLOGY:
The present study is descriptive in nature. The study involves survey of consumption units such as bulk users, Retailers & Prospective customers and industrial purposes in Bengaluru city. The data will be collected by personally administering a structured questionnaire on the consumption level of biodiesel from the respondents. In addition to the above a survey of biodiesel consumption units to determine the demand is carried on.

- SAMPLE TECHNIQUE: Stratified Sampling Technique (In order to select the required number of respondents from the population, stratified random sampling technique has been incorporated)
- SEGMENTATION: Bulk users, Retailers & Prospective customers
- SAMPLE SIZE: 170 (Includes all the 3 segments)
- DATA COLLECTION METHOD:
  PRIMARY DATA – Questionnaire & Personal Interview from Bulk users, Retailers & customers
  Biodiesel Production with Green Technologies by Islam.

OBSERVATION: It has been observed during the study that there are large number of customers for Biodiesel in various segments who were consuming bio-diesel. Since there is lack of adequate supply of biodiesel the customers
have stepped back from using it. Majority of the respondents that they are interested to continuing in buy biodiesel if proper supply is provided.

EXPECTED OUTCOMES:
- Identifying the demand of biodiesel in Bangalore city
- Development of a potential market opportunities for biodiesel.
- It helps in creating awareness about significance of biodiesel as alternative to diesel from fossil fuel.
- It provides inputs to Government in policy making related to commercialization of biodiesel in the segmented markets.

IMPROVEMENT: This project is an improvement over the previous Best project titled “Financial and Economic Assessment of Biodiesel Production and use in Bengaluru” (39th series).

The Improvements are:
- Identification of the consumption units of biodiesel in Bangalore city.
- Determination of the demand for biodiesel from these units.

DEVELOPMENT OF A SUPPLY CHAIN MODEL FOR BIODIESEL PRODUCTION FROM NON-EDIBLE COOKING OIL

Project Reference No.: 41S_B_MBA_002

COLLEGE : RAMAIAH INSTITUTE OF TECHNOLOGY, BENGALURU
BRANCH : DEPARTMENT OF MANAGEMENT STUDIES
GUIDE : Dr. Y. M. SATISH
STUDENTS : Mr. KARTHIKEYAN V
            Mr. KARTIK SHEREGAR
            Mr. JEETENDARA T

Introduction: Biofuels are combustible fuels created from biomass; in other words, fuels created from recently living plant matter. The term biofuel is usually used to reference liquid fuels, such as ethanol and biodiesel that are used as replacements for transportation fuels like petroleum, diesel and jet fuel. There are two main types of biofuels viz. ethanol and biodiesel. Biodiesel is produced by extracting naturally occurring oils from plants and seeds.

Biodiesel has high potential as a new and renewable energy source in the future, as a substitution fuel for petroleum-derived diesel and can be used in existing diesel engine without modification. Currently more than 95% of the world biodiesel is produced from edible oil which is easily available on large scale but in this context the tables will turn towards non-edible oil and its advantages. Non-edible or used cooking oil is the oil which is generated from the left over burnt edible oil consumed during cooking. This non-edible cooking oil is generated in various food ventures viz. Hotels, bars/pubs, restaurants, fast-food chains, caterers, marriage halls, household, snack industries, canteens, chat-centres, food cart vendors etc.

Oil is very essential part of cooking especially Indian cooking. Right from the tadka to sautéing of vegetables, oil comes into play. Since it is so frequently used often people tend to use it several times which a safe practice is not. The problem with reusing oil is that it can create free radicals which cause ailments in long run. These free radicals attach themselves to healthy cells and lead to diseases. These free radicals can be carcinogenic i.e. can cause cancer and also atherosclerosis which can lead to increase in bad cholesterol levels blocking the arteries. Acidity, heart disease, irritable throat, Alzheimer’s and Parkinson’s disease are other health issues.

Turning towards environment, used cooking oil also has adverse impact over it. When not disposed properly used cooking oil cause severe damage for the environment. It can cause large number of issues with sewer and septic systems, because as vegetable oil cools and settles it congeals, which can clog-up pipes and cause corrosion of certain
materials. The production of bacteria will arise due to the accumulation of the solid oil used. All life forms need water to live, when used cooking oil is poured down the house drains, some of the drain systems will lead to the rivers, streams or ponds. This oil will be dumped into it and causes a disastrous effect on many kind of life forms living in it. The main harm is that it creates a thin layer on the surface of water which prevents the diffusion of environmental oxygen into the water. This indirectly affect underwater habitats like plant to photosynthesis and fishes to get proper oxygen and food from the plants. Used oil when applied to land can render the soil unproductive. Used oil placed in landfills may seep through the bottom of such landfill and subsequently contaminate ground water supplies. Uncontrolled burning of used oils may result in significant levels of hazardous emissions to the environment. This may expose humans, wildlife and vegetation to harmful substances.

Bengaluru being the IT capital and Pub capital of India is growing in the means of population, which is directly impacting the growth of various food ventures day-by-day. This increasing number in food ventures are generating a large amount of used oil and used unusable oil. The used oil generated in the kitchens of all these food ventures are either been dumped into garbage through BBMP or are been passed into the sewage system of the city. This may create problem in future to the environment and society. To overcome the problems of disposal of this used cooking oil, best methodology can be applied to utilize this used cooking oil to generate biodiesel out of it.

Bengaluru will be the great source for non-edible cooking oil and its generation for biodiesel. But the challenge here lies with the collection of used cooking oil from various sources spread across Bengaluru city. This report totally focuses on the various sources, availability, variations and frequency of disposal of used cooking oil. This report will also focus on various methodologies of collection of used cooking oil throughout Bengaluru. On the other hand, also will be considered as important aspect for this procedure.

Objectives:

➢ To identify the organized and unorganized units of used cooking oil generation in the Bengaluru city.
➢ To estimate the amount of used cooking oil generated from these units.
➢ To determine the cost-effective collection mechanism for used cooking oil.

Methodology:

A. Data Collection:

I. Primary Data: The study relies majorly on primary data which will be collected through a structured questionnaire. Structured questionnaire will be administered to the Administrative staff of the Organized units and owners of the Unorganized units for collecting relevant data required for achieving objectives of the study.

II. Secondary Data: the secondary data will be collected from the published sources such as newspapers, magazines, Govt Publications and other related websites.

B. Sampling:

A stratified random sampling will be followed to get proportionate samples from both organized and unorganized units operative in Bengaluru city. The samples will be drawn from North, East, South, West and Central Bengaluru. At least 30% of the units will be randomly selected from each identified strata of the population.

Observations:

➢ We have collected 120 samples across the areas of Bengaluru North.
➢ The data collected has been categorized as Organized and Unorganized units.
➢ Total number of Organized units visited is 63.
➢ Total number of Unorganized units visited is 57.

➢ Total used cooking oil generated from both organized and unorganized units is 2819.5kgs.
➢ Used cooking oil generated from Organized units is 2266 kgs.
➢ Used cooking oil generated from Unorganized units is 553.5 kgs.
➢ It was observed that re-usage of cooking oil in Unorganized units is being severely practiced.
➢ Deliberate disposal of used cooking oil in both Organized and Unorganized units is being practiced. The disposal here is either through their Sewage system or into the garbage.
➢ Procurement of used cooking oil from most of the Organized as well as Unorganized units is already being followed.
   Most of the proportion from this is been procured by Soap-Oil factory at the price of INR 350-450 per can.
➢ The study also tells that the disposal in various units of both Organized and Unorganized ventures is fluctuating twice in a week, weekly or monthly.
➢ We observed lack of knowledge among many of the Organized and Unorganized units about used cooking oil and its disposal.

FUTURE WORKS:
➢ There is an immediate need to educate and create awareness among all the units about the drawbacks of re-using and disposal of used cooking oil also its importance to generate Biodiesel out of it.
➢ We will estimate amount of used cooking oil generated from all the 5 regions of Bengaluru City.
➢ Through Stratified Random Sampling we shall estimate total amount of used cooking oil in Organized units.
➢ We shall select food streets where there is more concentration of food centers for estimating total amount of used cooking oil in Unorganized units.
➢ Once we get a better picture of available sources of used cooking oil throughout Bengaluru City we shall come up with cost effective Collection Mechanism.
COST ANALYSIS AT DIFFERENT STAGES OF OPERATION OF BIO MASS FUEL BRIQUETTES

Project Reference No.: 41S_B_MBA_003

COLLEGE: SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT ADYAR, MANGALURU
BRANCH: DEPARTMENT OF MANAGEMENT STUDIES
GUIDE: Dr. RASHMI KODIKAL & Dr. VIDYAVATHI. K
STUDENTS: Mr. VARUN.K
Mr. SHREEHARSHA. T
Ms. VAISHNAVI C BHAT
Ms. PRAJNA

Scope/ Objectives of the project: Biomass fuel briquettes or white coal are renewable and non-conventional energy fuel. They are made from agro forestry wastes. Agro forestry wastes are passed into briquettes machine and biomass briquettes are produced. Briquettes are widely used for any type of thermal application like steam generation in boilers, heating purpose, drying process & gasification plant to replace existing conventional fuel like coal, wood & costly liquid fuel like Fossil Oil, Diesel, Light Diesel Oil, Kerosene etc. Thus, briquetted fuel is an ideal, future fuel. The use of biomass briquettes is predominant in the southern parts of India, where coal and furnace oil are being replaced by biomass briquettes.

M. S Kukkadi Industries is a firm manufacturing Briquettes or the White Coal from Agricultural biomass, which is located in Puttur in Dakshina Kannada district of Karnataka. This project is undertaken in order to examine the Cost Benefit Analysis by using briquettes as bio fuel.

1. To examine how effectively the available advanced technology is used in order to optimally utilize the feed material of low-cost or unused materials for the dual purpose of producing briquettes as well as providing an environmentally acceptable form of agricultural. waste disposal
2. To analyze the various cost involved in procuring feed stock, producing storing and distributing white coal. And also the evaluation of benefit getting out of these processes so that it is helpful to the manufacturer to know the steps to be adopted in order to reduce cost and increase profit
3. To suggest feasible strategies to reduce the cost at different stages of production and distribution of white coal.

Methodology:
1. Primary Sources: Empirical Investigation &Face to face discussion with the proprietor of the plant, project guides to understand the actual process of producing briquettes.
2. Secondary Sources: Detailed information will be collected from websites, journals, articles and newspapers.

Analytical Tools:
1. Cost sheet prepared to know the cost per unit of briquettes if it is using different combination of raw materials.
2. Comparative statements of cost and profit is prepared to know the best combination of raw materials which will give good return.

Expected Outcome of the project:
1. To enhance the knowledge of the readers and how they can convert their business ideas into reality. The readers will come to know various technological advancements prevailing in the market and how they can make use of those in implementation their new ideas, especially the agricultural waste management.
2. To help the existing manufacturers in order to reduce the cost and efficient utilization of available biomass. It also helps to increase the income of agriculturists.
3. To help initial startup to develop their new business ideas, so that the potential entrepreneurs can convert their ideas into product.
Results:
1. Analyzed the various cost involved for the production of briquettes using different combination of raw materials like ground nut shell, areca husk, coffee husk, saw dust, ply wood dust, and some other.
2. Found out the process and cost cut off area that can be used to improve the production as well as reduce the cost.
3. Created awareness among the public regarding uses of briquettes by conducting campaign in some rural punchayat areas so that it helps both the public by reducing pollution and to proprietor by increasing sales as well as easy availability of raw materials.
4. Suggested the firm regarding cost reduction and thereby increase the profit portion by adopting new technology for production and using optimum combination of raw materials.

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CAPITAL BUDGETING DECISION ON INSTALLATION OF BIO-FUEL PLANT WITH SPECIAL REFERENCE TO BIO-DIESEL FROM RUBBER SEED

Project Reference No.: 41S_B_MBA_004

COLLEGE : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT ADYAR, MANGALURU
BRANCH : DEPARTMENT OF MANAGEMENT STUDIES
GUIDE : DR. VISHAL SAMARTHA
STUDENTS : Ms. ANUPAMA P S
Ms. PRAJWALA K
Ms. JEEVITHA

Scope / Objectives of the project:
- To understand the availability of rubber trees and rubber seeds (selected region: Mangalore, Bantwal, Karkala, Belthangadi)
- To estimate the Cash inflow and Cash out flow for bio fuel plant using rubber seeds
- “Feasibility Study” with reference to installation of Bio-Fuel Plant with special reference to Bio-Diesel from rubber seeds

Methodology:
- Primary Sources

<table>
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<tr>
<th>Bio Fuel Park</th>
<th>Visiting Bio Fuel Park, Hassan and interviewing manager in order to collect information about Bio Fuel Diesel</th>
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<td>Visiting rubber board in Mangalore to collect the information regarding the total number of rubber tree and quantity of rubber seeds available in South Canara, and to determine prices of rubber seed per kg</td>
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<th>Pay Back Period</th>
<th>With PBP method we can identify the period of recovery of initial investment on installation of bio-fuel plant</th>
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<td>Internal Rate of Return</td>
<td>With IRR method we can find out profitability of potential investment on installation of bio fuel plant</td>
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<td>Net Present Value Method</td>
<td>With NPV we can find out the difference between present value of cash inflow and present value of cash out flow</td>
</tr>
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Expected Outcome of the project:

• Dakshina Kannada is meant for agricultural commodities like Areca nut, Coconut, Cashew, Paddy, Rubber etc. Where arecanut is grown in larger volume with main view of making profit by selling areca seeds; but rubber trees are grown mainly for the purpose of extracting milky white liquid which is used to manufacture tyre, rubber sheet etc., As we can see rubber seeds are not used for any purpose. Therefore, the motive behind this project is to study how efficiently rubber seeds can be used to produce bio diesel, and to know quantity of rubber seeds available

• This project will give additional profit to rubber growers

• With the lower exhaust emission bio diesel reduces the pollution and also safe guard the health of farmer who has tractor

• Bio diesel can be used as substitute for petrol which is going to be exhausted in near future

• Another Expected Outcome of this project is to know whether Installation of bio fuel plant is financially feasible or not

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ECONOMIC VIABILITY OF BIO FUEL PRODUCTION FROM TREE BORN SEEDS

Project Reference No.: 41S_B_MBA_007

COLLEGE : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT ADYAR, MANGALURU
BRANCH : DEPARTMENT OF MANAGEMENT STUDIES
GUIDE : Dr. Vidyavathi. K & DR. Rashmi Kodikal
STUDENTS : Ms. Kshama Hegde
            Ms. Apoorva A. Rao
            Mr. Prajwal Kaverappa
            Ms. Samhitha G.

Scope of the project: Energy is backbone of Indian Economy, India today is third largest importer of crude oil from Saudi Arabia 19.9%, Iraq 16.2%, Iran 11% and Nigeria 10.9%, and India’s oil consumption grew 8.3% to 212.7 million tons in 2016 and spends $330 Million a day on imported oil and gas. Fossil fuels are non-sustainable energy which may create scarcity in future, because of which today it has become a necessity to think on generating and promoting renewable energy i.e. “Future Fuel”. As per information by Hassan Bio Fuel Park there are totally twenty-two farmers associations having bio fuel production units, out of which ten production units are selected for the survey. This project covers ten bio fuel associations engaged in the production of bio fuel from nonedible seeds such as Pongamia, Neem, Simarouba, Mahua, Amoora, Nagasmpige, and Kotte in various villages like Ambuga, Madenur, Machagowdanahalli, Golenahalli, etc… across Hassan District.

Objectives:
1. To examine the scale of operation of selected production units.
2. To assess whether the production of biofuel is economically viable or not.
3. To examine the hurdles particularly business related in production of bio fuel.

Methodology: The study uses primary and secondary data. To a large extent it is based on the survey data collected. Ten production units will be selected for this study from which six farmers from each unit are intertwined using questionnaires method. Also survey will be undertaken in six bio fuel associations at Hassan, registered with the Hassan Bio Fuel Park. Secondary data collection tools are internet, information from bio fuel park Hassan, information from different bio fuel associations, journals, articles and libraries. Qualitative data can be obtained from newspapers, quantitative data can be obtained through survey statement and statistics.

Analytical Tools:
3. Weighted average method would be used to know the average oil extraction by each of the seeds.
4. Present value method will be used to know the net present value of the return.
5. Sensitivity analysis would be used to understand the increased understanding of relationship between input and output of variable in the system.
6. Payback period to know length of time required to cover the cost of investment.

**Expected Outcome of the project:** New generation energy sources is very essential in Indian and global context. The available renewable source has to be optimized to give maximum biofuel returns.

1. Ideal tree borne oil seed that are used for the extraction of oil which would be used for generation energy.
2. Ideal size of machinery that would be required for different category of seeds
3. The total amount required for installing the machine and to know if the investment is worth
4. To understand the benefits in terms of employment, income and standard of living

**Results:**
5. Explored various tree borne seeds and its economic significance.
6. Conducted survey in various villages, including Hassan Biofuel Park in order to understand the ideal size of machinery for biofuel production.
7. Analyzed the cost requirements in order to implement and run the machineries.
8. Understood the significant of biofuel production in terms of generating employment, income and standard of living.

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**SUPPLY CHAIN MANAGEMENT OF BIODIESEL FROM TREE BORNE SEEDS**

**Project Reference No.: 41S_B_MBA_008**

**COLLEGE** : SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT ADYAR, MANGALURU
**BRANCH** : DEPARTMENT OF MANAGEMENT STUDIES
**GUIDE** : DR. VIDYAVATHI K & Mr. DEEPAK BANGERA
**STUDENTS** : Ms. AISHWARYA K. VIJAYAN
               Mr. ROHAN B AIL
               Mr. AMAL MANOHAR
               Ms. SHREEgowri M.K.

**Scope / Objectives of the project:**

**Scope:** In the district of Hassan, a large number of farmers / farmers associations are engaged in producing non-edible seeds such as pongamia, Neem, simarouba glauca, Madhuca indica etc. Some of these associations extract diesel from these seeds. The biodiesel so produced are either used for running the tractors or sold outside to the industries. The Hassan biofuel park promotes all the activities related to biofuel. The proposed study aims at understanding and improving the collection network prevailing between the farmers, production units and the end users of biodiesel.

**Objectives:**
1) To examine and evaluate the supply chain of tree borne seeds from the suppliers to producer of bio-diesel.
2) To examine and evaluate the supply chain of biodiesel from production units to the end customers.
3) To develop a model for supply chain of biodiesel from tree borne seeds so as to improve the existing collection network.
4) Methodology:
5) The sources of data and information for this study are the farmers, farmers associations, production units and the end customers. Some of the basic information will also be collected from the biofuel park in Hassan. Information of this study is collected through face to face interview by administering the structured questionnaire.
As per the information provided by the biofuel park there are 480 farmers associations engaged in cultivating non-edible seeds and 22 farmers associations are having production units to generate biodiesel. Of these 480 farmers 80 farmers and 10 production units will be selected as our sample. This sample will be taken from villages namely Kallahalli, Golenahalli, Danayakanahalli, Ambuga, Kallahalli of Hassan district.

**Expected Outcome of the project:** The expected outcome is to develop a model for the supply chain of biodiesel from the non-edible seeds.

**Application of the project:**

**The application of the project is towards:**

1) Agriculture: How the cultivation of non-edible seeds can be promoted and encouraged among the farmers as an activity which would guarantee an additional income to the farmers.
2) Societal: How the cultivation of non-edible seeds and the production of biofuel can be promoted and encouraged for the sustainable development of villages/society.
3) Education: This can be used as case study or for further referral.

**Results:**

- The farmers from their neighboring villages grow the seeds and when the seed falls down they collect it and soak them for a week to remove the outer layer and then the seeds kept outside to dry under the sunlight for 2 months then the farmers sell the seeds to the production unit or the farmers sell the seeds to the agents or brokers who again sell it to the production unit.
- From the production unit the seeds are converted to oil which will be further converted to biodiesel and then used for vehicle’s, the production unit even supplies it to the engineering students who require the biodiesel for their machines and projects and sometimes the production unit sells the dry seeds as they have their own field and farmers. The biodiesel is used by the farmers for their tractor’s and vehicle’s too.

**Findings:**

- The oil collected from the seeds are used for the domestic purposes. And the biofuel park uses it for their vehicles and sells the biodiesel to the students for their project works as well as the farmers for their tractors. It is sold for 25-50 rupees per liter.
- The main disadvantage found is once the vehicle fills the tank with biodiesel then the vehicle cannot be halted for a long period of time. This is why many people do not prefer biodiesel.
- The production process takes a long period if done manually and when done automatically it is expensive. The production units do it manually as they have no much demand or urgency for biodiesel.
- The demand is not mainly there because of the lack of largescale production. And it is not very well advertised too.

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KSCST: SPP-41st SERIES: BIOFUEL PROJECTS COMPRENDIUM: 2017-18
SYNOPSIS OF B.E. EXHIBITION PROJECTS

KITCHEN TOP BIOGAS DIGESTER

Project Reference No.: 41S_B_BE_101

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Keywords: digester, Taguchi, methane production, bio digestion, food waste.

Introduction: The current use of fossil fuels is rapidly depleting the natural reserves. Therefore, a lot of research effort is put into finding renewable fuels nowadays to replace fossil fuels. Biogas is one such renewable fuel which can be harnessed easily and in most economical way. But the traditional method of biogas generation is time consuming and output is limited and also as seen from the market survey the bio digester available in the market do not have temperature control and stirring which were found out to be the main factor influencing the biogas generation. Considering this drawback, in our product we have made an attempt to overcome this by introducing wood ash, temperature control through water jacket and automated stirrer in biogas generation. An additional advantage in this product is that kitchen waste is used as main input. Kitchen waste is organic material having high calorific value and nutritive values to microbes, by which efficiency of methane production can be increased by several orders of magnitude.

Objectives: The purpose of this study is to optimize the generation of biogas using kitchen waste with the help of Design of Experiment (DOE) by Taguchi method and to study the effect of temperature, wood ash and yeast on the biogas generation. Also, designing and building up of kitchen top biogas digester to cater to the need of household cooking purpose based on the suggestions obtained from experts.

Methodology:
1. Selection of important parameter affecting the biogas generation from literature survey.
   Parameters selected in this project are:
   a. Temperature                b. Diameter to depth ratio               c. Retention days d. Total solid content e. Additives
2. Selection of orthogonal array for Design of Experiment (DOE) - L9 array.
3. Carrying out different trails for various combinations of parameters selected.
4. Plotting out graphs for obtained results to see the affect of each parameter.
5. Carrying out market survey to obtain the waste generated in each kitchen.
6. Designing of the biogas digester for the kitchen waste value generated.
7. Testing of the fabricated product.

Product specification: The product consists of a PVC pipe 10" in diameter fitted with 2 end caps, sealed at both the ends which acts as digester. The top of the digester is conical in shape which helps in concentration of gas in one direction and is provided with a non-return valve (NRV) which allows one directional flow for the gas generated to come out. This is a safety measure which avoids explosion during fire hazard. The slurry inlet is provided from the side end about 30 degree with gate value fitted to it and outlet is also provided from the side walls of the pipe with end cap on it. This entire assembly is housed inside a brass drum. The brass drum which has higher thermal conductivity is used to provide a water jacket for the digester which is used to maintain the temperature inside the

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digester. The Brass drum is provided with tapings for inlet and outlet of water for the water jacket. The Brass drum is provided with heater at the bottom along with the thermostat provided with it in order to heat the water. The heater is switched on and off by a thermostat which is actuated by change in water temperature directly. The gas generated will inflate a rubber bladder which is the visual representation of gas generation.

Results:

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Temperature °C</th>
<th>Ash particles (g)</th>
<th>Yeast (g)</th>
<th>Gas generated (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Trail 1</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>2</td>
<td>1</td>
<td>1730</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>4</td>
<td>2</td>
<td>1790</td>
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<td>1690</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>2</td>
<td>2</td>
<td>1990</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>4</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
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<td>40</td>
<td>2</td>
<td>3</td>
<td>1800</td>
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<td>8</td>
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<td>1940</td>
</tr>
<tr>
<td>9</td>
<td>40</td>
<td>6</td>
<td>2</td>
<td>1850</td>
</tr>
</tbody>
</table>

Fig 1: Experimental setup for Design of Experiments – Taguchi Method

Fig 2: CAMD model of digester

Fig 3: Kitchen top biogas digester
• Graphs obtained:

![Graph showing the relationship between temperature, ash, and yeast on gas generation.](image)

**Conclusion:** From the graph shown above it can be concluded that optimum gas generation takes place at 35°C along with 4 gram of wood ash and 2 gram of yeast along with slurry mixture of 0.75 kgs of kitchen waste, 0.75 kgs of cow-dung with 1.5 ltrs of water. It can also be concluded that as the concentration of yeast and wood ash increases there is a reduction in gas generation.

**Scope for future work:**
1. Experimentation with other parameters affecting the gas generation.
2. Experimentation with other type of feedstock like food leftover, non-vegetarian waste, etc.
3. Attempts can be made to bring down bad odour of the biogas.
4. Complete automation of the product.
5. Analysis of the gas generated through gas chromatography.

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**DESIGN AND FABRICATION OF MOTOR DRIVEN CATTLE DUNG MIXER FOR BIOGAS PLANT**

**Project Reference No.: 41S_B_BE_098**

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**INTRODUCTION:** Biomass used as a fuel reduces need for the fossil fuels for the production of heat, steam and electricity for residential, industrial and agricultural use. Biomass is always a readily available source of energy and can be produced as an abundant and renewable resource. Use of biomass in biogas generation reduces the landfilling makes no harm to the atmosphere, it's a clean energy. Fresh cattle dung is collected in baskets/buckets and hand-mixed with an equal amount of water before being fed into digester. Manual mixing is un-hygiene, homogeneous mixing increases the efficiency of the biomass plant. There is a need for an economical, mechanical mixer to get a homogeneous mixture. Biogas production significantly contributes to world’s energy source. Governments in many developing countries also encourage installation of biogas plants. In India, Government provides 25% subsidy, besides encouraging banks to offer loans for construction of biogas plants.

OBJECTIVES:
1) To design a motor driven cattle dung mixer to maximize the generation of biogas, thereby increasing the efficiency of biogas plant.
2) To fabricate the necessary parts and assemble the parts.
3) To test the applicability of the fabricated machine.
4) To increase the efficiency of the Biogas plant to get better energy from Biomass.
5) To avoid the manual effort to maximum extent.

METHODOLOGY:
After fabrication and assembly of the parts testing of cattle dung mixer was carried out. For optimizing anaerobic digestion, the key factors are the process of mixing and mixing ratio 1:1. Mixing ratio gives the best results and hence initially 5kg of fresh cattle dung was loaded to the mixer. Then 5L of water was added to it. The mixer was switched on and mixing was carried out for 4 minutes. As only a certain amount of mixing is required for increasing the biogas yield. Slurry is collected from outlet valve.

Again 10 kg of fresh cattle dung was loaded to the mixer followed by 10L of water. The mixer was switched on and mixing was carried out for 6 min. the slurry was collected through the outlet valve.

During testing it was observed that the curved shaped rotating Blades mounted on the shaft helped through mixing of dung and water.

RESULTS AND CONCLUSION:
- A homogeneous slurry was obtained from the mixer after testing. It was observed that the Blades revolving as well as rotating about its axis helped thorough mixing.
- Cylindrical shape of the mixer ensured optimal mixing. Mixing is sub optional in conventional square or rectangular mixing tanks as flow will be limited in the corners.
- From fig 1 it is evident that the degradation process is accelerated by grinding and mixing of the substrate before charging it to the digester fig 2 shows the influence of grinding and mixing on the technical time of fermentation.
- Hence it can be understood that mechanical mixing increasing degradation rate and decreases the time required for fermentation of the cattle dung.
- Also during mechanical mixing of the substrate in the mixer there is some amount of disintegration that will takes place as the substrate coming contact of the moving propellers.
- Disintegration of substrate increases the degree of decomposition there in increasing the biogas yield.
- While manual mixing of cattle dung human get exposed to infections. Hence it is most important that a mechanical mixer is used which avoids the exposure to the infections.

SCOPE FOR FUTURE WORK:
1. By increasing the volume of the mixing container, the mixer can be used as a fodder mixer to find the cattle.
2. Propeller design can be altered in order to suit grinding and can be utilized for grinding and mixing of solid substrates.

Fig 1: Increase of the biogas yield through grinding and mixing
Fig 2: Increase of the grinding and mixing on the technical time of fermentation
DESIGN AND FABRICATION OF A CERATONIA SILIQUA DEPULP AND SEED EXTRACTION MACHINE

Project Reference No.: 41S_B_BE_102

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Objectives:
- Designing an effective model for extracting the pulp and seed’s of *Ceratonia siliqua* or locust bean.
- Utilize the seeds’ pulp is to replace cocoa powder.
- The literature recommends research to get the fruit to ripen more uniformly or also for cultivars which can be mechanically harvested (by shaking).
- In order avoid the traditional process, develop the machine which is used for pulp and seed extraction.
- Designing the hoper, belt, shaft, crushing chamber, casing etc.,
- Fabricating the model for inspection.
- Reduces pulp and seed losses.
- Expand pulp and seed marketing by refining pulp and seed quality.

Methodology:
- Literature review
- Problem identification
- Designing a Ceratonia Siliqua L pulp and seed extraction machine
- Fabrication of prototype model
- Inspection
- Pulp and seed packing

Outcome of the project:
- Designing a pulp and seed Extraction for *Ceratonia siliqua L* or locust bean.
- Effective design model, should involvement of Unskilled Labors also.
- Invoking the farmers to cultivate the *Ceratonia siliqua L* or locust bean trees.
- Improvement of economic growth
- Pulp and seed Extraction should be taken separately.
- Which is ready for marketing, used for antiotics, home products, beverages etc.,

Applications:
- **Industry**: Used for Industries, in order to improve the marketing skill on this kind of machine.
- **Health**: For health Purpose, consumed by humans is the dried (and sometimes roasted) pod. The pod consists of two main parts: the pulp accounts for 90% and the seeds for 10%.
- **Agriculture**: Improvement of the economic growth of farmers.
- **Societal**: For Society, absolutely no caffeine and no theobromine, so is used to make chocolate-flavored treats for dogs.
- **Education / Academic**: Designing a suitable product for extraction of pulp and seed.
Conclusion:
- Ceratonia Siliqua L depulp and seed extracting machine were developed.
- By design consideration, the shaft used as 28mm diameter, motor 1HP, maximum speed of 1440 rpm, 230 V of supply, 2 v-belts were used. Extracting pulp and seeds from the machine, it can be used as potential resource for edible purpose.
- For fabrication all design aspects have been considered and also performance test has been carried after the fabrication of machine.
- Result reveals accepted of design configuration primarily the performance machine is satisfactory.

MECHANIZED PONGAMIA POD HARVESTER

Project Reference No.: 41S_B_BE_109

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            Mr. PRAVEEN KUMAR C MADIWALAR
            Mr. ARUN KUMAR I

Due to Increase in the demand for the biofuel it is necessary for us to get large amount of biofuel raw materials. There are plenty of sources which can be used for the production of biofuel such as Vegetable waste, animal’s fats, soybean oil and seeds oil etc. Among one of them is Pongamia pinnata pod. These trees are normally planted along the Highways, Roads, canals etc. to stop soil erosion. Billions of trees exist all over the India to get the pods from these trees so that we need mechanized one to get large quantity of pods, it is impossible to keep many labours to harvest the Pods.

Mechanized pongamia pod harvester is used to cultivate or harvest the pods from pongamia pinnata Tree. In our project, this device is used to harvest the pod from trees. Here we used slider crank mechanism as a basic. This project
gives details of harvesting method and sizes of components. This machine can be used in biofuel plants where pods needed.

A MECHANIZED PONGAMIA POD HARVESTER is a simple inversion. It uses slider crank mechanism in which rotary motion is converted into reciprocating (linear) motion. It consists of a dry battery, starter motor, hitter etc.; Hitter is mounted at the top of the device through the connecting rod.

When the motor is connected to battery through plugs, the charge (power) is passed and motor gets rotated as well, due to this crank will rotate. During this rotary motion of the crank it is converted into reciprocating motion of the connecting rod, by this action the hitter can hit the branches of the tree so that the pods easily fall down and finally harvest is done by hitting the branch. From the observation, the stroke length of a striker is found to be 80 mm.

METHODOLOGY:

1. Study the existing method of pongamia pod harvest
2. Study the machine available for similar operation
3. Identify the best methodology and mechanism for pod harvest
4. Designing of the machine
5. Fabrication or assembly of the machine components
6. Trail, testing of the newly developed machine
7. Modification of the machine if required.
8. Final field trial of the machine

DESIGN AND DEVELOPMENT OF THERMAL PYROLYSIS UNIT FOR THE PRODUCTION OF LIQUID FUEL BY USING HOUSEHOLD PLASTIC WASTE

Project Reference No.: 41S_B_BE_097

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           : Mr. SURAJ M KATGERI

INTRODUCTION: Fossil fuels are dwindling and in order to maintain the current levels of energy use and the transport systems we need to find alternatives. There are also environmental concerns about the effects of using fossil fuels such as pollution and climate change. The present rate of economic growth is unsustainable without saving of fossil energy like crude oil, natural gas, or coal. There are many alternatives to fossil energy such as biomass, hydropower, and wind energy. Also, suitable waste management strategy is another important aspect. Development and modernization have brought about a huge increase in the production of all kinds of commodities, which indirectly generate waste. Plastics have been one of the materials because of their wide range of applications due to versatility and relatively low cost.

Objectives: This project gives 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 materials oil. Fuel obtained from thermal pyrolysis process shows nearly same properties as that of diesel fuel. So, we can use plastic oil as alternative fuel. The objectives are as follows.

1. To establish the basis for the development and implementation of waste plastics recycling with the application of environmentally sound technologies (EST) to promote resource conservation and greenhouse gases (GHG).
2. To raise awareness in developing countries like INDIA on plastic waste and its possible reuse for conversion into diesel or fuel, this could be generated and marketed at cheaper rates compared to that of the available diesel or oil in the market.
3. To reduce the dependency on gulf countries for fossil fuels, thereby contributing to the Economic growth of the country.

**Methodology:**
1) Collection and washing of all type of plastic waste material
2) Development of thermal pyrolysis unit
3) Waste plastics are feed into reactor
4) Heating of plastic waste with the help of heater
5) Condenser/condensing
6) Collection of liquid fuel
7) Purification of liquid fuel
8) Comparison of properties of liquid fuel with diesel.

**Advantages:**
1) Simple process, no new machinery is required, easy to operate.
2) Lesser emission of unburnt HYDROCARBONS in waste plastic pyrolysis oil compared to that of diesel.
3) Low production cost.
4) Problem of disposal of waste plastic will be solved.
5) Environmental pollution is controlled.
6) Industrial and automobile fuel requirement shall be fulfilled to some extent at lower price.
7) The crude oil and the gas can be used for generation of electricity.

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**LOW COST AND PORTABLE SCRUBBING AND BOTTLING UNIT USING HYBRID COMPRESSOR FOR BIO FUEL SYSTEM**

Project Reference No.: 41S_B_BE_072

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            Mr. NAGARAJ

**INTRODUCTION:** Due to rapid industrialization and urbanization in last few decades there is a huge pressure on fossil fuels and need for the alternatives. Biogas is one of the most important renewable source which would cope up to cater for heat and power. At present it is not possible to transport biogas over long distances and to put in use to the extent where it is required. Biogas is a clean-burning, renewable fuel that is 60-70% methane and can be used to power household appliances and generate electricity. Biogas is becoming an increasingly important source of energy for rural areas in developing countries, as can be seen by the increased construction of bio digesters. Biogas has become an important fuel source because it is driven by readily available biomass. Because of this, there is a need to increase the versatility and availability of this natural fuel source to accommodate increased use. This biogas is produced by bio digesters that are currently in place. At present there is no system available to store the gas that these digesters produce, so all the gas that is created must be used at the same rate that it is produced. Biogas projects face a number of technical problems when implemented in the developing world. Biogas is an environment friendly, clean, cheap and versatile fuel can be used for thermal applications, power generation and as an automobile fuel. In India there is an estimated potential of 63.8 billion cubic meters (m³) of biogas per annum from 980 million tons of cattle dung produced from around 280 million cattle.
Storage: It is suggested that limitations also exists based upon maximum requirements of biogas in the user community. Most digesters will have limited capacity to store the product of their fermentation and, should demand not exceed supply, biogas production will be slowed. This is inefficient and occurs due to the lack of safe methods of transportation and storage.

Transportation: Generally, if biogas is stored, it will be at the digestion site in large impermeable bags. These are impractical to transport and require direct connection to cooking/lighting apparatus. In regions where piping systems are unachievable, biogas systems prove to be unsustainable and such systems may fail. So it is necessary to compress the biogas & store it in bottles/Cylinders so that it can be used in place of LPG and can be transported as per requirements. Even it can be used in place of CNG cylinders as a clean & green fuel to the vehicles.

METHODOLOGY OF BOTTLING AND SCRUBBING UNIT SYSTEM

The biogas compression and bottling process consist of different steps such as biogas purification, compression and bottling. The typical arrangement of biogas compression and bottling process. It consists of three basic units viz
scrubbing unit, compressor unit and storage unit. The raw biogas from the digester is first allowed to pass through a set of three scrubbing units for removal of impurities. The methane rich content biogas is now allowed to compress by passing it through a compressor. The compressed gas is finally stored into small cylinders with the help of manifold system and adapter. The manifold system used in the prototype is of single input and double output. Gas cylinder is connected to one output port where as a pressure gauge is connected to the other output port. The reverse flow of the biogas is avoided by using Ball valve and Non-return valve.

**Biogas Upgrading:**
The use of a biogas upgrading or purification process in which the raw biogas stream like CO₂, H₂S and moisture are absorbed or scrubbed off, leaving above 90% methane per unit volume of gas.

**Presence of CO₂ in biogas poses following problems:**
- It lowers the power output from the engine.
- It takes up space when biogas is compressed and stored in cylinder.
- It can cause freezing problems at valves and metering points where the compressed gas undergoes expansion during engine running.
- The traces of H₂S produces H₂SO₄ which corrode the internals of pipes, fittings etc.
- Moisture causes corrosion and decreases heating value of the fuel.

**Technologies for Conversion of Raw to Upgraded Biogas:**
- Water scrubbing
- Chemical absorption
- Pressure swing absorption
- Membrane
- Cryogenic

<table>
<thead>
<tr>
<th>Methods Parameters</th>
<th>High pressure water scrubbing</th>
<th>Chemical absorption</th>
<th>Pressure swing absorption</th>
<th>Membrane separation</th>
<th>Cryogenic</th>
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<td>Gas Pre-Cleaning Requirement</td>
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<td>Working Pressure</td>
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<td>1 Bar</td>
<td>4 – 7 bar</td>
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<tr>
<td>Methane Loss</td>
<td>1– 2 %</td>
<td>1-2 %</td>
<td>1-9 %</td>
<td>10 - 15 %</td>
<td>1-2%</td>
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<tr>
<td>%purity attained of upgraded Biogas</td>
<td>95-98 %</td>
<td>Up to 99 %</td>
<td>95 - 99 %</td>
<td>Up to 90 %</td>
<td>Up to 99 %</td>
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<td>Heat requirement</td>
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<td>-</td>
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<td>Moderate</td>
<td>Low</td>
<td>High</td>
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<tr>
<td>Initial Cost</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Process Handling</td>
<td>Easy</td>
<td>Complex</td>
<td>Easy</td>
<td>Easy</td>
<td>Complex</td>
</tr>
</tbody>
</table>

As per the table, **High pressure water scrubbing** is selected for the bio-gas purification process.

**High pressure water scrubbing:**
- Involves the physical absorption of CO₂ and H₂S in water at high pressures and regenerates by releasing in pressure with very little change in temperature.
- Easiest and cheapest method involving use of pressurized water as an absorbent.
- The absorption process is, thus a counter-current one. The dissolved CO₂ and H₂S in water are collected at the bottom of the tower.
The scrubbing unit consists of the following sub units:

- CO₂ separation unit.
- H₂S separation unit.
- Moisture separation unit.

**Figure - schematic flow of single pass high pressure water scrubbing**

The function of each unit is as follows:

**CO₂ separation Unit:** The raw biogas is first passed through a CO₂ separation unit. Limestone crystals are used to remove carbon dioxide. Limestone reacts with carbon dioxide to form calcium carbonate. The chemical reaction is as follows;

\[ \text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3 \]

**H₂S separation Unit:** Hydrogen sulphide is removed by using catalyst iron oxide in the form of oxidised steel wool or iron turning from any workshop. Once biogas comes in contact with this wool, iron oxide is converted into elemental sulphur. The chemical equations are as follows:

\[ 2\text{Fe}_2\text{O}_3 + 6\text{H}_2\text{S} = 2\text{Fe}_2\text{S}_3 + 6\text{H}_2\text{O} \]
\[ 2\text{Fe}_2\text{S}_3 + 3\text{O}_2 = 2\text{Fe}_2\text{O}_3 + 6\text{S} \]

**Moisture separation Unit:** Finally, the biogas is passed through a moisture separation unit. Here silica gel crystals are proposed to separate moisture. Silica gel crystals should be replaced after a specific time according to the rate of purification. The capacities of the scrubbing units are decided according to the size of the biogas plant. Now the outgoing biogas from the scrubbing unit is 98% pure. Further, if the purification is required the multiple number of scrubbing units can be used. It consists of one inlet for raw biogas to enter the unit and one outlet for clean biogas. The glass jar is tightly closed with a lid and hose attachment in order to prevent gas leakage. Likewise, two more scrubbing units are connected in series for carbon dioxide and moisture separation. Finally, the clean biogas from scruber unit is allowed to pass through a compressor.

**BOTTLING OF BIO-GAS USING HYBRID COMPRESSOR**

**Need of compression and storage of Biogas:**

- Large quantities of kitchen wastes are available at rural households. But no efforts have been made to use these wastes for the purpose of production of energy. Effort was made to use this Biogas as a source of cooking with the help of bio digesters.
- Due to smaller size of the plants and improper handling, the output of the gas was limited and irregular. It has always been considered only as a stand by alternative arrangement. Therefore, compression and storage system has been proposed to use the Biogas from digesters. Biogas is purified, compressed and stored in LPG cylinder which makes it easy to transport for use.

**Advantages of Compressing bio-gas into cylinders:**

- Reduces storage space requirements.
- Concentrates energy content.
- Increases pressure to the level needed to overcome resistance to gas flow.
• Compression can eliminate the mismatch of pressures and guarantee the efficient operation of the equipment.
• Provides multipurpose usage of bio gas anywhere, anytime.
• Portable unit makes easy operation of bio gas system.
• Avails usage of biogas for the operation of engines.

**Design of Hybrid scrubbing and bottling unit system:**

1. Inlet for the Bio-gas.
2. Scrubber unit.
3. Water pump (0.5HP, 1440 RPM).
4. Temporary storage tank for scrubber (40 Ltr).
5. Stage-1 low pressure (6 bar) compressor.
6. Stage-2 high pressure (10.3 bar) compressor.
7. Drive motor (2 HP, 1425 RPM).
8. High pressure storing tank (70 Ltr).
12. Rollers.
13. Pressure regulator.
15. Gas outlet.
17. Gas inlet.
18. Bends, connecting pipes (dia =1inches).
19. Pump inlet or to sump.
20. Collars (dia =1inches).
21. High pressure gas outlet.
22. Bottling or cylinder-filling knob.
23. CI Base of cylinder, compressor, roller.

**COMPARISION BETWEEN MODERN AND HYBRID SCRUBBING AND BOTTLING UNIT**

<table>
<thead>
<tr>
<th>MODERN TYPE</th>
<th>HYBRID TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Complex in design and operation.</td>
<td>• Simple in design and operation.</td>
</tr>
<tr>
<td>• High cost equipment.</td>
<td>• Low cost equipment.</td>
</tr>
<tr>
<td>• Not fully automatic.</td>
<td>• Fully automatic.</td>
</tr>
<tr>
<td>• It is not portable equipment.</td>
<td>• It is portable equipment.</td>
</tr>
<tr>
<td>• Operation and maintenance cost is high.</td>
<td>• Operation and maintenance cost is low.</td>
</tr>
<tr>
<td>• Suitable for larger biogas production units.</td>
<td>• Suitable for smaller and household biogas production units.</td>
</tr>
<tr>
<td>• Need of temporary storage equipment for gas.</td>
<td>• No need of temporary storage equipment for gas.</td>
</tr>
</tbody>
</table>

**PROBLEMS WE FACED IN PROJECT:**
- Corroded and damaged pipe line system and valves.
- Biogas scrubber was allowing gas to flow out of effluent line when system was not running.
- 0.5HP motor was getting heated quickly.
Instant water supply was not available.
High back pressure to the compressor.
Over suction of gas from digester.

SOLUTIONS:
A new non-corrosive and high temperature withstand able pipe line system has been installed.
Gas trap piping has been installed.
A new 1HP high performance motor has been installed.
Temporary storage tank has been installed.
Uni-directional valve has been fitted to the output gas line.
A gas level sensor has been provided to switch off the system automatically.

OUTCOME OF THE PROJECT:
Provision of bio-gas bottling unit for utilization of kitchen waste.
Portable scrubbing and bottling unit for bio-gas system.
Automatic cut off system to avoid over suction.
Conversion of kitchen waste gas into eco-friendly Gas for the vehicles.
Elimination of usage of petrol and diesel for transportation.

CONCLUSION:
Raw bio gas is converted into pure methane.
The scrubber utilizes water to filter the raw bio gas.
The purified bio gas can be either be used for the cooking purpose or fuel for vehicles.
The compression of methane is done and stored in cylinder.
Up to 50-100bar pressure is obtained using 2 stage compressors.
The working of 2 stage compressor is equally distributed to the motor.
The stored bio gas can be utilized to run the vehicles.

SCOPE OF THE PROJECT:
Development of Large digester Plant for the fulfilment of daily automobile usage.
Development of Liquification system for Biogas.
Development of temporary storage gas balloons for avoiding wastage of extra gas from digester.
Development of low cost high pressure Biogas cylinders.

~`*~`*~`*

DESIGN AND FABRICATION OF NEEM DE-PULPING MACHINE

Project Reference No.: 41S_B_BE_074

COLLEGE : S.J.M. INSTITUTE OF TECHNOLOGY, CHITRADURGA
BRANCH : DEPARTMENT OF MECHANICAL ENGINEERING
GUIDE : PROF. SRIDHAR & MR. VISHWANATH D
STUDENTS : MR. SHYAM SHANKAR S
           MR. SHARATH S B
           MR. TANVEER AHAMED N
           MR. HEMANTH KUMAR R

INTRODUCTION: In the modern era, the field of biofuel has found greater scope and importance contrasting to the depletion of fossil fuels. There has been lot of developments in regard to the production and usage of biodiesel. Biodiesel can be produced from various bio seeds such as Millettia pinnata, Pongamia, Jatropha, Neem and even from animal fats etc.
Neem seeds have to be de-pulped before the extraction of neem oil. This project deals with de-pulping of neem seeds. The present method of removing the outer pulp is manual which is tedious and time consuming. Also, the cost of de-pulped seeds is nearly 3 times more than that of normal seeds in the market which will definitely help the farmers. Along with this during crushing of pulped seeds most of the oil goes along with the cake reducing oil recovery. So, in our project, we have made an attempt to design and fabricate NEEM SEED DE-PULPING MACHINE. We have made sure that the dimension of parts comes in accordance with good specification.

OBJECTIVES:

- To make the process of de-pulping simple and time saving.
- To ensure farmers get more profit by selling the de-pulped seeds.
- To design a simple mechanism for de-pulping.
- To design the machine to suit working in rural atmosphere.
- To see that the cost of the machine is low.

METHODOLOGY:

- Fabrication of temporary model.
- Initial testing and observations on temporary model.
- Design of neem seed de-pulping machine.
- Fabrication of neem seed de-pulping machine.
- Final experimentation and results analysis.

The initial observations and experimentation was done of an temporary model. Tests like soaking test, time test and speed tests were conducted and approximate suitable conditions were determined. The de-pulping machine was then designed. The drum, frame, motor and blades were designed and then fabricated.

RESULTS:

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Soaking period (in hrs)</th>
<th>Weight (in kg)</th>
<th>Speed (in rpm)</th>
<th>Machine run time (in sec)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>2</td>
<td>460</td>
<td>10</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>2</td>
<td>460</td>
<td>20</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>36</td>
<td>2</td>
<td>460</td>
<td>30</td>
<td>Paste formation starts</td>
</tr>
</tbody>
</table>
• The machine was run at 450 rpm and continuous feeding was done with a small break after every 20 sec. It was observed that we were able to depulp 18 Kg of seeds in 189 sec. Considering a break of 1 sec for each break,
• Seed depulped = 18 Kg.
• Total time required = Time of depulping - Time of break
  = 189 Sec – 09 Sec = 180 Sec
• Hence in 1 Hr we can depulp 6 x 60 = 360 Kg
• Considering production η of 85% in 1 hr we can depulp 300 Kg of seeds.
• So capacity of the machine is 300 Kg per Hr.

CONCLUSION:
➢ The experimentation work on the final model revealed a good result.
➢ Even the capacity of the machine is found satisfactory when run at 450 rpm and continuous feeding of 1.5 Kg of seeds at a time with a break of 1 or 2 Sec for each feed.
➢ The time is around 20 Sec for each load.
➢ The only drawback is the cost. Since it is designed for formers the cost should be reduced.

FUTURE WORK:
➢ The whole machine can be designed for one or two Kg capacity and continuous feeding instead of 10 Kg capacity and hence cost can be reduced.
➢ A hopper can be designed for proper feeding of seeds.
➢ Direct drive can be designed for rotor instead of a belt drive so that capacity of the motor can be reduced hence the cost.
➢ A cleaning mechanism can be designed for cleaning the depulped seeds.
➢ An hot air drying mechanism can be designed for drying the seeds.
➢ A timer can be introduced to control the working time.
INTRODUCTION: Biodiesel is a renewable, clean-burning diesel replacement that is reducing U.S. dependence on foreign petroleum, creating jobs and improving the environment. Made from a diverse mix of feedstocks including recycled cooking oil, soybean oil, and animal fats, it is the first and only EPA-designated Advanced Befoul in commercial-scale production across the country and the first to reach 1 billion gallons of annual production. Meeting strict technical fuel quality and engine performance specifications, it can be used in existing diesel engines without modification and is covered by all major engine manufacturers’ warranties, most often in blends of up to 5 percent or 20 percent biodiesel. It is produced at plants in nearly every state in the country. Reaching that goal would significantly lessen U.S. dependence on imported oil, bolstering national security and reducing our trade deficit. At the same time, biodiesel’s growth would boost the U.S. economy, not just by creating jobs but also by reducing our dependence on global oil markets and vulnerability to price spikes. There are currently about 200 biodiesel plants across the country – from Washington state to Iowa to North Carolina – with registered capacity to produce some 3 billion gallons of fuel. The industry is supporting nearly 48,000 jobs, generating billions of dollars in GDP, household income and tax revenues. The industry’s economic impact is poised to grow significantly with continued production increases. The industry supports jobs in a variety of sectors, from manufacturing to transportation, agriculture and service.

METHODOLOGY

- Designing the drum for 10 kg pongamia seed capacity.
- Designing turning and steaming mechanism inside the drum.
- Designing a mechanism for generating steam.
- Testing and optimizing the time of steaming for maximum oil yield.

MATERIAL AND EQUIPMENTS REQUIRED:

<table>
<thead>
<tr>
<th>Parts</th>
<th>Details</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopper (outside chamber)</td>
<td>Mild steel plane sheet 14 gauge</td>
<td>1</td>
</tr>
<tr>
<td>Hopper (inside chamber)</td>
<td>Mild steel mesh sheet of 6mm dia hole 14 gauge</td>
<td>1</td>
</tr>
<tr>
<td>Pressure gauge</td>
<td>100 psi</td>
<td>1</td>
</tr>
<tr>
<td>Pressure relief valve</td>
<td>1 bar</td>
<td>1</td>
</tr>
<tr>
<td>Steam supplying pipes</td>
<td>Silicon rubber transparent tube</td>
<td>1</td>
</tr>
</tbody>
</table>

EXPECTATION

- We feel that oil yield will increase as seeds get hydrated maximum oil will come out.
- The load on the machine will decrease as the seed become soft and this will increase the life of screw of machine.

~*~*~*~*~
Increasing population density and economic development, particularly in developing countries like India, has led to a 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 no or very minor engine modification. Biodiesel is oxygenated and essentially free of sulfur making it a cleaner burning fuel than petrol and diesel, with reduced emissions of SOx, 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.

Transportation of the biodiesel seeds is the major cost and time-consuming process and this can be overtaken by the portable device developed by us. Since the device developed is of portable type we can produce a biodiesel at the location of availability of seeds and we are using a solar energy has a mean of power instead of conventional electricity supply this will be an eco-friendly action and also cost reductive.

Now, in most of the biodiesel production process, rumoured in the literature, reaction temperature is earned by the utilization of electricity which results in increase in production cost. So to bring down this high biodiesel production costs, in this method by using solar radiation and solar power to obtain the heat and running the stirrer, and therefore the use of radiation as heating supply, would lead to a method for getting a low cost sustainable biofuel.

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DESIGN AND FABRICATION OF MINI PORTABLE BIODIESEL PRODUCTION UNIT

INTRODUCTION: Now a days Biodiesel being a developing sector and there is a requirement of production of Biodiesel. However, in order to reduce the high capital investment for small scale production unit, our project provide a portable
biodiesel production unit (10 litre capacity), where the investment is low. The moto originally considered in the development of our project is for favouring small scale production plants located in remote locations & Research laboratories, where the portable unit can be moved for processing the oil into biodiesel.

**NON-EDIBLE SEED:** The seeds from which the non-edible oil can be extracted is known as non-edible seeds such as Neem seeds, Honge seeds, Simarouba seeds etc.,

**NON-EDIBLE OIL:** Other oils which cannot be added in food are called as Non-edible oils such as engine oils Honge seed’s oil, Simarouba seed’s oil, grease and lubricants etc.

**HONGE SEED:** This species is commonly known as Pongamia pinnata, Karanja. It is a tree that grows to a height of about 15 to 25m with a large canopy which spreads equally wide. It is one of the few nitrogen fixing trees (NFTS) to produce seeds containing 30 to 40% of oil & it is considered as source for biodiesel.

**OBJECTIVE:**
The main objectives of the project are:
- To fabricate a mini portable Biodiesel Production Unit.
- Small scale biodiesel production (10 litres Capacity).
- Research laboratory purpose.
- Low cost & Remote place applications.

**METHODOLOGY**

**CONCEPTUAL DESIGN:**

**CONSTRUCTION:** The assembly of our project mainly consists of Frame, Reactors, Pump, Heating Coil, Condenser, Water storage tanks, Pipes & Fittings, Pressure gauge, Temperature gauges & Wheels. There are two reactors, Reactor 1 & Reactor 2. The Reactor 1 is a closed circuit connected through pipes & fittings, with a pump 1 at bottom and a
condenser at the top, where the cold water is pumped to the condenser through pump 2 for heat exchanging purpose. The pump 1 is also connected to Reactor 2, where there is facility to supply hot water, which is stored in hot water storage tank. Both these Reactor has heater for heating purpose & Temperature gauges to measure temperature and control valves which control the flow rate. A pressure gauge & safety valve is mounted on the top of Reactor 1. The above-mentioned components are mounted on a frame which has wheels at the bottom, which enables the unit to move from one place to another place.

WORKING PRINCIPLE: The working principle of the portable biodiesel production unit is based on the reaction between Non-edible seed’s oil (e.g., Hongae seed’s oil) & methanol (alcohol) including catalyst (Sodium hydroxide or Pottasium hydroxide). The above-mentioned solution is filled in reactor & heated upto 60°C and circulated within the reactor through the pump and then the obtained partial biodiesel phase is transferred to the washing column, which results in extraction of pure biodiesel.

WORKING MODEL:

CALCULATION & RESULT

DETAILS OF WORKING MODEL:
- Length : 800mm
- Width : 400mm
- Height : 1200mm
- Weight : 58.5 Kg

CALCULATION OF ELECTRICITY COST:

Power consumption of Pump 1 = 74.5 w
Run time of Pump 1 = 2 hr
Total power consumed by Pump 1 = 74.5 * 2 = 149 wh

Power consumption of Pump 2 = 25 w
Run time of Pump 2 = 2 hr
Total power consumed by Pump 2 = 25 * 2 = 50 wh

Power consumption of Heaters = 2000 w
Time required for Heating = 0.33 hr
Total power consumed by Heaters = 2000 * 0.33 = 660 wh

Total Power consumed by the Unit = 149 + 50 + 660 = 859 wh / per day

i.e., 0.859 Kwh/day or 0.859 Units/day
Overall power consumed by the Unit per month = 0.859 * 30 = 25.77 Units / Month

Electricity Cost = Overall power consumed by the Unit per month * Cost / unit
= 25.77 * 3.15
= Rs. 81.17

The electricity cost for the Biodiesel production unit per month is Rs. 81.17 /-

CALCULATION OF CYCLE TIME FOR PRODUCTION OF BIODIESEL:

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- Reaction time = 2.5 hrs.
- Settling time = 4 hrs.
- Washing time = 1.5 hrs.

The cycle time for Biodiesel production is 8 hours.

\[
Yield\ of\ Biodiesel = \frac{\text{Mass of Biodiesel produced}}{\text{Mass of Honge oil used}}
\]

\[
= \frac{9400}{10000}
\]

\[\therefore\ Yield\ of\ Biodiesel = 94\%
\]

RESULT: Yield of Biodiesel Produced is 94%

The above procedure is carried out for 5 trials of Biodiesel Production and the following results were obtained:

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Honge Oil Used in ml</th>
<th>Biodiesel produced in ml</th>
<th>Yield of Biodiesel in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10000</td>
<td>9100</td>
<td>91%</td>
</tr>
<tr>
<td>2.</td>
<td>10000</td>
<td>9200</td>
<td>92%</td>
</tr>
<tr>
<td>3.</td>
<td>10000</td>
<td>9300</td>
<td>93%</td>
</tr>
<tr>
<td>4.</td>
<td>10000</td>
<td>9300</td>
<td>93%</td>
</tr>
<tr>
<td>5.</td>
<td>10000</td>
<td>9400</td>
<td>94%</td>
</tr>
</tbody>
</table>

Table No. 1.0 Results of Biodiesel production

ADVANTAGES
- Low capital investment & Less complexity in operation.
- Small scale industries located in remote places.
- Since it is portable, it can be easily moved from one place to another place.
- Since, it is a green technology, utilization of biodiesel in automobile can reduce the pollution.
- It saves the fuel cost and also it reduces the dependency on fossil fuels.
- Electricity needs can be supplied by a generator, that runs on biodiesel.

APPLICATIONS
- It is utilized in small scale production plants located in remote locations.
- It is used in Research laboratories
- Utilization of biodiesel to run the automobiles, like car, buses, etc.
- It is also used to run agricultural equipment's i.e., diesel engine assisted machines like generators.
- The by-product (glycerine) produced during the biodiesel production can be used in production of bio-soaps.

COST DETAILS:
The overall cost of the project is Rs. 30500 /-

CONCLUSION
- Successful development of Portable Biodiesel Production Unit (10 litres capacity) with a yield of Biodiesel Production of about 91% to 94%.
- This unit can be used in laboratories which require small quantity of biodiesel for research purposes.
- This unit can be in utilized in small scale industries located in remote place.
- To run agricultural equipment's.

SCOPE FOR IMPROVEMENT
- The developed Mini Portable Biodiesel production unit is semi-automatic but, it can be automated by using timers, sirens and alarms etc., electrical device.
- Solar powered fully automated unit can be developed using logic circuits.
SEMI AUTOMATED HONGE SEED CLEANING MACHINE

Project Reference No.: 41S_B_BE_108

COLLEGE : SIDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU
BRANCH : DEPARTMENT OF MECHANICAL ENGINEERING
GUIDE : Dr. R. SURESH
STUDENTS : Mr. MUSTHAFAEEZ MUHEEB AHAMED
Mr. L MANU
Mr. M SAGAR
Mr. MOHAMMED SABEER

INTRODUCTION: The world is facing the crisis of depletion of fossil fuels as well as the problem of environmental degradation. The rapid depletion of fossil fuels, reservoirs with increased demand and uncertainty in their supply, as well as rapid rise in petroleum price, has stimulated the search for other alternatives to fossil fuels. In view of this, there is an urgent need to explore new alternatives which are likely to reduce our dependency on oil imports as well as can help in protecting the environment for sustaining the development. Many alternative fuels are being recently explored as potential alternatives for the present high pollutant diesel fuel derived from diminishing commercial resources.

Bio diesel emerges as one of the most energy efficient environmentally friendly options in recent times to fulfil the future energy needs. Bio diesel is a renewable diesel substitute can be obtained by combining chemically and natural oil. During the last 15 years bio diesel has progressed from the research stage to a large-scale production in many developing countries. In Indian context, non-edible oils are emerging has preferred feedstock for extraction of bio oil.

Seed cleaning is necessary before the extraction of Bio-oil. ‘Semi-Automated Seed Cleaning Machine’, reduces time and increases production.

Existing Observation
➢ Cleaning of Honge Seeds is a difficult and time-consuming task.
➢ The presence of stones and metal particles may damage the machine.
➢ Presence of waste material affects quality of Bio Diesel.
➢ New equipment is required for 32 Bio-Fuel Research and Development centres.

METHODOLOGY

Fabrication Procedure:
By several observations of the manual honge seed cleaning, here is an alternative which reduces the time consumed for cleaning and also enhances the quality of the Bio-Fuel. Here is the methodology of the semi-automated honge seed cleaning machine. The methods are:
➢ Collecting of seeds.
➢ Transfer of seeds into hopper.
➢ Passing of seeds from the hopper with control feed.
➢ Passing of seeds to salt solution bath.
➢ Scooping of seeds into sieving machine.
➢ Seeds are passed through different meshes were different size unproductive are removed.
➢ At last, cleaned seeds are collected.

Existing Method Study: Several samples were taken and recorded and tabulated in the table 3.1 the weights of the seeds were taken in the increments of 1kg and the readings were taken.

Table: Details of the experiment conducted on manual seed cleaning.

<table>
<thead>
<tr>
<th>Group selected</th>
<th>Weights of seed taken (in grams)</th>
<th>Weight of the Waste (in grams)</th>
<th>Time (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1000</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>
Huge tons of seeds are grouped into A, B, C slots and the seeds are taken from every slot in the increment of 1kg and the seeds are manually cleaned and the time required to clean the seeds are recorded.

**Calculation of Density:** Secondly another experiment we had performed to check the required density of salt solution for the honge seeds to float so that they can be scooped from the salt solution easily.

So water of 200ml was taken in beaker and salt was added at increments of 10gms. honge seeds of different masses were dumped in the salt solution.

The weight of empty beaker was recorded and then the 200ml of water is poured into the beaker. Then the weight of salt was recorded and salt is poured into the beaker and stirred thoroughly and then the values that were recorded during the experiment are tabulated in the table 3.2. The density of the salt solution was found by trial and error method.

**Table:** Details of the experiment conducted on density of salt solution

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Salt added to Water in grams</th>
<th>Result of Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>Seeds Sink</td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>Seeds Float</td>
</tr>
</tbody>
</table>

**Discussion:** For one litre of water 350 grams of salt is required so that seeds float during cleaning.

**DESIGN AND DEVELOPMENT OF THE EQUIPMENT**

**Table:** Details of the Equipment’s required for Fabrication of the model

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Equipment</th>
<th>No’s</th>
<th>Material</th>
<th>Size</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hopper</td>
<td>1</td>
<td>Sheet metal</td>
<td>45x45cm</td>
<td>Control seed flow</td>
</tr>
<tr>
<td>2.</td>
<td>Salt Bath Tank</td>
<td>1</td>
<td>Sheet metal</td>
<td>60x50x15cm</td>
<td>Storage of salt solution</td>
</tr>
<tr>
<td>3.</td>
<td>Meshes</td>
<td>2</td>
<td>Mild steel</td>
<td>75x75 cm</td>
<td>Rhombus shape</td>
</tr>
<tr>
<td>4.</td>
<td>Mainframe</td>
<td>1</td>
<td>Round tube</td>
<td>80x60x90cm</td>
<td>Holding structure</td>
</tr>
</tbody>
</table>

**Final model:**

![Figure: Front view of the model](image1)

![Figure: Side view of the model CATIA model of machine](image2)
PERFORMANCE TEST OF THE MODEL: The seed cleaning machine performance was tested by taking unclean seeds in increments of 5000 grams. The time taken for seed cleaning and the debris collected were noted and are tabulated in table 6.1

Table: Details of the experiment conducted on seed cleaning machine

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Weight of seeds taken (in grams)</th>
<th>Time taken for cleaning (in minutes)</th>
<th>Weights of waste collected (in grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5000</td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>10000</td>
<td>15.0</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>15000</td>
<td>22.5</td>
<td>375</td>
</tr>
<tr>
<td>4</td>
<td>20000</td>
<td>30.0</td>
<td>500</td>
</tr>
<tr>
<td>5</td>
<td>25000</td>
<td>37.5</td>
<td>625</td>
</tr>
<tr>
<td>6</td>
<td>30000</td>
<td>45.0</td>
<td>740</td>
</tr>
<tr>
<td>7</td>
<td>35000</td>
<td>52.5</td>
<td>870</td>
</tr>
<tr>
<td>8</td>
<td>40000</td>
<td>60.0</td>
<td>990</td>
</tr>
</tbody>
</table>

Technical specification:
- Time required to clean 40 Kgs of seed = 1 hour
- Time required to clean 1 Kg of seeds: 
  \[ \frac{3600}{40} = 90 \text{ seconds} \]
- Time required to clean 200Kg of seed:

  \[
  \begin{align*}
  &= 200 \times 90 \\
  &= 18000 \text{ seconds} \\
  &= 5 \text{ hours}
  \end{align*}
  \]

**Outcomes of the project:**

- The demand of existing mini expeller i.e. required cleaned seeds of 200 kg/day is achieved.
- Increased the production of bio-oil.
- Maintaining the expeller life and its parts by restricting the foreign particles entering it.
- Seed cleaning solution for 32 Bio Fuel IR & D centers.
- Solution of manual cleaning.
- By doing so the work life of expeller screw conveyor is increased.
- Provision of automation.

**Result:** Capacity Specification of the equipment is 40 kg per hour.

~`*~`*~`~`
## LIST OF PROJECTS SANCTIONED UNDER
### 41st SERIES OF STUDENT PROJECTS PROGRAMME: 2017 – 2018
### BIOFUEL PROJECTS

### BE PROJECTS

#### 1) ACS COLLEGE OF ENGINEERING, BENGALURU

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>41S_B_BE_073</td>
<td>AN EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE OF SINGLE CYLINDER CI ENGINE FUELLED WITH BIODIESEL AND HYDROGEN</td>
<td>MECHANICAL ENGINEERING</td>
<td>Dr. R. SIVA SUBRAMANIYAM Mr. CHETHAN KUMAR PATIL</td>
</tr>
</tbody>
</table>

#### 2) ADICHUNCHANAGIRI INSTITUTE OF TECHNOLOGY, CHIKKAMAGALURU

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>NUMERICAL INVESTIGATION OF KIRLOSKAR DIESEL ENGINE USING CALOPHYLLUM INOPHYLLUM AS A BIODIESEL</td>
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<td>Prof. SUCHITH KUMAR MT Ms. SONU DK</td>
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#### 3) AMC ENGINEERING COLLEGE, BENGALURU

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<td>1.</td>
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<td>UTILIZATION OF SIMAROUBA SEED CAKE AND SPENTWASH FOR THE PRODUCTION OF BIOMASS</td>
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<td>Mr. SANTHOSH U Mr. PUSHPANSHU SAHU</td>
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<td>FABRICATION OF OIL EXTRACTOR FROM PONGAMIA SEEDS FOR BIODIESEL</td>
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<td>Dr. A K MURTHY Mr. AKSHAY MAHABALESHWAR BADIGER</td>
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#### 4) AMRITA SCHOOL OF ENGINEERING BENGALURU CAMPUS

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<td>A STUDY ON DIESEL ENGINE USING WASTE COOKING OIL WITH BIOTIC ADDITIVE</td>
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<td>Prof. DIVAKAR SHETTY AS Ms. SRIRAM SRINIVASAN</td>
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#### 5) BLDEA P G HALAKATI COLLEGE OF ENGINEERING AND TECHNOLOGY, VIJAYAPURA

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#### 6) CANARA ENGINEERING COLLEGE, MANGALURU

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<td>41S_B_BE_101</td>
<td>KITCHEN TOP BIOGAS DIGESTER</td>
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#### 7) DAYANANDA SAGAR COLLEGE OF ENGINEERING, BENGALURU

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<td>PRODUCTION OF MYCODEiesel FROM COST EFFECTIVE HYDROCARBONS OF ENDOPHYTEicular FUNGAL SPECIES OF PONGAMIA AND JATROPHA</td>
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<td>BIOFUEL PRODUCTION USING INNOVATION AND COST EFFECTIVE BIOREACTOR FROM MICROALGAE AND PVA BY HYDROTHERMAL LIQUEFACTION TECHNOLOGY (AT LOW TEMPERATURE).</td>
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<td>Mrs. MANASA V ANAND Ms. VAISHNAVI CONETI</td>
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#### 8) EAST WEST INSTITUTE OF TECHNOLOGY, BENGALURU

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<td>41S_B_BE_040</td>
<td>SYNTHESIS OF COMPARATIVE ANALYSIS OF PONGAMIA OIL BIO LUBRICANT</td>
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#### 9) GIRIJABAI SAIL INSTITUTE OF TECHNOLOGY, KARWAR

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<td>PRODUCTION OF BIOETHANOL FROM WASTE CASHEW APPLE AND USE OF BIOETHANOL AS FUEL FOR IC ENGINE</td>
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<td>Prof. SANTOSH BHUMBAR Mr. NARAYAN NAIK GAONKAR</td>
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#### 10) GM INSTITUTE OF TECHNOLOGY, DAVANGERE

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<td>41S_B_BE_018</td>
<td>PRODUCTION OF BIOFUEL AND BIOSORPTION OF HEAVY METALS BY MICROALGAE USING INDUSTRIAL WASTE WATER</td>
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<td>Dr. H GURUMURTHY Ms. SAHANA S KULKARNI</td>
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### 11) GURU NANAK DEV ENGINEERING COLLEGE, BIDAR

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<td>Mr. CHANDRASHEKAR PATIL Mr. PRASHANT KAMBLE</td>
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### 12) HKBK COLLEGE OF ENGINEERING, BENGALURU

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### 13) JAIN COLLEGE OF ENGINEERING, BELAGAVI

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<td>16.</td>
<td>41S_B_BE_079</td>
<td>DESIGN AND DEVELOPMENT OF LOW CAPACITY PRESSURE REACTOR FOR PRODUCTION OF CEIBA PENTANDRA, MILK SCUM OIL BIODIESEL USING GRAPHENE OXIDE AS CATALYST</td>
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<td>Prof. BHASKAR BOGAR Mr. RAJAT PALAKSHAPPA</td>
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### 14) JAIN INSTITUTE OF TECHNOLOGY, DAVANGERE

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<td>17.</td>
<td>41S_B_BE_102</td>
<td>DESIGN AND FABRICATION OF A CERATONIA SILIQUA DEPULP AND SEED EXTRACTION MACHINE</td>
<td>MECHANICAL ENGINEERING</td>
<td>Mr. PRADEEP KUMAR ILAY Mr. SANTOSH C</td>
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### 15) JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA

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<td>41S_B_BE_094</td>
<td>DESIGN AND FABRICATION OF BIODIESEL FILTER</td>
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<td>Mr. RAVIKUMAR B. N. Mr. GOWTHAM S</td>
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<td>41S_B_BE_109</td>
<td>MECHANIZED PONGAMIA POD HARVESTER</td>
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### 16) KARAVALI INSTITUTE OF TECHNOLOGY, MANGALURU

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<td>20.</td>
<td>41S_B_BE_053</td>
<td>OPTIMIZATION AND PRODUCTION OF BIODIESEL FROM DAIRY WASH WATER USING NANO SCIENCE, RSM METHODOLOGY AND ITS PERFORMANCE EVALUATION IN DI- DIESEL ENGINE FOR VARIOUS COMPRESSION RATIOS</td>
<td>MECHANICAL ENGINEERING</td>
<td>Prof. DINESH KUMAR K Mr. ASHISH KUMAR</td>
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### 17) KLE COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI

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<td>21.</td>
<td>41S_B_BE_097</td>
<td>DESIGN AND DEVELOPMENT OF THERMAL PYROLYSIS UNIT FOR THE PRODUCTION OF LIQUID FUEL BY USING HOUSEHOLD PLASTIC WASTE</td>
<td>MECHANICAL ENGINEERING</td>
<td>Prof. P. I. UGRAN Mr. MALLINATH C KUMBAR</td>
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### 18) KLE COLLEGE OF ENGINEERING AND TECHNOLOGY, CHIKODI

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<td>22.</td>
<td>41S_B_BE_047</td>
<td>OPTIMIZATION OF PERFORMANCE CHARACTERISTICS OF DI DIESEL ENGINE WITH BLENDS OF HONNE(CALLOPHYLLUM INOPHYLLUM LINN) BIO-DIESEL AND PURE DIESEL</td>
<td>MECHANICAL ENGINEERING</td>
<td>Mr. MURALI AMBEKAR Mr. MUDASI S.K</td>
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### 19) KLS GOGTE INSTITUTE OF TECHNOLOGY, BELGAUM

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<td>23.</td>
<td>41S_B_BE_041</td>
<td>PREPARATION OF BIOFUEL BLENDED WITH NANOPARTICLES</td>
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<td>Dr. T.R. ANIL Mr. VISHNU SHETTY</td>
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### 20) MALNAD COLLEGE OF ENGINEERING, HASSAN

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<td>24.</td>
<td>41S_B_BE_019</td>
<td>ECOTOXICITY AND BIODEGRADABILITY STUDIES OF NEEM OIL BASED METAL CUTTING FLUID</td>
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<td>25.</td>
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<td>PERFORMANCE EVALUATION OF NEEM OIL AS BIO-LUBRICANT USING NANO ADDITIVES</td>
<td>MECHANICAL ENGINEERING</td>
<td>Dr. S. R. JAYARAM Mr. THEJAS K. S.</td>
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<td>26.</td>
<td>41S_B_BE_021</td>
<td>COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF FOUR STROKE GASOLINE ENGINE UNDER THE VARIOUS BLENDS WITH BIO LUBRICANTS.</td>
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<td>Dr. Y. M. SHASHIDHARA Mr. ASHOKA G U</td>
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### 21) Mangalore Institute of Technology and Engineering, Moodbidri

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<td>27.</td>
<td>41S_B_BE_057</td>
<td>Performance and Emission Characteristics Studies of CI Engine using Graphene and Alumina Oxide Nano Particles Blended Dairy Waste Scum BIO Diesel and Effect of Injection Pressure and Three and Five Hole of Nozzle Combustion Process</td>
<td>Mechanical Engineering</td>
<td>Dr. Vignesh Nayak</td>
<td>Mr. Mohammed Safwan</td>
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### 22) Manipal Institute of Technology, Manipal

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<td>28.</td>
<td>41S_B_BE_099</td>
<td>Optimization of Biogas Production in Semi Batch Reactors</td>
<td>Chemical Engineering</td>
<td>Dr. Gautam Jeppu</td>
<td>Mr. Jayalal J.</td>
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### 23) Nagarjuna College of Engineering and Technology, Bengaluru

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<td>29.</td>
<td>41S_B_BE_042</td>
<td>Pilot Plant Study for Sustainable Energy Generation in Septic Tank Using Bio-Fuel Cell</td>
<td>Civil Engineering</td>
<td>Dr. K. Kumar</td>
<td>Mr. Mayana Ismail Khan</td>
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### 24) New Horizon College of Engineering, Bengaluru

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<td>41S_B_BE_003</td>
<td>Experimental Study of Acetylene and Alcohol as an alternative fuel for Gasoline Engine</td>
<td>Mechanical Engineering</td>
<td>Dr. M S Ganesh Prasad</td>
<td>Mr. Zaki Amer</td>
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<td>31.</td>
<td>41S_B_BE_006</td>
<td>A Comparative Study of the Properties and Effects of Different Blends of Bio-Diesel on Crankcase Lubricant and Perform Exhaust Gas Analysis for the Same</td>
<td>Mechanical Engineering</td>
<td>Mr. Kamalasish Deb</td>
<td>Mr. Amar Kumar Bhatt</td>
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<td>32.</td>
<td>41S_B_BE_007</td>
<td>Design and Fabrication of Machine to Convert Plastic into Oil and Gaseous Fuel Production</td>
<td>Mechanical Engineering</td>
<td>Prof. Lakshmana Naik</td>
<td>Mr. Sital Kumar Sah</td>
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<td>33.</td>
<td>41S_B_BE_008</td>
<td>Improvement of Physical and Combustion Properties of Fuel Briquette From Pongamia and Glycerin Mixing Different Binders</td>
<td>Mechanical Engineering</td>
<td>Mr. Lakshminarasmihani</td>
<td>Mr. Arjun Yadav</td>
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<td>34.</td>
<td>41S_B_BE_067</td>
<td>A Coupled Process Integrating Heavy Metal Bioremediation and Biodiesel Production Using Oleaginous Microalgae</td>
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<td>Dr. R.S. Upendra</td>
<td>Ms. Chathanya Lakshmi</td>
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<td>35.</td>
<td>41S_B_BE_090</td>
<td>Design of Pyrolysis Reactor for Synthesis of Biodiesel from Poultry Waste (Chicken Feathers) and Engine Performance Testing</td>
<td>Biotechnology</td>
<td>Mr. Girish N Desai</td>
<td>Mr. Manan Chamaria</td>
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### 25) NMAM Institute of Technology, Nitte

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<td>41S_B_BE_063</td>
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<td>Dr. C. Vaman Rao</td>
<td>Ms. Shaikh Anambanu Ameer</td>
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<td>37.</td>
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<td>Glycerol as a Feed Stock for Microbial Lipid Production</td>
<td>Biotechnology</td>
<td>Ms. Harshitha M Jathanna</td>
<td>Ms. Elsa Joissy J</td>
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### 26) PES College of Engineering Mandy

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<td>41S_B_BE_072</td>
<td>Low Cost and Portable Scrubbing and Bottling Unit Using Hybrid Compressor for Bio Fuel System</td>
<td>Mechanical Engineering</td>
<td>Prof. K J Mahendra Babu</td>
<td>Mr. Manoj T</td>
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### 27) R. V. College of Engineering, Bengaluru

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<td>41S_B_BE_081</td>
<td>Production of Bacterial Cellulose from Sewage and its Use in Power Generation Through Enzymatic Fuel Cell Formulation</td>
<td>Biotechnology</td>
<td>Dr. Lingayya Hiremath</td>
<td>Ms. Aishwarya Bhat</td>
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### 28) Ramaiyah Institute of Technology, Bengaluru

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<td>40.</td>
<td>41S_B_BE_027</td>
<td>Chemical and Enzymatic Conversion of Bio-Glycerol to Acetins</td>
<td>Chemical Engineering</td>
<td>Dr. Rajeswari M Kulkarni</td>
<td>Mr. Syed Saqline</td>
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<td>41.</td>
<td>41S_B_BE_028</td>
<td>Catalytic Conversion of Glycerol to Oxygenated Fuel Additive (Solketal) Using Heteropolyacid</td>
<td>Chemical Engineering</td>
<td>Dr. Archana</td>
<td>Mr. Sudarshan C S</td>
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### 29) Sahyadri College of Engineering and Management, Adyar, Mangaluru

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<td>41S_B_BE_043</td>
<td>Biodiesel extraction from waste plastic material</td>
<td>Mechanical Engineering</td>
<td>Mr. Suhas</td>
<td>Mr. Chandan P S</td>
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<td>43.</td>
<td>41S_B_BE_044</td>
<td>Optimization for high yield biodiesel production from fish oil using nano catalyst and performance evaluation in diesel engine</td>
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<td>Mr. Ajith B.S</td>
<td>Mr. Mohammed Yasiruddin K B</td>
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<td>44.</td>
<td>41S_B_BE_046</td>
<td>Experimental investigation on performance &amp; emission characteristics using poultry waste biodiesel and additives in CI engine</td>
<td>Mechanical Engineering</td>
<td>Mr. Lawrence Joseph Fernandez</td>
<td>Mr. Mohammed Safuwan C A</td>
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### 30) Sapthagiri College of Engineering, Bengaluru

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<td>45.</td>
<td>41S_B_BE_062</td>
<td>Investigations on performance and pollution level on n-butanol blended petrol fueled IC engine (10% to 50% blending)</td>
<td>Mechanical Engineering</td>
<td>Prof. Raghuthama Rao</td>
<td>Mr. Chetan R</td>
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<td>46.</td>
<td>41S_B_BE_076</td>
<td>Design and lab scale ultrasound batch reactor for the production of biodiesel from the slaughter waste.</td>
<td>Biotechnology</td>
<td>Prof. Kavya MV</td>
<td>Ms. Niranjana S</td>
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### 31) SDM College of Engineering and Technology, Dharwad

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<tr>
<td>47.</td>
<td>41S_B_BE_100</td>
<td>Waste to energy with a Bio Gas Unit</td>
<td>Civil Engineering</td>
<td>Dr. S.G. Joshi</td>
<td>Mr. Akash Dhawale</td>
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### 32) Secab Institute of Engineering and Technology, Vijayapur

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<td>48.</td>
<td>41S_B_BE_082</td>
<td>Energy-exergy analysis of CI engine fueled with rapeseed/waste cooking oil based biodiesel</td>
<td>Mechanical Engineering</td>
<td>Prof. Syed Abbas Ali</td>
<td>Mr. Mudasi Basavaraj Bhimappa</td>
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### 33) SG Balekundri Institute of Technology, Belagavi

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<td>49.</td>
<td>41S_B_BE_012</td>
<td>Biodiesel from Sal seed oil</td>
<td>Mechanical Engineering</td>
<td>Prof. Prasad Kolloimath</td>
<td>Mr. Imamuddin S Rahimkhair</td>
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### 34) Siddaganga Institute of Technology, Tumakuru

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<td>50.</td>
<td>41S_B_BE_033</td>
<td>Solar heat assisted biodiesel production from non edible oil seeds and its performance study on CI engine</td>
<td>Mechanical Engineering</td>
<td>Dr. R. Suresh</td>
<td>Mr. Ananda G</td>
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<td>51.</td>
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<td>Study of Calophyllum inophyllum biodiesel and performance on CI engine using combination of bioethanol, biodiesel, diesel and its feasibility study using natural and synthetic antioxidant</td>
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<td>Mr. Arun S B</td>
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<td>52.</td>
<td>41S_B_BE_035</td>
<td>Production of biodiesel using animal fat and study of performance on CI engine using combination of butanol, biodiesel, diesel and its feasibility study</td>
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<td>Mr. Namith B M</td>
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<td>53.</td>
<td>41S_B_BE_107</td>
<td>Design and fabrication of Mini portable biodiesel production unit</td>
<td>Mechanical Engineering</td>
<td>Mr. Omkaresh B R</td>
<td>Mr. Manikanta B</td>
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<td>Semi automated Honge Seed cleaning machine</td>
<td>Mechanical Engineering</td>
<td>Dr. R. Suresh</td>
<td>Mr. Mustafieez Muheeb Ahamed</td>
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### 35) SJM Institute of Technology, Chitradurga

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<td>Design and fabrication of neem de-pulping machine</td>
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<td>56.</td>
<td>41S_B_BE_112</td>
<td>Study on effect of steaming Pongamia seeds before crushing on oil yield</td>
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### 36) STJ Institute of Technology, Ranebennur

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<td>Performance analysis of CI engine fueled with turmeric leaf oil assisted by magnetic fuel energizer</td>
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<td>Mr. Girish S Halli</td>
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<td>MECHANICAL ENGINEERING</td>
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### 38) THE NATIONAL INSTITUTE OF ENGINEERING, MYSURU

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<td>59.</td>
<td>41S_B_BE_023</td>
<td>APPLICATION OF GLOBAL POSITIONING SYSTEM (GPS) IN MAPPING OF BIOFUEL PLANTATION</td>
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### 39) THE OXFORD COLLEGE OF ENGINEERING

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<td>60.</td>
<td>41S_B_BE_038</td>
<td>PERFORMANCE AND EMISSION CHARACTERISTICS OF INTERNAL COMBUSTION ENGINE FUELLED WITH TWO BIO-DIESEL BLEND</td>
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<td>Dr. RAJU B R Ms. NISCHITHA L</td>
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### 40) VEMANA INSTITUTE OF TECHNOLOGY, BENGALURU

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<td>41S_B_MSC_019</td>
<td>PRODUCTION OF BIOETHANOL FROM AGRO WASTES</td>
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#### 43) DEPARTMENT OF BIOTECHNOLOGY, GULBARGA UNIVERSITY

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#### 44) DEPARTMENT OF MICROBIOLOGY AND BIOTECHNOLOGY, BENGALURU UNIVERSITY

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#### 45) DEPARTMENT OF MICROBIOLOGY, DAVANGERE UNIVERSITY

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<td>EFFICACY OF PONGAMIA OIL BASED SOAP AGAINST CONVENTIONAL SOAPS WITH RESPECT TO ANTIBACTERIAL ACTIVITY TO ENCOURAGE HYGIENE PRACTICE AMONG RURAL FOLK</td>
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<td>BIOETHANOL PRODUCTION PROCESS OPTIMIZATION FROM CITRUS SPS SEED OIL AND ITS CHARACTERIZATION</td>
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<td>Dr. SHARANGOUDA J. PATIL Ms. PUJA KUMARI</td>
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<td>GENETIC VARIATION ANALYSIS OF MICROALGAL SPECIES UNDER NUTRIENT STRESS THROUGH MARKER ASSISTANCE FOR POTENTIAL BIOFUEL SOURCE</td>
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<td>Dr. SIBI G</td>
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<td>BIO-CAPSULE FORMATION FOR BIOETHANOL PRODUCTION FROM AGROWASTE</td>
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<td>Dr. LATHA B V</td>
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### 49) MAHARANI LAXSHMI AMMANI COLLEGE FOR WOMEN, BENGALURU

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<td>ISOLATION AND CHARACTERIZATION OF KARANJIN FROM PONGAMIA SEED CAKE FOR INSECTICIDAL ACTIVITY</td>
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<td>Dr. BABITHA B.</td>
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<td>74.</td>
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<td>Dr. VISHWANATHA.T</td>
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<td>75.</td>
<td>41S_B_MSC_008</td>
<td>PRODUCTION OF BIOETHANOL FROM AGRICULTURAL WASTE USING FUNGI AND SACCHAROMYCES CEREVISIAE</td>
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<td>Dr. VISHWANATHA. T</td>
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<td>76.</td>
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<td>EFFECTIVE COMPOSTING OF BIOWASTE AND PONGAMIA PINNATA CAKE USING TRICHODERMA</td>
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<td>41S_B_MSC_020</td>
<td>DETECTION OF ANTIFUNGAL ACTIVITY OF PONGAMIA OIL AND BIODIESEL PRODUCTS AGAINST PATHOGENIC PLANT FUNGI</td>
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<td>41S_B_MSC_006</td>
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<td>Dr. R. G. SHARATHCHANDRA</td>
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<td>Prof. SREENIVASALU REDDY</td>
<td>Mr. RAMACHANDREGOWDA P L</td>
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### 54) VTU CENTRE FOR POST GRADUATION STUDIES, MYSURU

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<td>Dr. MALLIKARJUNAYYA C MATH</td>
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### 55) NMAM INSTITUTE OF TECHNOLOGY, KARKALA

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<td>Prof. SANTHOSH KUMAR S</td>
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<td>Dr. Y.M.SATISH</td>
<td>Mr. KARTHIKEYAN V</td>
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<td>Dr. Rashmi Kodikal</td>
<td>Mr. Varun.K</td>
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<td>Dr. Vishal Samarth</td>
<td>Ms. Anupama P S</td>
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<td>Dr. VidyaVathi K</td>
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### Karnataka State Council for Science and Technology
Indian Institute of Science Campus, Bengaluru - 560012

#### List of Projects Sanctioned for Seminar and Exhibition Under 41st Series of Student Projects Programme: 2017 – 2018

**Biofuel Projects**

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<td>41S_B_BE_087</td>
<td>Numerical Investigation of Kirloskar Diesel Engine Using Calophyllum Inophyllum as a Biodiesel</td>
<td>Mechanical Engineering</td>
<td>Prof. Suchith Kumar MT</td>
<td>Ms. Sonu DK</td>
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2) **Amrita School of Engineering Bengaluru Campus**

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<td>2.</td>
<td>41S_B_BE_065</td>
<td>A Study on Diesel Engine Using Waste Cooking Oil with Biotic Additive</td>
<td>Mechanical Engineering</td>
<td>Prof. Divakar Shetty AS</td>
<td>Mr. Sriram Srinivasan</td>
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3) **Canara Engineering College, Mangaluru**

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<td>3.</td>
<td>41S_B_BE_101</td>
<td>Kitchen Top Biogas Digester</td>
<td>Mechanical Engineering</td>
<td>Mr. M Prashanth Kamath</td>
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4) **Dayananda Sagar College of Engineering, Bengaluru**

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<td>41S_B_BE_013</td>
<td>Production of Myco-Diesel from Cost Effective Hydrocarbons of Endophytic Fungal Species of Pongamia and Jatropha</td>
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<td>Dr. Govindappa M</td>
<td>Ms. Zoya Noorain</td>
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<td>5.</td>
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<td>Biofuel Production Using Innovation and Cost Effective Bioreactor from Microalgae and PVA by Hydrothermal Liquefaction Technology (At Low Temperature).</td>
<td>Biotechnology</td>
<td>Mrs. Manasa V Anand</td>
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5) **East West Institute of Technology, Bengaluru**

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<td>41S_B_BE_040</td>
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<td>Mechanical Engineering</td>
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<td>Mr. Rahul V</td>
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<td>41S_B_BE_088</td>
<td>Design and Fabrication of Motor Driven Cattle Dung Mixer for BioGas Plant</td>
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<td>Prof. Shwethashree B</td>
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6) **Girijabai Sail Institute of Technology, Karwar**

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<td>Mechanical Engineering</td>
<td>Prof. Santosh Bhimbar</td>
<td>Mr. Narayan Naik Gaonkar</td>
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7) **GM Institute of Technology, Davangere**

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<td>Dr. H Gurumurthy</td>
<td>Ms. Sahana S Kulkarni</td>
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### 8) GURU NANAK DEV ENGINEERING COLLEGE, BIDAR

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<td>10.</td>
<td>41S_B_BE_010</td>
<td>Production of biodiesel from non edible oil and investigating its suitability for IC engine application</td>
<td>Mechanical Engineering</td>
<td>Mr. CHANDRASHEKAR PATIL</td>
<td>Mr. PRASHANT KAMBLE</td>
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### 9) JAIN INSTITUTE OF TECHNOLOGY, DAVANGERE

| 11.     | 41S_B_BE_102  | Design and fabrication of a Ceratonia silquia depulp and seed extraction machine      | Mechanical Engineering | Mr. PRADEEP KUMAR ILAY                   | Mr. SANTOSH C                 |

### 10) JAWAHARLAL NEHRU NATIONAL COLLEGE OF ENGINEERING, SHIVAMOGGA

| 12.     | 41S_B_BE_094  | Design and fabrication of biodiesel filter                                           | Mechanical Engineering | Mr. RAVIKUMAR B. N.                       | Mr. GOWTHAM S                 |
| 13.     | 41S_B_BE_109  | Mechanized pongamia pod harvester                                                    | Mechanical Engineering | Prof. J ASHOK                             | Mr. SACHIN M B                |

### 11) K.L.E. Dr. M.S. SHESHAGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI

| 14.     | 41S_B_BE_097  | Design and development of thermal pyrolysis unit for the production of liquid fuel by using household plastic waste | Mechanical Engineering | Prof. P. I. UGRAN                        | Mr. MALLINATH C KUMBAR       |

### 12) KLE COLLEGE OF ENGINEERING AND TECHNOLOGY, CHIKODI

| 15.     | 41S_B_BE_047  | Optimization of performance characteristics of DI diesel engine with blends of honne(gallopityllum inophyllum linna) bio-diesel and pure diesel | Mechanical Engineering | Mr. MURALI AMBEKAR                       | Mr. MUDASI S K                |

### 13) MALNAD COLLEGE OF ENGINEERING, HASSAN

| 16.     | 41S_B_BE_019  | Ecotoxicity and biodegradability studies of neem oil based metal cutting fluid        | Mechanical Engineering | Dr. S.R.JAYARAM                          | Mr. PRADEEP KASHYAP K.S.      |
| 17.     | 41S_B_BE_021  | Comparative study of performance and emission characteristics of four stroke gasoline engine under the various blends with bio lubricants. | Automobile Engineering | Dr. Y. M. SHASHIDHARA                    | Mr. ASHOK G U                 |

### 14) MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING, MOODBIDRI

| 18.     | 41S_B_BE_057  | Performance and emission characteristics studies of CI engine using graphene and aluminium oxide nano particles blended dairy waste scum bio diesel and effect of injection pressure and three and five hole of nozzele cumbution process | Mechanical Engineering | Dr. VIGNESH NAYAK                        | Mr. MOHAMMED SAFWAN           |

### 15) NAGARJUNA COLLEGE OF ENGINEERING AND TECHNOLOGY, BENGALURU

| 19.     | 41S_B_BE_042  | Pilot plant study for sustainable energy generation in septic tank using bio-fuel cell | Civil Engineering     | Dr. K.KUMAR                               | Mr. MAYANA ISMAIL KHAN        |

### 16) NEW HORIZON COLLEGE OF ENGINEERING, BENGALURU

| 20.     | 41S_B_BE_007  | Design and fabrication of machine to convert plastic into oil and gaseous fuel production | Mechanical Engineering | Prof. LAKSHMANA NAIK                      | Mr. SITAL KUMAR SAH           |
| 21.     | 41S_B_BE_008  | Improvisation on physical and combustion properties of fuel Briquette from pongamia and Glycerin mixing different binders | Mechanical Engineering | Mr. LAKSHMINARASIMHA N                    | Mr. ARJUN YADAV               |
| 22.     | 41S_B_BE_067  | A coupled process integrating heavy metal bioremediation and biodiesel production using oleaginous microalgae | Biotechnology         | Dr. R.S.UPENDRA                          | Ms. CHAITHANYA LAKSHMI        |
### 17) NMAM INSTITUTE OF TECHNOLOGY, NITTE

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<td>Ms. HARSHITHA M JATHANNA</td>
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### 18) P E S COLLEGE OF ENGINEERING MANDYA

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### 19) R. V. COLLEGE OF ENGINEERING, BENGALURU

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### 23) SJM INSTITUTE OF TECHNOLOGY, CHITRADURGA

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### 24) SAHYADRI COLLEGE OF ENGINEERING AND MANAGEMENT ADYAR, MANGALURU

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### 38) MAHARANI LAKSHMI AMMANNI COLLEGE FOR WOMEN, BENGALURU

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### 39) MAHARANI'S SCIENCE COLLEGE FOR WOMEN, BENGALURU

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