COMPARATIVE STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF FOUR STROKE S.I. ENGINE UNDER VARIOUS BIO LUBRICANTS

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COLLEGE : MALNAD COLLEGE OF ENGINEERING, HASSAN
BRANCH : DEPARTMENT OF AUTOMOBILE ENGINEERING
GUIDE : DR. Y.M. SHASHIDHARA
STUDENTS : MR. HAMSARAJ
MR. JITHIN KUMAR RAI D.
MR. AKHIL KAUSHIK
MR. CHARAN RAJ B.C.

Introduction:

Enormous use of petroleum based oils created many negative effects on the environment. The major one is particularly linked to their inappropriate use, which results in surface water and groundwater contamination, air pollution, soil contamination and consequently the agricultural product and food contamination. To overcome these challenges, various alternatives to petroleum-based oils are being explored which include synthetic lubricants, solid lubricants and vegetable-based lubricants.

This work deals with use of modified/formulated Pongama, Jatropha and Castor oils as bio lubricants base oils for operating a four stroke S.I engine. Performance and emission characteristics of an engine are determined under these oils of lubrication. Experiments are also carried out for tribological studies such as friction and wear. The results are compared with those obtained under mineral oil operation.

Objectives:

- To formulate bio based lubricant from raw vegetable oils.
- To study the Tribological properties formulated bio lubricants.
- To study the performance and emission characteristics of the engine under formulated bio lubricants.

Methodology:

The three vegetable oils are chemically modified by transesterification with methanol to obtain their methyl esters like Pongama oil methyl ester (POME), Jatropha oil methyl ester (JOME) and Caster oil methyl ester (COME). Further, to improve thermal and oxidative stability, all the three methyl esters are transesterified with Trimethylolpropane (TMP) to form their TMP ester. The obtained Trimethylpropylene esters such as Pongama Trimethylolpropane ester (PTMPE), Jatropha Trimethylolpropane ester (JTMPE) and Castor Trimethylolpropane ester (CTMPE), are washed with ethyl acetate to get bio lubricant base oil for engine lube oil application.

Tribological studies are carried out using Pin-on-disc tribometer to understand the Tribological characteristics of formulated oils.

Experiments are carried out on a vertical single cylinder air cooled four stroke gasoline Honda engine developing 1.3 kW at 4200 rpm, under PTMPE, JTMPE and CTMPE lubrication. The engine is coupled to an electric generator for varying the load. The performance values like specific fuel consumption, power and engine efficiency are measured. Also, the emission readings such as Carbon monoxide, Hydrocarbon are measured using a gas analyzer. The obtained results from these experiments are compared with the results under mineral oil lubrication.

Results and discussions:
Tri biological Study:

Fig. 1 Variation of wear with time under various lubricants

It is seen for the fig. 1 that the wear pattern under bio lubricants during the initial sliding distance is lower. However, as the sliding distance increases, the wear under PTMPE and JTMPE increases when compared to mineral oil. Further, the trend under CTMPE is opposite to other two bio lubricants.

Fig. 2 Variation of co-efficient of friction with time under various lubricants

It is seen from fig. 2 that, except PTMPE, the co-efficient of friction values are lower under bio lubricants mode of lubrication compared that of mineral oil for the whole range of tested period. About 25% drop in friction co-efficient values are seen under bio oils compared to mineral oil lubrication.

Fuel consumption:

It is seen from fig. 3 that when the engine is operated under mineral oil lubricant mode, the engine shows a moderate drop in specific fuel consumption. But when engine operated at bio lubricants mode of operation, there is slight increase in specific fuel consumption.
Brake thermal efficiency:
It is observed from fig. 4, that the brake thermal efficiency of the engine is escalated under JTMPE compared with mineral oil. However, under the lubrication of PTMPE and CTMPE thermal efficiency of the engine is decreased compared to mineral oil lubrication mode.

Emission Study
Carbon Monoxide
The engine emits about 20% lower in carbon monoxide (CO) under JTMPE and CTMPE compared to mineral oil lubrication mode of engine operation. However, about 20% increase in CO values are seen under the operation of PTMPE mode of lubrication (Fig.5)
Unburnt Hydrocarbon

It is seen that the engine emits lower unburnt hydrocarbon for all the loads of operation under bio lubricant mode of lubrication compared to mineral oil mode.

Conclusions:

Based on the experimental results, the following conclusions are drawn,

- Significant drop in wear under the Castor Trimethylolpropane ester lubrication and lower values of co-efficient of friction are seen under both under Jatropha Trimethylolpropane ester and Castor Trimethylolpropane ester mode of lubrication compared to mineral oil.

- Engine consumes slightly higher fuel at low load operations and at full load operations, engine consumes almost similar amount of fuel under all modes of lubrication. However, about 20% lower fuel consumption is observed under Jatropha Trimethylolpropane ester to produce same power as under mineral oil mode of lubrication.

- Thermal efficiency of the engine under all bio lubricants is at par with mineral oil lubrication. However, a slight increase in efficiency is seen under Jatropha Trimethylolpropane ester mode compared to mineral oil.

- Engine emits lower carbon monoxide and unburnt hydrocarbon, operated under all bio lubricants, compared to mineral oil mode of lubrication. Particularly, lowest carbon monoxide and unburnt hydrocarbon are observed when engine is operated under Jatropha Trimethylolpropane ester mode of lubrication compared to mineral oil mode.