

Experimental Investigations on the Mahua Fuelled C.I Engine with Different Oxygenates

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ABSTRACT

The present work deals with performance analysis of a Mahua fuelled variable compression ratio C.I engine at a compression ratio 15.7 by the addition of different oxygenates namely, Di Ethyl Ether (DEE), Di Methyl Carbonate (DMC) and a mixture of DEE and DMC in varying quantities. All the experiments were carried out at a constant speed of 1500rpm and a compression ratio of 15.7.

The results showed a significant improvement in the performance and emission characteristics of the engine. Optimum mixture blends arrived at based on the brake thermal efficiencies are 10%, 15% and 5% respectively with DEE, DMC and mixture of DEE and DMC blended with Mahua. The addition of DMC to Mahua resulted in reduced smoke densities, exhaust gas temperatures and reduction in the HC & CO emissions however NO emissions found to increase with the increase in DMC share in the blend.

The addition of DEE to Mahua resulted in reduced exhaust gas temperatures and a reduction in HC, CO and NO emissions.

The addition of a mix of DEE and DMC to Mahua also resulted in improved performance and emission parameters of the engine.

Keywords: Mahua Fuelled, Oxygenates

1. INTRODUCTION

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth depends entirely on the long term availability of energy from sources that are affordable, accessible and environmentally friendly. India ranks sixth in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations.

The rising oil import bill has been the focus of serious concerns due to the pressure it has placed on scarce foreign exchange resources and is also largely responsible for energy supply shortages. The sub-optimal consumption of commercial energy adversely affects the productive sectors, which in turn hampers economic growth.

2. LITERATURE REVIEW

Several experimentations have been carried out on C.I engines using additives to analyse the performance and other characteristics. Song et al [1] analysed the structure of an oxygenated compound blended with diesel fuel. 5% oxygen by mass of a fuel was added to ethane using Di methyl ether and ethanol. It has been reported that a significant reduction in aromatic species relative to pure ethane was observed with the addition of DME to ethanol, but DME was found to be more effective in reducing aromatic species than ethanol. More over addition of DME lead to higher final temperature.

Cheng et al [2] conducted engine tests using oxygenates (DMC and DEE) Blended with Diesel. His studies revealed the reduction in particulate matter at higher loads. No

change has been observed at low loads. Higher fuel consumption and increase in CO₂ emissions were reported with addition of oxygenates .

Kajitani et al [3] conducted performance and emission tests on a direct injection Yamar diesel engine with neat dimethyl ether. In addition, they analysed injector needle lift and heat release and compared with conventional diesel. They reported that the engine operated by dimethyl ether exhibited remarkable high energy conversion efficiency with low exhaust temperature. The injection period was found much longer than diesel. They observed higher NO_x emissions with DME with reduced HC and CO emissions. They noted injector wear with DME and suggested that lubricating additives must be added in small quantities when DME is used as fuel.

3. EXPERIMENTATION AND EXPERIMENTAL SETUP

An Experimental setup was made with necessary instruments to analyse the performance, emission and combustion parameters of the engine at various operating conditions.

A four stroke single cylinder variable compression ratio diesel engine having a bore of 70mm and stroke 110mm, rated speed 1500rpm with an auxiliary water cooled head is coupled to an eddy current dynamometer with the use of star coupling (genuine part from Kirloskar) mounted on a sturdy mild steel channel base.

A stand alone control panel with all digital instrumentation is interfaced with the test rig and suitable PC.

4. RESULTS AND DISCUSSIONS

4.1 Experiments with Mahua-DMC Blend

5%, 10%, 15% and 20% of DMC were added to Mahua in different proportions and their effect on the performance and emission characteristics of the engine were studied.

The variation in brake thermal efficiency with different DMC quantities is shown in the fig 4.1. The brake thermal efficiencies are 26%, 28%, 27% and 25% respectively with 5%, 10%, 15% and 20% of DMC respectively. A reduction in fuel consumption has also been noticed from fig. 4.2 with the addition of DMC.

Fig. 4.3 shows the variation in smoke density with different DMC quantities. It can be found that Smoke density decreases with an increase in DMC percentage. Similarly from fig 4.5 and 4.6 it can be revealed that the HC and CO emissions are less with Mahua –DMC blend when compared with neat Mahua oil.

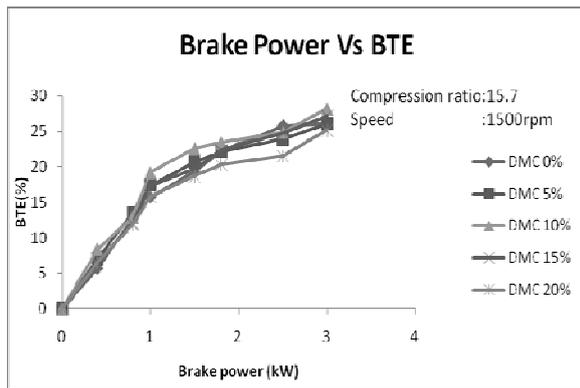


Fig. 4.1 Variation in Brake thermal efficiency

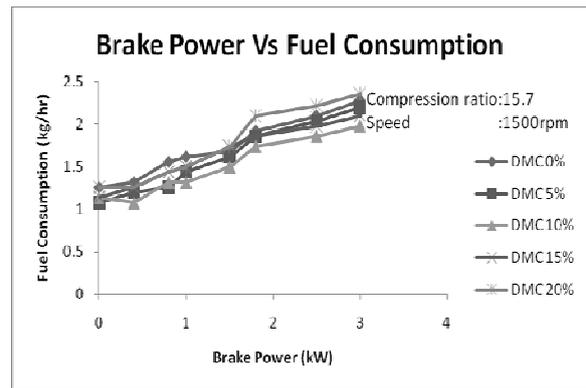


Fig. 4.2 Variation in Fuel consumption

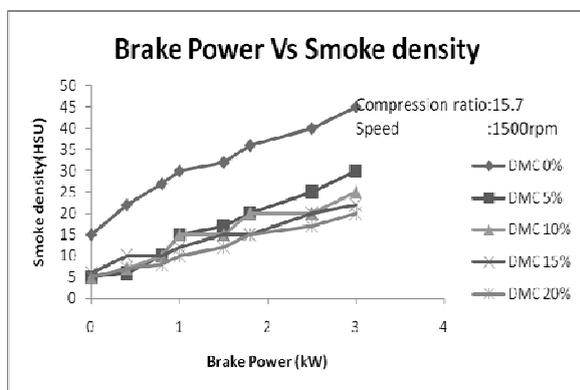


Fig. 4.3 Variation in Smoke density

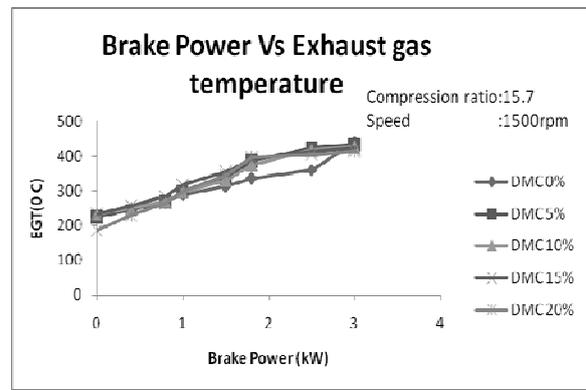


Fig. 4.4 Variation in Exhaust gas temperature

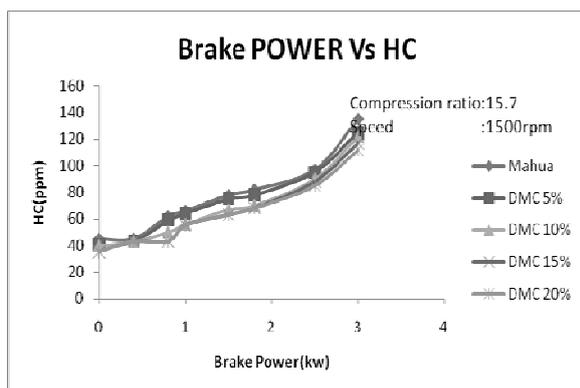


Fig. 4.5 Variation in HC

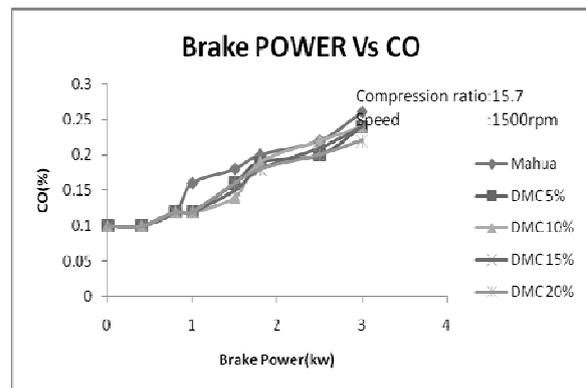


Fig. 4.6 Variation in CO

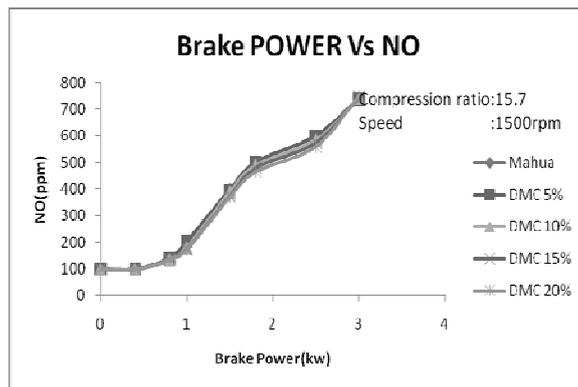


Fig. 4.7 Variation in NO

4.2 Experiments with Mahua-DEE Blend

Diethyl ether (DEE) is blended with Mahua oil in concentrations of 5%, 10%, 15% and 20% respectively. Fig 4.8 shows the variation in brake thermal efficiency with different DEE quantities. The maximum brake thermal efficiency of 28% is obtained with the addition of 15% DEE to Mahua .

Fig. 4.9 shows the variation in fuel consumption with different DEE quantities added to Mahua. The fuel consumption is found to be 2.04kg/hr, 1.92kg/hr, 1.74kg/hr and 1.98kg/hr with the addition of 5%,10%,15% and 20% DEE to Mahua oil.

A reduction in the smoke density with the addition of DEE is evident from the fig 4.10. There is a reduction in HC emissions with the addition of DEE to Mahua , which is evident from the fig 4.12. Reduced CO emissions can be observed from fig 4.13 with the DEE blend. CO emissions were reduced from 0.26% with neat Mahua oil to,0.22 % with 20% DEE.

From the Fig 4.14, it can be seen that the NO levels in the exhaust decrease with the addition of DEE in the Mahua.

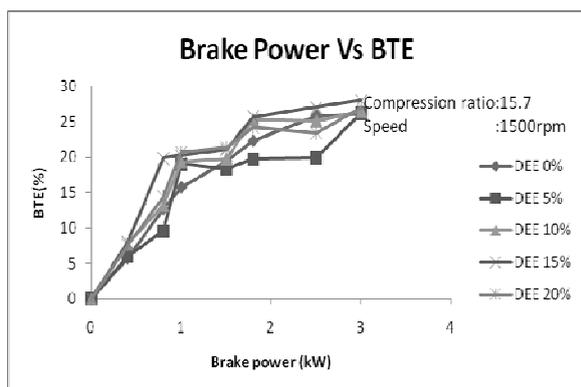


Fig. 4.8 Variation in Brake thermal efficiency

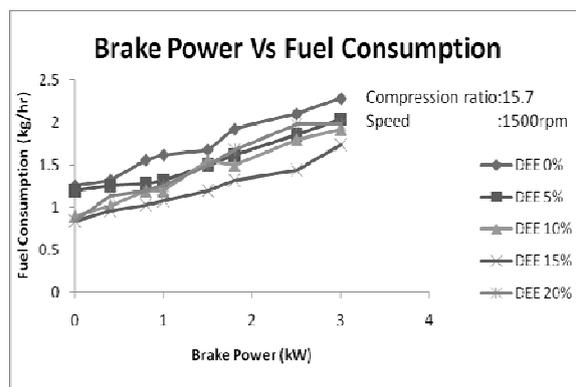


Fig. 4.9 Variation in Fuel consumption

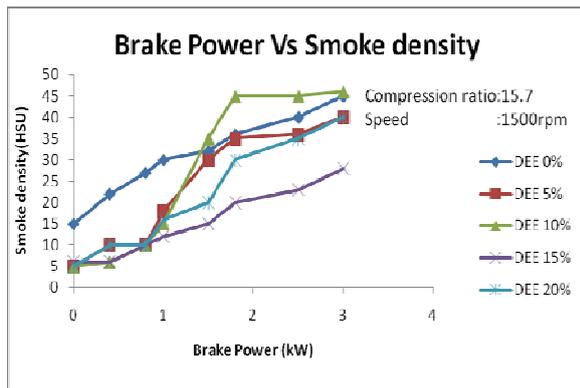


Fig. 4.10 Variation in Smoke density

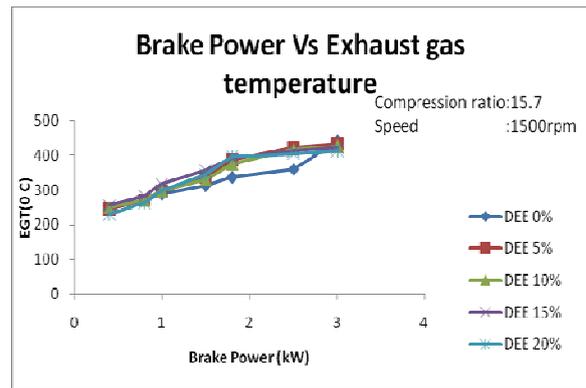


Fig.4.11 Variation in Exhaust gas temperature

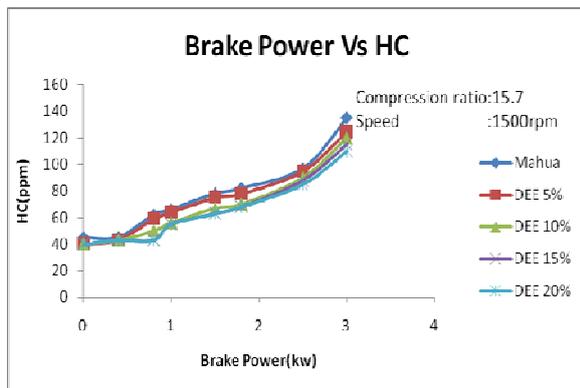


Fig. 4.12 Variation in HC

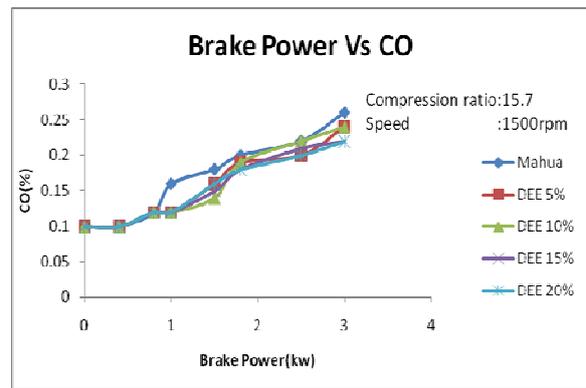


Fig. 4.13 Variation in CO

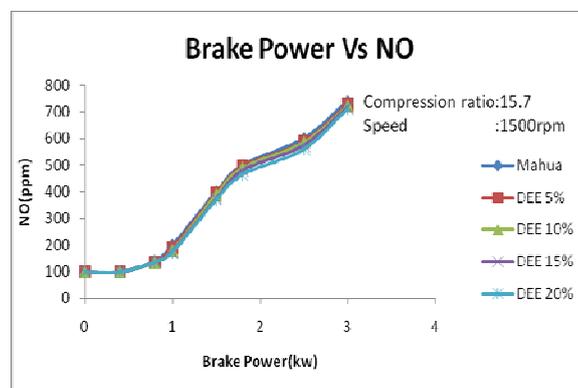


Fig. 4.14 Variation in NO

4.3 Experiments with Combined DEE and DMC Blend

Di ethyl ether (DEE) and Di methyl carbonate (DMC) were mixed together in each 5% and 10% by volume with Mahua and the performance and the emission tests were carried out on the engine.

From the fig 4.15 the brake thermal efficiency is found to be 26.14% with neat Mahua oil, 29% with 5% DEE-DMC each blend and 27% with 10% DEE-DMC each blend. The fuel consumption is found to be less with 5% blend as predicted from the fig 4.16. Fig 4.17 indicates a better and improved combustion with the addition of DEE and DMC o the fuel.

HC, CO emissions were also found to be reduced with the blending of DEE and DMC from fig 4.19. This can be attributed to the improved combustion due to the addition of this oxidizing mixture.

From fig 4.20, indicates a reduction in the CO emissions with the addition of DEE and DMC . From fig 4.21 we can observe a drop in NO emissions with 5% blend where as there is an increase in emissions at 10% blend.

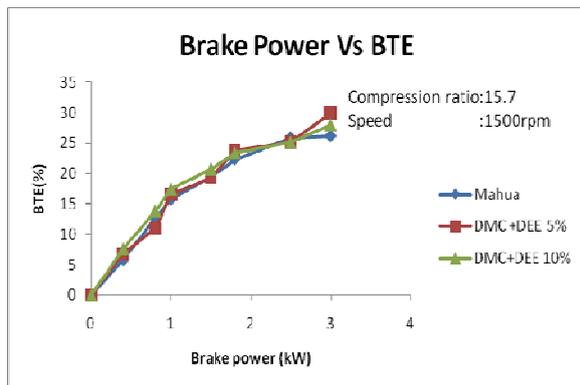


Fig. 4.15 Variation in Brake thermal efficiency

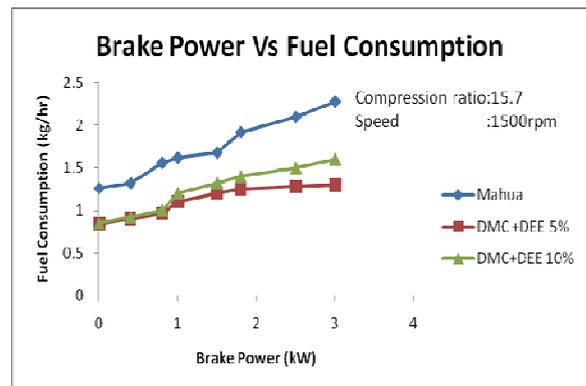


Fig. 4.16 Variation in Fuel consumption

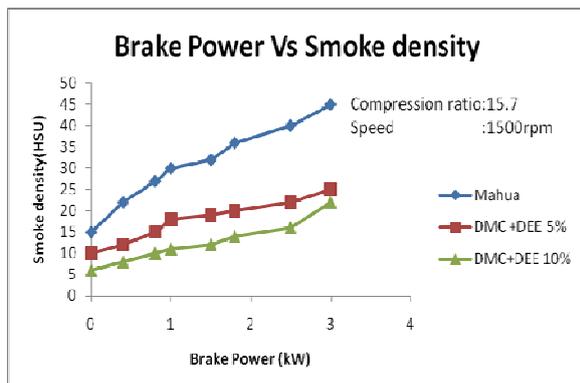


Fig. 4.17 Variation in Smoke density

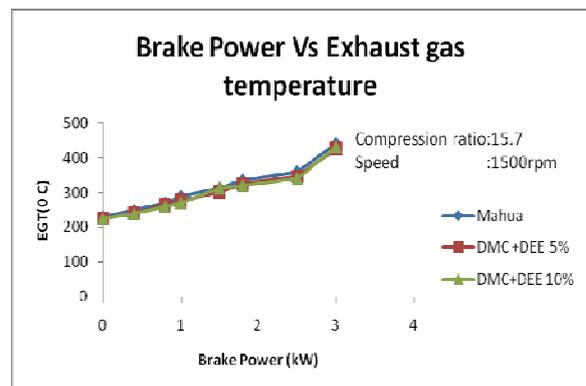


Fig. 4.18 Variation in Exhaust gas temperature

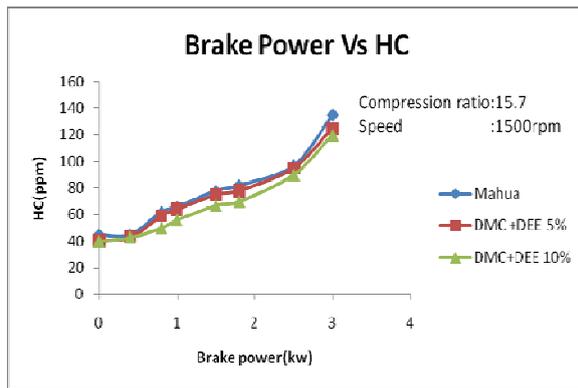


Fig. 4.19 Variation in HC

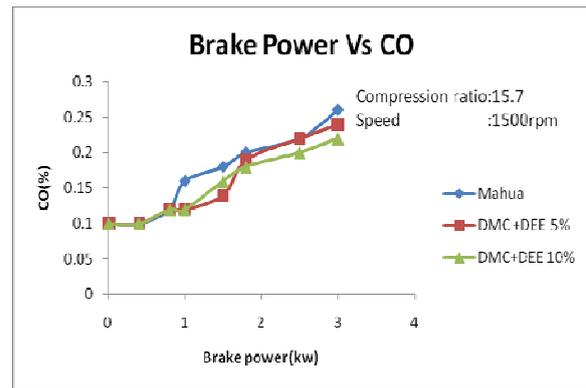


Fig. 4.20 Variation in CO

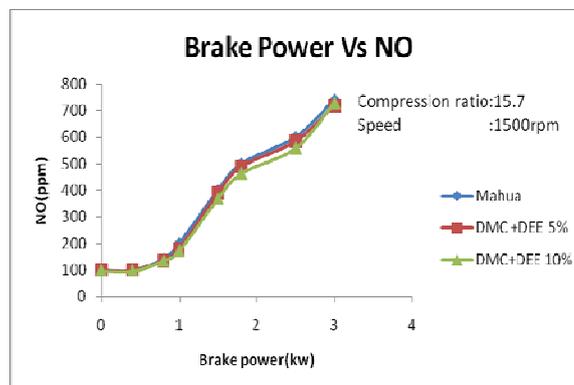


Fig. 4.21 Variation in NO

5. CONCLUSIONS

Various conclusions were drawn from the experimentation .They are as follows.

5.1 Experiments with mahua –DMC blend

The tests on the engine using mahua-DMC blend in various proportions results in

- Maximum brake thermal efficiency with 10% DMC blend , 15%DEE blend and 5% each DMC and DEE blend.
- Minimum fuel consumption with 10% DMC blend15%DEE blend and 5% each DMC and DEE blend.
- Reduced smoke density with increase in oxygenate quantity
- Reduced exhaust gas temperatures with oxygenates
- Reduction in HC and CO emissions with oxygenates
- NO emissions increased with DMC addition and reduced with DEE.

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