Feasibility Study of Soyabean Oil as an Alternate Fuel for CI Engine at Variable Compression Ratio

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Abstract

The present study reports the effect of compression ratio on the performance and exhaust emissions of variable compression diesel engine using soyabean oil and it's methyl ester.Results show that brake specific fuel consumption , exhaust gas temperature and smoke density are increased but brake thermal efficiency is decreased both in Soyabean - diesel oil blend and esterified Soyabean oil compared to 100 % diesel operation at two different compression ratios.Engine used for the present work is 5 H.P. ,1500 rpm single cylinder diesel engine of compression ratio 16.

Keywords: CI Engine , Soyabean Oil , Esterification & Compression ratio (CR)

Introduction:-

Rapid depletion of conventional energy sources, alongwith increasing demand of energy is a matter of serious concern about energy crisis. Over 90 % of today's energy demand are being met with fossil fuels, mainly the petroleum products. Therefore, energy crisis means oil crisis to a certain extent. The problem of oil crisis has two distinct facets, both of which are serious enough to concern about. Firstly, the oil crisis points towards a future possibility of total unavailability of petroleum fuels. Second facet of problem, which is of great concern for countries like ours, is the dependence on outside sources for fuel oil. Two major factors which cause worry are the sky-rocketing oil prices which exert enormous pressures on our resources and have been seriously affecting our economy and the fact that dependence on others always leads to a sense of insecurity and uncertainty. However, the paucity of our petroleum reserves and the realisation that they will be eventually depleted, have spurred a search for renewable engine fuels**.**

The possibility that petroleum based fuels will be available neither in sufficient quantities nor at reasonable price in further has revived interest in exploring alternate fuels for diesel engines. To avoid new independencies, it is essential that alternate fuels for engines should be derived from indigenous sources and preferably renewable energy sources. These requirements have generated a great deal of interest in vegetable oils as substitute fuel for diesel engines .At present, India is importing the oil of Rs.90,000 Crore. By mixing the ethanol into petrol and bio-diesel into diesel ,our country can save Rs.40,000 Crore. By using 10% bio-diesel into diesel ,India can save Rs.10,000 Crore.The present work is undertaken to study the performance evaluation of Soyabean oil and it's

methyl ester (Bio-Diesel) on the performance parameters of diesel engine at two different compression ratios of 16 and 18. .Engine used for the present work is 5HP, 1500 rpm, single cylinder CI engine of compression ratio 16.

Experimental Test Set-Up

The present work has been carried out on a 5 H.P., 1500 r.p.m. engine at two different compression ratios of 16 and 18. It is stationary, vertical, single cylinder, cold start, water cooled, four stroke, DI diesel engine working on high speed diesel oil. Experimental investigations are carried out with soyabean oil blended with diesel for different proportions and with it's methyl ester with standard injection parameters. Experiments are carried out at constant speed of 1500 r.p.m. and six different loads ranging from no load to full load. Various performance parameters such as brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature and smoke are studied for both the compression ratios.

Transesterification

As the viscosity of vegetable oils are significantly higher and densities are slightly higher compared with the diesel fuel , vegetable oils cannot be directly used in the diesel engine. Hence they have to be modified to bring them closer to diesel oil in their properties. The methods employed includes- The heating of vegetable oil, 2. Blends of vegetable oils with diesel & 3. Transesterification. A very effective way of overcoming the high viscosity and smoke emissions of vegetable oils is to form their ethyl and methyl esters. Methyl esters of vegetable oils was prepared by direct esterification process wherein methyl alcohol was mixed with soyabean oil and stirred for a little while. As the reactions in direct esterification are slow, the mixture was stored in the presence of a catalyst at specified temperature for about a fortnight. It has been seen that the density of the esters is slightly lower and the viscosity is very much lower than for the parent soyabean oil. The cetane rating was improved beyond even the diesel range. Carbon residue was decreased.

Experimentation

The following sets of experiments are programmed running the engine on six different loads for both the compression ratios of 16 & 18.

1] Load performance of the engine with pure diesel.

2] with 10% Soyabean oil with diesel.

3] with 20% Soyabean oil with diesel.

4] with 30% Soyabean oil with diesel.

5] with 40% Soyabean oil with diesel.

6] with 50% Soyabean oil with diesel.

7] with esterified Soyabean oil (MESO)

The observations such as Speed , Load ,Time required for 20 cc fuel consumption , Exhaust gas temperature ,Inlet water temperature , Outlet water temperature , Time for 500 ml flow of water into engine cooling system , Head , Smoke are recorded for each run.

Results And Discussions

Brake Specific Fuel Consumption (BSFC)

At higher compression ratio , the temperature and pressure of air at the beginning of injection are higher. At the higher temperature ,the effect of proportion of soyabean oil - diesel blends and esterified soyabean oil on BSFC are shown in figures 1 and 2 at two compression ratios of 16 &18 respectively. Figures show that 100% diesel oil has the lowest BSFC than other blends and esterified soyabean oil in both the compression ratios.The probable reason behind the result is that the dissimilar specific gravity and heating value among the blends , esterified soyabean oil and diesel oil are responsible for the increase in fuel flow and BSFC. So, with the lower energy value fuels (blends of soyabean oil and esterified soyabean oil), the engine responds to the load by increasing the fuel flow . It is also observed that the increase in BSFC for esterified soyabean oil operation with respect to 100% diesel operation is slightly lower in CR - 16 than in CR-18.

Brake Thermal Efficiency

The variation of brake thermal efficiency (BTE) with respect to proportion of soyabean oil - diesel blends and esterified soyabean oil at two different compression ratios are shown in figures 3 & 4. Figures show that BTE decreases as the proportion of soyabean oil increases in the soyabean oil - diesel oil blends in both the compression ratios. As the compression ratio increases , the wall temperature of the combustion chamber increases and due to that the volumetric efficiency decreases. The decrease in volumetric efficiency and the effect of ignition delay are the main reasons for the deterioration of fuel combustion resulting in increase in fuel consumption and subsequent reduction in BTE. In CR-16, the wall temperature is comparatively lower than CR-18 and due to this fact , the reduction in BTE in CR-16 is slightly lower than in CR-18 .

Exhaust Gas Temperature

Figures 5 & 6 represents the variation of exhaust gas temperature with respect to proportion of soyabean oil - diesel blends & esterified soyabean oil at two different compression ratios of 16 & 18 . It is observed from the figures that as the proportion of diesel oil decreases in the blends, the exhaust gas temperature increases in both the compression ratios. Esterified soyabean oil has higher cetane no. which helps to burn the fuel comparatively better than the higher soyabean oil - diesel blends .In CR - 18, exhaust gas temperature is slightly higher than in CR- 16.

Smoke Density (HSU)

The variation of smoke density with respect to proportion of the soyabean oil- diesel blends and esterified soyabean oil at two different compression ratios of 16 & 18 are shown in figures 7 & 8 . Figures show that 100% diesel oil has lower smoke density than the other blends and esterified

soyabean oil. Smoke density in case of the MESO is in between diesel oil and soyabean oil - diesel oil blends. Smoke density in case of CR - 16 is less than that of in CR - 18.

Conclusions

Based on the present investigations on selected vegetable oil , its blends with diesel oil and esterified soyabean oil in a standard single cylinder diesel engine at two different compression ratios of 16 and 18, the following conclusions are drawn.

1. Brake specific fuel consumption is increased in Soyabean - diesel oil blend and esterified Soyabean oil at different compression ratios .In CR-16 and CR-18 , brake specific fuel consumption are increased by 29 % and 37 % respectively compared to 100% diesel operation.
2. For the same injection angle , brake thermal effiency is decreased in Soyabean - diesel blends and esterified Soyabean oil compared to 100% diesel operation at different compression ratios. The reduction in BTE in CR-16 is slightly lower than in CR-18.
3. Similarly, the exhaust gas temperature and smoke density are on better side in CR - 16 rather than in CR-18. In CR-18, the exhaust gas temperature is slightly higher than in CR-16.

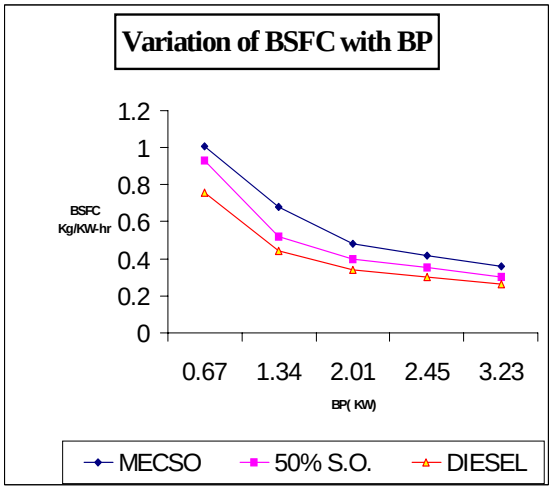


Fig-1

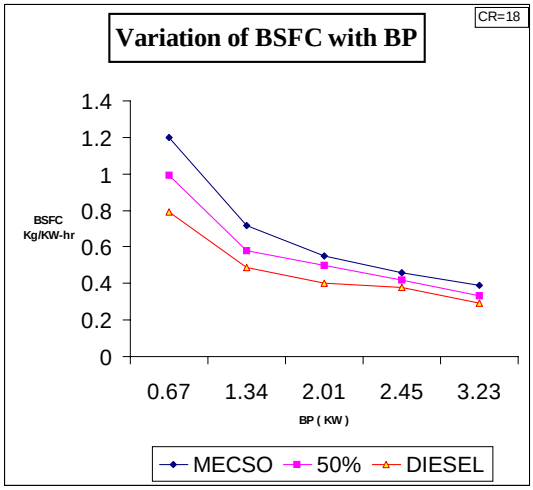
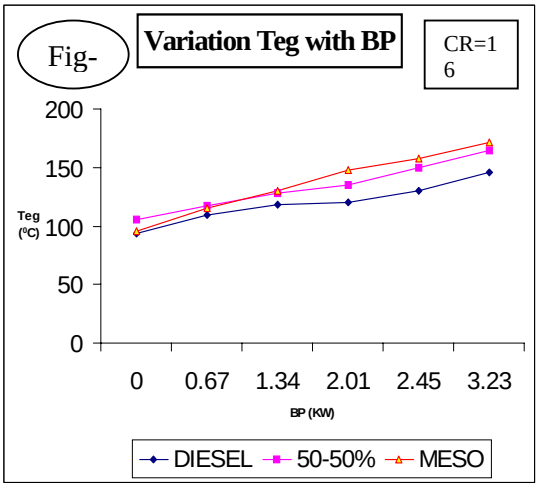


Fig-2



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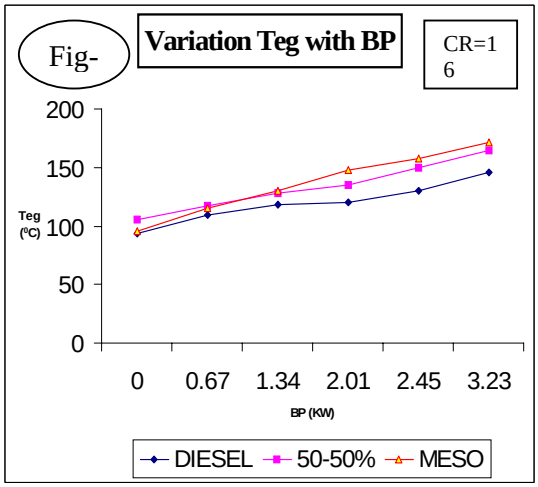
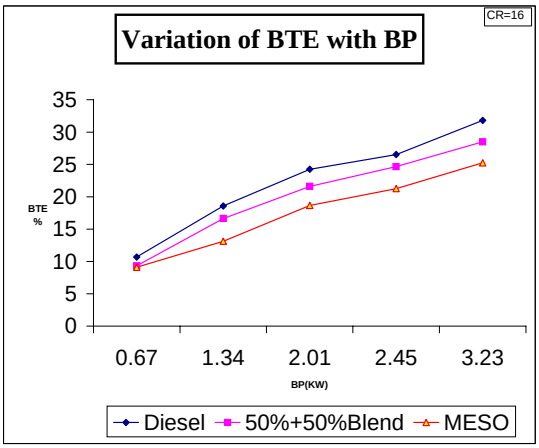


Fig-4



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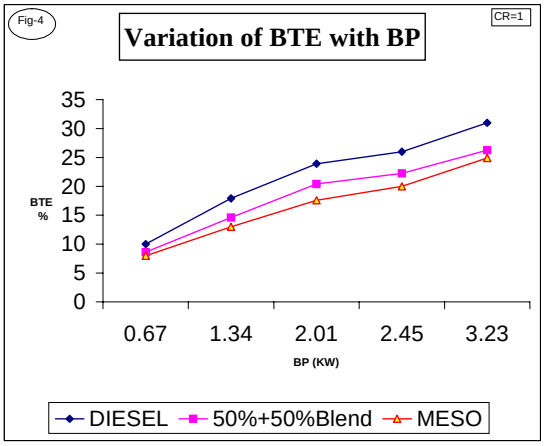

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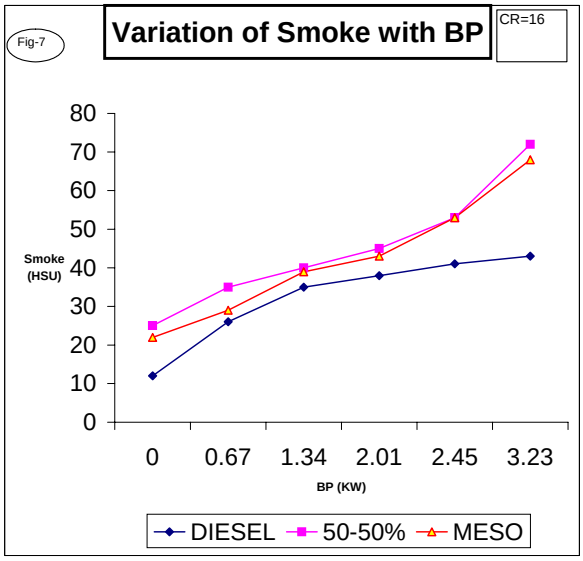

Fig-7

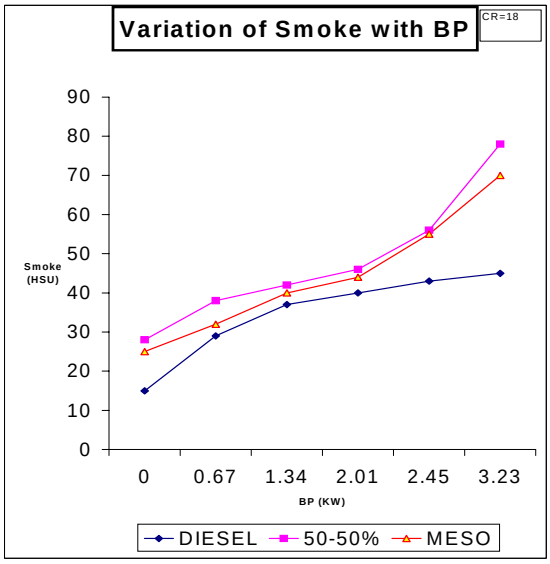

Fig-8

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