The Experimental Investigation of The Performance Of Al_2o_3 Nano Fluid on Air Gap Insulated Aluminium Piston With Canola Oil

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Abstract- *In view of recent developments, the cost of petroleum supplies are raising and the budding danger of environmental pollution have led to an intensive search for an alternative fuel or increasing the efficiency of the available diesel engines. The alternative fuel selected must be a renewable, environmentally friendly liquid fuel, and should provide less pollutant emissions. As ours is an agricultural country, the production of canola seeds is good which is considered to be a substitute for diesel. With the properties of canola oil, it becomes difficult to burn in the existing diesel engines. But it can be done at the elevated temperatures in the combustion chamber. Hence, in the present work it is planned to develop an air gap insulated engine piston which retains temperature in the combustion chamber and aids for the burning of canola diesel blends. Further the performance and the emission characteristics of the engine is tested with air gap insulted aluminium piston and compared with normal piston. As the combustion performance depends on the fluid flow, it is also planned to work with Al2O3 nano fluids at various proportions. The results are compared with existing diesel engine. It is concluded that air gap insulated piston with B15 showed best results at 90ppm* Al_2O_3 *nano fluid.*

Keywords- Biodiesel, air gap insulated piston,Aluminium piston, Nano particles

I. INTRODUCTION

Diesel engines are employed particularly in the field of heavy transportation and agriculture on account of their higher thermal efficiency and durability. But the diesel fuel is depleting at a fast rate and it causes pollution. It's major contributors of oxides of nitrogen, carbon and particulate emissions. Hence stringent norms are forced on exhaust emissions.So, an alternative fuel is required. Hence, the alternative fuel selected must be**.** The characteristics of renewable fuels are replenishable, Low cost, Easy availability and transportation, High calorific Value, produced by farmers and renewable in nature.

Various types of biodiesel such as cotton seed oil,pongamia, sun flower, canola oil etc., are reviewed and Canola oil biodiesel is one type of biodiesel, and it has an advantage in oil production per unit area compared with other biodiesels. We focus on evaluating the among them Canola biodiesel plays a vital role in the replacement of diesel with its characteristics. The major advantage is with its availability, because the Canola plant will grow in any environmental conditions in India. With minor changes in the engine, one can easily use Canola biodiesel as a fuel in diesel engine. As India is an agricultural country, if the cultivation of Canola plants is made by farmers it will be very useful to the farmers and also to our Indian economy.

A considerable amount of work has been done on diesel engine for increasing the performance with various biodiesel blends. Some of the works are as follows.

Kamo and Bryzik. R.Kamo et al. **[1]** conducted experiments with 0.13 mm thick thermal barrier coating of PSZ for the piston and cylinder head and 0.5 mm thick coating for cylinder liner. They observed, in the experiment, a higher premix, lower diffusion combustion, a reduction heat transfer loss, a higher heat release in the combustion chamber with 5 to 6 percent improvement in fuel efficiency at all the loads and speeds. **T.Morel et al. [2**] attained higher thermal efficiency at all loads for both heavy and light engines with the various level of insulation at constant peak pressure and A/F ratio. An eight percent improvement in the brake thermal efficiency was observed. Heat rejection was reported to be decreased while exhaust temperature was increased. **Murthy PVK et al. [3]** reported the results of their investigations on LHR diesel engine with 3 mm air gap between piston skirt and insert with Nimonic alloy crown. They revealed that the performance was deteriorated at the available injection timing and pressure. At peak loads, the BSFC was decreased by 12 percent and smoke levels by 16 percent, but NOx levels were increased by 34% with an injection timing of 32 0bTDC. Wallace et al. [11] have reported the use of a thermal barrier piston in the adiabatic engine and developed the temperature distribution analysis and reported that the piston top temperature was higher by around 4000C for the thermal barrier pistons.**Y. V. Hanumantha Rao et al, [4]** investigated the effect of DM-32 and methyl-ester as a fuel additive on diesel engine performance fueled with Jatropha oil biodiesel and found that the engine performance values increases significantly with DM-32 and methyl-ester fuel blends compare with jatropha oil biodiesel and also the brake specific energy consumption is lower in both fuel additives blends compare with Jatropha oil biodiesel and also the engine emissions like HC, CO and NO_x are educed significantly in both the DM-32 and methyl-ester fuel blends compare with jatropha oil biodiesel.

A major breakthrough in the technology of diesel engines has been achieved by the innovative work done by

Biodiesel production(Trans-esterification)

In this study, the base catalyzed Trans-esterification process is used to prepare biodiesel from Canola oil. For trans-esterification process 500 ml of Canola oil is heated up to 70°C to drive off moisture. Methanol of 99.5 % purity having density of 0.791 g/cm³ is used. Further 2.5 gram of catalyst KOH is added to Methanol and stirred the mixture continuously. The mixture was maintained at one bar pressure and 60°C for one hour. After completion of trans-esterification process, the mixture is allowed to settle under gravity for 24 hours in a separating funnel. The products formed during trans-esterification were Canola oil methyl ester and Glycerin. Canola oil methyl ester (biodiesel) is mixed, washed with hot distilled water to remove the unreacted alcohol; oil and catalyst and allowed to settle under gravity for 25 hours. The biodiesel which is separated is taken for characterization.

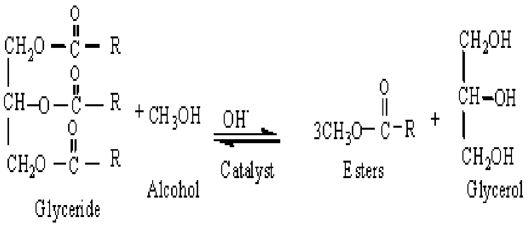


Fig 1 The process for trans-esterification.

Piston Insulation:

In this a 2-mm air-gap (whose thermal conductivity is low) is provided between a metallic crown and the standard piston made of Aluminium alloy.

Fig 2: Air-gap insulated Aluminium piston

This air gap is optimized based on the literature available. The metallic crown and standard piston were separated by copper and steel gaskets.

II. METHODOLAGY

The detail of the experimental set up is shown below.

Fig 3 Experimental Set up

Specifications of the Engine:

For the experimentation single cylinder water cooled DI diesel engine is used. The specifications are as follows.

Engine	Four stroke, single cylinder, water cooled, D.I diesel engine, Kirloskar engine Ltd
Rated power	5 HP
Speed	1500 rpm
Bore	80 mm
Stroke	110 mm
Calorific value (C.V)	43000 kJ/kg
Specific Gravity	0.860 kg/m^3
Co-efficient of discharge (C_d)	0.62
Orifice diameter	0.033m
Compression ratio	16.5:1
Density of air (ρ_{air})	1.29 kg/ m^3
Dynamometer	Belt brake
Injection Pressure	180 bar

III. EXPERIMENTAL PROCEDURE

The experimental procedure is as follows.

- The engine is started with no load condition and is allowed for 10 min for the stabilization.
- Loading has been done with 25% increment up to full load for B15 blend.
- Engine performance and emission parameters were taken as per the observation table.
- The same procedure is repeated for diesel and B15 blend with different mass fractions of Nano particles.
- Further the piston is changed with an air gap insulated and the same experiment is repeated.

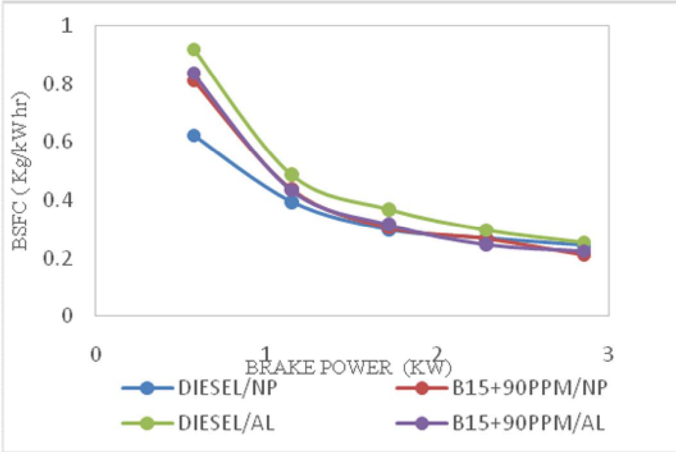
Finally, the engine was made to run on canola biodiesel and diesel blend with nano additive, the corresponding observations are noted.

IV. RESULTS AND DISCUSSIONS:

The tests were conducted on diesel engine and change of Aluminium piston and Aluminium pistons for diesel, blending of diesel and Canola oil, blending of diesel and biodiesel with different proportions of nanofluid as additive for 30ppm, 60ppm,90ppm and 120ppm.

The performance parameters and emission characteristics are calculated and compared with pure diesel, blending of B15 and by using Al_2O_3nanofluid as additive for different proportions. The obtained values for brake thermal efficiency, specific fuel consumption and emissions are calculated and plotted against brake power

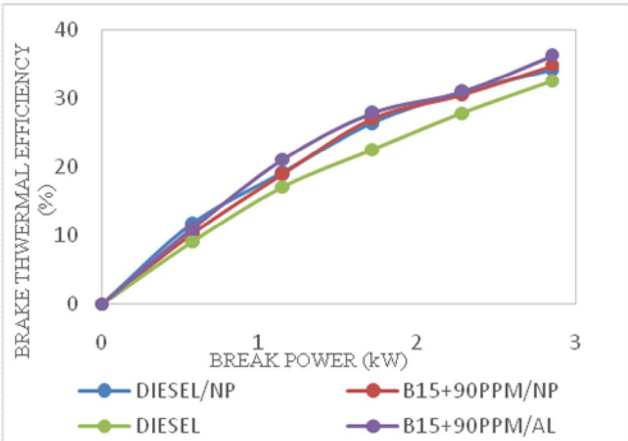
4.1 Specific fuel consumption:



Graph 4.1Variation of Specific fuel consumption with Brake power

The Specific fuel consumption is decreased by 3.37% in Aluminium with air gap piston compare to normal piston. In Aluminium with air gap piston due to complete combustion the brake thermal efficiency is maximum. Hence complete fuel in the combustion chamber takes part in the combustion and so the specific fuel consumption is decreased. Additionally, with the Aluminium piston the weight of the piston is increased which further reduces the SFC.

4.2 Brake thermal efficiency:

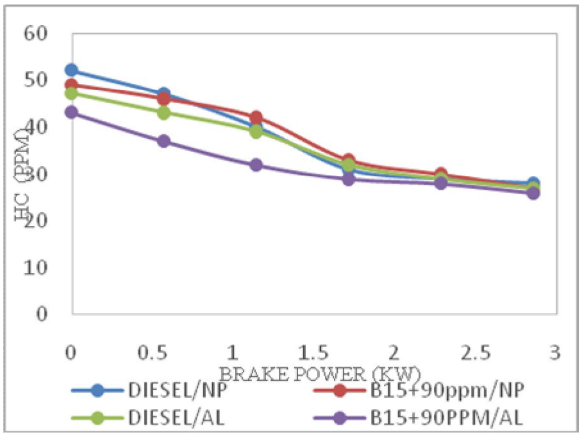


4.2. Variation of Brake thermal efficiency with Brake power:

The Brake thermal efficiency of Aluminium air gap insulated piston is increased by 2.7% and compare to normal piston.In Aluminium piston the thermal conductivity is increasing and further it enhances the combustion with homogeneous mixture formation and oxygen content in biodiesel compare to the normal piston.

V. EMISSION CHARACTERISTICS

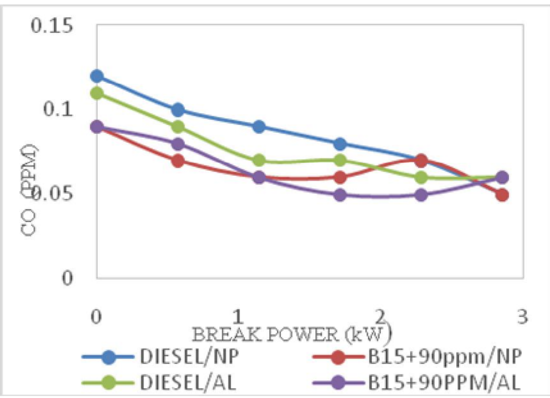
5.1 HC Emissions:



Graph 5.1Variation of HC Emissions with Brake power compare

The HC emissions are formed due to improper combustion. The HC emissions are decreased by 14.81%for 15+90ppm and by 16%compare to 15+120ppm blend of biodiesel and diesel respectively. At B15+90ppm the complete combustion takes place due to sufficient oxygen present in combustion chamber by means of nano additive. so the hydrocarbon emissions are decreased. But at B15+90ppm due to incomplete combustion in chamber compare to 90ppm blend the hydrocarbon emissions are increases.

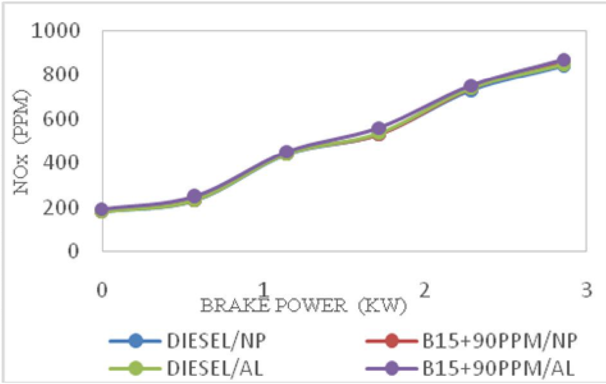
5.2 CO Emissions values:



Graph5.2. Variation of CO emissions with Brake power

The formation of CO emissions are due to lack of oxygen for combustion in the chamber. In the present work, the CO emissions are decreased by 13%at B15+90ppm and CO emissions are decreased 11% at B15+120ppm compare to diesel and it is decreased by 8% at 90ppm blend of biodiesel. At B15+90ppm the air fuel mixture is equal to the stoichiometry air fuel ratio; the complete combustion takes place in the combustion chamber. so, the CO emissions are decreased compare to diesel and 90 ppm blend of nano additive.

5.3 NOx Emissions for Normal piston:



Graph 5.3. Variation of NOx emissions with Brake power

The NO_x is formed due to higher temperatures in chamber, at lower temperature the NO_x is inactive. In present work, the NO_x emissions are increased by 4.3%at B15+90ppm NO_x emissions are increased Aluminium air gap insulated piston piston 2.3% at B15+90ppm compare to diesel and it is increased by 1% at B15+120ppm blend of biodiesel. At 90ppm blend of biodiesel we got the maximum brake thermal efficiency. So, the temperature in the combustion chamber is also maximum. The NO_x is depending up on the temperature in combustion chamber. So, at that blend of biodiesel the NO_x is increased compare to diesel and other blends of biodiesel.

VI. CONCLUSION

The experiments were conducted with Canola oil biodiesel and Al_2O_3 as a nano-fluid has been studied and investigated the performance and emission characteristics. And experimental investigation has done for variation of piston materials on piston crown and comparison of performance and emission characteristics has done with aluminum with air gap insulatedpiston. From the results the following conclusions are drawn based on the experiment are,

1. The Brake thermal efficiency is increased by 2.7% compare to normal piston and Aluminium piston.
2. The Specific fuel consumption is decreased by 3.37%compare to normal piston and Aluminium pistons.
3. The HC emissions are decreased by 14.81% compare to normal piston and Aluminium piston.
4. The CO emissions are decreased by 13% compare to normal piston and the Aluminium and Aluminium piston.
5. The NO_x emissions are increased and 2.3% compare to normal piston and Aluminium piston.

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