INFLUENCE OF THERMAL BARRIER COATING ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE – A REVIEW

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ABSTRACT
It is well known that biofuels have numerous advantages when compared with petroleum diesel. Biofuels are eco friendly fuel for environment. Biodiesel cannot be directly used as a fuel in engines due to its high viscosity and high degree of flash and fire point. But biofuels can be used as a fuel by blending it with petroleum diesel in appropriate proportion. The main advantage of biodiesel is the reduced rate of emission except nitrous oxide in some cases. The increased amount of nitrous oxide emission is one of the major drawbacks of biodiesel. The efficiency of engine can be increased; specific fuel consumption and emission rate of nitrous oxide can be reduced to the maximum extent by the thermal coating of cylinder wall, cylinder head, combustion chamber and piston crown with suitable material (thermal insulating material).

Keywords: *Petroleum diesel, blending, efficiency, combustion chamber, thermal barrier coating*

1. INTRODUCTION

Biodiesel can be produced from seeds of plant, vegetables and even from waste fats. Biodiesels have numerous advantages when compared with conventional petroleum fuels. The biodiesels cannot be able to use as fuel to drive an engine in its pure form due to its high viscosity. Transesterification is the widely used method to reduce the viscosity of biodiesel. Transesterification process is nothing but the reaction of a triglyceride with an alcohol to form esters and glycerol. However biodiesels can be used to run engines by blending it with petroleum diesel/petrol in appropriate proportion. On the other hand biodiesels can able to run low thermal conductivity engine after esterification. In general combustion chamber of engine coated with low thermal conductivity material utilizes major part of heat developed in the engine to combust the fuel completely; as a result the thermal efficiency of the engine increases.

2. LITERATURE REVIEW

The cylinder heads, surfaces, engine pistons top surfaces and engine valves surfaces coated with copper material by electroplating processes with 400 microns thickness resulted in slight improvement on performance, better improvement of exhaust emission, reduction in NOx and smoke level [1]. An indirect injection diesel engine with combustion chamber of variable geometry, coated by $MoSi_2$ and ZrO_2 catalysts was tested using inhibition technique, the results showed that NOx and CO emissions as well as exhaust opacity were significantly reduced due to in-cylinder catalytic coating at slightly improved fuel economy [6]. The experiment conducted on the single cylinder four stroke engines using various catalytic coating like nickel, chromium and copper with different EGR. The maximum NOx reduction for copper coated engine surface with 10% EGR is about 45% lower than the standard engine [2]. In an experimental study, alumina (40%), Titania and nickel- chromium are used as thermal barrier materials. AL-Ti coated diesel engine shows better specific fuel consumption compared to conventional and Ni-Cr coated diesel engine which is 16.6% lower than the standard engine. NOx emission from AL-Ti coated engine is lower by 40% than the standard engine. In AL-Ti and Ni-Cr coated engine, the NOx level is reduced by 40% and 20% respectively [3]. Piston crown of a single cylinder four stroke diesel engine coated with titanium dioxide and performance test is carried out mechanical efficiency is increased as 6-7% for the TiO_2 coated piston when compared to uncoated piston. TiO_2 believed to be a low thermal conductive material result in improved efficiency. The efficiency is said to be increase to 5%, results in decreased fuel consumption as 0.3Kg/KW hr [7]. Plasma ray have higher integrity and perform better than coatings applied by other thermal spray processes. Wet flame spray is the best choice for all purpose saying, coatings can be applied rapidly and at low cost. Electric arc spray can spray up to a large area and can also apply thick coatings. High velocity oxy-fuel (HVOF) is well suited to producing high quality tungsten and chromium carbide coatings [4]. 7-8% yittria stabilized zirconia has high thermal expansion coefficient, low thermal conductivity and high thermal shock resistance [5]. Engine components coated with Mg-PSZ of which 150 µm thickness of ZrO_2-24Mgo over a 50 µm thickness of NiCrAlY bond resulted increase in brake thermal efficiency by 10.25% for Mg-PSZ coated engine, there is a decrease in specific fuel consumption by 15.35% for Mg-PSZ coated compared to normal engine. HC emissions are lowered of 10% for coated piston and cylinder head compared to normal engine. Co emissions are lower of 23% for coated engine compared with conventional engine. NOx emissions are lowered by 15.38% for engine coated with Mg-PSZ and running with nelli oil diesel fuel blend compared to non coated engine [8].

3. COATING PROCESS

Coating the combustion chamber of an engine increases the efficiency, reduces the specific fuel consumption and at the same time emission can also be minimized. In normal coating comprise of the following layers namely the metal substrate, bond coat, thermally grown oxide and ceramic outer coat. Coating can be achieved by thermal spray coating (plasma spray, wire flame spray, powder flame spray, detonation gun technique and electrical arc spray), Chemical ceramic coating (sole-gel, slurry, chemical vapour sedimentation, physical vapour sedimentation), ion coating, splash coating, electron beam evaporation coating, reactive ion coating, hot izostatical press coating, electroplating, etc.

4. COATING MATERIALS

Alumina has high hardness, high thermal conductivity, low thermal expansion coefficient, but when added with yittria stabilized zirconia increases the hardness. Zirconates posses low sintering activity, low thermal conductivity, high thermal expansion coefficient. Garnets are best suited for high temperature operations. Mullite when compared with yittria stabilized zirconia has a lower thermal expansion coefficient and higher thermal conductivity. Yittria stabilized zirconia has low thermal conductivity, high thermal resistance, inertness to chemicals. Brass crown coatings provides high rate of brake thermal efficiency.

5. ADVANTAGES OF THERMAL BARRIER COATING

- Increased brake thermal efficiency
- Reduce rate of emission
- Improved specific fuel consumption
- High thermal resistance
- High fire point fuels (biodiesel) can also be easily ignited
- Increased mechanical efficiency

6. CONCLUSION

From the review of literature by the researchers it is concluded that by providing suitable thermal barrier coating on the engine parts like combustion chamber, cylinder head, piston crown, etc. the running temperature of the engine increases. The proper utilization of heat developed during the combustion process by coating results in improved specific fuel consumption, increases the thermal efficiency and in turn mechanical efficiency of the engine. Application of ceramic materials for coating purpose is expensive. Further it is also possible to use biodiesels as a fuel to in the low hest rejection engine..

7. REFERENCES

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