ABSTRACT

Diesel engines are widely used in light, medium and heavy duty vehicles, load carriers, tractors, and power generation in heavy machinery, because of higher fuel efficiency and the ability for lean operation. Further, the lean burn capability helps to lower the carbon monoxide and hydro carbon emissions compared to those of a gasoline engine. However the emission of oxides of nitrogen and particulate matter are higher in a diesel engine.

A nation’s development is strongly dependent on the availability of fuels for transportation, agriculture and power generation. For many developing countries like India, meeting the high demand for oil is a major challenge. Only by using the renewable sources of fuel with clean combustion can, the exhaust emissions and also the dependence on conventional petroleum sources, be reduced. Several alternative fuels are being considered for use in diesel engines. The potential alternative fuels are liquid fuels, like vegetable oil and vegetable oil methyl ester (Biodiesel). The performance of a vegetable oil fuelled diesel engine is improved by various methods like preheating, higher injection pressure and transesterification of vegetable oil to reduce its viscosity. These require additional energy sources, which increases the cost of the engine. A simple method is used to improve the performance of a diesel engine by inducing in-cylinder turbulence through internal jets on the combustion chamber is investigated.

In the present work, the improvement in performance of the biodiesel fuelled (Jatropha oil) diesel engine combustion and emission processes are experimentally investigated, through in-cylinder air motion by the internal jets with thermal barrier
coating like partially stabilized zirconia (PSZ), and copper coating on the combustion chamber. Beside, comparing the measured performance and the exhaust emissions (exhaust smoke and oxides of nitrogen) and a detailed combustion analysis of the acquired cylinder pressure histories on these samples has been attempted for understanding the effect of in-cylinder turbulence on the biodiesel combustion characteristics. From this analysis, it is observed that the engine combustion has become smoother with the internal jet piston. The maximum improvements in BSEC and exhaust smoke level are found to be 8 % and 24 % respectively with the internal jet piston with Jatropha methyl ester as compared to that of the base engine.

In the second stage of the work, the effects of partially stabilized zirconia coated internal jet piston on the diesel engine are investigated. It is observed that the PSZ internal jet piston showed improvement in the engine brake thermal efficiency and drastic reduction exhaust smoke level with increase in NOx concentration. The CO and HC emissions are also decreased due to the high temperature combustion chamber of the ceramic coated piston and more oxygen molecules present in the Jatropha methyl ester fuel as compared with the base engine.

In the third stage of the work, the effects of copper coated internal jet piston on the diesel engine are investigated. It is observed that the copper internal jet piston showed improvement in the engine brake thermal efficiency and marginal reduction in exhaust smoke level with the increase in NOx concentration. The CO and HC emissions are also decreased marginally due to the high temperature combustion chamber of the copper coated internal jet piston and more oxygen molecules present in the Jatropha methyl ester fuel as compared with the base engine.
Finally, it is concluded that the Jatropha methyl ester combination with the PSZ coated internal jet piston engine operation suggests superior performance in terms of fuel consumption with lower exhaust emissions. The brake thermal efficiency increased by about 3.0% and 12% decrease in BSEC. The exhaust smoke decreased by about 36% with a marginal increase of about 15% in NOx level at full load. This may be due to the heat retention in the ceramic coated piston as compared with the copper coated internal jet piston and the base engine.