ABSTRACT

Rising fuel costs and impending emission regulations have sharpened the automotive industry’s focus on suitable substitute for the petroleum based fuel. Vegetable oils are receiving a lot of attention as an alternative fuel for engines as they are renewable and can be used in engines without any major modification. Their properties are closer to those of diesel except viscosity. The main problems of using neat vegetable oil in diesel engines are higher emission level and lower thermal efficiency due to higher viscosity and carbon residue compared to diesel. Transesterification of vegetable oil into biodiesel is the best method to overcome this problem. The present work mainly focuses on comparing different methods to improve the performance of neem oil in a DI diesel engine.

A single cylinder four stroke air cooled DI diesel engine with a rated output of 3.6 kW at 1500 rpm was used for conducting experiments. Tests were carried out to study the combustion, performance and emission characteristics of a diesel engine fueled with neem oil and neem oil ethyl ester, glow plug assisted neem oil and neem oil ethyl ester operation, dual fuel operation of neem oil and neem oil ethyl ester with LPG and glow plug assisted dual fuel operation.

Neem oil results in lower thermal efficiency of about 3 % lesser than diesel at full load. NO\textsubscript{x} reduced by about 12 % when compared to diesel.
Smoke, HC and CO emissions are higher compared to diesel due to the high viscosity of neem oil. The ethyl ester of neem oil shows a comparable performance and reduced emissions compared to diesel. The maximum brake thermal efficiency observed for NOEE and diesel is 25.8 % and 26.7 % respectively at rated power. Better ignition quality, higher combustion temperature and higher oxygen content increase the NO\textsubscript{x} emission by about 8 % in the case of NOEE. The smoke level of NOEE is lower by 30 % than diesel. The HC and CO emissions are reduced on an average of 39 % and 37 % respectively in NOEE operation compared to diesel.

The glow plug assisted operation of NOEE advance the combustion process and promote the premixed combustion process which increase the thermal efficiency. Smoke, HC and CO levels are reduced by 40 %, 47 % and 52 % respectively but 11 % increase in NO\textsubscript{x} emission is noticed compared to diesel. Higher viscosity of neem oil results in late combustion in glow plug assisted neem oil operation than diesel operation. The smoke, HC and CO emissions are higher by about 17 %, 20 % and 13 % respectively than diesel, but 7 % reduction in NO\textsubscript{x} emission is noticed compared to diesel.

The dual fuel operation of neem oil with LPG shows a poor performance in low power range due to insufficient ignition sources for the lean gas air mixture. However the performance is better at high power range due to the complete burning of LPG due to elevated temperature. The NO\textsubscript{x} reduces upto 70 % of the rated power and the smoke in the entire power range but HC and CO emissions are increased marginally compared to neem oil. The dual fuel operation of NOEE with LPG gives a better performance at
high power range but it shows a poor performance in low power range. The thermal efficiency increased by about 1.5% with dual fuel operation at rated power. The NO\textsubscript{x} emissions reduces upto 75% of the rated power and smoke emissions reduces by about 62% in the entire power range in dual fuel mode of operation compared to diesel. HC and CO emissions are higher in dual fuel operation compared to diesel fuel operation.

The glow plug assisted dual fuel operation improves the part load efficiency by about 2% compared to dual fuel operation but it is lesser than diesel fuel operation. There is no appreciable change at higher loads. The glow plug assisted dual fuel operation further reduce the smoke emission by 18% compared to dual fuel operation, which is 67% lower compared to diesel operation. HC and CO emissions are reduced by 7% and 16% compared to dual fuel operation but it is higher than diesel operation. The variation in NO\textsubscript{x} emissions is minimal.

It is concluded that it is possible to use neem oil and its ethyl ester as an alternate fuel for diesel engine, either as a neat fuel or in dual fuel mode with LPG without any major modification in the existing diesel engine. The NOEE gives performance closer to diesel with reduced emissions. The dual fuel operation of NOEE with LPG improves the performance at maximum power range with reduced smoke emission. The glow plug assistance improves the part load performance of the dual fuel engine.