RJC

RASĀYAN J. Chem.
Vol. 10 | No. 4 |1189-1193 | October - December | 2017
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

EFFECT OF NANO AL_2O_3 ADDED JATROPHA METHYL ESTER ON CI ENGINE PERFORMANCE AND EMISSIONS

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ABSTRACT

The purpose of this work is to investigate the influence of nano Aluminum Oxide nano on the performance and emission properties of a diesel engine operated with Jatropha methyl ester. The nano Aluminum Oxide was added to a blend of B10 such as 90% diesel + 10% Jatropha methyl ester. The JME was mixed with Aluminum Oxide particles using an ultrasonicator. It has been observed that, the Aluminum Oxide additive improves the brake thermal efficiency (BTE) and reduces consumption of fuel per unit output for almost at all tested loads. The Aluminum Oxide is good in regulating the hydrocarbon (HC), oxides of nitrogen (NOx), carbon monoxide (CO) and smoke.

Keywords: Jatropha methyl ester, transesterification, Aluminum Oxide, performance, emissions, diesel engine.

INTRODUCTION

The biodiesel and their blends produced from various sources were good in properties, CI engine performance and exhaust emissions.[1-4] The engine operation and performance directly influence the entire design of automobile.[5,6] Most of the literature has reported that the inbuilt Oxygen in biodiesel and operating temperatures lead to increases in NOx.[7-11] A few researchers found the opposite trend.[12-16] An H et al. [17] also found there was a reduction in NOx with pure biodiesel, resulting to lower the heat release rate and cylinder pressure. The pure biodiesel is viscous in nature and leads to the formation of sticky tar-like deposition in engine. [18] The excessive emissions which are toxic in nature can be after-treated.[19-25]

EXPERIMENTAL

The modified fuel was prepared in stages. In the first stage, the raw oils converted into biodiesel by transesterification process and the nano particle is added by ultra-sonication in next stage.

Biodiesel preparation by transesterification

The raw Jatropha oil was procured from the local market. Raw oil is heated to 60^0C, then 100 ml methanol and 2-3 ml of sulphuric acid are added followed by 3 Hrs. of settling. After separation of the pulp, Sodium methoxide is added at 60^0C to the acid treated oil followed by 6 Hrs of settling to separate biodiesel and glycerol. The base-treated oil is water washed and dehydrated to obtain pure biodiesel.[18,19] as shown in Fig.-1.

Fuel sample preparation

Biodiesel in the proportion of 100 ml is added to 900 ml diesel to get B10. For the prepared B10 fuel sample, Al_2O_3 of 25 ppm is added by ultra-sonication of 20 kHz to get the B10+25 ppm fuel sample.

Vol. 10 | No. 4 |1189-1193 | October - December | 2017

Experimental setup

Experiments were conducted on a single cylinder four stroke CI engine to determine the performance and emission characteristics as shown in Fig.-2 fuelled with modified and base fuels. The engine was tested at five loads from no load to full load with diesel and 25 ppm of nanoparticles (Aluminum oxide) + 10% of JME+80% of diesel. The CRPTON 5 gas analyzer is used to find the emission parameters.

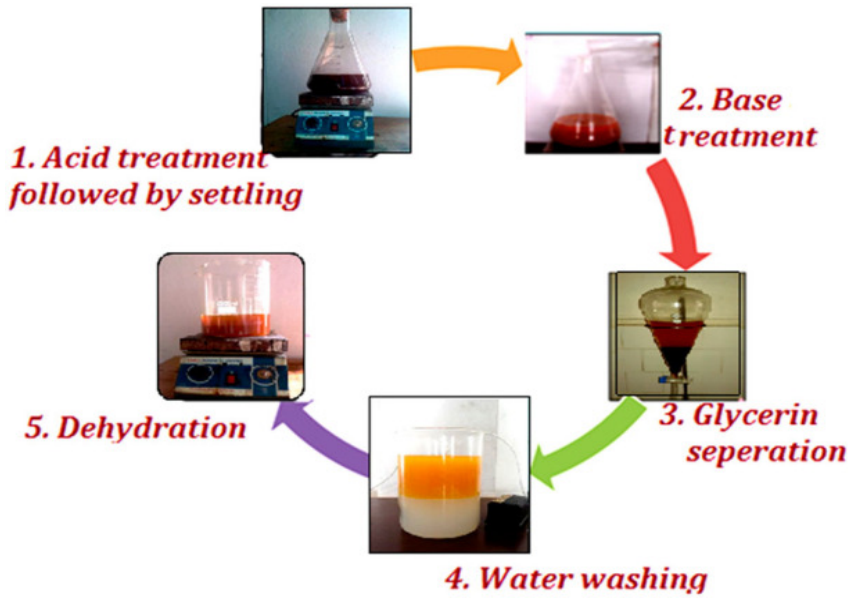

Fig.-1: Biodiesel preparation process[13]

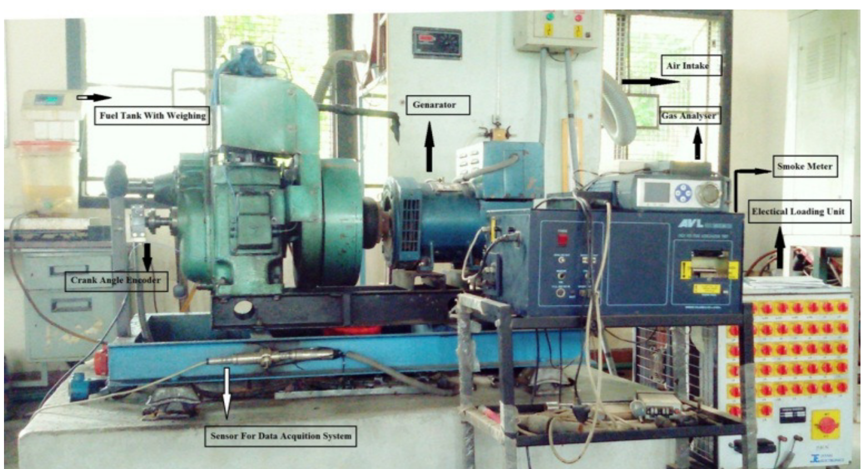

Fig.-2: Experimental setup

RESULTS AND DISCUSSION

Figure-3 shows the disparity in brake thermal efficiency with the load. The B10+25 ppm nano additive has given 2-3% improvement in Thermal efficiency. This is because of improved combustion.[14] Figure-4 shows variation in specific fuel consumption (SFC). With the B10, the consumption of fuel is increased because of the lesser calorific value of biodiesels.[13-15] The nano-additives in fuel resulted in better combustion, So the SFC is increased by 2-5%.

Vol. 10 | No. 4 |1189-1193 | October - December | 2017

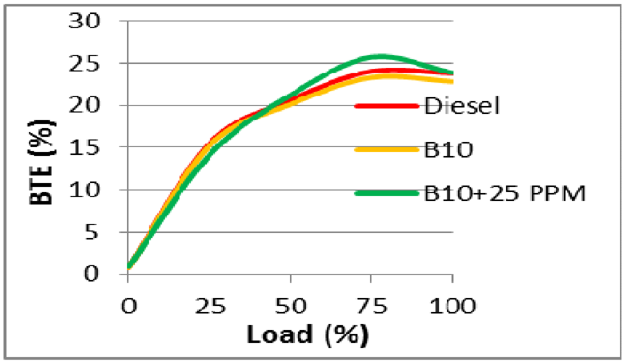

Fig.-3: Trends of BTE with load

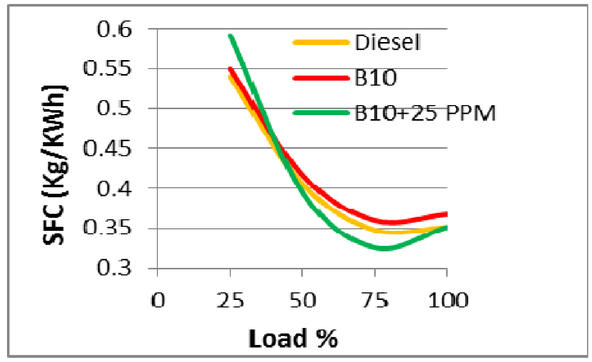

Fig.-4: Trends of SFC with load

Figure-5 shows change in NOx and Fig.-6 shows a change in exhaust gas temperature (EGT) with the load. The NOx and EGT are increased with load because of more heat release rate.[13-15] The EGT is less with nano added fuel which ensures the improved combustion. Similar trends were observed with the NOx up to 50 % load. But, towards the maximum load, the inbuilt oxygen reacts more at elevated temperatures and leads to formation of more NOx.

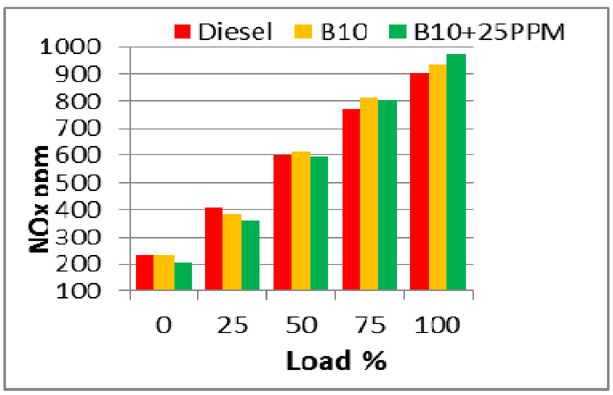

Fig.-5: Variation of NOx with load

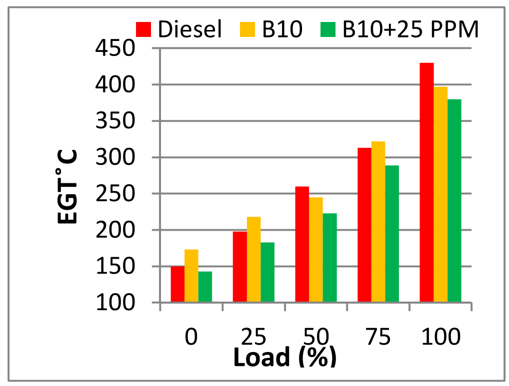

Fig.-6: Variation of EGT with load

Figure-7 shows variation in carbon monoxide (CO) and Fig.-8 shows a change in hydrocarbon (HC) with the load. For all the tested fuels the CO emissions are almost 1% less.[13-15] With the B10, the HC emissions were decreased compared to diesel as the inbuilt Oxygen contributed towards the complete burning. The nano added fuel further reduced the HC emissions by 10- 50 ppm. Figure 9 shows variation in carbon dioxide (CO_2) with the load. With the increase in load, the CO_2 emission was increased ensuring complete combustion.

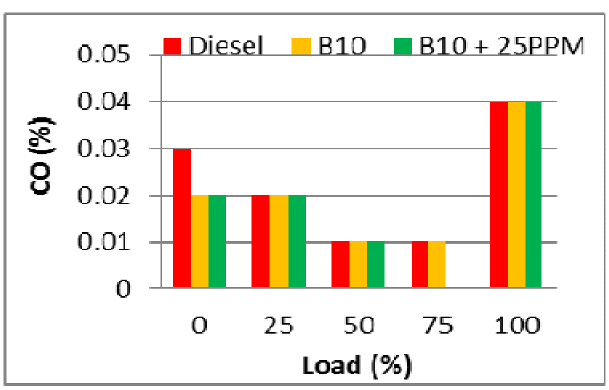

Fig.-7: Trends of CO with load

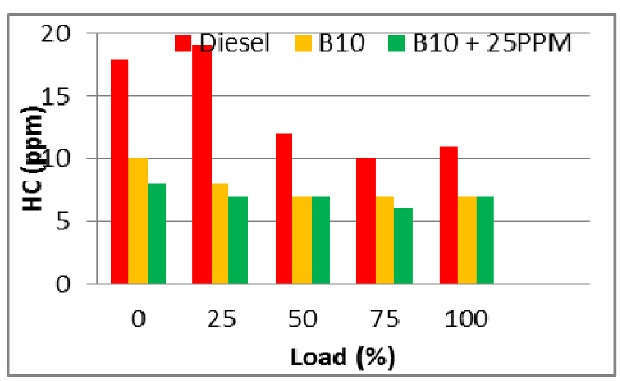

Fig.-8: Trends of HC with load

Vol. 10 | No. 4 |1189-1193 | October - December | 2017

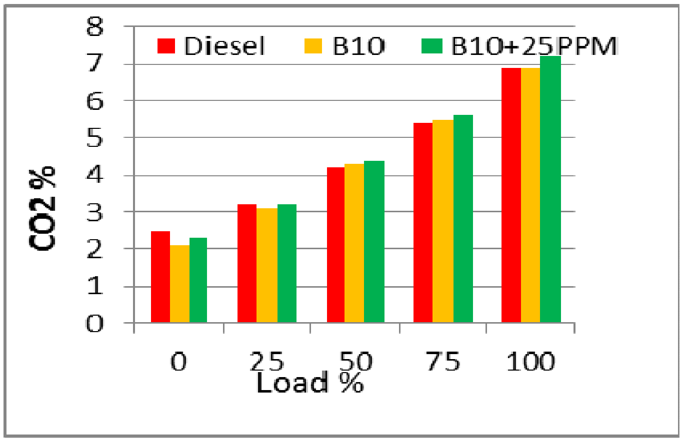

Fig.-9: Trends of CO_2 with load

CONCLUSION

From the experimentation, it is observed and concluded as

- The BTE of Al_2O_3 blended fuels increased by 2 to 3 % with B10+25 ppm
- The SFC was decreased by 8% with B10+25, compared to diesel.
- There is a significant reduction in CO, CO_2, HC, and NOx with alumina added biodiesel fuel blend, related to diesel at almost all the loads.

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[RJC-1901/2017]