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Research studies on biodiesel production and performance check in compression ignition engines: A review

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ABSTRACT

The best alternate fuels to compression ignition engines are found in the current work from various studies. It is observed that biodiesel blends of diesel reduce the emission contents in diesel engines and gave same performance as compared to engine running on diesel. The performance of various biodiesels is also presented in order to analyze the variation of response parameters of diesel engines.

Keywords: Biodiesel, Performance check, compression ignition engines

INTRODUCTION

The alternate fuels of compression ignition engines are now in demand in India due to large emission ontents in the environment. Therefore various researchers [Dhingra et al., 2013a; Dhingra et al., 2013b; Dhingra et al., 2014a; Dhingra et al., 2014b; Dhingra et al., 2014c; Dhingra et al., 2014d; Dhingra et al., 2016] have observed biodiesel as alternate source of fuel to compression ignition engines. Pandian et al. (2011) applied desirability approach for optimization of performance and emission characteristics operating on pongamia-pinnata (karanja) biodiesel-diesel blends on twin cylinder water cooled naturally aspirated CIDI diesel engine.

The experiments were designed (to measure performance and emission parameters) based on response surface methodology (RSM) by considering injection system parameters such as injection timing, injection pressure and nozzle tip protrusion. It was observed that NO_x emissions were higher for all the designed experiments for pongamia biodiesel-diesel blend as compared to diesel. Therefore desirability approach was helpful in achieving the required objectives (BSEC, BTE, CO, HC, smoke opacity and NO_x) and optimum conditions were found to be at 225 bar injection pressure, 21° bTDC injection timing and 2.5 mm nozzle tip protrusion for pongamia biodiesel-diesel blend in an engine of 7.5 KW at 1500 rpm. The sunflower oil based biodiesel was utilized in a CI engine by Reddy and Mohan (2011) for prediction of optimum parameters using artificial neural network.

Shivakumar et al. (2011) proposed ANN model for the prediction of performance and emission parameters in a single cylinder, four stroke, variable compression ratio diesel engine. The tests were conducted for three injection timings (24°, 27° and 30° bTDC) by adjusting the thickness of advance shim. The inputs to ANN were: Compression ratio, injection timing, blend percentage and load percentage while brake thermal efficiency (BTE), brake specific fuel consumption (BSFC) and exhaust gas temperature (T_{EXH}) were used as ouputs to the trained network. The results from the trained neural models showed a good correlation between the actual and predicted values of engine output parameters with 8 % relative mean square error. Yoon and Lee (2011) considered biogas-biodiesel as a dual fuel in a compression ignition engine and compared its combustion and emission characteristics with straight diesel. Zhu et al. (2013) evaluated particulate and unregulated emissions by considering the effects of ethanol-biodiesel blends and diesel oxidation catalyst. Xue et al. (2011) evaluated the performance of biodiesel in a diesel engine.

Diya'uddeen et al. (2012) studied the performance of biodiesel produced from used domestic waste oils (UDWOs) and demonstrated the scope of applying these fuels in various industries by replacing mineral diesel. The benefits of UDWO as

a biodiesel feedstock were also presented. It was found that energy from domestic waste (UDWO) could be the possible alternative to diesel due to low cost of biodiesel production, reduction in greenhouse gas emissions, enhancing fuel diversification and comparable energy output to diesel fuels.

Malvade and Satpute (2013) prepared and checked the performance of biodiesel derived from palm fatty acid distillate (PFAD) oil in a single cylinder, four stroke, water cooled diesel engine. The various properties (calorific value, density, flash point, viscosity and cetane number) of produced biodiesel were comparable to that of commercial diesel which resulted in suitability of PFAD fuel in a diesel engine. Experimental investigations revealed that 50 % PFAD biodiesel-diesel blend performed equally well at various loads as compared to straight diesel. However slightly higher specific fuel consumption and lower indicated power of PFAD blends was obtained as compared to diesel.

Giakoumis et al. (2012) reviewed the various articles of biodiesel-diesel blends running in compression ignition engines. Majority of the articles suggested a decreasing trend of PM, HC and CO, and an increasing trend in NO_x emissions with an increase in biodiesel-diesel blends. Jiang Dayong and Bai Yun (2012) prepared ethylene glycol monobutyl ether palm oil monoester and tested in biodiesel-diesel fuelled compression ignition engine for evaluating performance, combustion and emission parameters. The significant reduction in smoke emissions (9 %-54.6 %) was observed for B25 and B100 fuelled diesel engine while CO, NO_x and unburnt HC emissions decreased in the ranges of 50.0-66.7 %, 25.7-37.1 % and 45.5-58.3 % respectively. An improvement in brake thermal efficiency was seen due to early ignition of B100 fuel in the diesel engine operation. A higher cetane number, shorter ignition delay, increased in-cylinder pressure along with its changing rate with crank shaft angle up to some extent was observed (based on the experimental results).

Jindal and Salvi (2012) suggested an optimum value of 10 % linseed biodiesel blend with diesel for significant improvement in performance, combustion and emission parameters in a single cylinder diesel engine running at 1500±10 rpm. Karuppasamy et al. (2012) found response surface methodology, an effective tool for predicting optimum performance, combustion and emission parameters in a single cylinder DI diesel engine.

Murugesan et al. (2012) experimentally investigated methyl esters of pongamia, ethyl esters of pongamia and ethyl esters of neem biodiesel-diesel blends (B20, B40, B60, B80 and pure blend) in a single cylinder, direct injection diesel engine loaded with eddy current dynamometer. The values of performance and emission parameters were measured at varied load conditions and blending ratio. Slightly reduced emissions were observed for B40 blend with no change in the brake thermal efficiency (BTE). B40 was suggested as the optimum blending ratio. However slight decrease in maximum cylinder pressure in comparison to base diesel at same operating conditions was also experienced. Further higher heat release rate and cumulative heat release rate was observed for base diesel in comparison to B40 blend.

CONCLUSION

- The emission contents of diesel engines running on biodiesel blends are reduced as compared to engine running on commercial diesel
- The biodiesel blends of upto 30 % are best used in diesel engines.

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