A review on effect of biodiesel-diesel-water emulsion in di diesel engine

***Arularasu. S, Appu Raja. S, Thangaraj. M, Annamalai. K**
*Department of Automobile Engineering, Madras Institute of Technology, Anna University, Chennai, Tamil Nadu.
***Corresponding author: EMail : arularasus@yahoo.com.**

ABSTRACT

In the world of increased emission standards, diesel engine plays a vital role in various applications. The oxides of nitrogen (NOx) and particulate matter (PM) are the major pollutants from diesel engines. To surmount these difficulties many researches were held out, at which diesel engine powered with emulsified fuel is one of the effective methods for cutting exhaust emissions. Water-Diesel-Vegetable oil (W-D-V) emulsions are identified as suitable fuel for regular diesel engines. The advantages of an emulsified fuel are reduction in the emissions of nitrogen oxides and particulate matters, which are both health hazards. It has also shown a reduction in fuel consumption and improved combustion efficiency. This review demonstrates the influence of water on the emissions and on the combustion efficiency while using W-D-V emulsified fuel. The review paper also covers similar fuels, such as double emulsions i.e., diesel-in-water-in-diesel emissions, water-in-diesel micro emulsions, and biodiesel emulsions i.e.,water-in-vegetable oil emulsions.

Keywords: diesel-water emulsion, biodiesel, micro-explosion, NOx emission, PM emission

INTRODUCTION

Increasing demand for petroleum fuels, day to day increase of automotives and stringnent emission norms across world side created a thrust among the researchers in the alternative fuel. Dr. Rudolph Diesel himself demonstrated his invention with peanut oil in an exhibition at Parris in 1900 itself. Followed with researches went on with vegetable oil. The various vegetable oils tested were Jatropha, Mahua, Pongamia, Karanja etc. India being a developing country, non-edible oils were used as the test fuels as the edible oils were preferred for cooking. Vegetable oils created few problems such as clogging of nozzle, poor combustion due to its heavier molecular size. Hence to reduce the viscosity of vegetable oils, a chemical process called Transesterification has been used to extract biodiesel from the raw vegetable oil. The extract of the vegetable oil (Biodiesel) were under research for past two decades. Common problems produced by the biodiesel are increased NO_x emission and reduced efficiency. Recent researches were ongoing with emulsified fuels. Diesel-water emulsion and biodiesel-water emulsion have been under testing as the alternative fuel. This paper has an indepth analysis of various researches went on with emulsified fuels. Few suggestions have been made for the continual work too.

Emulsified fuels in diesel engines – a review: Mohammed et al (2014) reviewed the current trends in the emulsified fuels and they stated that introduction of water into combustion chamber could be done by three ways. They are introduction of water with the inlet air in liquid or in the form of vapour, parallel diesel and water injection and water in diesel emulsion with or without surfactants. They also mentioned that the first two methods would cost more than the third system, as the engine required a separate injection system. They added that there might be corrosion problems.

Senthur et al (2014) carried out an experimental study on eucalyptus biodiesel fuel in a single cylinder diesel engine. They have mentioned that there was an increase in oxides of nitrogen emission (NO_x). There was appreciable reduction in emission parameters such as unburnt hydrocarbon, carbon monoxide and carbon dioxide emissions. There was a marginal decrease in brake thermal efficiency when compared to diesel. Pradeep kumar et al (2013) conducted an experimental study on diesel-emulsion with various proportions of water in the ranges of 5%, 10% and 15%. They have reported that there was marginal in brake thermal efficiency and appreciable reduction in smoke and oxides of nitrogen emission. They have also suggested that endurance test may be conducted to study the durability of the engine.

Alam et al (2013) conducted an experimental study on a single cylinder direct injection diesel engine with diesel-water emulsion as fuel with varying load conditions. They reported that there was decrease in exhaust temperature and carbon monoxide for all engine loading conditions. They also mentioned that carbon monoxide emission was initially high at low load conditions and it was significantly reduced at higher engine rpm. Narkpakdee et al (2012) carried out their experiment with diesel and crude palm oil (CPO) emulsion as fuel in a small diesel engine to test the engine performance and emission. In the study, the compositions of diesel/CPO/water of 95/0/5, 90/0/10, 90/5/5, 85/5/10, 85/10/5, and 80/10/10 by volume were used in a four-stroke single cylinder diesel engine having a pre-combustion chamber. The engine speed was in a range of 1000 – 2000 rpm. From the results, it was found that the torque and the engine power for the emulsion of 90/5/5 were close to those for the diesel oil and the performance was poorer when the percentages of CPO and water were increased. The specific fuel consumption of the emulsified oil with the composition of 90/5/5 was quite close to that of the diesel oil at low engine speed and higher consumption was needed with higher amount of CPO and water in the emulsion due to lower heating value in the emulsion. The emissions in terms of CO, NO_x and black smoke for the emulsified oil could be reduced significantly.

Prakash et al (2011) investigated the performance, combustion, and emission parameters of a diesel engine fueled by wood pyrolysis oil (WPO) diesel emulsion with Diethyl ether (DEE) as an ignition improver. They carried out the research work, with three fuels in DI diesel engine and a little amount of (2% and 4%) DEE also added with WPO diesel emulsions. They compared and analyzed the results with the diesel fuel. The brake thermal efficiency was found to be higher by 6.34, 9.5, and 9.3 percent for WPO diesel emulsion, WPO diesel emulsions with 2% and 4% DEE respectively when compared with diesel fuel at full load. The percentage reductions in NO emissions for WPO diesel emulsions were observed as 19.21, 28.38, and 34.81. Omar et al (2011) conducted an experimental investigation using a stable diesel-water emulsion fuel on diesel engine under different operating conditions. The effective mixing process and emulsifying agent were used to produce stable emulsions of 10% to 30 % water by volume in diesel. These emulsions normally takes one week to 4 weeks for stability. The physical properties of stable water-diesel emulsions such as density, viscosity

and pour point were observed. The results showed that the water emulsification has a potential to improve the diesel engine performance and to reduce gas pollutants. Alahmer et al (2010) carried out an experimental work to analyze the engine performance with emulsified fuel. They reported that there was an appreciable increase in brake thermal efficiency when 5% of water was blended with diesel fuel.

Roila & Choo (2008) carried out experimental work on single cylinder diesel engine with water in oil emulsion of Palm-Oil biodiesel as fuel. They have found that polymeric surfactant was found to be the most suitable emulsifier for palm oil biodiesel. They also found that stability of emulsion was improved by increasing the speed. The preliminary results of this experimental work showed a reduction of oxides of nitrogen emission (NO_x), but the increase of water in the emulsified fuel reduced the calorific value. Nadeem et al (2006) carried out an experimental investigation on emulsified fuel with Gemini surfactant. In their study, they tested upto 10% of water blended with diesel fuel. They have stated that there was a reduction of particulate matter, oxides of nitrogen (NO_x) emission, and carbon monoxide emission. Samec et al (2002) carried out numerical study as well as experimental investigation to study the performance, combustion, and emission characteristics of diesel water emulsion. They conducted the study with 10% and 15% of water content by volume with diesel. They concluded that there was a reduction of 20% reduction of oxides of nitrogen (NO_x) emission with 10% water content and 18% of oxides of nitrogen (NO_x) emission with 20% water content. Masjuki et al (1994) compared the palm oil emulsion with diesel emulsion in their experimental investigation. They reported that the engine performance, fuel consumption and wear resistance of palm oil emulsion were on a par with diesel fuel.

CONCLUSION

With the foregoing literature review, the following observations were reported.

- Simultaneous reduction of smoke and oxides of nitrogen (NO_x) emission could be achieved with diesel-water emulsion
- There was a slight increase in NOx emission with biodiesel-water emulsion. However it is lesser than diesel and biodiesel fuels.
- There was a slight increase in brake thermal efficiency due to the secondary atomization of fuel particles.
- There was remarkable decrease in unburnt hydrocarbon, carbon monoxide and carbon dioxide emission.

SUGGESTION S FOR THE FUTURE WORK

Endurance test may be carried out to observe the wear and tear of the piston, piston rings and valve. Fuel additives such as diethyl ether (cetane improver) could be added as water has no calorific value. Manufacturer's settings such as injection timing, injection pressure, and compression ratio can be altered and optimized.

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