Chapter 8

Reduction of NOx on a Single Cylinder CI Engine Running on Diesel–Biodiesel Blends by New Approach

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ABSTRACT

Diesel-water emulsion has been used in diesel engine combustion for a long time with encouraging results, but the point of efficiency and NOx trade-off represent a highly challenging task for diesel engines. A new approach was used in this study. The new blends which were obtained by mixing diesel-neem oil biodiesel blend (70:30 by volume) with water (5% by volume), span-80 surfactant (1% by volume), and cetane enhancing additive of Di-tertiary butyl peroxide (0.5% by volume). The blend is designated as B3. This chapter investigates performance and emission characteristics of a single cylinder diesel engine running on B3 fuel. Performance and emission of the engine fueled by B3 fuel results were compared with diesel (D), diesel-biodiesel blend (B1), and diesel-biodiesel with water emulsion through surfactant (B2). B3 fuel had better performance and improved emissions than B1 fuel and diesel fuel, with NOx emission especially reduced by up to 35%.

INTRODUCTION

Biodiesel derived from plant oils and animal fats is considered a promising substitute for petroleum diesel fuel because of its advantages, such as renewability, biodegradability, less environmental toxicity, and superior combustion efficiency (MingHuo et al. 2014). Consistent scientific investigations are performed to find alternate to petroleum oil. Vegetable oils are a viable substitute for diesel fuel, and short-term tests using pure vegetable oils did not show any variation on performance and the results are as good as to diesel fuel (Dwivedi et al.2013). However, the problems arise due to the high oil viscosity
Reduction of NOx on a Single Cylinder CI Engine Running on Diesel-Biodiesel Blends

after long-term usage. Direct use of vegetable oil blends has been considered to be not agreeable and unrealistic for both direct and indirect diesel engines (Baskar and Senthil Kumar 2017). To reduce the viscosity, transesterification reactions on the triacylglycerol are carried out to convert it into esters by converting each fat oil molecule into one molecule of glycerine and three molecules of ester. Separation of glycerine from the ester produces biodiesel. The prevalent method followed by the researcher for biodiesel production is the transesterification process. Transesterification is the reaction of a fat or oil with an alcohol to form esters and glycerol. The catalyst (Alkalis and acid) and enzymes are used to improve the reaction rate and yield. An alkali-catalyzed process is much faster than the acid-catalyzed process and is used commercially. A diesel-biodiesel blends up to 80:20 by volume is widespread in the worldwide for any biodiesel blends (Nabi et al.2009). The main drawback of commercial use of B20 blend operation is higher NOx emission (Subramanian 2011; Suresh and Amirthagadeswaran 2016). Hence research has been a quest toward reduction of NOx emission for biodiesel blend fuels. Simple and easiest method might be carried out by many studies in water emulsion with a surfactant. Based on the literature (Alahmer et al.2010; Fahd et al. 2013; Noge et al 2015; Selim and Ghannam 2010; Varatharaju Perumal, Ilangkumaran 2018), the methods for admitting water into the combustion zone are (i) direct injection of water into the engine through separate injectors; (ii) modification to be made on nozzle to inject both diesel and water known as hybrid injection (iii) fumigate the water into the engine intake air along with air (iv) Diesel-water emulsions through surfactant. Among the four methods of water addition, diesel-water emulsion with a surfactant is most widely used (Suresh and Amirthagadeswaran 2016). Water addition to the blended fuel influences on reducing the peak flame temperature thereby NOx emission is reduced (Koc and Abdullah 2013; Basha and Anand 2014). An emulsion is a finely dispersed mixture of two liquids that cannot normally be mixed without visible separation. A surfactant can reduce the oil and water surface tension, activate their surfaces, and maximize their superficial contact areas to make oil-in-water or water-in-oil two-phase emulsions (Mura et al. 2010; Ochoterena et al 2010). Based on the past literature, the many studies dealing with performance and emission study on diesel engines fueled with diesel-water emulsions. Their conclusion reveals both convergent and divergent results (Attia and Kulchitskiy, 2014; Noor El-Din et al., 2013; Sachin et al., 2014; Selim and Ghannam, 2010). In general, engine performance decreases with water content, due to the lower heating value of emulsion fuel compared to pure diesel fuel however a significant reduction in NOx emission. The trade-off between the improved engine performances and reduction in NOx emission for blended fuel with water emulsion was obtained through the addition of cetane number enhancing additive(Basha and Anand 2012: Mohamed Musthafa et al.2018; Yang et al. 2013). Study on diesel engine performance fuelled by diesel-biodiesel-water- Di-tertiary butyl peroxide blend is unexplored. Hence the study has focused on the engine performance and emission characteristics test running on the new blend (B3) so that to bring research works in this area under one platform to research community and to further update the possible area of intervention for researchers.

MATERIALS AND METHODS

Preparation of Biodiesel

The raw neem oil was obtained from the local market. In the transesterification method, the raw oil was first filtered and then heated to a temperature of 110°C for the removal of water content and then
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