Characteristic of Blended Fuel Properties and Engine Cycle-To-Cycle Variations with Butanol Additive

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Abstract. Biodiesel fuel characteristics are one of the most important parameters that limited their application in diesel engines. Though biodiesel-diesel blended fuel can replace diesel satisfactorily at low blending ratios up to 20%, problems related to fuel property persist at high blending ratio. Hence, in the present study, the feasibility of biodiesel-diesel blended fuel B30 was investigated with respect to its properties and engine cyclic variations with increasing butanol additive. The blended fuel with additive were tested experimentally in a diesel engine and the in-cylinder pressure data were collected and analyzed using the coefficient of variation and wavelet power spectrum to evaluate the engine cyclic variations compared to diesel fuel engine test results. The fuel property test results showed slight improvement in density and acid value with significant reduction in viscosity when increasing butanol additive. Furthermore, the blended fuel pour point was reduced to -6 ^{o}C at 8% butanol additive. On the other hand, the energy content slightly affected with increasing butanol additive in the blend. From the wavelet power spectrum, it is observed that the short-period oscillations appear intermittently in pure blended fuel, while the long and intermediate-term periodicities tends to appear with increasing additive ratio. Moreover, the spectral power increased with an increase in the additive ratio indicating that the additive has a noticeable effect on increasing the cycle to cycle variation. The coefficient of variation of indicated mean effective pressure for B30 were found to be the lowest and increases with increasing additive ratios. Both the wavelet analysis and coefficient of variation results reveals that blended fuel B30 has engine cyclic variations comparable to diesel fuel with increasing butanol additive up to 4%.

Keywords: Blended fuel; butanol additive; fuel properties; cyclic variations; wavelet analysis.
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INTRODUCTION

The development of renewable and clean energy has become an urgent option for fulfillment the increasing energy demand in all the scopes of life, compensation the continuous depletion of fossil fuel resources and controlling the raising environmental pollution. The availability and sustainability of biodiesel feedstocks will be the crucial determinants in the popularization of biodiesel [1]. Biodiesel (a mixture of mono-alkyl esters of saturated and unsaturated long-chain fatty acids) generally has a higher cloud and pour point (CP and PP), density, and kinematic viscosity as well as higher acid value compared to petroleum diesel. Alternative fuel like biodiesel can replace diesel as a fuel for internal combustion engine without any required modification for the diesel engine, as they have similar combustion characteristics [2]. Biodiesel is sympathetic with existing engine design and has been blended as a commercial transportation fuel with diesel up to 20%, in a number of countries [3]. Biodiesel blends are being considered to replace pure petroleum diesel in many applications.

Major properties of biodiesel that restricted its application in high blending ratio are higher viscosity, lower energy content [4], [5], higher pour point and cloud point, higher nitrogen oxides (NOx) emissions, lower engine speed and power, injector coking, and engine compatibility [6]. The most available method to make the biodiesel available as a fuel in high blending ratio alternative to petroleum diesel is the use of chemical additives [7]. These additives mainly affects on improving fuel properties and improving combustion [8]. Palm oil biodiesel-diesel blend has a higher ignition temperature, shorter ignition delay, and pressure as well as peak heat release compared to diesel fuel. Furthermore, the output engine power and brake power efficiency were found to be comparable to diesel fuel.

Fuel injection systems measure fuel by volume, and thus, engine output power influenced by changes in density due to the different injected fuel mass [9]. Thus, density is important for various diesel engine performance aspects. The use of fuel with a high kinematic viscosity can lead to undesired consequences, such as poor fuel atomization

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