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Hydrous Ethanol-gasoline Blends as Alternative Fuels for Spark Ignition Engine: Fuel Properties and Engine Performance

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ABSTRACT

The fuel characteristics of hydrous ethanol (HE) and gasoline blends (HE10, HE15 and HE20) were investigated as an alternative fuel for spark-ignition (SI) engines and test their performance. The densities of the blends (754.4-769.1 kg m-3) were higher than that of gasoline (739.7 kg m-3); however, their API gravity (55.88-52.3) was lower than that of gasoline (59.53). The kinematic viscosity of the blends (0.588 to 0.670 mm2 s-1) indicated that the blends were more viscous than gasoline (0.4872 mm2 s-1). Flashpoint values of the blends varied from 28.4 to 29.2°C, which were higher than that of gasoline flashpoint value (25.0°C); however, the calorific value of the blends (ranging between 45.21 and 45.08 MJ kg-1) was lower compared to that of gasoline (45.27 MJ kg-1). The Octane number of the blends varied from 92.9 to 95.8, which was higher compared to that of gasoline (90.5). At low engine speed (1500 rpm) and high load (2.5 kg), the engine torque obtained with gasoline was 10.7% higher than that obtained with the blends. However, at high engine speed (2500 rpm) and high load (3.2 kg), the torque with gasoline was only 2.7% higher than with the blends. Overall, HE15 blend showed the best results among the examined blends.

1. INTRODUCTION

The consumption of fossil oil products is rapidly increasing as the global economy develops. The excessive use of fossil fuels has resulted in a number of severe problems to human society's continued development and progress, including global warming, depletion of fossil fuel resources, and environmental fragility. As a result, present research efforts are focusing on renewable energy sources to ensure the global economy and society's long-term viability [1]. In this context, biofuels, such as biodiesel and ethanol, are promising alternatives to fossil fuels.

Ethanol has recently gained popularity as a fuel additive or alternative fuel in both spark-ignition (SI) and compression-ignition engines [2]. However, because of its relatively high-octane number and the fact that it is a clean-burning fuel, ethanol has proven popular in SI engines. The large-scale commercial use of ethanol as a fuel began in the early 2000s. Currently, it is used in SI engines in three forms, namely, as pure ethanol, as a mixture of ethanol and gasoline, and the use of dual fuel injection systems for gasoline and ethanol.

There are two kinds of ethanol consumed for gasoline fuel, namely, hydrous ethanol (HE) and anhydrous ethanol. The hydrous (or wet) ethanol represents the most concentrated grade of ethanol from simple distillation, without the additional dehydration step required to produce anhydrous (or dry) ethanol. Due to the enormous amount of energy required during the distillation and drying processes, anhydrous ethanol (water content less than 1%) is expensive to be produced [3]. As a result, using aqueous ethanol as a fuel will directly enhance the overall energy efficiency, by making it more appealing as a fuel source [4], whereas water distillation and drying account for around 37% of the total cost of producing anhydrous ethanol. In this regard, a research carried out in an ethanol plant based in Minnesota suggested that 10-45% of energy can be saved by just removing the dehydration process from hydrous ethanol Eh95 (95% Ethanol, 5% water) [5]. In 2008 a study done by HE Blends in the Netherlands noted that Eh10-Eh26 ethanol blends are 10-20% less expensive than anhydrous ethanol [6].

Ethanol, as an octane booster and powerful oxygen compound, has been used as a fuel for more than 30 years. The use of ethanol as a fuel reduces greenhouse gas emissions, reduces carbon monoxide, reduces nitrogen oxides and unburned hydrocarbon emissions, increases combustion efficiency, reduces fuel costs, and creates jobs in rural areas. On the other hand, the

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