Impact of alcohol–gasoline fuel blends on the performance and combustion characteristics of an SI engine

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ABSTRACT

In this study, the effects of ethanol–gasoline (E5, E10) and methanol–gasoline (M5, M10) fuel blends on the performance and combustion characteristics of a spark ignition (SI) engine were investigated. In the experiments, a vehicle having a four-cylinder, four-stroke, multi-point injection system SI engine was used. The tests were performed on a chassis dynamometer while running the vehicle at two different vehicle speeds (80 km/h and 100 km/h), and four different wheel powers (5, 10, 15, and 20 kW). The results obtained from the use of alcohol–gasoline fuel blends were compared to those of gasoline fuel. The results indicated that when alcohol–gasoline fuel blends were used, the brake specific fuel consumption increased; cylinder gas pressure started to rise later than gasoline fuel. Almost in all test conditions, the lowest peak heat release rate was obtained from the gasoline fuel use.

1. Introduction

Increasing global concern due to air pollution has generated much interest in the environmental friendly alternative fuels. Alternative fuels for internal combustion engines are also becoming important because of diminishing petroleum reserves and increasing air pollution. Methanol and ethanol are good candidates as alternative fuels since they are liquids and have several physical and chemical properties similar to those of gasoline and diesel fuels. Indeed, when Henry Ford designed his first automobile (Model T), it was built to run on both gasoline and pure ethanol [1]. However, in the past, ethanol was not given expectancy due to its insufficient production and high price.

Ethanol can be produced from biomass such as sugar cane, sugar beet, wood, corn, and other grain. The production of ethanol from biomass sources involves fermentation and distillation of crop [2]. Ethanol is biodegradable and will evaporate quickly if spilled on land [3]. Methanol can be produced from natural gas, gasification of coal or biomass. However, coal is not preferred as a feedstock because conversion process is complex and costly than using other feedstock in commercial methanol production [4]. Both methanol and ethanol have much higher octane number than gasoline [5]. This allows to alcohol engines to have much higher compression ratios, and so increasing thermal efficiency. Nevertheless, a significant disadvantage of methanol and ethanol relative to gasoline is that they have lower energy content [6].

Many additives can be added to gasoline to enhance the combustion efficiency and engine performance. The addition of high-octane oxygenated fuel to gasoline is very important. Palmer [7] stated that addition of ethanol to unleaded gasoline resulted in an increase in research octane number by 5 units for each 10% ethanol addition. He also stated that 10% ethanol in gasoline as a fuel additive improved the engine power by 5%. Brinkman et al. [8] measured the octane number of methanol–gasoline blends. They found that the research and motor octane numbers increased with increasing methanol amount in the fuel blend. Hasan [9] investigated the effect of ethanol–unleaded gasoline fuel blends on the performance of an SI engine (Toyota Tercel-3A). The results showed that when ethanol blended gasoline fuel was used, brake power, brake thermal efficiency and volumetric efficiency increased by 8.3%, 9% and 7%, while the brake specific fuel consumption and air–fuel equivalence ratio decreased by 2.4% and 3.7%, respectively. Hasan stated that 20% ethanol fuel blend (E20) gave the best results in the engine performance. Shenghua et al. [10] operated a three-cylinder SI engine with several fractions of methanol (10%, 15%, 20%, 25% and 30%) in gasoline under the full load condition. They saw that the engine power and torque decreased, while the brake thermal efficiency improved with the methanol fraction increase in the fuel blend.

Hsieh et al. [11] tested 10%, 20%, 30% ethanol–gasoline blends in an SI engine. They found that using ethanol–gasoline blends...