Performance and combustion characteristics of alcohol–gasoline blends at wide-open throttle

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This study discusses the performance and exhaust emissions of a vehicle fueled with low content alcohol (ethanol and methanol) blends and pure gasoline. The vehicle tests were performed at wide-open throttle and at vehicle speeds of 40 km h⁻¹, 60 km h⁻¹, 80 km h⁻¹ and 100 km h⁻¹ by using an eddy current chassis dynamometer. The test results obtained with the use of alcohol–gasoline blends (5 and 10 percent alcohol by volume) were compared to pure gasoline test results. The test results indicated that when the vehicle was fueled with alcohol–gasoline blends, the peak wheel power and fuel consumption slightly increased. And also, in general, alcohol–gasoline blends provided higher combustion efficiency compared to pure gasoline use. In exhaust emission results, a stable trend was not seen, especially for CO emission. But, on average, alcohol–gasoline blends exhibited decreasing HC emissions. In 100 km h⁻¹ vehicle speed test, the alcohol–gasoline blends provided lower vehicle performance and lower NOₓ emission values compared to pure gasoline. At all vehicle speeds, minimum CO₂ emission was obtained when 5% methanol was added in gasoline. The low content alcohol blends did not reveal any starting problem, or irregular operation on the engine.

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1. Introduction

It can be obviously seen that the world’s fossil fuel reserves are limited. The recent environmental disaster in the Gulf of Mexico has led to increased interest on the energy sources. It is well known that passenger vehicles are dependent on fossil fuels such as gasoline, diesel fuel, liquefied petroleum gas, and natural gas. The fossil fuel used in passenger vehicles induces the air pollution, acid rains; build up of carbon dioxide, changing the heat balance of the earth, etc. Hence, in the last three decades, there is a progressively interest related with using non-fossil sources in vehicles. The researchers recognized the biofuel as a major renewable energy source to supplement declining fossil fuel resources. Especially, the alcohol fuels (methanol, ethanol etc.) have been showed good candidates as alternative fuels for the vehicles equipped with SI (spark ignition) engines because they are liquid and have several physical and combustion properties similar to gasoline [1,2].

Indeed, the use of ethanol as a vehicle fuel dates back to the initial development of the automobile a century ago. When Henry Ford designed his first automobile (Model T), it was built to run on both gasoline and pure ethanol [3]. In the early years of automobile history, ethanol was not given expectancy due to its insufficient production and high price. From the past to today, the production of alcohol (methanol and ethanol) has increased and became cheaper owing to advanced production technology, and also they can be widely available from biomass [4,5].

Methanol and ethanol can be used in blends with petroleum based engine fuels. The smaller the alcohol addition, the easier typical blending problems (phase separation, corrosion, changed vapor pressure, changed air requirement etc.) can be solved [6]. Alcohols have a high octane number; consequently their addition to gasoline enhances the octane number of the fuel, therefore reducing the knock problem in the engine [7]. Methanol and ethanol have nearly the same anti-knock effect [8]. However, increasing alcohol content of the blend results in increasing fuel consumption caused by its lower energy content [9]. Palmer [10] stated that the addition of ethanol to unleaded gasoline resulted in an increase in the research octane number by 5 units for each 10% addition. He also found that 10% ethanol addition to gasoline improved the engine power by 5%.