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A STUDY ON THE PERFORMANCE AND EMISSIONS CHARACTERISTICS OF SPARK IGNITION ENGINE FUELLED WITH ETHANOL GASOLINE BLENDED FUEL

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Abstract

This paper presents the influences of ethanol addition to gasoline on bench test a spark ignition engine performances and emissions characteristics. The use of ethanol gasoline blended fuels decrease the brake power and brake torque, and increases the brake specific fuel consumption (BSFC). Ethanol gasoline blended fuels show lower brake torque and brake power and higher BSFC than gasoline. When ethanol containing oxygen is blended with gasoline, the combustion of the engine becomes better and therefore CO emission is reduced. HC emissions decrease to some extent as ethanol added to gasoline increase. as the percentage of ethanol in the blends increased, NOx emission was decreased under various engine speeds.

Key words : Torque, Brake power, Brake specific fuel consumption (BSFC), CO, HC, NOx

1. INTRODUCTION

Depletion of fossil fuels and environmental pollution has led researchers to anticipate the need to develop bio-fuels. Alcohols are an important category of bio-fuels. Methanol can be produced from coal, biomass or even natural gas with acceptable energy cost. Also, gasification of biomass can lead to methanol, mixed alcohols, and Fischer–Tropsch liquids. Ethanol is produced from sugars (particularly sugar cane) and starch by fermentation. The biomass industry can produce additional ethanol by fermenting some agricultural by-products [1, 2].

Alcohol has been considered to be an appropriate fuel for vehicles and a substitute for petroleum resources. Substituting alcohol for petroleum has not only been experimented in the spark ignition engine but also in the compression ignition engine. However, the use of alcohol in the compression ignition engine might be difficult because of combustion characteristics. The cetane number of the fuel used for the compression ignition engine should be within the level of 45 thru 66. But the cetane number of alcohol are ethanol 8 and methanol 3, this makes the ignition of the compression ignition engine impossible. Also, this alcoholic fuel has low viscosity than diesel oil and causes a problem in the lubrication of diesel oil injection pump. Thus due to all of the above facts, it is not easy to substitute alcohol fuel for common fuel. To solve these problems, one method is to blend alcohol with diesel oil but this also causes the phase separation between each oil (moisture in the fuel causes the phase separation). Alcohol fuel is apt to absorb the moisture in the fluid. The stability of the mixture is decided according to the temperature, moisture content and specific gravity of diesel oil. So the anti-phase separation fluid is

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needed to resolve this problem [3-5].

Yousufuddina et al. [6] studied the effect of ignition timing and compression ratio on the performance of a hydrogen-ethanol fuelled engine. From their study they observed that ignition timing is very important operating parameter that affects spark ignition engine performance and efficiency and not much previous work was done on hydrogen -ethanol dual fuel engine, thus this study concentrates on investigation of ignition timings on performance characteristics of engine fuelled with hydrogen-ethanol mixtures and in determining the optimum value of spark timing for maximum brake thermal efficiency and minimum brake specific fuel consumption.

Consequently alcohols are particularly attractive as alternative fuels because they are a renewable biobased resource and oxygenated, thereby providing the potential to reduce particulate emissions in spark ignition engines. This paper investigates the engine performance and emission characteristics of spark ignition engine fuelled with ethanol gasoline blended fuel.

2. EXPERIMENTAL SETUP AND EXPERIMENTS

Figure 1 shows the schematic diagram of the engine tested. And Table 1 is showing the specification of test engine. The engine which was spark ignited had a compression ratio of 7.0, single cylinder, and a displacement of 482 cc. The performance was tested by connecting the crank shaft to the dynamometer. An engine control system (IC 5460, INTELLIGENT CONTROLS, INC.) was used to control the fuel injection timing and spark timing. An air-fuel ratio measurement system (UEGO Sensor, HORIBA 110) was used to measure the air-fuel ratio. The spark timing, and air-fuel ratio were the experimental operating variables at a part load. The engine speed changed from 1000 rpm to 1800 rpm. The cooling water temperature is fixed at 80°C. The spark timing is

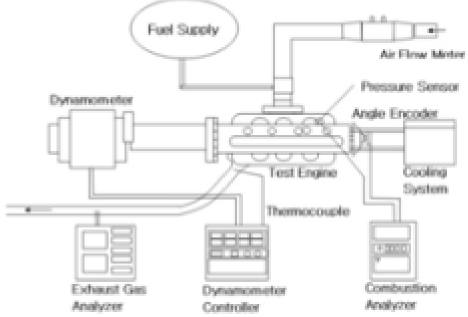

Fig. 1. Experimental setup.

Table 1. Specification of test engine

Engine type	Four stroke Single cylinder Water cooled type
Bore x stroke	85 x 85 mm
Displacement	482 cc
Compression ratio	7.0
Length of connecting rod	150mm
Method of ignition	Battery ignition

fixed at minimum spark advance for best torque (MBT). A piezo-electric pressure transducer, Kistler 6061B, was mounted in the cylinder head to measure the cylinder pressure. The average cylinder pressure diagram of the 100 consecutive cycles was used to evaluate the stability at the rpm. An absolute pressure sensor (Kistler 4045A2) was used to measure the inlet pressure.

Each fuel has its own set of combustion-related properties. These properties change the engine performance and emission characteristics. A list of fuel properties that compares ethanol and methanol gasoline blended fuels is given in Table 2. It shows heat of combustion, Reid vapour pressure (RVP), research octane number (RON), density at 15.5ºC. Ethanol (ethyl alcohol) C2H5OH is a clear, colorless liquid with a characteristic, agreeable odor. Ethanol is an alcohol, a group of chemical compounds whose molecules contain a hydroxyl group, -OH, bonded to a carbon atom. Ethanol melts at -114.1 °C, boils at 78.5 °C, and has a

Table 2. Properties of ethanol gasoline blended fuels.

Property item	Test fuel			
	Gasoline	E10	E20	E30
Heat of combustion (MJ/kg)	44.13	42.45	40.67	38.67
Vapor pressure (kPa)	35.00	59.53	54.61	53.31
Research octane number	84.8	88.3	93.4	98.9
Density at 15.5°C (kg/L)	0.768	0.776	0.778	0.779

density of 0.789 g/mL at 20°C. The heating value of ethanol is lower than that of gasoline. Table 2 further indicates that the heating value of the blended fuel will decrease with the increase of the ethanol content. RON increases with the increase of ethanol concentration [7].

3. RESULTS AND DISCUSSION

The performance and emission characteristics of the spark ignition engine running on ethanol blended with gasoline was evaluated and compared with neat gasoline fuel. The results of the torque (Figure 2), brake power (Figure 3), and specific fuel consumption (Figure 4) for ethanol gasoline blended fuels at different engine speeds are presented here.

Figure 2 shows the influence of ethanol gasoline blended fuels on engine torque. When the ethanol content in the blended fuel was increased, the engine brake power slightly decreased for all engine speeds. However, the engine torque of gasoline was slightly higher than that of E10, E20, and E30.

Figure 3 shows the effect of ethanol gasoline blended fuels on brake power. The increase of ethanol content decreased slightly the brake power of the engine. The brake power of gasoline was higher than those of E10, E20, and E30.

Figure 4 shows the effect of ethanol gasoline blended fuels on brake specific fuel consumption (BSFC). From this figure, it shows the variations of the BSFC for different ethanol gasoline blended fuels under various engine speeds. As shown in this figure, the BSFC increased as the ethanol percentage increased. Also, a great difference exists between the BSFC using pure gasoline and using ethanol gasoline blended fuels. As engine speed increases reaching 1400 rpm, the BSFC decreases reaching its minimum value.

Figure 5 shows the effect of various ethanol gasoline blended fuels on CO emissions under various engine speeds. CO is a toxic gas that is the result of incomplete combustion. When ethanol containing oxygen is blended with gasoline, the combustion of the engine becomes better and therefore CO emission is reduced [5].

Figure 6 shows the effect of various ethanol gasoline blended fuels on HC emissions under various engine speeds. This figure indicates that ethanol can be treated as a partially oxidized hydrocarbon when it is added to the blended fuel. Therefore, HC emissions decrease to some extent as ethanol added to gasoline increase. According to HC emissions increase, engine brake power can slightly decrease [5].

Figure 7 shows the effect of various ethanol gasoline blended fuels on NOx emissions under various engine speeds. It shows that as the percentage of ethanol in the blends increased, NOx emission was decreased. Since ethanol has a higher heat of vaporization relative to that of neat gasoline, the blends temperature at the end of intake stroke decreases and finally causes combustion temperature to decrease. As a result, NOx emissions decrease [5].

CONCLUSIONS

Based on the results of this study, the following conclusions were observed. This paper presents the influences of ethanol addition to gasoline on bench test a spark ignition engine performances and emissions characteristics. The use of ethanol gasoline blended fuels decrease the brake power

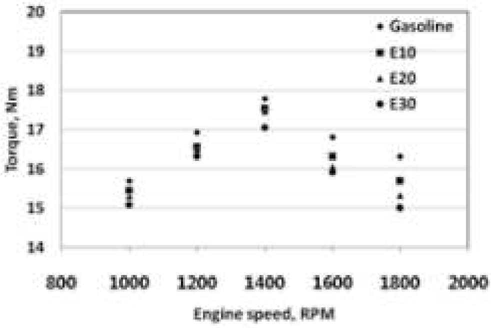

Fig. 2. Experimental results of engine torque characteristics using ethanol gasoline blended fuels under various engine speeds.

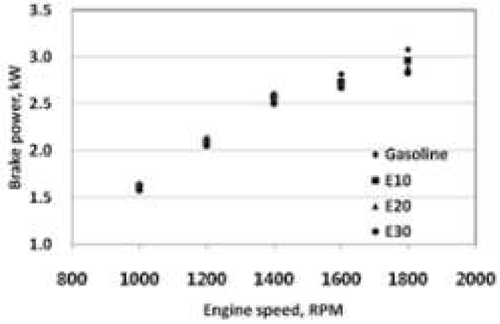

Fig. 3. Experimental results of engine torque characteristics using ethanol gasoline blended fuels under various engine speeds.

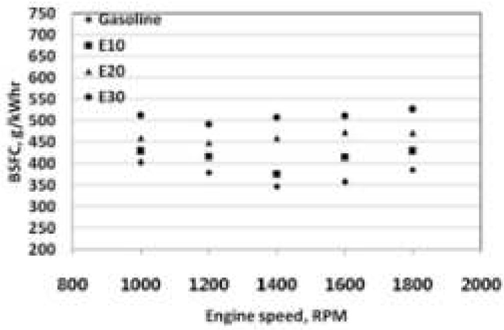

Fig. 4. Experimental results of brake specific fuel consumption characteristics using ethanol gasoline blended fuels under various engine speeds.

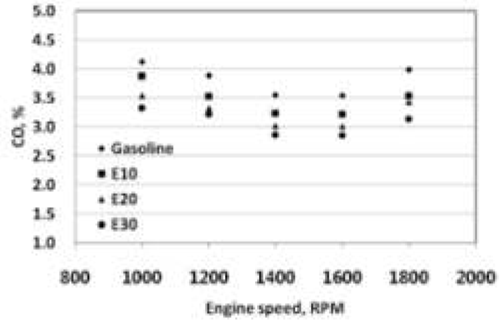

Fig. 5. The effect of various ethanol gasoline blended fuels on CO emissions..

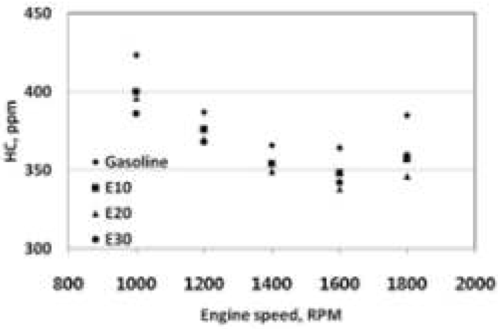

Fig. 6. The effect of various ethanol gasoline blended fuels on HC emissions

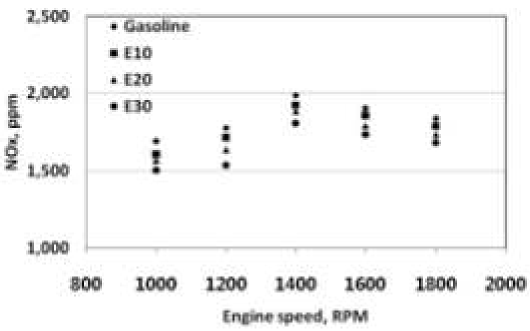

Fig. 7. The effect of various ethanol gasoline blended fuels on NOx emissions.

and brake torque, and increases the BSFC. Ethanol gasoline blended fuels show lower brake torque and brake power and higher BSFC than gasoline.

When ethanol containing oxygen is blended with gasoline, the combustion of the engine becomes better and therefore CO emission is reduced. HC emissions decrease to some extent as ethanol added to gasoline increase. as the percentage of ethanol in the blends increased, NOx emission was decreased under various engine speeds.

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