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Research Article

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Evaluation of Engine Performance of Gasoline Fuel and Methanol Fuel in Spark Ignition Engines

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Abstract Alcohol fuel is attracting attention as an alternative fuel for automotive engines. In this study, the engine was operated using gasoline fuel and pure methanol fuel using spark ignition engine. Methanol has 27% less low calorific value than gasoline. However, the latent heat of vaporization is about four times larger. The large latent heat of vaporization of methanol can be a positive factor for engine power. The torque, power, brake specific fuel consumption and volumetric efficiency of gasoline and methanol fuel were compared.

Keywords Gasoline, Methanol, Torque, Bake Horse Power, Brake Specific Fuel Consumption, Volumetric Efficiency, Low Calorific Value, Latent Heat of Vaporization

Introduction

Recently, alcohol fuels have been attracting attention as alternative energy sources. Alcohol fuel is the fuel that is attracting attention by researchers during the global oil shock. Methanol and ethanol are the main fuel sources for alternative energy. In particular, methanol can be easily obtained from natural gas through chemical treatment. In addition, methanol can be supplied by using coal, and it can be easily produced from sugar cane in hot areas [1,2]. Since methanol has good affinity with water, it is possible to reduce the heat loss as a cooling system by adopting the internal cooling system. The low calorific value of methanol is relatively low compared to gasoline. If the low calorific value is small, the fuel consumption rate is increased and the fuel economy is deteriorated. In addition, the low calorific value, the weaker the output is. However, since the latent heat of vaporization is larger than that of gasoline, the lower heat value is not so low. A low calorific value is a negative factor, but a larger latent heat of vaporization can be an advantage [3-5].

Since the latent heat of vaporization of methanol is about four times that of gasoline, it may be difficult to form a combustible mixture at a low temperature. Especially when using pure methanol, there is difficulty in cold starting. However, such a problem can be improved by using an intake heater. However, the large latent heat of vaporization is a disadvantage, but it is also an advantage. The latent heat of vaporization refers to the phenomenon that the liquid fuel is converted to gas and absorbs the surrounding heat to lower the ambient temperature [6-8]. This study adopts gasoline and methanol as fuel. Particularly, the liquid fuel has to be mixed with the air which is the gas, and the advantage that the temperature of the intake air can be lowered can be utilized because it absorbs the ambient heat in the process of changing from the liquid to the gas. Particularly, as the temperature of the intake air is lowered, the volumetric efficiency can be increased. Therefore, methanol will have a larger volumetric efficiency than gasoline.

Experimental Apparatus and Method

The engine used in this study is a four-cycle, four-stroke water-cooled type. The number of cylinders is four, and a commercial engine equipped with a spark plug was modified. The specifications are shown in Table 1.The displacement is 1598 cc and the compression ratio is 8.0.

Table 2 presents the characteristics of gasoline and methanol. The major property of gasoline is iso-octane, which iso-octane character.

The outline of the experimental apparatus is shown in Fig.1. The pressure value inside the combustion chamber was obtained by using a pressure sensor, and the indicated diagram was obtained by using this. The crank angle was measured by attaching an encoder to the crankshaft. The obtained pressure value was a stable average value of 100 cycles. The pressure value obtained by the pressure line is analyzed by the pressure rise rate curve, the pressure-volume curve, the heat release rate, and the mass burned rate required for the combustion analysis.

Engine speeds were performed stepwise at 1500 rpm, 1700 rpm, 1900 rpm, 2100 rpm, and 2300 rpm. The fuel was pure gasoline and methanol. The ignition timing was selected by selecting the optimum ignition timing at which the maximum torque was generated.

Fuel supply was supplied using carburetor. Fuel supply was controlled at the theoretical air-fuel ratio by adjusting the needle valve. The theoretical air-fuel ratio of gasoline is 14.53 and the theoretical air-fuel ratio of methanol is 6.44. This experiment was carried out at stoichiometric ratio. That is, gasoline was carried out at an air-fuel ratio of 14.53 and methanol at an air-fuel ratio of 6.44.

Table 1: Engine specifications

Items	Specifications
Cooling system	Water-Cooled
Displacement	1598 cc
Bore × stoke	76.9 × 86 mm
Compression ratio	8.0
Number of cylinder	4
Length of connecting rod	153.7 mm

Table 2: Properties of gasoline and methanol [9]

Items	Gasoline	Methanol
Molecular formula	C_8H_{18}	CH_3OH
Molecular weight	114.23	32.04
Low heat value (MJ/kg)	44.13	11.77
Heat of evaporation (kJ/kg)	272	1100
Specific gravity	0.768	0.796
Stoichiometric air-fuel ratio	14.53	6.44

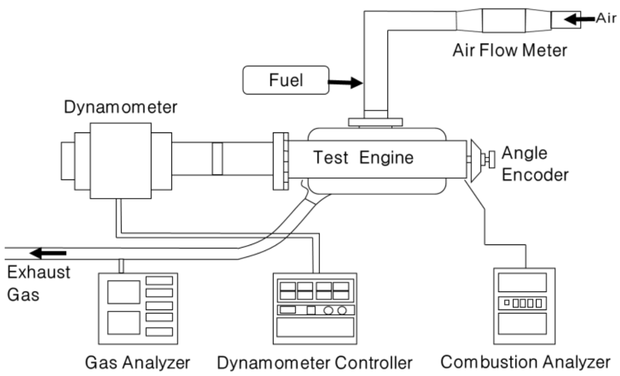

Figure 1: The schematic diagram of the experimental set-up

Results and Discussion

Figure 2 shows the results of a comparison of the torque of gasoline and methanol when the engine speed is changed from 1500 rpm to 2300 rpm at a constant load. Torque measurements were made using a dynamometer. Torque has a relatively low value of about 5 to 9% for methanol with lower heat value. The low calorific value of methanol is 28% lower than that of gasoline, but torque is about 5 to 9%, not 28%. It can be seen that the torque does not drop unconditionally because the low calorific value is simply low.

Figure 3 shows the experimental results of gasoline and methanol brake horsepower according to engine speed variation. It can be seen that the power of methanol drops by about 5 to 9%, but this also indicates that the lower heat value is 28% less methanol than gasoline, but the brake horse power differs from 5% to 9% can be.

In general, the BHP (Brake horse power) is proportional to the engine speed and torque. Especially, it is more sensitive to engine speed than the influence of torque. The relation between Power W and Torque T is as follows.

$$\mathrm{W} = \frac{2\,\pi\,N\,T}{60}$$

Where N is engine speed and T is torque.

Figure 4 is a graph showing the BSFC (Brake Specific Fuel Consumption) of methanol and gasoline fuels with varying engine speeds.

BSFC shows an increase of about 6 to 13% in methanol compared to gasoline. This is because the low calorific value of methanol is 28% lower than that of gasoline. However, it can be seen that the reason why BSFC is not 28% but 6 to 13% is not simply a linear increase.

The brake specific fuel consumption (BSFC) was obtained as follows.

$$\mathrm{BSFC} = \frac{L}{H\,B}$$

H is the low calorific value, B is the fuel consumption, and L is the output.

Figure 5 shows the volumetric efficiency of engine speed. The volumetric efficiency of methanol is 4 to 12% larger than that of gasoline. The reason for this is that the latent heat of vaporization of methanol is about 4 times larger than that of gasoline, so that the volumetric efficiency is increased due to the effect of lowering the temperature of the intake air.

The volumetric efficiency is theoretically summarized as the amount of air actually inhaled for the amount of air that can be received. It can also be expressed as the weight of air actually inhaled (kg/s) for the weight of air per hour (kg/s) which can theoretically be taken into consideration in consideration of the density of air.

$$\eta_v = \frac{V_a}{V_{th}} = \frac{V_a \gamma_a}{V_{th} \gamma_o}$$

However, in order to calculate the volumetric efficiency, experimental data such as engine speed, fuel amount measurement, intake pipe pressure measurement, etc. are required.For determining the specific gravity $\gamma_a$of air, the ideal gas is used as the air, so the ideal gas equation of state is used.In the ideal gas equation of state, the relationship between the weight of the air ratio in the standard state and the weight of the air ratio in any state has the following relationship.

$$\gamma_o : \gamma_a = \frac{P_o}{R\,T_o} : \frac{P_a}{R\,T_a}$$

Where T is the temperature, R is the gas constant, and P is the pressure of the intake air.

Therefore, the specific weight of air can be obtained under arbitrary conditions. As the temperature of the air decreases, the amount of air per hour increases, which is thought to lead to an increase in the volume efficiency. Also, as the air pressure is increased, the amount of air is increased, leading to an increase in volume efficiency.

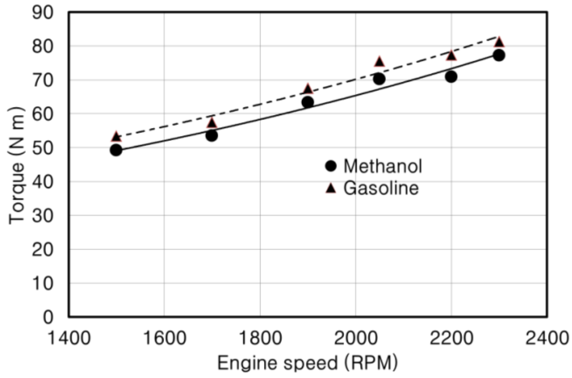

Figure 2: Torque vs. engine speed

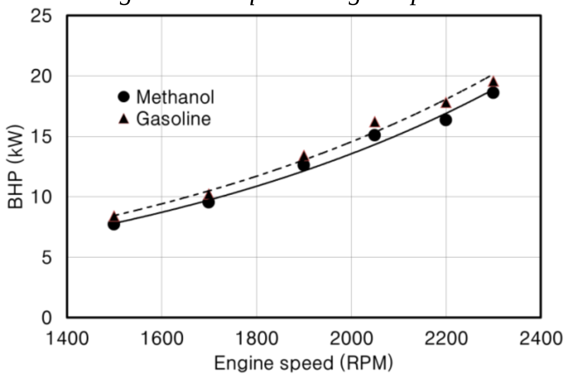

Figure 3: Brake horse power vs. engine speed

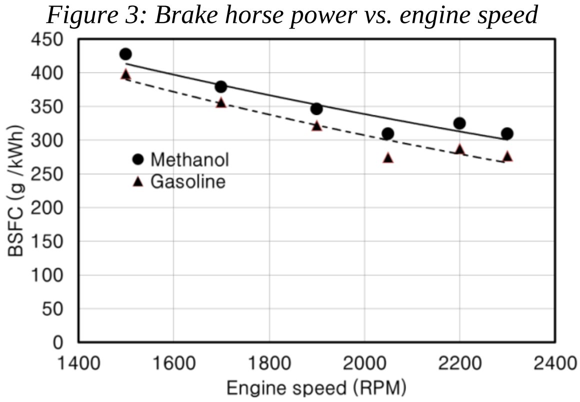

Figure 4: Brake specific fuel consumption rate vs. engine speed.

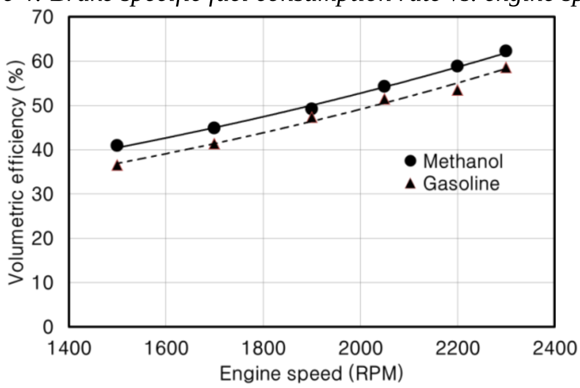

Figure 5: Volumetric efficiency vs. engine speed.

Conclusions

As a basic study for using pure methanol as an alternative fuel, the experimental results obtained compared with gasoline engine are as follows.

- When the engine speed is changed from 1500 rpm to 2300 rpm, the torque of the methanol and the brake horse power are reduced by 5 to 9% compared to the gasoline. This is because the low calorific value of methanol is 28% lower than that of gasoline.
- BSFCs in methanol show an increase of about 6 to 13% compared to gasoline.
  The reason for this is that the BSFC is inversely proportional to the low calorific value and the fuel consumption, and is a result proportional to the output.
- Volumetric efficiency of methanol is 4 to 12% higher than that of gasoline. The reason for this is that the latent heat of vaporization of methanol is about 4 times larger than that of gasoline, so that the volumetric efficiency is increased due to the effect of lowering the temperature of the intake air.

References

[1]. Brusstar, M. J. and Gray, Jr. C. L., High efficiency with future alcohol fuels in a stoichiometric medium duty spark ignition engine, SAE Paper 2007-01-3993, 2007

[2]. Pearson, R. L., Turner, W. G., Eisaman, M. D. and Littau, A., Extending the supply of alcohol fuels for energy security, , SAE Paper 2009-01-2764, 2009.

[3]. Chockalingam, S. and Ganapathy, S., Performance and emission analysis of a single cylinder constant speed diesel engine fueled with diesel-methanol-isopropyl alcohol blends, SAE Paper 2012-01-1683, 2012.

[4]. Deep, A., Potential utilization of the blend of orange peel oil methyl ester and isopropyl alcohol in CI Engine, SAE Paper 2014-01-2778, 2014.

[5]. Singh, A. K., Mishra, C., Vibhanshu, V and Kumar, N., Performance evaluation and emission studies of a single cylinder diesel engine fuelled isopropyl alcohol and diesel, SAE Paper 2013-01-1132, 2013.

[6]. Deep, A., Kumar, N., Kumar, M., Singh, A., Gupta, D. and Patel S., Performance and emission studies of diesel engine fuelled with orange peel oil and n-butanol alcohol blends, SAE Paper 2015-26-0049, 2015.

[7]. Michikawauchi, R., Tanno, S., Ito, Y. and Kanda, M, Combustion improvement of diesel engine by alcohol addition-investigation of port injection method and blended fuel method, SAE Paper 2011-01-0336, 2011.

[8]. Bromberg, L. and Cohn, D., Alcohol fueled heavy duty vehicles using clean, high efficiency engines, SAE Paper 2010-01-2199.

[9]. www.chemiway.co.jp