Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2017, 4(7):58-62

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

A Study on the Evaluation of Engine Performance by Using Methanol Fuel in Spark Ignition Engine

Sung Bin Han

Department of Mechanical & Automotive Engineering, Induk University, 12 Choansan-ro, Nowon-gu, Seoul, 01878, Republic of Korea

Abstract Alcohol fuels such as methanol and ethanol are attracting attention as alternative fuels for automotive engines. However, alcohol fuels are not easy to vaporize in the intake pipe because of latent heat of vaporization. Especially in hot areas, it is not a problem. If you are driving in a cold area, you will not be able to absorb the heat required for vaporization in the intake pipe.In this study, the authors evaluate the engine performance when pure methanol is used in spark ignition engines. In addition, the effect of the relationship between pressure and temperature on the volume efficiency in the intake pipe is examined.

Keywords Methanol, Bake Horse Power, Volumetric Efficiency, Brake Mean Effective Pressure, Ambient Pressure, Ambient Temperature

Introduction

Methanol is the fuel that is receiving a good response as an alternative energy. Methanol can be easily produced from natural gas, LPG, heavy oil and coal. In particular, methanol can be supplied for a long period of time by using coal with a large amount of reserves, and can be easily produced by chemical treatment from natural gas [1, 2].

The advantages and disadvantages of using methanol are as follows. Methanol has higher octane number than gasoline, so it can improve the thermal efficiency by designing the engine for high compression ratio. Flame propagation speed is faster than that of gasoline as the equivalence ratio increases, and the range of misfire is wide. When methanol is used, CO and NOx are reduced, and HC is more likely to be emitted than gasoline engines. Since it has good affinity with water, it adopts an internal cooling system to form an ideal lamellar mixer so that heat loss during combustion can be suppressed to the minimum, and a radiator, a water pump, a cold fan, maybe [3-5].

The latent heat of vaporization of methanol is about three times that of gasoline, and it is difficult to form a combustible mixture at low temperatures. In particular, when pure methanol is used, starting at a temperature below 10 °C becomes impossible, so that improvement in start ability at low temperatures is required. For this reason, if it is easy to form a combustible mixer, combustion promoting effect is obtained. Therefore, improvement of atomization of fuel or heating of intake air is considered for atomization of fuel. You can only use gasoline at start-up, or choose a dual fuel system. However, the dual fuel system has a drawback that the fuel supply system becomes complicated [6-7].

Methanol corrodes fuel-based materials such as fuel chambers, lowers the viscosity of the lubricating oil, has a high flash point, and has a large latent heat and low startability when the ambient temperature is low. Alcohol fuels can be used in spark ignition engines if methanol improves at low temperatures and is corrosive due to formaldehyde emission. The problem of startability is obtained by using gasohol which is a mixture of gasoline and ethanol, or mixed fuel by mixing iso-pentane with good vaporization. However, it is a good idea to improve the glow plug and the ignition system because the problem of phase separation occurs when using the mixture fuel of gasoline and methanol and the intake system becomes complicated when using the dissociated methanol gas [8, 9].

Therefore, pure methanol was used as fuel in this study. In addition, since the methanol absorbs the ambient heat in the course of changing from liquid to gas, if the temperature of the intake air can be lowered, the effect of increasing the volume efficiency can be expected.

Experimental Apparatus and Method

The engine used in this experiment is a 4-cycle water-cooled four-cylinder engine. Table 1 shows the specifications. The outline of the experimental apparatus is shown in Fig. The compression ratio was 8.0. Direct-current dynamometer with maximum absorbing power of 150kW was directly connected to the engine, and intake air was measured by installing an orifice flow meter from the intake air inlet.

Instead of the existing ECU, we used an engine control system that can freely control the fuel injection system and the ignition system while functioning as an existing engine ECU. The throttle opening of the engine was composed of a motor and a controller so that it could be controlled automatically by a computer. The measurement of the air fuel ratio was made by inserting four wide-area sensors in the exhaust pipe, so that the instant air fuel ratio can be obtained for each cylinder.

In addition, a piezo electric pressure transducer is inserted into the combustion chamber, and the signal is amplified there from and input to the combustion analyzer. From the combustion analysis device, pressure rise rate, P-V line, heat generation rate and mass combustion rate were obtained.

Experimental parameters were varied from 1500 rpm to 2500 rpm with engine speed as a variable, and the load was tested at a constant load at half part load. The air fuel ratio was performed at the equivalence ratio of 1.0. Spark timing was performed at the optimum ignition timing.

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

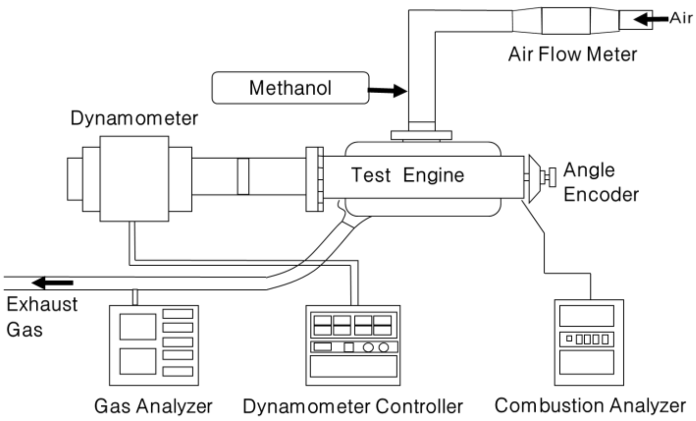

Figure 1: The schematic diagram of the experimental set-up.

Results and discussion

Figure 2 shows experimental results showing the brake mean effective pressure for a change from engine speed of 1500 rpm to 2500 rpm using pure methanol using a conventional spark ignition engine. The brake mean effective pressure is proportional to the torque when the displacement is constant. Also, as the number of engine revolutions increases, it generally tends to increase. In this engine test, it is assumed that the maximum BMEP is shown near 2200 rpm and then decreased. In this study, gasoline is not used as a fuel, but it is estimated that BMEP of methanol as a whole is smaller than that of gasoline because the gasoline fuel has a low calorific value relatively.

Figure 3 shows the results of the experiment showing the brake horse power against the change in engine speed when using methanol fuel. BHP (BHP, Brake Horse Power) is proportional to torque and engine speed. In the figure, the BHP increases linearly as the torque increases as the engine speed increases.

Figure 4 shows the experimental results of BSFC (BSFC, Brake Specific Fuel Consumption rate) for changes in engine speed. The BSFC is proportional to the amount of fuel used and is inversely proportional to the power output and the low calorific value. It is estimated that the BSFC of methanol is slightly larger than that of gasoline because gasoline usually has 1.64 times lower calorific value than methanol.

Figure 5 shows the volumetric efficiency of the intake pressure change at the intake side with increasing engine speed. The amount of fuel used was taken from the experiment, the temperature was the standard temperature, and the air density was theoretically calculated. It is generally accepted that the use of a turbo charger on the intake side generally has a positive effect on power output as the air pressure increases. The turbo charger increases the volumetric efficiency because of the increased air density.

Figure 6 shows the volumetric efficiency of the change in intake temperature with increasing engine speed. The amount of fuel used was obtained from the experiment and the pressure was calculated using standard atmospheric pressure. The volumetric efficiency increases as the intake temperature decreases. This increases volumetric efficiency as the air density increases as the intake temperature decreases. It is thought that the output and volumetric efficiency will increase if the temperature of the intake air is decreased by using the intercooler.

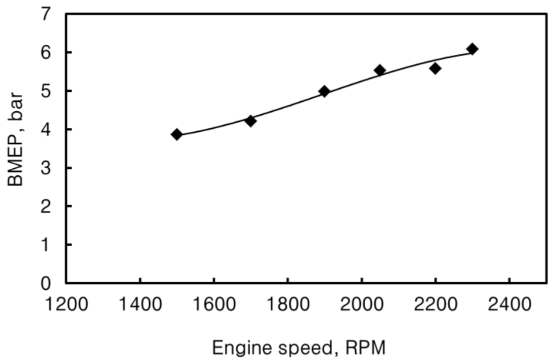

Figure 2: Brake mean effective pressure vs. engine speed.

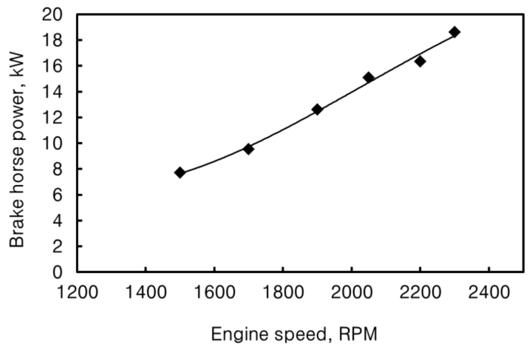

Figure 3: Brake horse power vs. engine speed

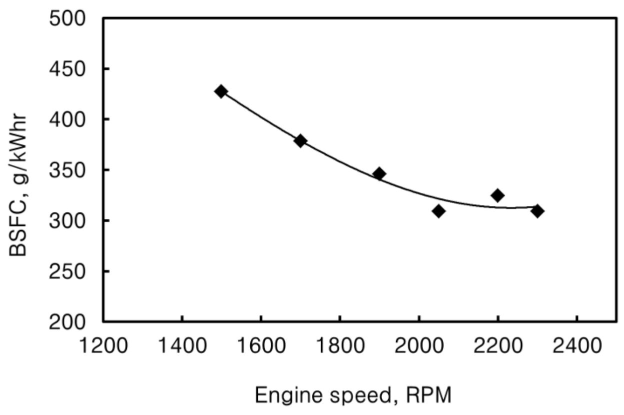

Figure 4: Brake specific fuel consumption rate vs. engine speed

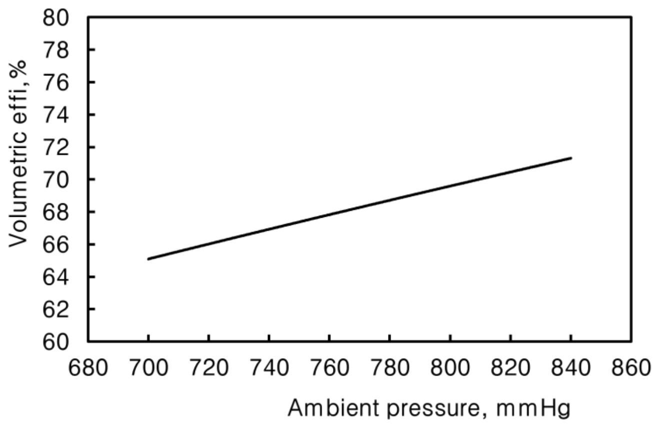

Figure 5: Volumetric efficiency vs. ambient pressure

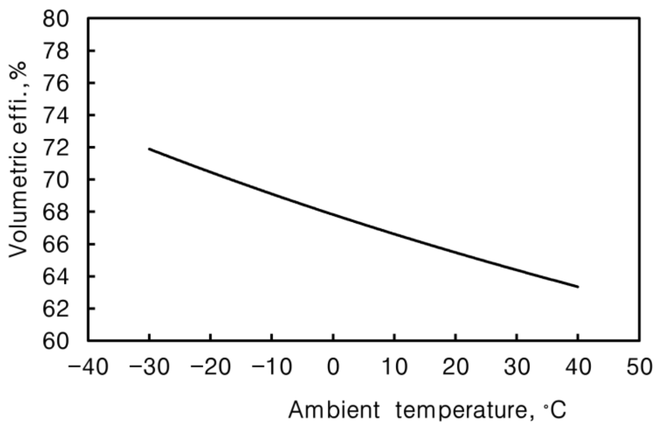

Figure 6: Volumetric efficiency vs. ambient temperature

Conclusions

The experimental results obtained using pure methanol as an alternative fuel are as follows.

(1) Spark ignition engine can be operated with pure methanol without any device. However, since the lower calorific value of methanol is less than that of gasoline, it is presumed that BMEP and BHP are less.

(2) Increasing volumetric efficiency with increasing engine speed is the same with any fuel. However, if you use a fuel with a large latent heat of vaporization, such as methanol, you can use the intercooler because it has the effect of lowering the ambient temperature. When methanol is used, a low calorific value has a negative effect. However, lowering the ambient temperature will have a positive effect on output and volumetric efficiency.

References

[1]. Chum, H. L., Overend R. P., Biomass and renewable fuels, Fuel Processing Technology, Vol.71, pp. 187–195, 2001.

[2]. Katoh, K., Imamura, Y., and Inoue, T., Development of methanol lean burn system, SAE Paper No.860247, pp.236-244, 1986.

[3]. Hsia, J., Kuo, L.K., Lin, C.S, and Chou, T.L., Effects of methanol-gasoline blends on performance, emissions and wear in SI engines, VII International Symposium on Alcohol Fuels, pp.136-141, 1986.

[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]. 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.

[6]. 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.

[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]. Chum, H. L., Overend R. P., Biomass and renewable fuels, Fuel Processing Technology, Vol.71, pp. 187–195, 2001.