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On the Effect of Addition of 1,2-Propylene Glycol Composition on Power and Torque of an EFI Passenger Car Fueled with Methanol-Gasoline M15

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Abstract. The utilization and development of clean and renewable energy resources is very attractive because of the world sustainability and environmental pollution. Methanol, ethanol and their blends with gasoline are well known as important alternative fuels for vehicle engines. A serious problem encountered in using gasoline–alcohol blends as motor fuel at low temperatures is the separation of the mixture into two liquid phases, which is strongly influenced by the water content. An important multi-purpose chemical that has an extensive use as anti-freeze agent, 1,2-propylene glycol, is attracting interest in recent years as an additive for methanol- gasoline fuel. The aim of this work is to investigate the effect of composition of the 1,2-propylene glycol additive on engine power and torque of an EFI passenger car fueled with methanol-gasoline blend M15. Research was conducted in the laboratory on a 1.2 L small gasoline passenger car, equipped with electronic injection system, using a blend of 15% gasoline and 85% methanol, by varying the composition of additive of 3 ml/l, 4 ml/l, 5 ml/l, 6 ml/l, 7 ml/l, 8 ml/l, 9 ml/ l, and 10 ml/l. The measurement of power and torque was facilitated by using a simple engine dyno scanner on a dynamometer roll chassis. From the study it has found that the effect of variation of additive composition tend to decrease engine power, but the value of the torque has a little bit increased, compared to pure gasoline engine. There was a best value of additive composition that showed high power and torque. According to the effect of additive composition on the power and torque it can be concluded that the best additive composition is 8 ml/l, which is 86.6 Nm on 2500 rpm, while the power remains constant in the value of 51.7 kW on 5800 rpm..

Keywords: additive; methanol; M15; power and torque; propylene glycol.

1. Introduction

Sustainable development, renewable energy and global warming are two major issues that are worldwide concerned over past decades. High increased in energy demand has resulted both in higher fossil fuel consumption and emissions. Presently, it is estimated that greenhouse gases release from fossil fuel combustion at a rate of around 7 billion tons each year [1]. Hence, the utilization and development of clean and renewable energy resources is very attractive. Methanol, ethanol and their blends with gasoline are well known as an important alternative fuels for vehicle engines.

Presently, an important multi-purpose chemical that has an extensive use as anti-freeze agent, 1,2-propylene glycol, is attracting interest in recent years as an additive for methanol-gasoline fuel. Therefore, it is important to investigate the effect of composition of the 1,2-propylene glycol additive on engine power and torque of an engine fueled with methanol-gasoline blends.

2. Literature Review

Compared with gasoline, methanol has several properties that is higher octane number, lower boiling point, higher oxygen content (50% wt), can be mixed, injected and atomized, and simpler chemical structure [2]. Moreover, methanol have a smaller negative impact on the environment than gasoline and benzene [3]. Brinkman et al, investigated the octane content of the fuel blend of methanol-gasoline and found that the octane content increases with increasing amount of methanol in the fuel blend [4]. Zhao H, et al studied on a car using methanol- gasoline fuel blend, and showed that the emissions of carbon monoxide and total hydrocarbons decreased by 9% -21% and 1% -55% , respectively, while emissions of nitrogen oxides increased by 175% -233% [5].

Abu-Zaid et.al [6] made an experimental investigation into the effect of methanol addition to gasoline on the performance of spark ignition engines. They found that the best engine performance, maximum power output, and minimum brake specific fuel consumption, occurs when a 15% volume methanol and 85% volume gasoline blend is used. Eyidogan et. al [7] investigated the impact of alcohol– gasoline fuel blends on the performance and combustion characteristics of an SI engine, and 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.

However, there is a serious problem encountered in using gasoline–alcohol blends as motor fuel at low temperatures which is related to the separation of the mixture into two liquid phases, which is strongly influenced by its water content [8, 9]. Siwale et.al [10] investigated the effects of addition of n-butanol on performance, combustion and emission characteristics of methanol–gasoline blend fired in a naturally-aspirated spark ignition engine. They obtained that the brake thermal efficiency improved whereas the exhaust gas temperature of the blends reduced, which is a benefit that reduces compression work.

3. Methods and Materials

Figure 1 illustrates the layout of the engine and data measuring and acquisition equipment. Research was conducted in the laboratory using a small city car Mitsubishi Mirage 1.2 L, sixteen valves multi-point fuel electronic injection system. The fuels used for the experiments are pure gasoline and a blend of 15% gasoline and 85% methanol (M15), by varying the composition of additive in the concentration of 3 ml/l, 4 ml/l, 5 ml/l, 6 ml/l, 7 ml/l, 8 ml/l, 9 ml/ l, and 10 ml/l. All the experiments were carried out on the roll dynamometer chassis. The engine specification is shown in Table 1. The engine is linked to the engine scanner to display and record engine operating condition such as mass air flow, ignition timing, injection timing, air fuel ratio and engine RPM, where all. The device is also used to obtain engine power and torque. Gasoline, namely Bensin Premium, is obtained from a gas stations. Methanol with a purity of 75% and received a certificate from the Central Technology of Prevention Industry Pollution Semarang, Indonesia. The fuel blended is prepared before beginning the experiment to ensure that fuel blend is homogeneous. The fuel properties of methanol and additive are shown in Table 2 and Table 3, respectively.

Figure-1. Experimental setup

Table 1 Engine Specification

Tabel 1 Engine Specification of Mitsubishi Mirage	
Engine type	1.2 –liter 12-*valve* 3-*cylinder* DOHC MIVEC (3A92)
Fuel Supply	**ECI-MULTI**
Cylinder Capacity	1,193 cc
Compression Ratio	**10.5 : 1**
Maximum Power	57 kW (6000 rpm)
Maximum Torque	100 Nm (4000 rpm)
Emission Standard	Euro-6

Table 2 Physical properties of Methanol

Physical Properties	Methanol
Chemical formula	CH3OH
Relative molecular mass	32
Density (kg/L)	0.794
Boiling Point (celcius)	65
Latent heat of vaprization (kJ/kg)	1100
Stichiometric air-fuel ratio	6.5
Auto-ignition temperature (celcius)	500
Lower heating value (kJ/kg)	20.260
Mixture heating value with λ = (1(kJ/m3)	3557
RON	110
Laminar Flame Speed (m/s)	0.523

4. Result and Discussion

As shown in Figure 2 and 3, the maximum power of pure gasoline-fuelled vehicles of 51.7 kW at 5900 rpm and maximum torque of vehicles of 84.5 Nm at 3000 rpm. The the power of the engine when using fuel M15 tend to decrease in compare with pure gasoline gasoline, but the value of the torque increased although only a bit. The highest torque value is on the addition of the additive 8ML/L of 86.6 Nm, with an increase of 2% than gasoline at 2500 rpm, and the highest power is on the addition of a8m/l additives too, where the value is 51.7 kW at 5800 rpm.

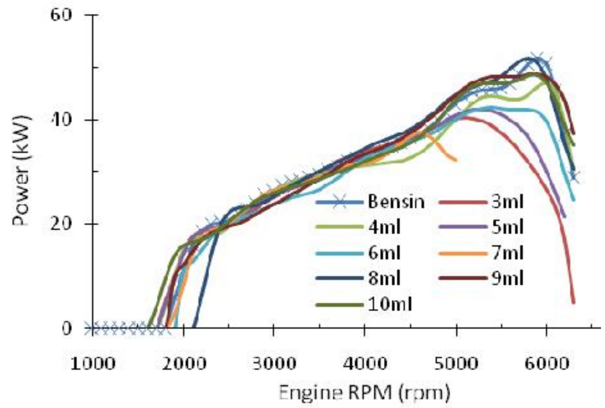

Figure-2. Effect of additive concentration on engine power

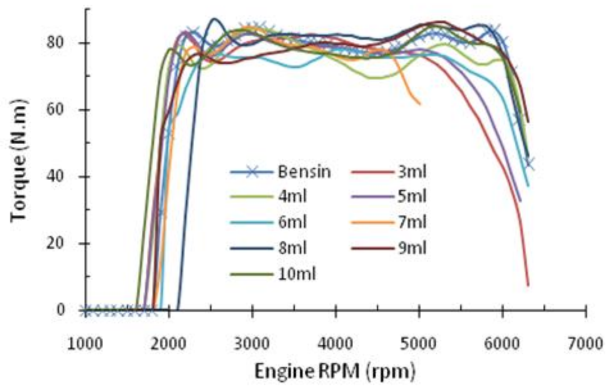

Figure-3. Effect of additive concentration on engine torque

5. Conclusions

It has been studied that the concentration of 1,2- Propylene Glycol additive in the gasoline-methanol blends will affect both the engine power and torque, and has the optimum or best value. In the range of the experiment, it can be concluded that the best additive concentration is 8 ml/l, that give highest engine power and torque. In addition, generally speaking, it can be said that the blend of M15 and 8 ml/l 1,2-Propylene Glycol, will not lowered engine performance of original vehicle fuel (gasoline).

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