Investigation of Performance and Exhaust Analysis of Petrol Engine Using Methanol-Gasoline mixes

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Abstract

The world assets are turned out to be rare and significant crunch is found if there should arise an occurrence of Crude oil a nd Petroleum items. There are numerous option powers like methanol, ethanol, Biodiesel, biogass, butanol. Among them methanol has more noteworthy octane number, high warms of vanishing, Oxygen substance by weight % higher than different energizes which come about that better motor execution and abatement in HC, NOx, CO discharge. This exploratory execution tests were done at motor velocity 2000 rpm and variable burden condition, utilizing different mixes of M0 to M20 fills into the impact of methanol expansion to fuel on execution and fumes discharge of SI motor. It is prompts a decrease of CO and HC by around 25% and 10% individually. It was reasoned that among the diverse mixes, the mix including M20 is the most suited for SI motor from the motor fumes discharge perspective.

KEY WORDS: *Methanol; Methanol-Gasoline blends; Exhaust emissions; fuel jet*

I. INTRODUCTION

Petrol engines are widely used for various applications in automobiles Two-stroke S.I. Engine has the advantages of low specific weight, compactness and simplicity in the design, low production cost and low maintenance cost. However this type of engine has two serious drawbacks Poor fuel economy and High-unburned hydrocarbon emission. With ever increasing concerns on environmental pollution, energy security, and future oil supplies, the global community has been seeking nonpetroleum based environment friendly alternative fuels for the past decade. Methanol can be produced from any material that can be decomposed into carbon monoxide (or carbon dioxide) and hydrogen (natural gas, gasification of coal, wood, straw, plant stalk, and even combustible trash).

The objective of this paper is to analyze the influence of the methanol-gasoline blend in the fuel consumption, brake thermal efficiency, brake power, and emissions HC, CO, CO_2 and find out best optimum methanol-gasoline blends without engine modification. Several studies have been conducted on the use of methanol-gasoline blends as fuel in SI engines. D.B Ganesh at el., [2] conducted two-stroke SI engine is fitted with a low pressure injection system for direct methanol injection. Injection pressure is considered for optimization studies and performance characteristics are studied at constant speed 2500 rpm. The performance conducted on with different C.R and pressure (45, 60 and 80 bar). It is observed that best C.R of 8.95:1 and pressure of 60 bar. He concluded that engine can be successfully operated with in cylinder methanol injection up to the maximum speed of 2500 rpm. Maximum BTE of about 17.82% is realized when speed is 2500 rpm and BMEP of 2.58 bar. Also HC and CO emission is lesser than pure petrol. M.Abu-zaid [3] studied the effect of methanol addition to gasoline in the performance of 4 stroke, single cylinder SI engine. The performance test were carried out with volume % of methanol added 3% to 15% at WOT and variable speed condition over range of 1000 to 2500 rpm. It was found that best engine performance for maximum power and minimum BSFC occurs when a mixture of M15 is used. M.Bahattin celik at el., [4] investigated the use of pure methanol and mixture blends as fuel in a gasoline engine and the effect of these fuels on engine performance and exhaust emissions, according to results as increasing the CR from 6/1 to 10/1 with methanol, the power output and BTE increased by up to 14% and 36% respectively. Moreover CO, CO_2 and NO_x emissions were reduced by about 37%, 30% and 22%. M.V. Mallikarjun at el., [5] investigated the effect of methanol addition to gasoline in the performance of 4 stroke, multi cylinder SI engine. The performance test was carried out with volume % of methanol added 3%, 5%, 10% and 15% at variable load condition. It was observed that there is an increase of octane number of gasoline along with increase in Brake thermal effiency , Indicated thermal efficiency and reduction in knocking also exhaust emissions CO, HC are considerably decreased but CO_2 and NO_x slightly increasing. At this methanol blends combustion temperature is found to be high and exhaust gas temperature decreasing gradually.

II. BIOMETHANOL AS AUTOMOTIVE FUEL

Physical and Chemical property of methanol and gasoline is given in table 1. From table 1 the following conclusions regarding methanol as an automotive fuel may be drawn:

Benefits

1) Using as a fuel in SI engines can offer an increased thermal efficiency and increased power output due to its high octane rating 114 and high heat of vaporization.
2) It can be obtained from a number of sources, both natural and manufactured.
3) It can be used to help control internal engine temperatures and heat flows so as to reduce heat losses and thus raising fuel efficiency
4) It is a high-octane fuel with anti-knock index numbers (octane number) of over 100. Engines using high-octane fuel can run more efficiently by using higher compression ratios. It has higher flame speed.
5) It has low sulphur content in the fuel.
6) Higher heat of evaporation resulting in a higher temperature drop and therefore higher volumetric efficiency.
7) Studies conducted with methanol on engine have shown substantial reduction in HC, NO_x due to lower combustion temperature and CO emissions were also reported to be lower.
8) This is very attractive for developing countries, because methanol can often be obtained from much cheaper biomass source than diesel oil.

Drawbacks

1) Methanol molecule contains oxygen, methanol contains only 53% as much energy per litre as gasoline. Methanol vehicles will require much larger fuel tanks, and suffer a weight penalty for having to carry the larger amount of fuel. One litre of methanol produces about 40 % less energy than petrol.
2) Its high specific heat and high heat of vaporization can cause starting and warm up problems.
3) Methanol has higher flash point of +11 $^{\circ}C$ than gasoline, which has a flash point of -45 $^{\circ}C$, so vehicle that use M100 requires special ignition systems to overcome this problem. The gasoline provides sufficient volatility for easy starting.
4) Corrosion and chemical degradation of materials.
5) Methanol vehicles require special engine oil, which is more expensive than conventional engine oil.
6) Methanol-fuelled vehicles typically have lower hydrocarbon, carbon monoxide, and oxides of nitrogen emissions, but higher formaldehyde, Aldehydes emissions, than typical gasoline vehicles.
7) The Reid vapour pressure of M 100 is only 4.6 psi, which made cold starts quite difficult.

III. EXPERIMENTAL SETUP AND PROCEDURE

The engine was started and allowed to warm up for a period of 10-20 min. Engine test were performed at constant engine speed. The speed can be measured by tachometer. Before running the engine to a new fuel blend, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment. For each experiment, five runs were performed to obtain an average value of the experimental data. Experiments were performed at various loads as 0 kg, 4 kg, 8 kg, and 12 kg at constant engine speed 2000 rpm. Methanol-gasoline blends were prepared by volume measure. Alcohol fuel used was methanol (laboratory grade, CH_3OH, 99.5 %). Methanol -gasoline blends used in the experiment were 5 %, 10 %, 15 %, 20 %, volume methanol. The parameters such as fuel consumption rate, brake power, brake thermal efficiency were estimated by standard equations. The exhaust gas sample was carried from the exhaust through a probe passing through a filter and dryer to prevent any water and particulate from entering the analyzer. Measurement distance of exhaust gas analyzer was 1 meter from the engine block

TABLE I
PROPERTIES OF METHANOL AND GASOLINE

Property	Methanol	Gasoline
Density (20 °C) kg/m^3	791	740
Lower calorific value (MJ/kg)	19.5	44
Viscosity (20 °C) (cP)	0.6	0.42
Heat of vaporization (kJ/kg)	1104	330
Boiling temperature (°C)	65	30-225
Octane number	110	92
Flame velocity (m/s)	55	40
Stoichiometric air-fuel ratio	6.5	14.6
Boiling point (°C)	64.7	149-270
Auto ignition temperature (°C)	464	257
Specific heat (KJ/kg °C)	2.6	2.009

TABLE 2 ENGINE SPECIFICATIONS

Name	Specifications
Engine type	Two-Stroke, stationary, S.I engine
Model Bajaj scooter	145 CC
Number of Cylinders	1
Bore and Stroke	57 * 57 mm
Maximum Power	3.357 kw at 6400 rpm
Compression ratio	6.5:1
Type of Cooling	Air-Cooled
Type of starting	Kick starting

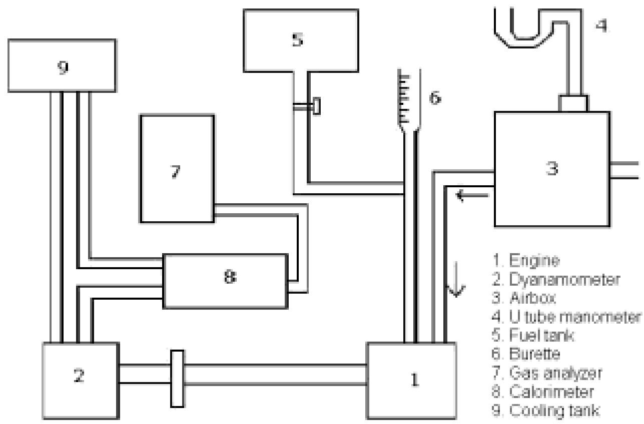

Fig.1 Two stroke, single cylinder petrol engine test rig using rope brake dynamometer

IV. RESULTS AND DISCUSSIONS

4.1 Effect on Brake Power

The effect of methanol-gasoline blends on the brake power is shown in Fig 2. The latent heat of methanol is higher measures are not necessary for the mixture preparing due to lower fraction while it may increase engine volumetric efficiency and thus increase engine power. High heats of evaporation cool down the incoming fuel-air charge and make it denser to promote the power output. The heat of evaporation of methanol is 3-5 times higher than that gasoline. From Fig 2, the nature of brake power curve increasing with the increase in engine speed. The brake power increases with increasing percentage of methanol-petrol blends at constant engine speed 2000 rpm. When M5 methanol-gasoline blend is used the BP is obtained 8.6536 KW which is about 7 % higher than pure petrol at higher engine speed condition.

4.2 Effect on fuel consumption

The effect of methanol-gasoline blends on the fuel consumption is shown in Fig 3. However, its low energy content of 19.7 MJ/kg and Stoichiometric air fuel ratio of 6.42:1 mean that fuel consumption will be higher than hydrocarbon fuels. From Fig 3, the fuel consumption increases on the engine brake power increases at constant engine speed 2000 RPM because methanol has calorific value less than gasoline. Fuel consumption increased about 2.9 times as the engine brake power increased from 0.15 KW to 3.807 KW. When M5 methanol-gasoline blend is used the FC is obtained 0.8 kg/hr which is lower 8 % than pure petrol at full load condition.

4.3 Effect on brake specific fuel consumption

The effect of using methanol-gasoline blends on brake specific fuel consumption (BSFC) is shown in Fig 4. This behaviour is attributed to the LHV per unit mass of the methanol fuel, which is distinctly lower than that of the gasoline fuel. Therefore the amount of fuel introduced in to the engine cylinder for a given desired fuel energy input has to be greater with the methanol fuel. Also BSFC increase at high loads, the friction power is increasing at a rapid rate, resulting in a slower increase in B.P than fuel consumption, with consequent increase in BSFC. BSFC is gradually decreasing as the brake power increases due to C.V of the blends decreases as the percentage of methanol increases. It is inversely proportional to the BTE of engine. BSFC decreased about 3.4 times as the engine power increased from 0.15 KW to 3.807 KW. M5 proportion of Methanol-gasoline gives lower BSFC about 8% than pure petrol at full load condition.

4.4 Effect on brake thermal efficiency

Fig 5 presents the effect of methanol-gasoline blends on brake thermal efficiency. According to the second law of thermodynamics, the engine thermal efficiency increases due to the reduced heat loss from the engine through heat transfer to the coolant and to atmosphere. Moreover, the efficiency is inversely proportional to the BSFC and LHV so decrease in heat loss, BSFC, and LHV improve the efficiency. Heat of vaporization is higher than petrol so absorbs more heat from cylinder during vaporization in compression stroke, this decrease the necessity work for compressing air-fuel mixture and finally thermal efficiency increase. Also methanol has a higher laminar flame propagation speed, which may fasten engine combustion process and thus improve engine thermal efficiency.M5 proportion gives higher brake thermal efficiency at higher loads about 12-15 % than pure petrol at constant engine speed. It is observed that BTE is low at low values of BP and is increasing with increase of IP for all additives of fuel.

4.5 Effect on exhaust gas temperature

Fig 6 presents the effect of methanol-gasoline blends on exhaust gas temperature. As shown in the figure exhaust temperature increases if methanol rate increases in the mixture at various engine loads and speed operating condition. Because heating value of methanol is lower than gasoline so if increase of methanol contents increases the octane number but decreases the heating value. Moreover, auto ignition temperature of methanol higher than gasoline so the temperature required for burning methanol-gasoline blend is also higher.

4.6 EFFECT ON EXHAUST EMISSIONS

The effect of the Methanol percentage in the fuel blend on the CO, HC is shown in Fig 7- 9.

4.6.1 Effect on CO emission

Fig 7 shows that the CO emission decreases as compared with petrol fuel for various blends. CO emission depends upon air-fuel ratio. CO emissions decrease due to oxygen enrichment resulting from increase mass fraction of methanol. The CO emissions are lower due to the complete burning of the fuel, and is due to the reduction in the overall C/H ratio of total fuel inducted into the engine. The increase in load and speed could probably augment volumetric efficiency; boost the turbulence in combustion chamber, thereby ensuring more homogenous mixture and better combustion. However, 20 % of methanol in blended fuels CO emission lowers 20-25 % in comparison to gasoline at suitable engine condition.

4.6.2 Effect on CO_2 emission

Fig 8 shows that the CO_2 emission decreases as compared with petrol fuel for various blends. CO_2 is non-toxic but contributes to the greenhouse effect. CO_2 is a normal product of combustion. Ideally, combustion of a hydrocarbon fuel should produce only CO_2 and water. It is known that amount of carbon dioxide emitted is proportional to the amount of fuel burned. From fig. 8 shows, 20 % of methanol in blended fuels CO_2 emission lowers 28.30 % in comparison to gasoline due to higher percentage methanol in blended fuel can make the air quality better in comparison to gasoline.

4.6.3 Effect on HC emission

Fig 9 shows that HC emission decreases as compared with petrol fuel for various blends. The reductions in HC emission in the case of dual fuel mode is due to the higher burning velocity of methanol, which enhances the burning rate. It can be seen that as the Methanol percentage increases to all engine brake power values. It is observed that the HC was decreased about 10% than pure gasoline at higher brake power operating condition. It was determined that content of the HC was decreased at higher engine load but noise level was increased.

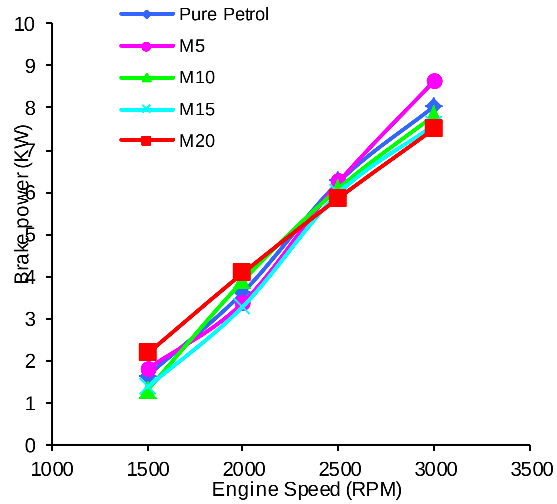

Fig.2 Variation of BP with engine speed

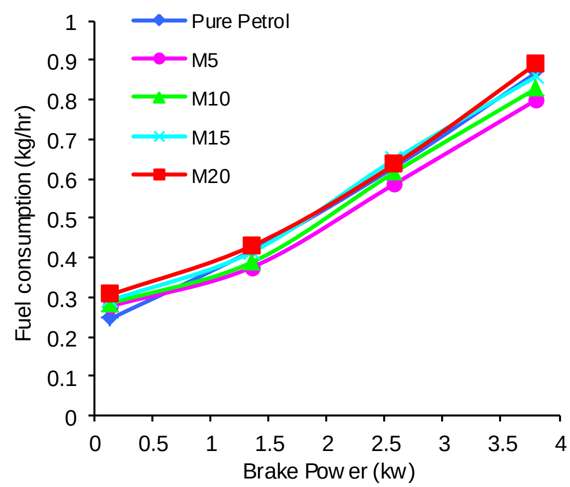

Fig.3 Variation of FC with BP

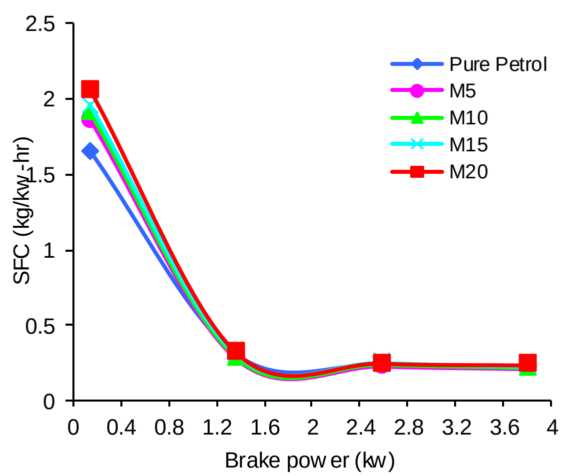

Fig.4 Variation of BSFC with BP

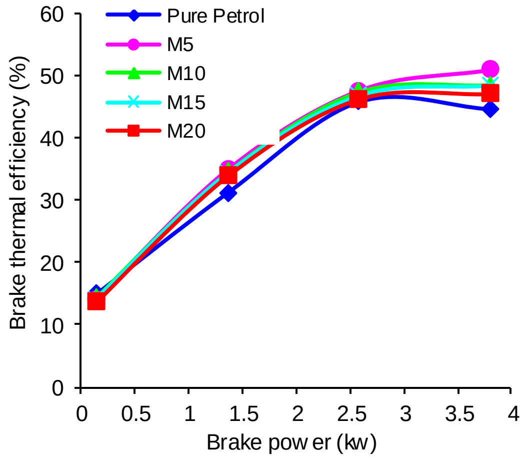

Fig.5 Variation of BTE with BP

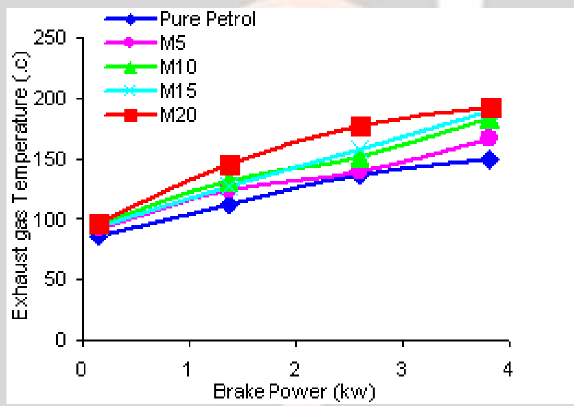

Fig.6 Variation of exhaust temperature with methanol-gasoline blends

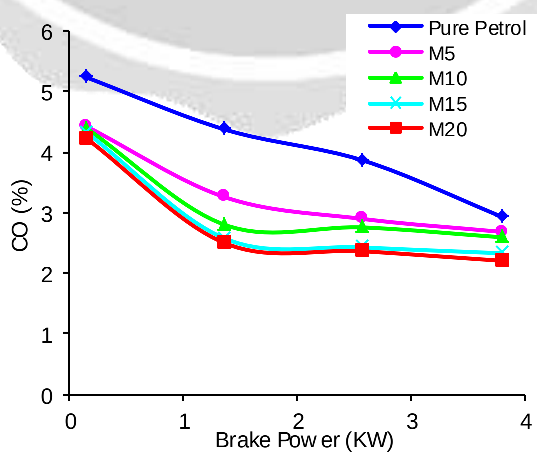

Fig.7 variation of CO emission with BP

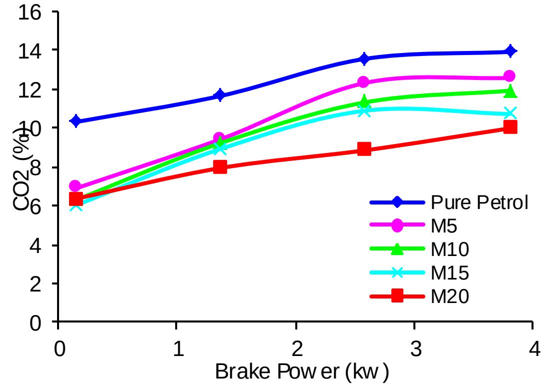

Fig.8 Variation of CO_2 emissions with BP

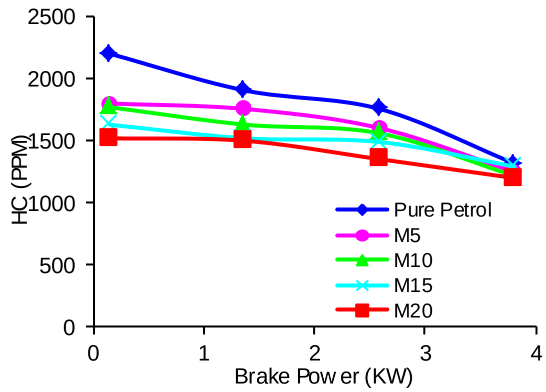

Fig.9 Variation of HC emission with BP

V. CONCLUSION

From experimental test result it may be concluded that Calorific value of methanol is less (22678.5kJ/kg) as compare to petrol (43790kJ/kg). Decrease in calorific value results in higher consumption of fuel for methanol-gasoline blend as compare to petrol. Methanol has higher specific gravity as compare to petrol. From this study, it is concluded that, the fuel consumption and noise level of engine will increase when it run using Methanol-gasoline blends. When M20 blends are used the BP is 4.1122 kW found which is higher around 10% than pure petrol at full load conditions. When M5 blends is used the BSFC obtained 0.1615 kg/kw-hr which is lower about 8% and brake thermal efficiency increased by 5% than pure petrol at constant speed condition.The result of gas analysis shows that, when 20% methanol-gasoline blends is used CO emission decrease by 25% and when HC emission decrease by 10% at full load condition. This may be due to the presence of oxygen of methanol which provides sufficient oxygen for conversion of carbon monoxide CO to carbon dioxide CO_2. Auto ignition temperature of methanol higher than gasoline so the temperature required for burning methanol–gasoline blend is also higher. Based on performance and emission analysis of engine using different methanol-petrol blends, optimum blend was found is M20 (20% methanol and 80 % petrol).section area of fuel nozzle, in CI engine valve timing, injection timing and atomization ratio, has been carried out in many studies on IC engines aiming to reduce emissions and performance better.

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