PROGRESS IN PERFORMANCE ANALYSIS OF METHANOL PETROL BLENDS ON SI ENGINE

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Abstract*—Fossil fuel is the major source for the production of energy used today. Due to the continuous rise in the cost of fossil fuel and demand of pollution free environment and clean energy has also been increasing Alternative fuel has become very noticeable and has a relevant role to play for both CI & SI engines, so it is important to reduce down dependency of gasoline as a fuel. Many research and investigation have been done focusing on using alternative fuel and minimizing the effect on fuel consumption and increasing engine performance. The aim of this review is to analyze the engine performance parameter and future hope of introducing blend of petrol-methanol, petrol with all other alcohol derivatives in varying ratios in SI engine and analyze brake torque, brake power, equivalence air fuel ratio, indicated and brake thermal efficiencies, fuel consumption, volumetric and mechanical efficiency.*

1. INTRODUCTION

The reserve of fossil fuel is limited and is directly related to the demand of humans for energy production. With rise in world population, transportation vehicles, equipment and industries. The demand of petroleum fuel is increased due to which it leads into the search of replacing the petroleum fuel which fulfills the demand and need of people today. Considering current condition of global crisis, the curiosity about alternative fuel is high [1]. Various research and investigations are done to find the economical alternative fuel source and reduces the dependency of fossil fuel; these alternative fuels are also environmental friendly [2]. It is very important to observe that the alternative fuel replacing the petroleum must be produced from renewable sources on not much production cost and the fuel should be used without any modification in engine design. Methanol is most prominent fitting fuel for spark ignition (SI) engine [3, 4]. Alcohols are the best alternative fuel in this Ethanol and Methanol are the good entrants as fuel for the vehicles consist of SI engines because have several physical and combustion properties similar to gasoline [5,6].

Many research and investigations has been done for evaluation of engine performance parameter by using alternative fuel and replace the petroleum reserve or use these in varying ratios with gasoline. This research will help mankind in saving the energy sources and pace the growing need of energy in different field. This review objective is to study the progress made by the researcher in past to improve the performance parameter of running engine using the different ratios of blends of petrol-methanol and comparing the various aspects such as brake torque, brake power, equivalence air fuel ratio, indicated and brake thermal efficiencies, fuel consumption, volumetric and mechanical efficiency.

2. METHANOL APPLICATIONS AND BASIC PROPERTIES

An alcoholic chemical compound which is considered to be simple alcohol is methanol. Due to its attractive properties, it is one of the alternative fuel. It is light in weight, at room temperature it is flammable and one of the most on burning it releases less carbon dioxide and contains more hydrogen than any other fuels. Methanol occurs naturally in environment and soon it breaks in aerobic and anaerobic stage. The common name of methanol is wool alcohol; the name is given because once it was produced by chiefly byproduct of the destructive distillation of wood. Common feed stocks for production are natural gas and coal. Methanol is one of the cleanest sources of energy and it has similar physical and chemical properties as ethanol. Currently Methanol is used as fuel additives in engine in small proportion in significant markets; china is one of largest consumer and producer of methanol fuel globally. Methanol is a simple alcohol and can be prepared from virtually anything that is or plants which includes fossil fuel like natural gas, coal, biomass, landfill and even CO2 from atmosphere, power plant emissions. [7] Reason to advocate methanol

Methanol is a clean burning high octane blending component made from alternative non-petroleum energy sources such as coal, biomass and natural gas. It is used in commercial places by blending in gasoline from various times. Methanol has many fuel properties that make it cleaner burning in petrol engine. Methanol also have high blending octane value for smoother burning, it has lower temperature for better fuel vaporization in cold engine, the highest hydrogen-to-carbon ratio for a lower intensity fuel, and no Sulphur contamination which disturb the catalytic converter operation [8 ,9]. Higher octane allows a significant increase in the compression ratio and a higher vaporization value may cool down the incoming fuel-air charge and increasing the volumetric efficiency and power output [10]. Methanol is ultimate fuel at its own place or it can be blended (85% methanol and 15% gasoline) or 100% methanol even it has half the volumetric energy of gasoline and diesel [11-12]. Celik et al. [13] found that using the pure methanol as fuel at high increasing compression ratio from 6:1 to 10:1 with methanol the power of engine and BTE increased by 14% to 36%.

3. METHANOL PRODUCTION

Methanol synthesis has undergone improvement, this alternative fuel methanol can be produced in many ways nowadays, it can be produced from natural gas, biomass or it can be recovered through flashing vaporization in continuous production of biodiesel or it can be produced bused on coke oven gas. [14]

a) Methanol produced from coal

Methanol can be produced from coal and overall coal consumption for production of methanol is about 1.42 – 1.59t of standard coal for per ton of methanol. In general production, the process begins with justification in which oxidation of coal takes place. This process is done under controlled amount of oxygen to produce synthesis gas. This syngas is then treated in order to make it suitable for methanol synthesis this process involves removal and recovery of acid gas and shifting of water gas which regulate ratio of CO to Hydrogen [15].

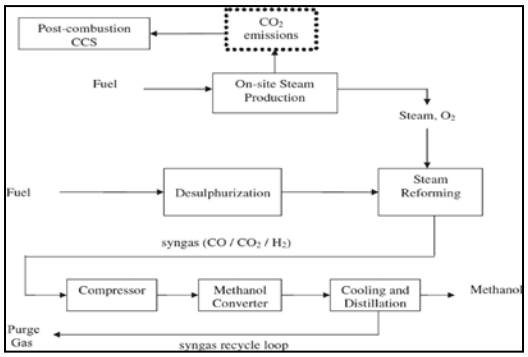

Fig. 1. The flow chart of the methanol synthesis process [16].

b) Methanol production from natural gas

A bust plant configuration which corresponds to the standard process for methanol production was compared by power plant fed by the unreacted gases and capital and operating casts were considered. They proposed a solution based on steam methane reforming consisted of methanol synthesis followed by power plant where unburned gases were burnt. By this way, they find that this process is profitable and then a new generation system for methanol production and power generation takes place taking biomass and natural gas as a raw material this new generation system could achieve the optimal ratio of hydrogen and CO for production of methanol adjusting the input biomass and natural gas. [17-18].

c) Methanol production from coke

Oven gas by products of coking plants consists of many gases like (about 55 to 66%), ((23 to 27 %), CO (5% - 8%), (3% - 5%) along with many hydrocarbons in small proportion. Coke oven gas produces methanol gases. Activated carbons used as catalyst to produce a syngas for methanol synthesis under dry reforming of COG.

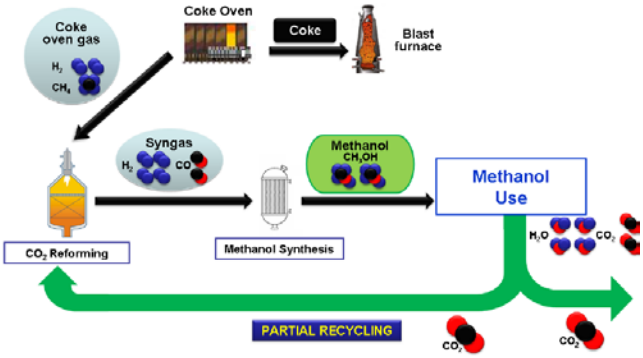

Fig 2: Partial recycling of by mean of reforming of coke oven gas for methanol production.

COMPARISON OF FUEL PROPERTIES OF GASOLINE / METHANOL/ETHANOL

TABLE 1.1 PROPERTIES OF METHANOL, GASOLINE & DIESEL [14]

Fuel property	Methanol	Gasoline	Diesel
Formula	CH_3OH	C_{5-10}	C_{10-26}
Molecular weight	32	95-120	180-200
Oxygen content	50%	0	0
Low calorific value (MJ/kg)	19.66	44.5	42.5
High calorific value (MJ/kg)	22.3	46.6	45.8
Stoichiometric air/fuel ratio	6.45	14.6	14.5
Freezing point (°C)	-98	-57	-4
Boiling point (°C)	64.8	30-220	175-360
Flash point (°C)	11	-45	55
Research octane number	108.7	80-98	
Auto ignition Temperature (°C)	465	228-470	220-260
Motor octane number	88.6	81-84	
Cetane number	3	0-10	40-55
specific heat (20 °C) (kJ/kg K)	2.55	2.3	1.9
latent heat (kJ/kg)	1109	310	270
Viscosity (20°C) (CP)	0.6	0.29	3.9

4. PERFORMANCE PARAMETER OF ENGINE

Engine performance is the degree of success of the engine to perform the assigned job or conversation of chemical energy into the useful mechanical work. the list of the performance parameter is given below-:

- Specific Fuel Consumption
- Specific Power Output
- Specific Weight
- Exhaust Smoke and Other Emission

The effect of various operating condition, modifications and design are studied by the evaluation of performance parameter of engine only and the basic performance parameter as follow-:

a) Power and Mechanical Efficiency

The main objective of engine is to obtain mechanical power thus power developed by an engine measured at the output shaft is known as Brake Power (bp). As an engine operate the fuel burns in combustion chamber and power developed is more than brake power and this power is known as Indicated Power (ip) or in simple we

can say total power developed by an engine is known as Indicated Power.

Brake & Indicated Power is given by

$$bp = \frac{2\pi NT}{60}$$

$$ip = \frac{P_{im} LANK}{60}$$

Mechanical Efficiency is obtained by

$$\text{Mechanical Efficiency} = \frac{bp}{bp+fp}$$

fp –It is the frictional Power or loss by friction

b) Mean Effective Pressure and Torque

Mean effective pressure is defines as the average pressure which is assumed to be acting on piston throughout power stroke. The power of engine is dependent on its size and speed thus the torque and mean effective pressure are related to engine size as large engine produces more torque on same mean effective pressure. Higher the MEP higher will be power developed for given displacement.

$$p_m = \frac{i_p \times 60}{LANk} \qquad i_p - \text{Indicated power}$$

Torque is given by- :

$$T = \frac{b_{emp}.A.L.k}{2\pi}$$

$$b_{emp} - Brake\ mean\ effective\ pressure$$

c) Volumetric Efficiency

Volumetric Efficiency is defined as the ratio of the air inducted into the cylinder during the suction stroke to the mass of the air corresponding to the swept volume of the engine at the atmospheric pressure and temperature. It is clear that the amount of air taken inside the cylinder is dependent on volumetric efficiency.

$$\eta_v = \frac{Actul\ Mass\ of\ air\ sucked\ in}{Mass\ of\ charge\ to\ the\ cylinder\ intake}$$

η_v-Volumetric efficiency

a) Brake Specific Fuel Consumption

$$\text{bscf} = \frac{\text{Fuel Flow in kg/hr}}{B.P}$$

b) Brake Thermal Efficiency

$$\text{Bte} = \frac{B.P \times 60 \times 1000 \times m_f}{100 \times .06 \times \rho \times C_v} \times 100$$

c) Fuel Air Ratio

$$\text{A/F ratio} = \frac{Air\ flow}{Fuel\ flow}$$

5. METHANOL USED AS FUEL FOR INTERNAL COMBUSTION ENGINE

The properties of methanol given in table [14] shows that alcohol is colorless, neutral, polar and flammable liquid. It can mix with water, alcohol, ester, and most of organic compound. Due to its high-octane rating and higher heat of vaporization value as compared to gasoline, methanol can be used in higher compression ratio engines with large outputs. It is because higher octane rating increases compression ratio and higher heat of vaporization cools the incoming air-fuel charge due to which volumetric efficiency and power output increases. [19]

Various researches is being done for using methanol as a fuel in different CI engine in proper ratio of blends without modifying the engine.

The aims of all researches are to improve the performance parameter and decrease exhaust toxic gas. Li at al. [20]- Studied about the injection and injection timing on the performance of engine and emission from SI engine fueled with methanol. The results show that direct injection methanol engine in which the mixture is non-uniform with a stratified distribution could be formed, had a favorable injection and injection timing obtaining good performance and low exhaust emission; for methanol engine, to make it best for injection timing and injection timing required an improvement of BSFC if more than 10% compared to non-optimized case in wide load range and engine speed of 1600 rpm as compared to non-optimized case.

Abu-zaid M. [21]- Studied in his experimental setup to demonstrate effect of methanol edition to gasoline on the performance of SI engine. This performance was done at open throttle at variable speed over range of 1000-2500 rpm using various ratios of blends of methanol gasoline. The results show that methanol shows the significance effect of performance of the petrol engine the studied shows that the best performance of engine for maximum power output, and maximum BFC occurs when the mixture is 15% of methanol and 85% of gasoline blender were used.

Bilgin and sezer [22]- Studied the performance on engine with the different ratio of the methanol-gasoline (leaded and unleaded) with different rpm of engine. They stated that maximum performance of engine is obtained from M5 fuel blend. At M5 the brake mean effective pressure shows the maximum valve.

Mallikarjun and venkataa rameshmamilla [23]- tested the four-cylinder SI engine by adding methanol into gasoline and also, they modified engine systems for different load condition the results shows that for various ratio of blend (0-15) the performance of engine changes it observed that there is slightly increase in octane rating of gasoline and also increase in brake thermal efficiency, indicated thermal efficiency and also the nocking reduces.

Turner et al. [24] studied in experiment the effect of ethanol- methanol-gasoline blends on exhaust gases (NOx and CO2) with the different ratio of fuels (G29.5 + E42.5 + M28, G37 + E21 + M42 , G42 + E5 + M53 , G40 + E10 + M50) and studied the result. The result shows that dual fuel blend reduces the exhaust emission of NOx and CO2 than the neat gasoline. The result also shows the performance of engine is slightly improved.

Tiegang Hu [25] studied the performance of engine and exhaust emission by using a three-cylinder engine with bore 68.5mm port fuel injection operated with methanol-gasoline blend during cold start and warm up. The cylinder pressure analysis that combustion in engine improves with methanol addition into gasoline. The indicated mean effective pressure become higher during the 50 cycles due to the shortening of flame developing period and fast burning period with the increase of methanol gasoline

fraction. With increase of methanol fraction the un burned hydrocarbon and carbon monoxide decreases.
The result shows 40% of hydrocarbon is reduced at 5 C and 30% at 15C during colds start and warm-up periods.

6. CONCLUSION AND RECOMMENDATIONS

This paper reviews systematically about methanol as an alternative fuel in internal combustion engine which includes production, supply, demand and effects of methanol on human health and environment. The result shows that methanol can be prepares from natural gas, coke-oven gas and biomass. As compared to fossil fuel methanol has capability of reducing emission and improve environment.
Many researchers made great efforts, methanol application is still decisive concerning methanol engine design and development and also it needs many improvements. From engineering point of view methanol is an ideal alternative, renewable, and environmental and economically attractive fuel. The development of high compression ratio methanol engine to replace high power and efficiency engines.

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