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Performance Evaluation of a Four Stroke Si Engine at Gasoline & At Varying Gasoline- Methanol Blends

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Abstract

Methanol has greater octane number, high heats of evaporation, Oxygen contents by weight % higher than other fuels which result that better engine performance and decrease in HC, NOx, CO emission .In the present work the properties of methanol have been analyzed from the point of view of its applications to spark ignition engine vehicles. Use of methanol – gasoline blends up to 15 percent methanol by volume requires only minor engine modifications. However, miscibility of methanol and gasoline is poor and in order to avoid fuel separation, mixture of these fuels requiresfuel additives. Morse test was also performed to evaluate the performance of each cylinder for gasoline as well as gasoline – methanol blends There was distinct variation in brake specific fuel consumption and brake thermal efficiency in shorting each cylinder due to mixture distribution reaching the cylinders due to their positioning with respect to intake manifold and also due to phase separation of gasoline and methanol at higher loads and speeds when the engine was run on methanol – gasoline blends. The feasibility of the use of methanol as an automotive fuel for SI engine is discussed from technical and economic points of view.

1. Introduction

All over the world, the use of petroleum products has increased tremendously. This has resulted in great scarcity of fuel for IC Engines and problem has become acute during the recent years. Petroleum supply of today cannot keep up with the demands made upon them due to many factors. Some of these factors may be summarized as follows: The increased use of automobile, rapid rate of industrial & technological development throughout the world.These factors are due to population growth and environmental impact such as global warming, acid rains and greenhouse effect etc. The problem of fuel scarcity has become very grave for developingcountries like India. About sixty five percent of total fuel oil requirements of India are met throughfuel oil requirements of India are met throughimports. Gasoline is the fuel of the majority of spark ignition-engines with the transport sector being themost oil dependent on all major energy consumption sectors in the present economy .The recent manifold increase in the price of this commodity in the world market is causing a heavy drain on the country's foreign exchange reserves. This is posing a major threat to the economy of the country. The increase in oil prices has brought an end to the era of cheap gasoline for SI Engines. Even though search of new oil resources in the country's land and sea is being intensified but there do not seem to be any changes of immediate relief. Moreover complete dependence on stored fuels like petroleum with its fast vanishing reserves is likely to cause a very grave energy crisis in time to come. This put heavy stress on the conventional reserve of fossil-based fuels to meet this demand. This problem has initiated the incentive for the search for alternative sources of energy, which are cleaner and more environmentally friendly. These alternatives may be either complete replacement for the present fuels or additives that can be added to the present fuels to improve its properties. Currently, various alternative fuels have been investigated for spark ignition engines to reduce the consumption of gasoline and NOX, CO, and unburned hydro- carbon (HC) emissions. In alcohols, methanol and ethanol are used most often as fuels and fuel additives, because their potential to improve air quality when used to replace

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conventional gasoline in engines because of its good anti-knock characteristics and the reduction of CO and unburned HC emissions in engines.

2. Literature Review

Alcohols such as methanol (CH3OH) and ethanol (C2H5OH) have received considerable attention recently because they are considered as highly efficient and low polluting future fuels through their lean operating ability. The oxygen present in alcohol fuel provides soot free combustion with low particulate level [1]. In recent years several researches have been carried out to the influence of methanol on the performance of spark ignition engines. Abu-Zaid et al. [6] studied an experimental investigation in to the effect of methanol addition to gasoline on the performance of spark ignition engines. The performance tests were carried out on 4-stroke, single cylinder, variable compression ratio engine having a displacement volume of 582 cm3 at wide open throttle and variable speed conditions, over the range of 1000 to 2500 rpm, using various blends of methanol-gasoline fuel. It was found that –Methanol has a significant effect on the performance of the gasoline engine.The calorific value of the blend decreases as the percentage of methanol increases. The best engine performance (within the range studied) for maximum power output and minimum brake specific fuel consumption occurs when a mixture of 15% methanol and 85% gasoline blend is used. The best operating conditions, with regard to brake specific fuel consumption, is operating the engine at low and moderate speeds. The addition of methanol to gasoline increases the octane number, thus engine fueled with methanol-gasoline blend can operate at higher compression ratios.

Liao et al. [10] made a study on the effect of methanol addition into gasoline on the combustion characteristics in a constant volume closed combustion chamber for methanol-gasoline blended fuel at relatively low temperatures which is related to the cold-start operation of the engine & concluded that - For methanol-gasoline blends with methanol content below 30 %, the suitable fuel/air ratio to realize fast flame propagation is about 1.3 and the emissions ofHC during the rich combustion at a relatively low temperature are increased with the addition of methanol into gasoline. In the view of the optimization equivalence ratio of combustion at a low temperature, HC and CO emissions can be reduced as moderate addition used. Shenghua et al. [13] made a study on spark ignition engine fueled with gasoline/methanol fuel blends. From their results conducted on a 3-cylinder port fuel injection engine under wide open throttle (WOT) conditions and using gasoline-methanol blend as an alternative fuel for motor vehicles they found that –With the increase fraction of methanol (M 15), engine power and torque decrease, while the brake thermal efficiency is improved. From this study, it can be concluded that low fraction methanol/gasoline blend can be used in SI engines without any modifications. For better operation, spark timing is optimum. The most interesting thing is that methanol addition to gasoline improves the SI engine cold start and reduces CO (25 %) and HC (50 % in cold start period and 30 % in warming up period) emissions significantly.

3. Criteria for fuel selection

Following criterion may be used while evaluatingand selecting potential future fuels.

3.1 Economic Criteria

3.1.1 Cost

This is the most direct criteria for comparisonalthough not easy to calculate. It includes cost of producing the resource, manufacturing the fuel and distributing it to the customers. However before estimating the preliminary economics for these operations, it is necessary to specify the process used to manufacture the fuel. There is also an obvious effect of time, as new and improved technology becomes available.

3.1.2 Operating cost of vehicle

It is important to consider the cost of fuel from point of consumers. In order to do a meaningful comparison of this type, it is necessary to have fairly reliable fuel economics and an appreciation of fuel vehicle interactions. The lateris important to make sure that all significant effects on vehicle weight and cost due to the fuel are considered.

3.2 Technical Criteria

3.2.1 Technological status

It is critical to determine when various alternative fuel can be made generally available.

In order to do this the technology of manufacturing these fuels has to be assessed which also leads 12 12 to a definition of technology gaps. The rate at which these can be filled is important in determining the relative attractiveness of various fuels at a given time in future.

3.2.2 Efficiency of resource utilization

Resources must be used prudently in order to prevent undue depletion. The overall efficiency of resource utilization comprises a number of steps including production of the resource, manufacture and distribution of fuel and use of the fuel.

3.3 Performance Criteria
3.3.1 Toxicity and safety

In judging the feasibility of alternative fuels, matters of toxicity and associated health hazards must be examined by the manufacturer and marketer for the potential impact upon employees, consumers and the public at large [7]. The major use in fuel safety involves flammability and danger of accidental detonation.

3.3.2 Efficiency of use

For a given engine, efficiency is measured by fuel economy, which determines the fuel component of vehicle operating cost.

4. Experimental Set Up
4.1 Test Engine Specifications

The engine selected for the purpose was a vertical; water cooled four stroke 4 cylinder stationary spark ignition enginehaving following specifications:

Engine	Four Stroke Fiat Car
No. of cylinders	Four
Rated BHP (With gasoline)	10
Compression Ratio	7.8 : 1
Rated RPM	1500
Bore	68 mm
Stroke	75 mm

Fig: 1. Experimental set-up (Front View)

Table: 1. Gasoline-Methanol Blend (10 % Methanol by volume) at constant load (using all four spark plugs)

Sr. no.	Speed (rpm) N	Load (kg.)	Brake horse power Bhp	Mass of air consumption (kg/ min) Ma	Mass of fuel consumption(kh/hr)mf	Air to fuel ratio A/F	Brake specific fuel consumption (kg/bhphr) bsfc	Brake thermal efficiency (%) Bth
1	1300	1.0	1.3	.3622	1.06	20.58	.812	6.06
2	1400	1.0	1.4	0.3582	1.15	18.75	0.818	7.81
3	1500	1.0	1.5	0.3541	1.19	17.88	0.792	8.06
4	1600	1.0	1.6	0.3499	1.25	16.82	0.780	8.19
5	1300	3.0	3.9	0.3931	1.25	18.90	0.320	19.96
6	1400	3.0	4.2	0.3894	1.32	17.70	0.314	20.32
7	1500	3.0	4.5	0.3856	1.40	16.48	0.293	20.48
8	1600	3.0	4.8	0.3818	1.53	14.97	0.318	20.40
9	1300	5.0	6.5	0.3415	1.32	15.38	0.205	31.17
10	1400	5.0	7.0	0.3372	1.42	14.29	0.202	31.58
11	1500	5.0	7.0	0.3328	1.48	13.52	0.197	32.46
12	1600	5.0	8.0	0.3284	1.65	11.94	0.195	32.97

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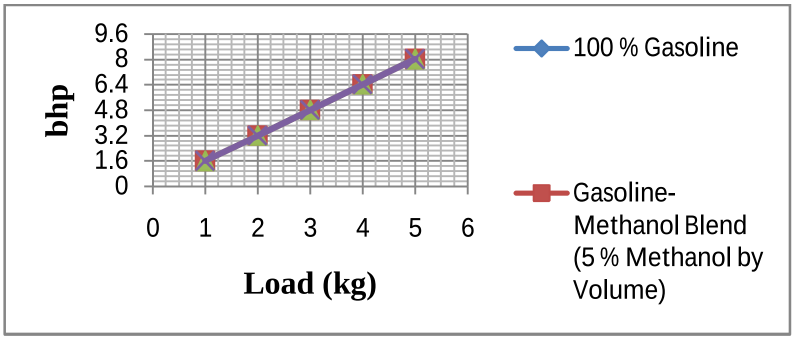

Fig: 2. Effect of Load on bhp at Constant Speed (1600 rpm)

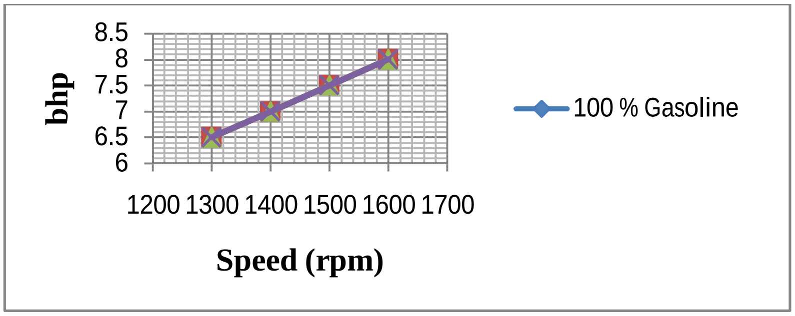

Fig: 3. Effect of Speed on bhp at Constant Load (5 kg)

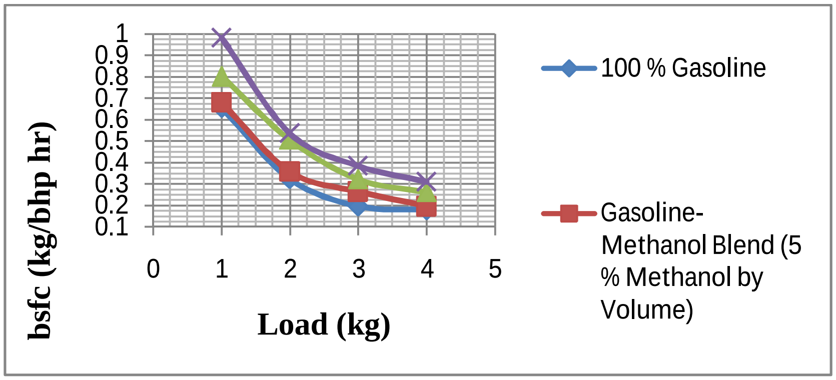

Fig: 4. Effect of Load on bsfc at Constant Speed (1600 rpm**)**

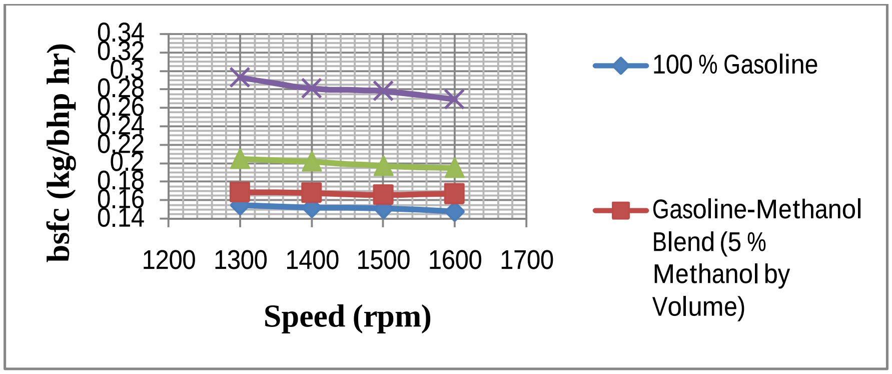

Fig: 5. Effect of Speed on bsfc at Constant Load (5 kg)

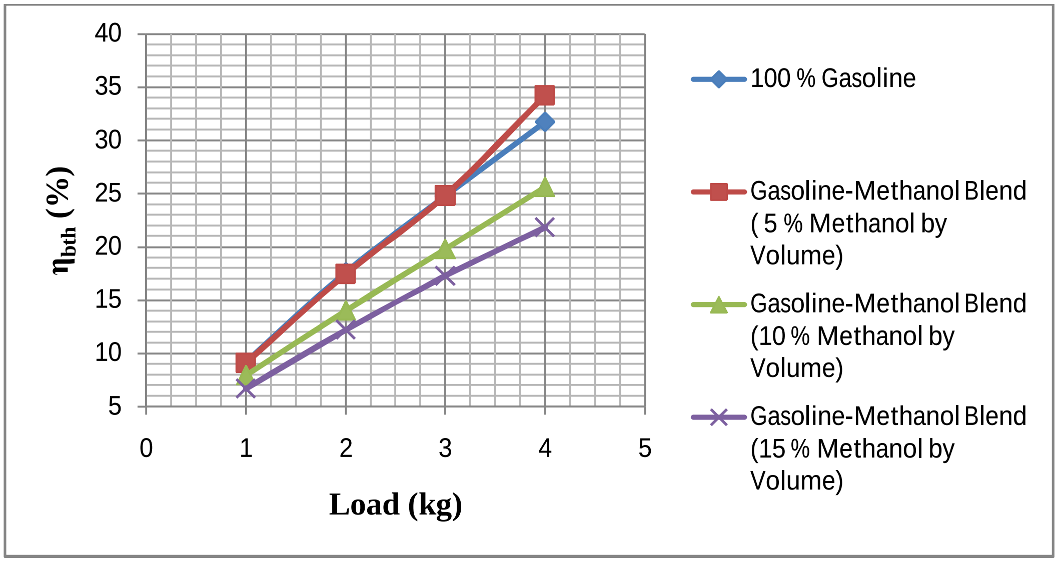

Fig: 6. Effect of Load on BRAKE THERMAL EFFICIENCY at Constant Speed (1600 rpm)

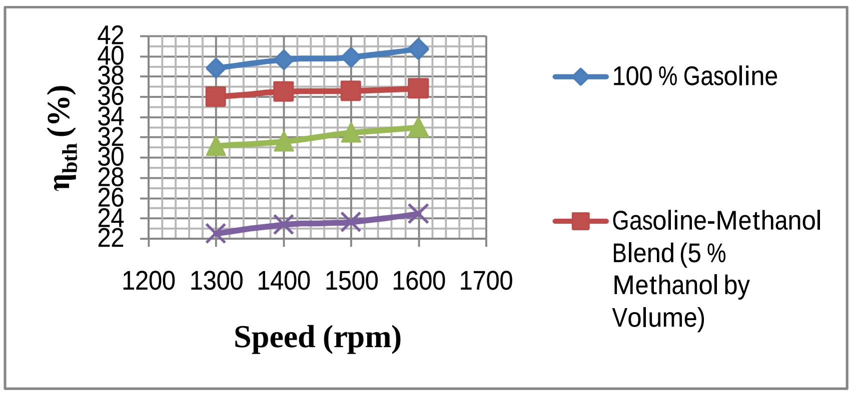

Fig: 7. Effect of Speed on BRAKE THERMAL EFFICIENCY on Constant Load (5 kg)

5. Conclusion

The engine performance was evaluated on gasoline as well as gasoline-methanol blends of 5, 10 and 15 % methanol by volume. Morse test was also conducted to evaluate the performance of each

- Methanol is a good SI engine fuel because of its physical and chemical properties (especially its high octane number).
- Performance parameters such as brake specific fuel consumption and brake thermal efficiency for 5 % blend of methanol with gasoline are nearly equal to that of pure gasoline.
- As the percentage of methanol is increased up to 15 %, thermal efficiency decreases and brake specific fuel consumption increases. The lowest thermal efficiency and highest brake specificfuel

cylinder with respect to brake specific fuel consumption, brake thermal efficiency and all other performance parameters. From analysis of results, following conclusions can be drawn:

consumption is found for 15 % methanol blend almost at all loads and speeds.

- It was also noticed that fuel separation occurred after a period of time when 10 and 15 % methanol was added with gasoline. Only minor engine modifications such as enlargement of fuel nozzles and addition of ignition improver are needed. Hence, satisfactory use of methanol in gasoline up to 5 % level by volume may be recommended.

- Morse test was performed to have a comparative analysis of performance of individual cylinder for pure gasoline as well as for blends. In the case of pure gasoline, the brake specific fuel consumption was higher when 1st and 4th cylinders were not in operation although the engine develops same power and in case of 5 % methanol blend, the brake specific fuel consumption was higher when 2nd and 4th spark plugs were not in operation.
- In case of pure gasoline, the brake thermal efficiency was higher when 1st and 3rd spark plugs were not in operation and in case of 5 % methanol blend; brake thermal efficiency was higher when 3rd spark plug was not in operations**.**

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