Performance and Study of Si Engine using Ethanol Blended Gasoline Fuel

Ashish Kumar Chaurasiya[1] Dr.N.Singh[2] Arun Kumar Pandey[3]
[1,3]M.Tech. Student [2]Associate Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]Madan Mohan Malaviya University of Technology, Gorakhpur-273010, India

Abstract— Due to growing energy needs and environmental concern worldwide have forced the interest for quest and consumption of renewable and environmental fuels .There are some other alternatives that can be accessible in engines with the possibility of reducing injurious gas radiations. Here we have considered gasoline as reference which is to be blended with ethanol. Then the Physical properties of the fuel are determined. SI engine runs on several speeds and part load which connected to dynamometer, in this mixture blend is containing 10%, 20%, and 30% ethanol and performance characteristics are assessed. In this paper it is shown that the ethanol blends can replace gasoline in SI engine, outcomes show that there is escalation in Brake power, Specific Fuel Consumption and Brake thermal efficiency on blending. The Result shows that using 20% ethanol blend is more effective and we can utilize it for further use in SI engines with little constraint on material used to sustain little increase in pressure.

Key words: SI Engine, Ethanol, Gasoline, Specific fuel consumption (SFC), Brake thermal efficiency (BTE), etc

I. Introduction

Rapidly increase in fuel prices and oil consumption along with scarcity of petroleum based fuels have accelerated an interest for search of alternative, renewable sources of fuel like biodiesel and alcohol-based fuels. In recent years ethanol is has become widely used renewable fuel with up to 10% by volume blended in to gasoline for regular engines or up to 85% for use in Flex-Fuel vehicles designed to run with higher concentrations of ethanol. Ethanol can also be used as a neat fuel in spark-ignition engines or blended up to 30% with Diesel fuel for use in compression-ignition engines [1-2].Ethanol is biodegradable, less pernicious to ground water, and has an octane number much higher than gasoline as well as having safer effect on vehicle emissions [3]. Environmental issues regarding the emissions of hydrocarbon, carbon dioxide, carbon monoxide, nitrogen oxides and particulate matter from petroleum based fuels such as gasoline and diesel are of serious concern worldwide. These emissions are not only have adverse effect on human body but also harmful to the environment as they vital role in formation of the greenhouse effect, acid rain and global warming. Therefore there is an acute need for renewable and environment friendly alternative fuels such as ethanol (alcohol), natural gas, and biodiesel. Today, the transport sector is a major contributor to net emissions of greenhouse gases, of which carbon dioxide is particularly important. The carbon dioxide emissions originate mainly from the use of fossil fuels; mostly gasoline and diesel oil in road transportation systems, although some originates from other types of fossil fuels such as natural gas and Liquefied Petroleum Gas (LPG). If international and national goals (such as those set out in the Kyoto protocol) for reducing net emissions of carbon dioxide are to be met, the use of fossil fuels in the transport sector has to be substantially reduced. This can be done, to some extent, by increasing the energy efficiency of engines and vehicles and thus reducing fuel consumption on a volume per unit distance travelled basis. However, since the total transportation work load is steadily increasing such measures will not be sufficient if we really want to reduce the emissions of carbon dioxide.

II. Ethanol

Ethanol is an alternative energy source. It is an alcohol made by fermenting corn or other similar biomass material. There are three primary ways that ethanol can be used as transportation fuel. As a blend of 10 percent ethanol with 90 percent unleaded gasoline called E10 Unleaded. As a component of reformulated gasoline, both directly and/or as ethyl tertiary butyl ether (ETBE) or as a primary fuel with 85 parts of ethanol blended with 15 parts of unleaded gasoline called E85. When mixed with unleaded gasoline, ethanol increases octane levels, decreases exhaust emissions, and extends the supply of gasoline.

Ethanol in its liquid form, called ethyl alcohol, can be used as a fuel when blended with gasoline or in its original state. It can also be used as a raw material in various industrial processes. Ethanol is made by fermenting almost any material that contains starch or sugar. Grains such as corn and sorghum are good sources; but potatoes, sugar cane, Jerusalem artichokes, and other farm plants and plant wastes are also suitable.

III. Experimental Set Up

A. Engine Set Up

The experiments are conducted on a four cylinder, four stroke spark ignition engine (type Fiat-3A). The engine has a swept volume of 1000 cm^3, a compression ratio of 9:1 and a maximum power of 22.8 kW at 3000 rpm.

Engine type	Water cooled SI engine
Number of cylinder	4
Firing order	1-3-4-2
Bore	68 mm
Stroke	75 mm
Capacity	1000 cc
Compression ratio	9:1
Maximum power (3000 rev/min)	22.38 kw or 30hp
Maximum torque (1500-2000 rev/min)	106.85 Nm

Table 1: General properties of the test engine

The engine was coupled to a hydraulic dynamometer through a flexible coupling. A clutch is provided, which can be operated at the starting of the engine .The engine is provided with all its accessories fitted to the bed and the panel board. Speed is measured by electric tachometer and the load is measured on the panel, which is vary on load fluctuation.

Fuel consumption was measured by using a calibrated burette and a stopwatch with an accuracy of 0.2s.

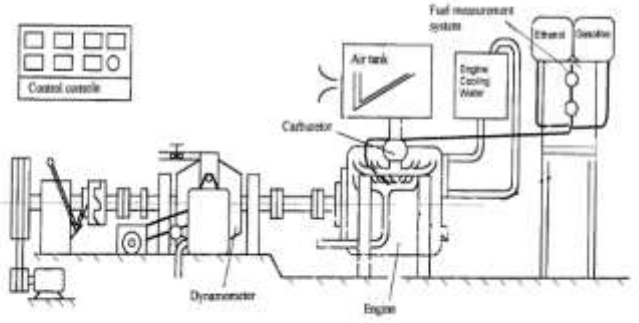

Fig. 1: Schematic diagram of the experimental system

The experimental apparatus included two major systems, i.e. the engine system and the power measurement system (Fig1). The engine system used in this experiment, whose technical data are shown in Table 1 was a commercial engine. Properties of the fuels used. The engine output power was metered by the hydraulic dynamometer.

B. *Procedure*

The engine was started and allowed to warm up for a period of 20–30 min. The air–fuel ratio was adjusted to yield maximum power on unleaded gasoline. Engine tests were performed at 1500, 1600, 1700, 1800, 1900 and 2000 rpm engine speed at three-fourth throttle opening position. The lowest desired speed is maintained by the load adjustment. The required engine load was obtained through the dynamometer control. 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, three runs were performed to obtain an average value of the experimental data. The variables that were continuously measured include engine rotational speed (rpm), time required to consume 100 cm3 of fuel blend (s), and air–fuel ratio. The parameters, such as fuel consumption rate, equivalence air–fuel ratio, volumetric efficiency, air consumption, brake power, brake specific fuel consumption, brake thermal efficiency, density, stoichiometric air–fuel ratio and lower heating value (LHV) of the fuel blends, were estimated using the following equations.

Fuel property	Ethanol	Gasoline
Formula	C_2H_5OH	C_4 to C_{12}
Molecular weight	46.07	100-105
Density, kg/1, 15/15 °C	690-790	710
Speci.gravity,15/15°C	.69-.79	.71
Freezing point, °C	-114	-40
Boiling point, °C	80	27-225
Vapor pressure, kPa at 38 °C	15.9	48-103
LHV,1000 kJ/L	21.2	32
Viscosity, mPa s at 20 °C	1.19	0.37-0.44
Stoichiometric air/fuel ratio	9.0	14.7
Octane number	90	94

Table 2: Properties of Gasoline and Ethanol

In the SI engine used, the air and fuel are mixed together in the intake manifold system prior to entry to the engine cylinder by using a carburetor. The engine under the investigation was tested with original fiat carburetor. Then, the carburetor originally used was replaced by maruti 800cc engine carburetor. The engine was tested using 100% gasoline and test performing part load test. Part load test was performed on the engine using 100% gasoline at different speed and variable load conditions. Fuel flow rate and load applied was recorded.

C. *Performance Parameters*

1) *Specific Fuel Consumption (SFC)*

Specific fuel consumption SFC is an engineering term that is used to describe the fuel efficiency of an engine design with respect to thrust output. SFC may also be thought of as fuel consumption (grams/second) per unit of thrust (KN). It is thus thrust-specific, meaning that the fuel consumption is divided by the thrust.

$$\text{S.F.C. in Kg / sec} = \frac{\text{QxSp.gr.}}{1000}$$

Where,
Q= Fuel consumption per min
Sp.gr= Specific gravity of fuel

2) *Brake Horse Power or Brake Power*

The power produced by an engine is expressed in horsepower. When the power developed is measured by means of a dynamometer or similar braking device, it is called brake horsepower. Brake or shaft horsepower is less than indicated power.

On the basis of experimental setup of engine at dynamometer when load is applied

$$\text{B.H.P.} = \frac{WN}{2000}$$

Where,
BHP= Brake horse power
N = Engine speed coupled with dynamometer in rpm
W = Weight in kg

3) *Brake thermal efficiency (BTE):*

Brake thermal efficiency is the ratio of brake horse power (delivered power) to the indicated horsepower (power provided to the piston):

$$\text{BTE} = \frac{Bp}{\text{s.f.c. x Cv of fuel}}$$

Where,
Bp= Brake power in (kw)
SFC=Specific fuel consumption rate (kg/sec)
Cv =Calorific value of fuel

IV. RESULTS AND DISCUSSION

The effects of ethanol addition to unleaded gasoline on SI engine performance and exhaust emissions at three-fourth throttle opening at variable engine speeds were investigated. The average changes and the mean of the average changes in the values of the parameters of engine performance and exhaust emissions for all fuel blends and the six different engine speeds obtained from the experimental runs are summarized.

A. *Effect of the Ethanol–Unleaded Gasoline Blends on the Fuel Consumption*

The effect of the ethanol–unleaded gasoline blends on the fuel consumption is shown in Fig.2.the fuel consumption increases as the increases as the E% increases for all engine speeds. This behavior is attributed to the LHV per unit mass of the ethanol fuel, which is distinctly lower than that of the unleaded gasoline fuel. Therefore, the amount of fuel introduced into the engine cylinder for a given desired fuel energy input has to be greater with the ethanol fuel. Fig. 2 show that at the engine speeds of 1500 and 2000 rpm, the relative fuel consumption rate increases.

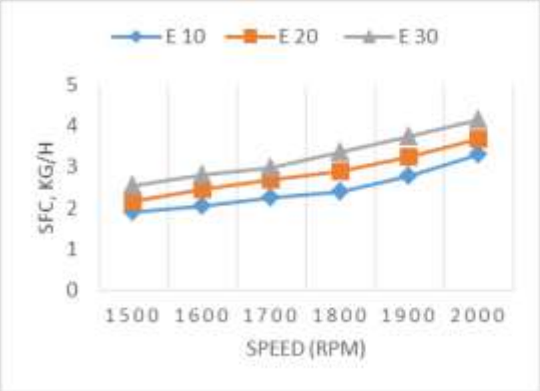

Fig 2: Graph 1. Specific fuel consumption rate vs speed

B. Effect of Using Ethanol–Unleaded Gasoline Blends on Brake Power

The effects of ethanol–unleaded gasoline blends on brake torque and brake power is illustrated in Fig. 3. It is Brake Power (Bp) increase as the E% increases for all engine speeds.

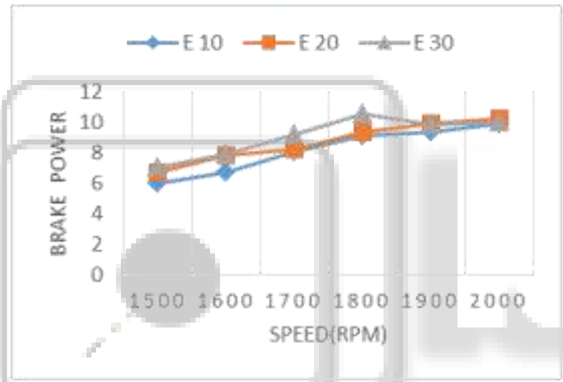

Fig 3: Graph 2. Brake power vs speed

This increase continues until the reaches 25% ethanol. The brake power is increases continuously on 30% ethanol until 1700 rpm speed. After this point, Brake Power (Bp) start to decrease.

C. Effect of Using Ethanol–Unleaded Gasoline Blends on Brake Thermal Efficiency

As shown in the fig 4 brake thermal efficiency ($\eta_{b.th}$) increases as the E% increases. The maximum brake thermal efficiency ($\eta_{b.th}$) is recorded with 30% ethanol in the fuel blend for at 1700 rpm engine speeds, after that brake thermal efficiency decreases.

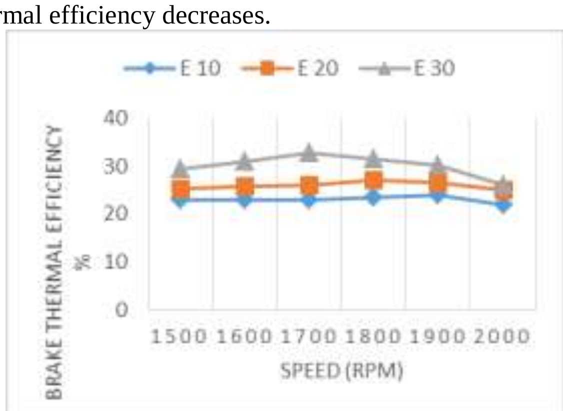

Fig. 4: Graph 3. Brake thermal efficiency vs speed

V. CONCLUSION

The objective of my thesis work was to increase the ethanol ratio in the fuel mixture, to ease the engine work. This was accomplished by making small change at the carburetor.
From the results of the study, the following conclusions can be deduced

1) Using ethanol as a fuel additive.it is observed that fuel consumption rate increases by increases the % of ethanol.
2) Ethanol addition 10 to 30 % results in an increase in brake power, brake thermal efficiency till 30% blends and 1700 rpm engine after that both are decreases.
3) The addition of 20% ethanol to the unleaded gasoline is achieved in our experiments without any problems during engine operation.
4) Therefore 20% ethanol fuel blend gave the best results of the engine performance.

VI. SCOPE FOR FUTURE WORK

Due to the inaccessibility of the exhaust gas analyzer I was not able to measure the exhaust gas emissions from the engine by using the Ethanol and the Gasoline blends in the engine. It is observed from various research papers that by using Ethanol blends as a fuel in the S.I engine reduces the emissions of carbon dioxide, carbon monoxide, hydrocarbon etc. and increases the radiations of N0x. Therefore by using the exhaust gas analyzer one can measure that which Ethanol blend can reduce these emissions in a large extent.

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