Experimental Investigation of Using Ethenol and Gasoline Blends In Single Cylinder 4 Stroke SI Engine

Anand Modi[1], C.S. Koli[2], S.K. Agrawal[3]

[1]*Research Scholar* , [2]*Assistant Professor* , [3]*Assistant Professor*

SRCEM Banmore Gwalior (M.P.)

Abstract - A large part of transportation, movement etc depends on SI engines. Even agriculture today is largely dependent on SI engines. However in recent past we have witnessed a rapid increase in petrol prices. This price rise has not only affected commuters but also farmers and industries. In the future of automobile based on internal combustion engines has been badly affected by two major problems. That is less availability of fuel and environmental degradation. So it is very important to found some new renewable non polluting alternative fuels to ensure the proper and safe survival of internal combustion engines. In This paper the investigation main purpose is to evaluate the performance of the engine and decrease fuel consumption by using alternative fuel on combustion in four stroke SI engine. The present research work is an attempt to increase to environmental protection and reduce dependency on petroleum. Ethanol is additive have batter antiknock characteristic and reduce the CO, HC emission so reduce the exhaust gas temperature. In present study we evaluate the performance of four stroke single cylinder spark ignition engine with ratio 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% ethanol and gasoline by volume. The performance parameter of the four stroke SI engine are determine at various load and low compression ratio (2.5), on different blends of ethanol-gasoline.

Key word: Ethanol, alternate fuel, gasoline, Performance.

I. INTRODUCTION

Ethanol, an alcohol, is most often made from corn but can also be made from other biomass resources. Although ethanol has been in use since the mid-1800s, use and production has varied greatly over the years. Recently there has been a resurgence of interest in ethanol-based transportation fuels. This study focuses on explanations for the revival, and on issues associated with ethanol development. The revival is due, in part, to the need for alternative agricultural markets due to all time low crop prices, mandates requiring fuel additives and alternative fuel vehicles purchases, and recent gasoline price hikes. The strength and persistence of ethanol development is contingent on successfully addressing a number of challenges. Challenges include increasing ethanol use in current markets and expanding its use in new markets; increasing production relative to cost; developing the use of feedstock other than corn, and optimizing the environmental benefits of ethanol in comparison to the use of petroleum products. Ethanol is alternative fuels and many research works are carried out on the development of these fuels.

The oil embargo against the U.S. by Arab countries in1973 created petroleum shortages, resulting in significant price increases for gasoline and creating long lines at gasoline stations. The gasoline shortage accelerated concern about U.S. dependency on imported petroleum products, and created an impetus for energy conservation and the development of alternative fuels. The 1978 Energy Tax Act was passed in response to this crisis. This Act exempted ethanol-blended fuel (with at least 10% ethanol) from the 44 /gallon Federal excise tax imposed on motor fuels. The Act also provided a 10% investment tax credit for ethanol production facilities. In 1980, three additional ethanol related Act's were passed. The Energy Security Act was created to provide the ethanol industry over $1 billion in loan guarantees. The incentives for increased ethanol production were created to utilize excess supplies of corn caused by the halting of grain exports (including corn) to the Soviet Union. The U.S. had ceased exports in response to the invasion of Afghanistan by the Soviets.

The 1990 Clean Air Act amendments mandated the use of RFG in areas with severe ozone pollution and Oxy fuels during winter months, and in areas with high carbon monoxide pollution. Alcohols, such as ethanol, were designated as the fuels to be used in reformulated and oxygenated gasoline. The 1992 Energy Policy Act mandated the purchase of alternative fuel vehicles in government and private fleets and established a goal of 30% replacement of petroleum fuels by 2010. This Act also expanded the E-10 excise tax exemption to include ethanol blends under 10%. In 1998, through the Transportation Efficiency Act, the 5.44 federal ethanol tax exemption was extended to 2007.[41] This same year, Ford manufactured approximately 90,000 E-85 compatible Ranger pickup trucks and a second public E-85 refueling station was established in Michigan in downtown Lansing.

The aim of the present study is to evaluation of performance test of different blends of ethanol with gasoline in a SI engine. The following are the major objectives to fulfil the aim of present study. Ethanol has higher octane number, flammability limit, oxygen ratio and is considered to be renewable fuel. Ethanol has high heat of vaporization which improves brake thermal efficiency, brake power and reduce specific fuel consumption for particular percentage of ethanol gasoline blends. One of the objectives is to investigate the performance of SI engine using different percentages of ethanol-gasoline blends as fuel on the different percentage of ethanol- gasoline blending which are E0, E5, E10, E15, E20, E25, E30, E35, and E40. By using ethanol fuel it reduces the air pollution problem up to some extent and also prevents fossil fuel reserves from depletion. Most of the emissions from the engines are harmful for environment as well as human health. Only four most important emissions considered under this study are CO, unburned hydrocarbon (HC), NOx and CO2. It has been found that exhaust gas temperature reduce for particular percentage of blending of ethanol with gasoline. Ethanol is an oxygen enriched chemical agent; containing 35% oxygen by weight. Here we use different ratio of ethanol and gasoline blends in the four stroke SI engine. Ethanol has higher octane number; hence addition of ethanol in the gasoline increases the octane number of the blends. Higher octane number reduces the knocking problem in the engine.

II. TEST FUEL

Experiment has been conducted ethanol-gasoline bland such as E0 (pure gasoline), E5(combination of gasoline 95% by volume, ethanol 5% by volume), E10(combination of gasoline 90% by volume, ethanol 10% by volume), E15(combination of gasoline 85% by volume, ethanol 15% by volume), E20(combination of gasoline 80% by volume, ethanol 20% by volume), E25(combination of gasoline 75% by volume, ethanol 25% by volume), E30(combination of gasoline 70% by volume, ethanol 30% by volume), E35(combination of gasoline 65% by volume, ethanol 35% by volume) and E40(combination of gasoline 60% by volume, ethanol 40% by volume), is used in the study.

Table: 1 The physical and chemical property of ethanol and petrol

Sr. No.	Character	Ethanol	Petrol
1	Molecular weight	46.07	100-105 avg.
2	Composition by mass	w(C)=52% w(H)=13% w(O)=35%	w(C)=85% w(H)=15%
3	Sp. Gravity	0.794	0.7-0.78
4	Density Kg/m3	790	700-780
5	Boiling Temp.(^{0}C)	78	27-255
6	Freezing Point(^{0}C)	-114	-57
7	Ignition Temp (^{0}C)	423	390-420
8	Theoretical air fuel ratio (Kg/Kg of air)	9	14.7
9	Octane number	100	80-99
10	Cetane number	8	0-10

III. LITERARUTE REVIEW

Tiwari [1] studied experimental determination of suitable ethanol– gasoline blend rate at high compression ratio for gasoline engine. In this study, ethanol and gasoline blends ware used as fuel to improve performance in SI engine. It was determined from the experimental results that the brake thermal efficiency is increasing for a particular percentage of blending of alcohol. And the percentage is different for different alcohols. After a particular fixed percentage of blending the performance of SI engine decreases. **Sarkar at al. [2]** investigated the performance and emission characteristics of SI engine running on different ethanol gasoline blends. The purpose of this study is to experimentally analyse the performance and the pollutant emissions of a four-stroke SI engine operating on ethanol gasoline blends. The performance characteristics are improved but only to some extent with the use of ethanol or blends of ethanol and gasoline. The power, torque increases at a certain percentages of ethanol in the blends and BSFC increases with the increment of the percentage of ethanol in the blend. **Yadav [7]** investigated the influence of compression ratio and ethanol-gasoline blending on the performance, emission of four stroke single cylinder SI (spark ignition) engine. **Pandya at al. [8]** study investigates the effect of using unleaded gasoline and alcohol as additives blends on spark ignition engine (SI engine) performance. Two strokes, single cylinder SI engine were used for conducting this study. **Kumar at al [9]** work gasoline is taken as reference which is blended with ethanol. Physical properties relevant to the fuel were determined for the four blends of gasoline and ethanol. A four cylinder, four stroke, varying rpm, Petrol engine connected to eddy current type dynamometer was run on blends containing 5%,10%,15%,20% ethanol and performance characteristics were evaluated. In this paper it is shown that the higher blends can replace gasoline in a SI engine, results showed that there is a reduction in exhaust gases and increase in Mechanical efficiency, Specific Fuel Consumption and air fuel ratio on blending.

IV. PREPOSED WORK

Under the environmental consideration, using ethanol gasoline blend is better than use of pure gasoline because of the renewability and less toxicity of ethanol. Several studies on the performance and emission characteristics of spark ignition engines, fuelled with pure gasoline and blended with ethanol, have been performed and are reported in the literature. The study reveals the understanding of the engine performance characteristics and emissions production under ethanol gasoline blending ratio. In this experiment, we evaluate the performance of four stroke single cylinder spark ignition engine at low compression ratio (2.5) at the blend of 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of ethanol and gasoline by volume. Performance parameters (brake thermal efficiency, weight of fuel consumed brake power and specific fuel consumption) were determined at various loads and compression ratio 2.5 on engine with ethanol blended gasoline. The comparison was made on performance of conventional SI engine with pure gasoline operation. Pure ethanol and high level blends may need some engine modifications. One of the purposes of the experiments is to investigate the performance of SI engine using different percentages of ethanol-gasoline blends as fuel.

Table 2: Calorific values of ethanol and gasoline blends-

Ethanol blend	Calorific Value (MJ/kg)
Petrol	45
E5	44.25
E10	43.5
E15	42.75
E20	42
E25	41.25
E30	40.5
E35	39.75
E40	39

V. EQUIPMENTS

A. *ENGINE***-** As shown in fig. 1 The engine is a “four stroke single cylinder variable compression ratio petrol engine coupled with eddy current dynamometer”. It is a vertical cylinder and air cooled spark ignition engine.

Fig. 1 Experimental set-up

Table 3: Engine Specifications

Sr. no.	Items	Specifications
1	Engine Make	GREAVES
2	Engine Sr. No.	G0H 6898076 SPT
3	Engine Variety	Vertical, Single Cylinder
4	Number Of Stroke	Four
5	Rated RPM	3000RPM
6	Compression Ratio	2.5:1 to10:1
7	Stroke	66.7mm
8	Bore	70mm
9	Specific Fuel Capacity	475 g/kwhr
10	Fuel Tank Capacity	5 litre
11	Starting	Hand starting
12	Lubricating Oil	SAE 20W40
13	Cooling System	Air cooling
14	Rated Power Output	2.5Kw

B. *AIR INTAKE MEASUREMENT*

The suction side of engine cylinder is connected to an air tank. The atmospheric air is drawn into the engine cylinder through the air tank. A manometer is provided to measure the pressure drop across an orifice provided in the intake pipe of the air tank .This pressure drop across the orifice is used to calculate the volume of air drawn into the cylinder. (orifice dia 20mm).

C. *FUEL MEASUREMENT*

The fuel is supplied directly to the engine from the fuel tank through a way manifold and a burette.

D. *COOLING SYSTEM*

Air Cooled Engine.

E. *EXHAUST SYSTEM*

The exhaust gas is passed through a calorimeter .The exhaust gas temperature at the inlet and outlet of calorimeter and watercooling temperature at the inlet and outlet of calorimeter are indicated by respective thermocouples and indicated in the digital temperature indicators.

VI. METHEDOLOGY

Measurement methodology includes the way and approach of taking observation during the experiment. In any experimental work there should be a proper methodology of experiment for getting proper data and results. So getting proper results the way of taking observation should be very accurate and systematically. In the particular experiment setup of four stroke SI engine measurement methodology is proceed in this way.

A. *Testing and inspection of experiment setup*

After settling all the instruments, observation is about to start but before starting any experiment on the setup it is very necessary to inspect all the places where care should be taken to avoid any danger during the observation process. The step of inspection of experiment setup is completed by checking all the important places of experiment setup in a regular time interval during whole process of taking observation. The way of inspection is described here.

a- Tightening all nuts on foundation structure coupled with engine frame.

b- Checking the level of oil in the tank to maintain proper level of oil on burette.

c- Checking the level of cooling water in water jacket.

d- Checking the leak points of oil in various gate valves where pipes are connected

e- Insure all switches kept off in electrical load panel before starting the engine.

f- Check and control speed of engine by adjusting the fuel supply before taking the observation.

Fig. 2 Making ethanol gasoline blend

B. *Precautions*

1. Do not run engine without lubrication oil (SAE 20W40 Type).
2. Use only petrol as fuel.
3. Keep the trainer on rigid surface & well-ventilated room. Keep the trainer at least 1 meter away from the nearest wall to allow sufficient air circulation.
4. Run the engine at no load for around 5 minutes. Do not remove the load suddenly. Load and unload the Engine gradually by adding weights to the weight hanger.
5. Before ending the experiment, bring the engine to the no load condition and then stop the engine after running for 2-3 minutes.
6. If you are not using the trainer for long time take following.
7. Drain the fuel tank, burette and all fuel pipes.
8. There must be sufficient oil in the oil box.
9. The rope should be wrapped around the brake drum properly such that it does not slip.
10. Ensure zero reading on weighting balance in no load condition. If not adjust it by screw provided on weighting balance.
11. Do not start the engine without cooling water supply to the engine and calorimeter.

C. *Measurement & Key thermodynamic parameter*

Fuel consumption: Experiment starts from first step of measurement of fuel consumption by filling the fuel in the burette. As the fuel is filled in the burette time is started in the stop watch from 0 to 15 ml fuel consumed in the burette. In this way fuel consumption in terms of ml/sec in noted from no load to maximum load. Same process is repeated for number of observations taken at different load condition.

Measurement of speed: Measurement of speed using a shaft encoder with analogue or digital display is in principle quite simple.

Specific fuel consumption and efficiency: In engine tests, the fuel consumption is measured as a flow-mass flow per unit time. A more useful parameter is the specific fuel consumption (SPF) the flue flow rate per unit power output. Specific fuel consumption is defined as the fuel consumed for one kilowatt power generation in one hour. Specific fuel consumption is decreases when load is increases. Fuel consumption is increases with load but brake specific fuel consumption decreases because it is function of fuel consumption and brake power. It measures how efficiency an engine is using the fuel supplied to produce work.

D. *Experimental Procedure*

1. Fill the fuel tank with the fuel.
2. Start the cooling water supply to the engine and the calorimeter.
3. Fill the burette with the fuel.

4. Switch on the control panel.
5. Start the engine with cranking handle provided.
6. Note down the readings in the observation table.
7. Load the engine gradually by providing weights on the loading hanger.
8. Note down the reading, for various load.

VII. RESULT AND DISCUSSION

Table 4: Break Power in KW at different blend of ethanol with gasoline ►

Load in kg	B.P. at E0	B.P. at E5	B.P. at E10	B.P. at E15	B.P. at E20	B.P. at E25	B.P. at E30	B.P. at E35	B.P. at E40
0.8	0.258	0.259	0.262	0.255	0.253	0.250	0.246	0.243	0.233
1.8	0.574	0.577	0.583	0.569	0.562	0.555	0.547	0.540	0.513
2.8	0.880	0.884	0.895	0.874	0.865	0.852	0.839	0.829	0.755
4.8	1.453	1.463	1.484	1.444	1.426	1.406	1.381	1.361	1.274
5.8	1.682	1.701	1.725	1.667	1.644	1.636	1.532	1.505	1.379

Variation of break power with load for different blend of ethanol-gasoline

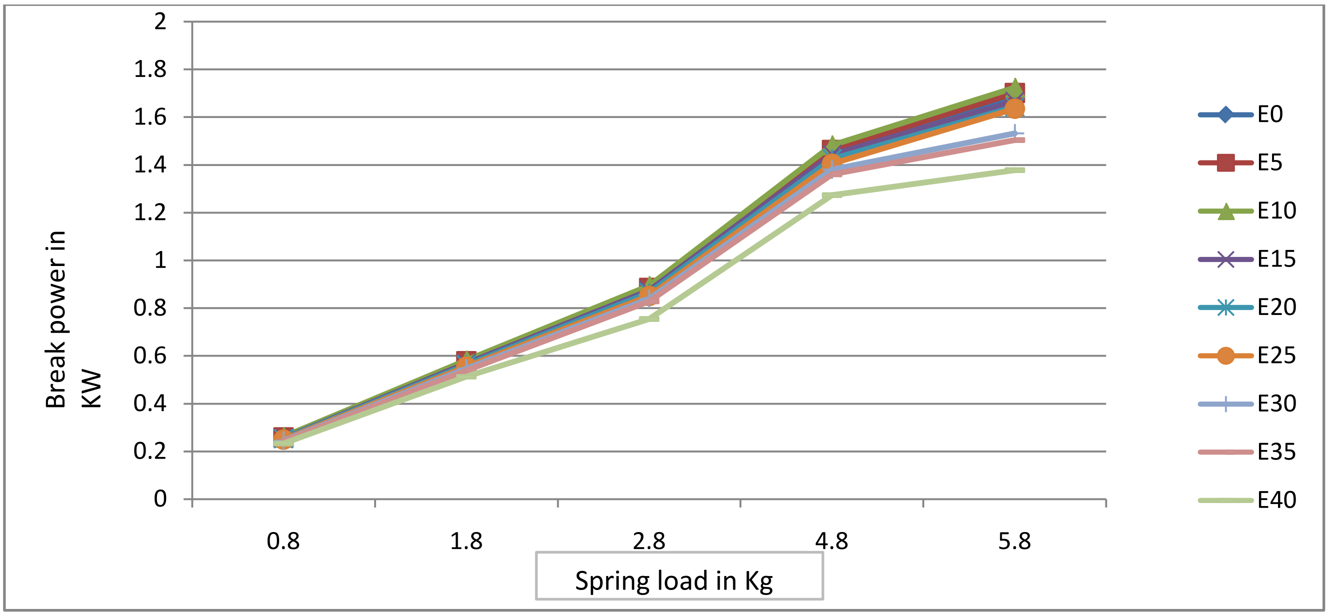

Figure 3: Variation of break power with spring load for different blend of ethanol-gasoline

Table 5: Exhaust gas temperature at outlet of the calorimeter & Different loads of different blending ratio of ethanol-gasoline.

Load(Kg)	Temp. at E0	Temp. at E5	Temp. at E10	Temp. at E15	Temp. at E20	Temp. at E25	Temp. at E30	Temp. at E35	Temp. at E40
0.8	97	93	87	99	101	102	103	104	107
1.8	104	99	93	105	112	115	117	121	124
2.8	115	104	101	113	118	121	125	129	132
4.8	119	117	112	121	123	126	128	131	137
5.8	128	124	119	129	132	135	139	142	145

Variation of exhaust gas temperature with load for different blend of ethanol-gasoline

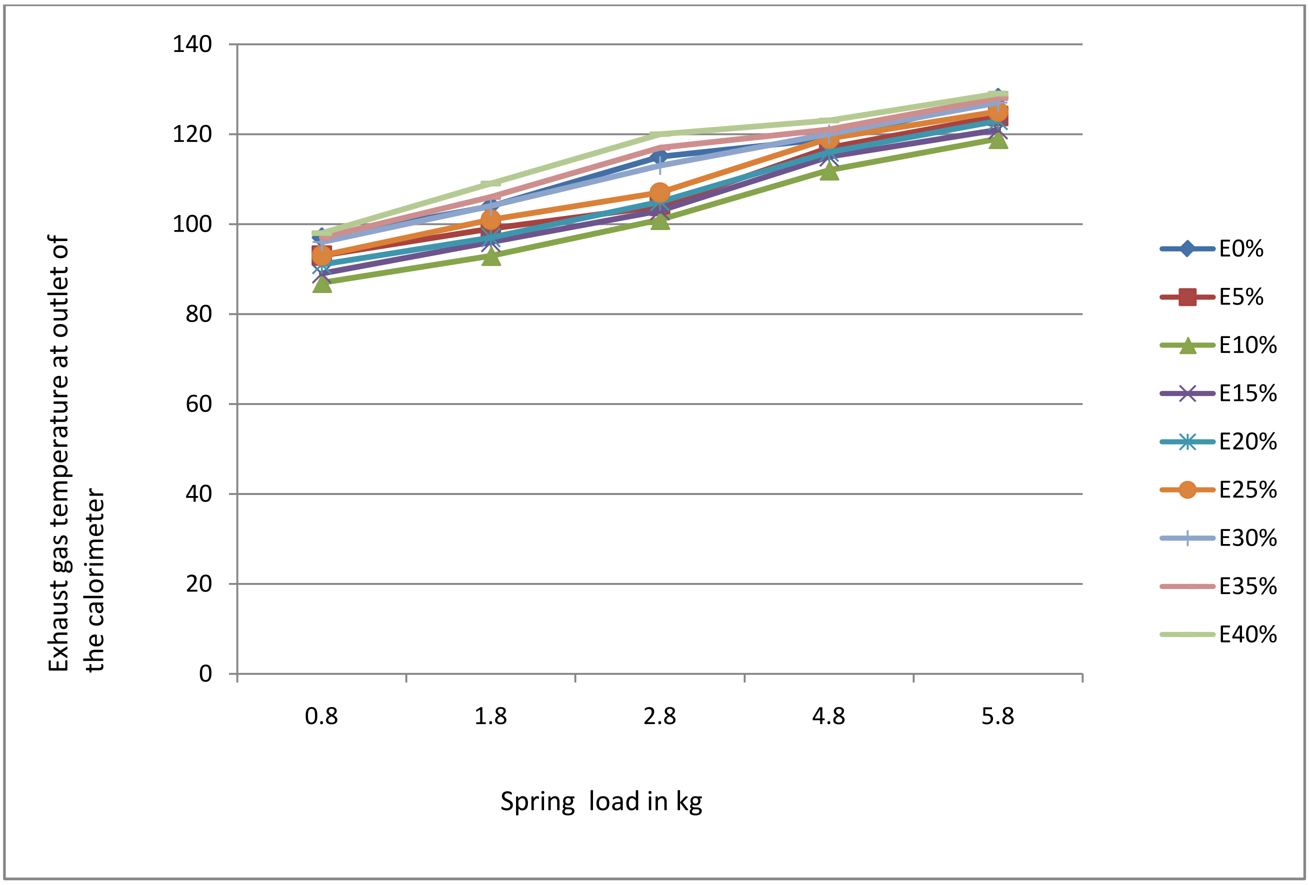

Figure 4: Variation of exhaust gas temperature with load for different blend of ethanol-gasoline

Figure 3, Depicts the effect of variation of load on brake power for different blends. From the curve it is observed that the value of the break power is increased as the load increases. It is observed the BP is increasing from E0 to E10, after that as blending ratio increases, decrease in the brake power. The maximum BP achieved at E10 and minimum BP found out at E40.

Figure 4**,** Depicts the effect of effect of variation of load on exhaust gas temperature for different blends. It is observed that the Exhaust gas temperature decreases from E0 to E10, after that as blending ratio increases, increase in the exhaust gas temperature.

VIII. CONCLUSION

By conducting the experiment on 4 stroke single cylinder SI engine in I.C Engine Lab of SRCEM Banmore, following Conclusions have been drawn:-

- Brake Power increases from blending E0 to E10, further increase in blend ratio, the BP decreases. The maximum BP achieved at E10.
- The exhaust gas temperature decreases from E0 to E10, further increase in blend ratio, increases the exhaust gas temperature. This concluded that the four stroke SI engine at E10 gives less exhaust gas temperature in the environment as compared to pure petrol.

  Various properties of petrol and ethanol like density, ignition temperature are similar. Also the two liquids can be mixed easily without any external agent. Ethanol helps in clean and complete combustion as it provides oxygen during combustion. Ethanol blends help with higher octane rating and lower exhaust emissions.

From the results, it can be concluded that ethanol blends are quite successful in replacing pure gasoline in four stroke spark ignition engine. Results clearly show that brake power is increasing for a particular percentage of blending of alcohol. After a particular fixed percentage of blending the performance of SI engine decreases. The blending of ethanol in gasoline provides good combustion property. If we add alcohols after a particular percentage than it is incapable in proper combustion of fuel which results in lowering thermal efficiency. Performance of E10 shows better result within group of various blends of ethanol with gasoline. E10 ethanol blended Gasoline is the best choice for use in the existing Spark Ignition Engines without any modification to increase Efficiency.

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