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Experimental Analysis of Alcohol Fuelled SI engine

Rajkumar Shinde
(Department of Mechanical Engg., Dr. D. Y. Patil institute of Technology Sant Tukaram Nagar, Pimpri, Pune-411 018)

Abstract: *Alternative fuels for both spark ignition (SI) and compression ignition (CI) engines have become very important owing to increased environmental protection concern, the need to reduce dependency on petroleum and even socioeconomic aspects. Alternative fuels like LPG, CNG, Hydrogen, Alcohol etc has emerged as a solution to depleting crude oil resources as well as to the deteriorating urban air quality problem. Alcohols are considered as a leading alternative fuel for automotive application because of its ability to reduce the air pollution and cost of the fuel. Alcohol is one of them, which can be produced from "cellulosic biomass", such as trees and grasses. Alcohol is made up of a group of chemical compounds whose molecules contain a hydroxyl group, - OH, bonded to a carbon atom. The most attractive properties of Alcohol as a SI engine fuel are high octane number, flame speed and latent heat of vaporization as compared to gasoline. Additional oxygen content of the ethanol improves the combustion due its leaning effect.*
Keywords: *Alcohol Fuelled SI engine, LPG, CNG, Hydrogen*

I. Introduction

During heat treatment Internal combustion engine are the most preferred prime mover across the world. Spark ignition engine is preferred locomotive prime mover due to its smooth operation and low maintains. The gasoline is fossil fuel which is limited in reservoirs and they are rapidly depleting. It has high exhaust emissions, causes varieties of study in search of alternative fuel for SI engine, where alcohol promises best alternative fuel.
Alcohol is a renewable fuel. It can be produced from agricultural feedstock's such as sugarcane, from forestry wood wastes and agricultural residues. It can also be prepared from flower of **Madhuca longifilia (Mahua)**. Alcohol has a simple molecular structure with well-defined physical and chemical properties. Alcohol can be employed as a transportation fuel even in its original form and can also be easily blended with other fuels, such as gasoline and diesel [1].

Using alcohols as fuel for Spark Ignition (SI) engine have some advantages over gasoline. Alcohol has better anti-knock characteristics and the engine's thermal efficiency improves with the increase in compression ratio. Alcohol burns with lower flame temperature and luminosity owing to the decrease of the peak temperature inside the cylinder so that the heat loss and NO emissions are lowered. Ethanol has high latent heat of vaporization. The latent heat cools the intake air and hence increases the density and volumetric efficiency. However, the oxygen content in ethanol reduces the heating value more than gasoline does. It is evident that ethanol can be used as a fuel in SI engines [2].

Currently, there is a lot of interest in alcohol production from renewable feedstocks, to minimize the emissions of carbon dioxide, which is a greenhouse gas that contributes to global warming. The addition of ethanol to gasoline results in the enhancement of the octane number in blended fuels and changes the distillation temperature, as well as reducing CO emissions.

For the economic development of any country energy is one of the major factors. In the developing country, the energy sector is critical issue. There is ever increasing energy need all over the world.

The investment requires is huge in any energy sources. Fossil energy use increased most in 2000-2008. In October 2012 the IEA noted that coal accounted for half the increased energy use of the prior decade, growing faster than all renewable energy sources.
The primary world energy used in terawatt-hours (TW-h)

Table No 1.1 Energy consumption

	Fossil	*Nuclear*	*Renewable*	*Total*
1990	*83,374*	*6,113*	*13,082*	*102,569*
2000	*94,493*	*7,857*	*15,337*	*117,687*
2008	*117,076*	*8,283*	*18,492*	*143,851*
Change 2000-2008	*+23.9%*	*+5.4%*	*+20.6%*	*+22.2%*

(1 terawatt-hour (TW-h) = 1 billion kilowatt-hours (kWh) = 1012watt-hours)

The use of energy resources in this era leads to environmental damages by polluting the atmosphere. The petrol and diesel engine motor vehicles emits wide variety of pollutants,

- CO,
- NOx,
- Toxic particles.

The major air pollution problem has typically been high levels of smoke.
In developing countries, this problem has significantly reduced over recent decades as a result of,

- Changing fuel use patterns,
- The increasing use of cleaner fuels,
- Using supplementary fuels,
- The implementation of effective smoke and emission control policies.

This all methods can be used as alternatives sources to reduced emission and increase performance.
Alcohol is as one of the important energy factor. Alcohol as a renewable energy source provides the potential for a sustainable development particularly in the transportation sector. Alcohol driven vehicles reduce both local as well as global emissions.
So we are using alcohol in IC engine to reduce load on conventional energy sources and emission.
In this present work, we have taken bio-alcohol as fuel used in SI Engine. This fuel is produced by the fermentation process on flowers of Madhuca Longifolia (Mahua) plant. It has high content of ethanol which having a similar property to gasoline, which is cheap also reduces exhaust emission.

II. Experimentation

Following are the results obtained by experimentation.

Table 2.1 Parameters

Sr. No.	Load (%)	Speed (rpm)	BP (KW)	bsfc (Kg/KWhr)	Mechanical Efficiency	Thermal Efficiency
1	0	3200	0	-	-	-
2	25	3200	0.5867	0.6726	21.73	11.15
3	50	3200	0.6844	0.5958	25.35	12.59
4	75	3200	0.7823	0.5384	29.10	13.93

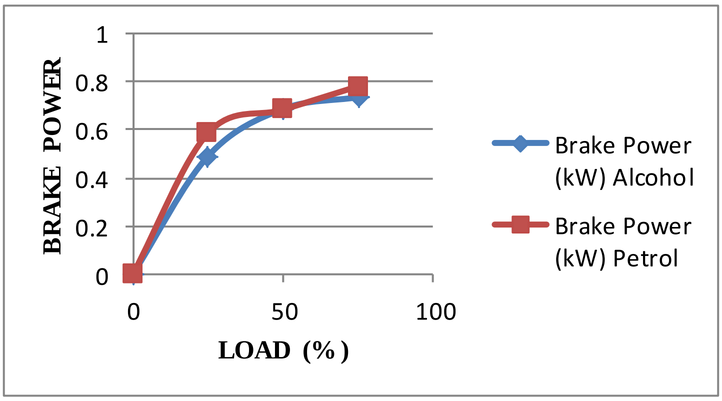
Table 2.2 For Petrol

Sr. No	Load (%)	Speed (rpm)	BP (KW)	bsfc (Kg/KWhr)	Mechanical Efficiency	Thermal Efficiency
1	*0*	*3200*	*0*	-	-	-
2	*25*	*3200*	*0.4889*	*1.2076*	*18.10*	*14.92*
3	*50*	*3200*	*0.6846*	*0.9036*	*25.35*	*19.94*
4	*75*	*3200*	*0.7334*	*0.8730*	*27.16*	*20.64*

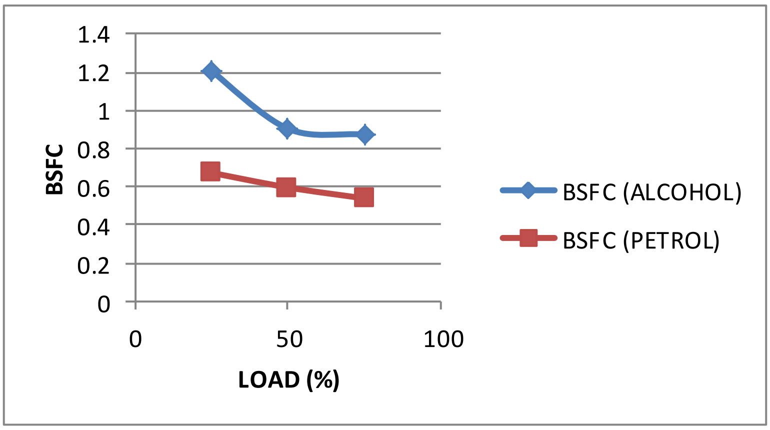
Table 2.3 Observations for Emissions

Exhaust Emission	Alcohol	Petrol
CO %	0.02	0.089
HC (ppm)	127	238
NO_x %	0	5
CO_2 %	16	14

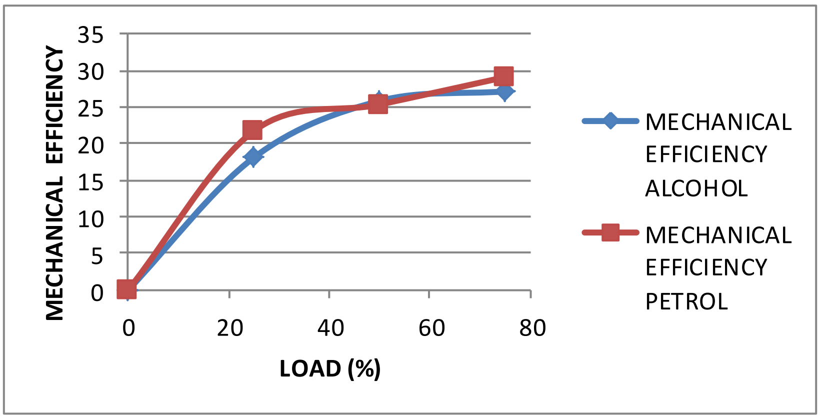
The following graphs 2.1-2.4 shows the variations and comparison of power output, efficiencies, and exhaust emissions for SI engine for alcohol and petrol.



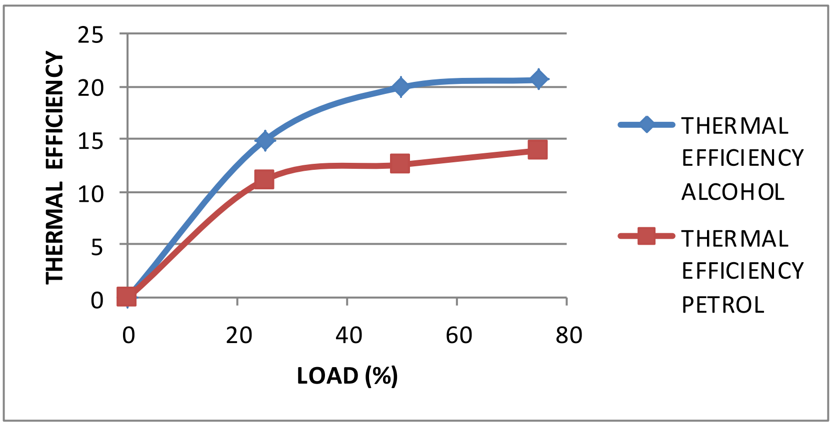
Graph 2.1 BP vs Load



Graph 2.2 bsfc vs Load



Graph 2.3 Mechanical Efficiency vs Load



Graph 2.4. Thermal Efficiency vs Load

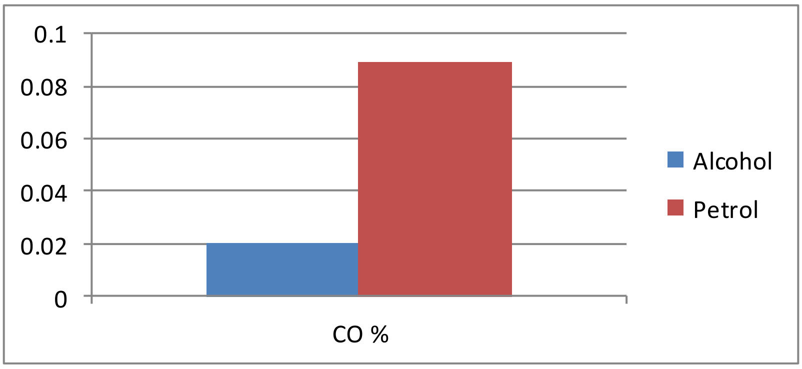


Fig 2.5 CO Emission

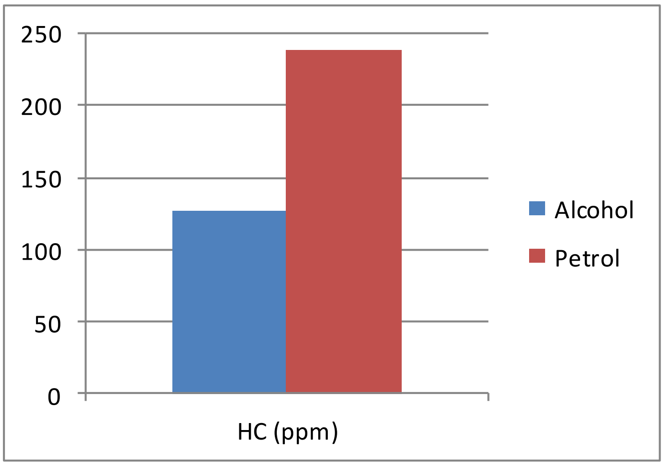


Fig 2.6 HC Emission

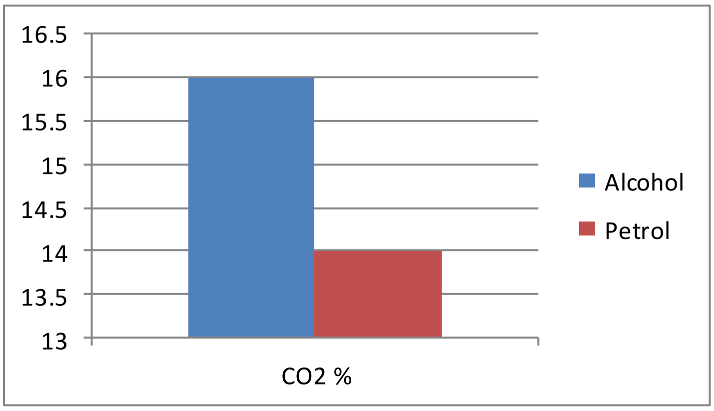


Fig 2.7 CO_2 Emission

2.2 EQUATIONS

Following is the experiment conducted to test the engine
Testing of SI Engine at constant speed and varying load.
Aim: To carry out test on petrol engine, at constant speed and varying load
Specification of SI Engine:
Engine Specifications
Rated power output =2.7 KW
Rated RPM = 3600 rpm
Stroke (L) = 56 mm
Bore (d) = 67 mm
Brake Drum Dia. (D) = 103 mm
Rope Diameter (dr) = 16 mm

Steps:

The SI engine is tested for performance calculations.

1. Before starting the engine check the fuel supply, lubrication oil.
2. Set the dynamometer to zero load.
3. Adjust the engine speed and engine load at some suitable values At the given values of speed, take the readings of,spring balance time required for certain drop of fuel level in burette
5. After taking first set of readings, change the load at some suitable value keeping speed constant and note all readings.
6. Take exhaust gas reading by gas analyzer.
7. In all take the readings for three different values of speed.

2.3 CALCULATION:-

Part I (for alcohol)
1. Brake Power:

$$BP = \frac{2\pi NT}{60 \times 10^3}, KW$$

2. Mass of fuel consumed (m_f):

$$m_f = \frac{\text{Density}}{\text{time}} \times \text{volume}, Kg/s$$

3. Heat supplied (Q_s):

$$Q_s = m_f \times C.V, KJ$$

4. Brake Specific Fuel Consumption:

$$b.s.f.c. = \frac{m_f}{B.P.}$$

5. Mechanical Efficiency:

$$\eta_m = \frac{\text{Brake power}}{\text{Rated Power}} \times 100$$

6. Brake Thermal Efficiency:

$$\eta_{th} = \frac{\text{Brake Power}}{\text{Heat supplied}} \times 100$$

Part II (for Petrol)

1. **Brake power :**

$$BP = \frac{2\pi NT}{60 \times 10^3}, KW$$

2. Mass of fuel consumed (m_f):

$$m_f = \frac{\text{Density}}{\text{time}} \times \text{volume}, Kg/s$$

3. Heat supplied (Q_s):

$$Q_s = m_f \times C.V, KJ$$

4. Brake Specific Fuel Consumption:

$$b.s.f.c. = \frac{m_f}{B.P.}$$

5. Mechanical Efficiency:

$$\eta_m = \frac{\text{Brake power}}{\text{Rated Power}} \times 100$$

6. Brake Thermal Efficiency:

$$\eta_{th} = \frac{\text{Brake Power}}{\text{Heat supplied}} \times 100$$

III. Conclusion

By using alcohol as a fuel in SI Engine, the following conclusions were drawn through the comparison and analysis with petrol.

- Fuel preparation method is simple and cheap.
- Emission of CO and HC are reduces and NOx formation is eliminated.
- Brake thermal efficiency is higher than petrol.
- For higher efficiency it can be blended with petrol.
- Brake specific fuel consumption is more than petrol.
- It is corrosive.
- Not suitable for heavy duty operation.

It can be concluded from these experimental result that use of alcohol offers some advantage over a performance and exhaust emission.

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