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Statistical Analysis of SI Engine Fuel by Different Alcohol

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Abstract- Due to the sharp rise in population and industrial and technological growth there has been a rapid rise in the need for fossil fuels like petrol. Hence there is a need to develop alternate fuels. One such alternate fuel can be petrol alcohol blends. The blends tested in this study are ethanol, methyl alcohol and benzol with proportions 5, 10 and 15 percent in petrol. The Brake Thermal Efficiency and Brake Specific Fuel Consumption (BSFC) has been found out and are compared for the above mentioned blends for different compression ratios and loads. It has been observed that the Brake Thermal Efficiency increases and the BSFC decreases.

Index Terms-Brake specific fuel consumption, Brake thermal efficiency, Fuel requirements, Maximum Efficiency, Performance analysis.

1. INTRODUCTION

The world in the 21st century presents many critical challenges. One of the most important challenges is the environment. As population increases and the standard of living improve, there is a growing concern that there will be a shortage of energy to heat our homes and power the vehicles on which we so heavily depend. We must also remember the need for clean air, clean water, cleaner burning fuels, and biodegradable, renewable materials. For many years the government and public demanding an increasing in fuel efficiency and reduction in pollutants emission from spark ignition engine. Ethanol Makes an excellent fuel for internal combustion engines (ICE's) with spark ignition. Ethanol, when used as a gasoline component, improves combustion–helping the fuel burn more completely. Ethanol blends also reduce carbon monoxide emissions. Use of ethanol is beneficial in urban areas.

2. ETHANOL

Ethanol is an alternative energy source. It is an alcohol made by fermenting corn or other similar biomass material.

2.1. Ethanol as a Blend

In the medium term ethanol produced from grain will probably be the most important alternative fuel for replacing gasoline and in the long term ethanol produced from cellulose might take over from grain ethanol.

2.2 Emission analysis

2.2.1. Carbon monoxide

The effect of the Ethanol percentage in the fuel blend on CO emission is that the CO emission decreases as compared with pure gasoline fuel for various blends.

2.2.2. Hydrocarbon

This effect is attributed because the stoichiometric air-fuel ratio of the ethanol blends decreases and increase of actual air-fuel ratio of the ethanol blends as a result of the oxygen content in the ethanol.

2.2.3. Carbon dioxide

This is due to improving combustion process as a result of the oxygen content in the ethanol fuel. Usable artichokes, and other farm plants and plant wastes are also suitable.

3. METHAYL ALCOHOL AND BENZOL

Methanol has greater octane number, high heats of evaporation and Oxygen contents by weight% higher than other fuels which result that better engine performance and decrease in HC, NOx, CO emission.
Benzol consists 70% benzene,20% toluene and 10% xylene and some amount of sulphur, It has high anti knock characteristic. It is considerably less detonating than gasoline.

3.2. Emission characteristic

Methanol can be obtained from many sources, both fossil and renewable. This includes coal, petroleum, natural gas, biomass, wood, landfills, and even the ocean.

4. LITRATURE REVIEW

Erol Kahraman, S. Cihangir Ozcanlı & Baris Ozerdem [1] had done an experiment on

"Performance Evaluation of an IC Engine (SI) Using Biogas as Fuel With Petrol Blends: A Case Study" .The result concludes that the compressed hydrogen at 20MPa has been introduced to the engine adopted to operate on gaseous hydrogen by external mixing. Two regulators have been used to drop the pressure first to 300KPa, then to atmospheric pressure. The variations of torque, power, brake thermal efficiency, brake mean effective pressure, exhaust gas temperature, and emission, CO, HC and versus engine speed are compared for a carbureted SI engine operating on gasoline and hydrogen. Energy analysis also has studied for comparison purpose. The test results have been demonstrated that power loss occurs at low speed hydrogen operation.

Md. Masood, S. N. Mehdi and Syed Yousufuddin [2] had done an experiment on "Performance Evaluation of an IC Engine (SI) Using Biogas as Fuel With Petrol Blends: A Case Study". The result concludes that The performance study carried out in a four cylinder SI engine shows that this can better be used as an automotive fuel with a comparatively much lesser cost than the conventional fuels. The results show that because of the low calorific value of biogas the thermal efficiency is lesser than that of petrol and remains same at low and high out puts. Same is the case for volumetric efficiency. Biogas is an excellent and economical fuel for both petrol and diesel engines. However the power obtained is less than that of liquid fuel. Biogas is a cheaper and better fuel for cooking, lighting and running engines.

5. EXPERIMENTAL SET UP

Fig.5.1 shows the experimental set up of 4-stroke SI engine

5.1 Instrumentation

- Digital RPM Indicator to measure the speed of the engine.
- Digital Temperature Indicator to measure various temperatures.
- Differential manometer to measure the quantity of air sucked into cylinder.
- Burette with manifold to measure the rate of fuel consumption during test.
- ORSAT Apparatus for analysis of Exhaust gas.
- Dynamometer arrangement for calculating torque.

Fig.5.2. shows different arrangement of a hydraulic dynamometer

5.2. Method of analysis

By means of a rubber tubing arrangement, the gas to be analyzed is drawn into the burette and flushed through several times. Typically, 100ml is withdrawn for ease of calculation. Using the stopcocks that isolate the absorption burettes, the level of gas in the leveling bottle and the burette is adjusted to the zero point of the burette.
The gas is then passed into the caustic potash burette, left to stand for about two minutes and then withdrawn, isolating the remaining gas via the stopcock arrangements. The process is repeated to ensure full absorption. After leveling the liquid in the bottle and burette, the remaining volume of gas in the burette indicates the percentage of carbon dioxide absorbed.
The same technique is repeated for oxygen, using the pyrogallol, and carbon monoxide using the ammoniacal cuprous chlori.

5.3 Diagram of ORSAT apparatus

6. TABULATION AND FORMULA

Table 6.1 Tabulation for Petrol

Serial No.	Load in Kg	T_1	T_2	Time(t) in sec	Speed in RPM	BP(watt)	MFC	SFC
01	0	35	470	33	3000	0	0.830	
02	1	35	440	35	2500	513.65	0.740	$1.44*10^{-3}$
03	2	35	435	33	2450	1006.75	0.780	$7.74*10^{-4}$
04	3	35	390	30	1780	1097.15	0.864	$7.87*10^{-4}$
05	4	35	320	29	950	780.748	0.893	$1.143*10^{-3}$
06	4.5	35	290	27	870	804.37	0.960	$1.193*10^{-3}$

Table 6.2 Tabulation for Ethanol 5° Blend

Serial No.	Load in Kg	T_1	T_2	Time (t)in sec	Speed in RPM	BP(watt)	MFC	SFC
01	0	37	450	29	3400	0	0.893	
02	1	37	512	21	3400	698.56	1.234	$1.76*10^{-3}$
03	2	37	510	19	3400	1397.12	1.364	$9.76*10^{-4}$
04	3	37	540	18.5	3350	2064.87	1.40	$6.78*10^{-4}$
05	4	37	540	18.08	2925	2403.84	1.43	$5.94*10^{-4}$
06	4.5	37	545	18	2836	2622.08	1.44	$5.49*10^{-4}$

Table 6.3 Tabulation for Ethanol 10° Blend

Serial No.	Load in Kg	T_1	T_2	Time (t)in sec	Speed in RPM	BP(watt)	MFC	SFC
01	0	38	450	32.75	3450	0	0.791	
02	1	39	500	21.05	3180	643.09	1.231	$1.91*10^{-3}$
03	2	39	520	20.48	3000	1232.09	1.265	$1.02*10^{-3}$
04	3	38	527	19.50	2940	1812.15	1.329	$7.33*10^{-4}$
05	4	39	530	18.24	2810	2309.37	1.421	$6.153*10^{-4}$
06	4.5	38	560	17.80	2730	2524.07	1.456	$5.768*10^{-4}$

Table 6.4 Tabulation for Ethanol 15° Blend

Serial No.	Load in Kg	T_1	T_2	Time(t) in sec	Speed in RPM	BP(watt)	MFC	SFC
01	0	39	485	27.3	3350		0.95	
02	1	38	560	22	3440	706.78	1.17	$1.66*10^{-3}$
03	2	38	520	18.80	2945	1210.16	1.37	$1.139*10^{-3}$
04	3	38	560	18.36	3230	1990.9	1.41	$7.087*10^{-4}$
05	4	38	530	16.7	2800	2301.15	1.55	$6.744*10^{-4}$
06	4.5	38	580	26	2820	2607.289	1.62	$6.21*10^{-4}$

- BRAKE POWER

  $BP=(2\Pi NT*9.81)/60000$ ………..kw
  Where, T=Torque=W*R.
  W=Load from the spring balance in kg.
  R=Arm length =20mm
  N=RPM of the engine.

- MASS OF FUEL CONSUMED

  $MFC=(x*0.72*3600)/(1000*T)$….. kg/hr

  Where, X=Burette reading in cc.
  0.72=Density of petrol in Gram/cc.
  T=time taken in seconds.

- SPECIFIC FUEL CONSUMPTION

  $SFC=(MFC/BP)$ ………………..kg/kWhr

- ACTUAL VOLUME OF AIR SUCKED INTO THE ENGINE CYLINDER $V_a=C_d*A*(2gH)^{.5}*3600$ …………..m^3/hr

  Where, $H=(h/1000)*(dw/da)$……meter of water
  A=Area of orifice meter=$(\pi d^2/4)$
  h=manometer reading in mm.
  (dw/da)=density of water =$1000 kg/m^3$
  C_d=co-efficient of discharge =0.62

- SWEPT VOLUME

  $V_S=(\pi d^2/4)*L*(N/2)*60$

  Where, d=diameter of bore =70mm
  L=length of stroke=66.7mm
  N=Speed of the engine in RPM.

- VOLUMETRIC EFFICIENCY

  $\eta_v=(V_a/V_s)*100$…………….%

- BRAKE THERMAL OR OVERALL EFFICIENCY

  $\eta_{bth}=(BP*3600*100)/(MFC*C_v)$….%

  Where, C_v=Calorific value of petrol =43500…KJ/Kg
  BP=Brake power in KW.

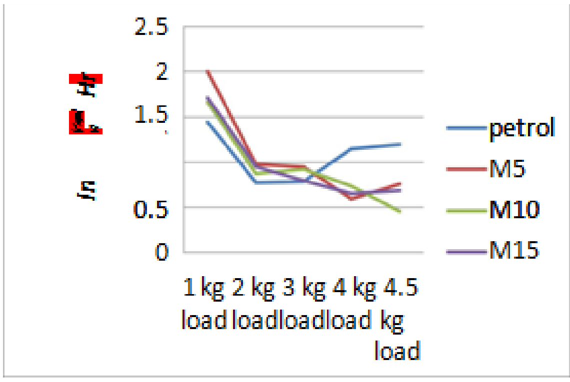
7. RESULTS

The analysis is mainly based on three type of alcohols Ethanol, methanol, benzol with different blend strength(5%,10%&15%) and with different load condition. The fuel characteristics get changed with the strength of mixture. The properties Methanol and Ethanol are nearly equal in most of the cases. Benzol has different property then methanol and ethanol as it is an aromatic compound.

7.1 Specific fuel consumption

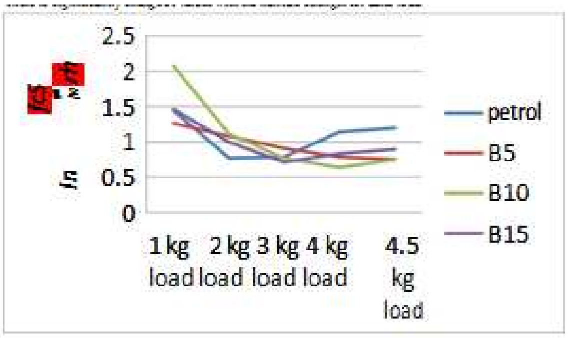
Specific fuel consumption means fuel consumed per unit power output. according to our analysis we found SFC for blended fuel is slightly more than petrol. At higher load SFC of blended fuel is less.

- **Methnol**



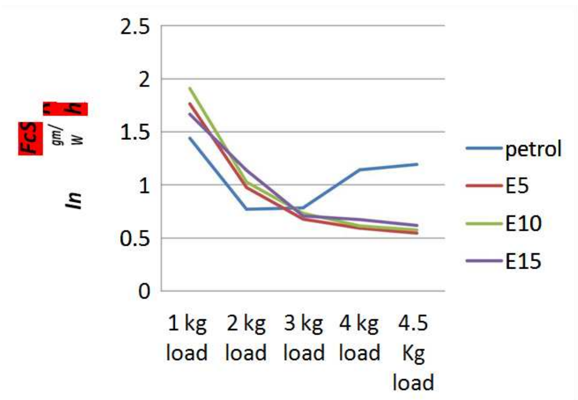
- The value of SFC for M5 is slightly different from M10 and M15.
- The values are nearly equal to Ethanol.
- Upto 3kg load SFC of petrol is less than blended fuel then after petrol has higher value of SFC. So at higher load blending has good impact on SFC.

- **Benzol**



- Among all three blend condition Benzol Petrol has nearly equal value of SFC.
- As like Petrol its value is less up to 3 kg then it increases with increase of load.

- **Ethanol**



- For E5 and E10 SFC is nearly same.
- E15 has slightly different value

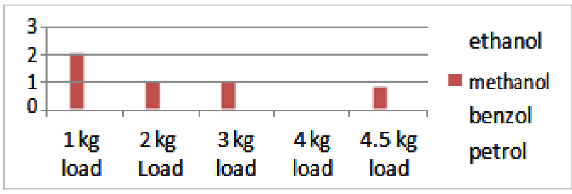


Fig 5.10 indicate the variation of SFC with 5% blending condition

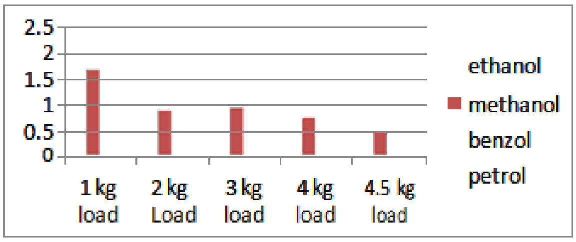


Fig 5.11 indicate the variation of SFC with 10% blending condition

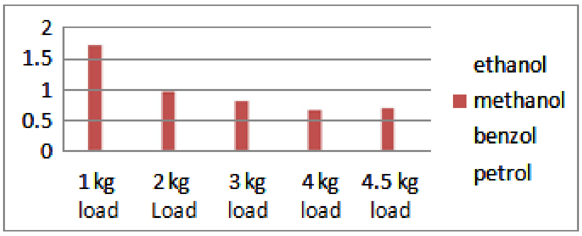


Fig 5.12 indicate the variation of SFC with 15% blending condition

7.2 Analysis on exhaust gas

In the analysis we have done the exhaust analysis with no load condition in pure petrol CO_2 content is much more then blended petrol, it is about 2.2%(by volume) of exhaust. O_2 value is less as compared to other blended fuels. It is about 44.8 %(by volume) of exhaust.CO content is about 3.8%(by volume) which is less then benzol blended but more then ethanol and methanol blended fuel.

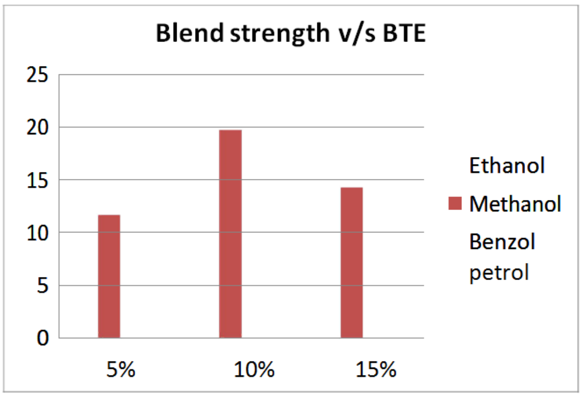


Fig.7.1. Blend strength Vs Brake Thermal Efficiency

7. CONCLUSION

From the above experiment we investigate that after blending with ethanol and methanol break thermal efficiency will increase. Oxygen content in exhaust will increase but at the same time SFC will decrease for low load condition.CO_2 and CO will decrease significantly. So blending of ethanol and methanol leads good control over exhaust gas. Most of the cases methanol at 10% is good enough. the values of methanol and ethanol blended fuel are nearly equal but the calorific value of ethanol is more than methanol so the combustion will better for ethanol and hence it has high octane number.

As Benzol is an aromatic compound so its combustion is better than methanol and ethanol but it produces more CO in the output of exhaust. Its BTE nearly equal to petrol.SFC for benzol is nearly equal to SFC of ethanol.

REFERENCES

[1] Erol Kahraman, S. Cihangir Ozcanlı & Baris Ozerdem had done an experiment on “Performance Evaluation of an IC Engine (SI) Using Biogas as Fuel with Petrol Blends: A Case Study”.

[2] Md. Masood, S. N. Mehdi and Syed Yousufuddin had done an experiment on “Performance Evaluation of an IC Engine (SI) Using Biogas as Fuel With Petrol Blends: A Case Study”.