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Performance Analysis of an Internal Combustion Engine Using Butanol as an additive in Ethanol Gasoline Blended Fuel

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Abstract

Gasoline and Diesel are basic in liquid form which are extensively used in the world from last century. Presently in India, 10 percent ethanol blending with gasoline is mandatory by the Government of India and from the year of 2017, it will be 20 percent. It has been found that ethanol is a good replacement of gasoline but is has some disadvantages. Due to its hygroscopic nature, ethanol damages the internal part to the engine. It affects the metallic as well as non-metallic part of the engine. For overcoming this problem an effort has been made in this study by using butanol as an additive with ethanol gasoline blends because butanol is not hygroscopic in nature and does not rust the internal parts of the engines. In this study, performance and emission characteristics of a multi cylinder spark ignition engine has been evaluated on ethanol gasoline blend with or without butanol addition. Ethanol was added with gasoline in three different volumetric ratio as 10,20 and 30 percent . Butanol was added in the volumetric ratios of 2.5,5,7.5 and 10 percent with ethanol gasoline and gasoline. Performance parameters of the engine such as bsfc. BTE, BSEC and EGT have been observed. Overall, additive blends have performed well and found suitable without any hardware modification of the engine.

Key words : Internal Combustion Engine, Gasoline, Ethanol, Butanol.

Introduction

The demand of fossil fuel is rising rapidly because of increase in automobile vehicles due to which the resource of crude oil are depleting rapidly. This situation will create a problem for energy crises in the future. In fact, with a worldwide increasing number of automobile and a rising demand of emerging economics demand will probably rise even harder.

About 75 percent of the total crude oil of India is met through imports. Total import of crude oil by India was about 189.238 MMT which cost about Rs. 8,64, 875 Crore during 2013-14. The total production of crude oil was 37,778 MMT in 2013-14. In recent years, the consumption of crude oil in India has been increasing at an annual rate of 5-6&. (MoPNG, 2014). If the use of alcohol as engine fuel is encouraged in India, then apart from saving foreign exchange, the farmers would be motive to cultivate the crops like potato, sugarcane etc. In a large manner and this will increase the production of alcohol through which the air quality increase.

Biofuels : Bio fuels are gaseous or liquid fuels produced from biomass resources and used in place of, or in addition to, diesel, petrol or other fossil fuel for transport, stationary portable and other applications. Example are alcohols (ethanol, methanol, butanol etc.) biodiesel (liquid oils and animal fat). Green diesel (derived from algae or other plant source) and biogas (methane derived from animal

manure and other digested organic matter).

Literature Review :

The Government of India (GOI) approved the National Policy on Biofuels on December 24, 2009, The policy empowers utilization of renewable energy resources as alternate fuel to supplement transport fuels and had proposes an demonstrative target to replace 20 percent of petroleum fuels consumption with biofuels (Biofuels and biodiesel) by end of 12th Five-Year Plan (2017***) TERI, 2007).***

Prasad *et. al.*[1] mentioned that ethanol has less energy and heat vale to gasoline, but it had the efficient combustion. The emission comes out from the engine is cleaner while more fuel is required for the same distance over. Addition of ehanol in small amount with unleaded gasoline acts as an octane booster, replacing the conventional additive (MTBE) for this purpose and up to 15 percent addition with diesel in unmodified engine greatly reduces visible smoke.

Gravalos *et al*. 2013) indicated that lower molecular mass alcohol such as ethanol and methanol used as a fuel extenders by blending with gasoline while higher moleculter mass alcohol/ gasoline fuel have higher resistance to knock than neat gasoline due to available of oxygen molecules which also improved compression ratio.

Sharudin *et. al.*[3] mentioned in the review article that methanol and ethanol comes under the category of lower molecular weight alcohols and from past it has been used as fuel booster for spark ignition engines by mixing them with gasoline at higher concentration also. While higher molecular weight alcohols categorized especially proponal, butanol and pentanol often used as additive with gasoline for spark ignition engines. It was found that lower molecular weight alcohol improves efficiency while higher molecular weight alcohol is having better water tolerance, solving phase separation; lower Reid vapour pressure and volatility control. In terms of exhaust emission, both type of alcohols help in the reduction of CO and UHC emission.

Experimental Procedure

Test Engine :

A Hindustan Motor make, four stroke, four cylinder MPFI gasoline run engine having 8.5:1 compression ratio wad selected for the study. The engine is commonly used in Ambassador cars for transportation. The specifications of the selected engine are shown in Table A.

Table A Specification of Engine

Make	Hindustan Motor
Model	Ambaddador
Number of Cylinder	4
Bore (mm)	84
Stroke (mm)	82
Displacement Volume (cc)	1817
Coolng System	Water Cooled

Fuels and Their properties :

The experiments were carried our using butanol, ethanol with gasoline as engine fuel. The volume percentage of butanol was carried from 2.5-10 percent and used as an additive. The volume percentage of ethanol was kept from 10-30 percent. The gasoline volume percentage was adjusted per the volume required. Total sixteen blends were prepared for the study.

Gasoline :

Gasoline is a hydrocarbon fuel which contains carbon molecular in number varying from 4 to 12. Gasoline is also known as petrol or motor sprit and produced by distillation of crude oil. Gasoline is not miscible with water and its elative density varying from 0.72-0.78. Gasoline octane rating is varying from 84 to 95.

Ethanol :

Ethanol (CH_3CH_2OH), an oxygenated organic carbon compound, is also known as Ethyl alcohol. It is a small chain high octane alcohol with molecular weight as 46 and containing 35 percent oxygen. Ethanol has high octane quality for spark ignition applications. The concentration of Ethanol is expressed as degree proof which represents twice the concentration of Ethanol.

Butanol :

Butanol or Butyl alcohol or normal butanol is a primary alcohol surround with four carbon structure and the chemical formula (C_4H_2OH) . It contains 21.5 percent oxygen and easily miscible with water. Octane rating of butanol is much closer to gasoline, which is very reliable with gasoline. The major benefit of using butanol with gasoline is that it does not damage the internal parts of the engine and also having energy density closed to gasolie

Brake Horsepower :

The brake horsepower developed by the engine was calculated using the given equation.

$$BHP = 2\pi NT/6000C \quad \ldots\ldots(3.5)$$

Where,

BHP = Brake horsepower, kW

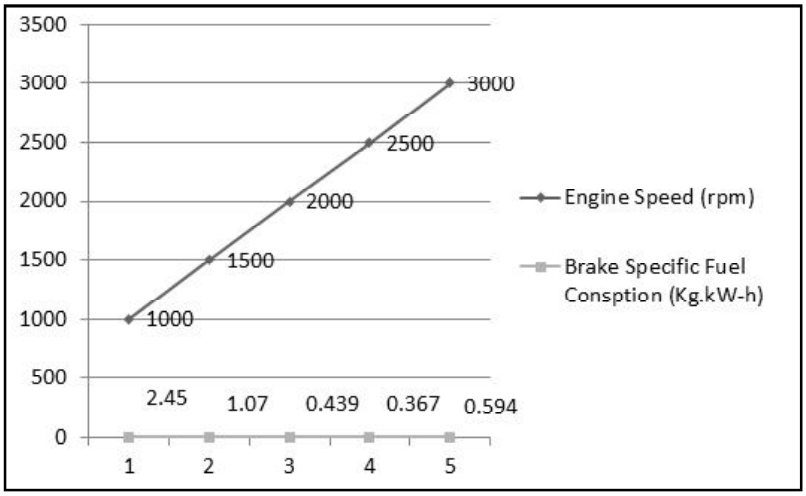
T = Torque, N-m

N = Engine speed, rpm

Table 1. Engine Performance Test Results of Hindustan Motor Make Ambassador Engine on Gasoline Fuel Ambient Temperature: 24 ºC

Engine Speed (rpm)	Brake Specific Fuel Consption (Kg.kW-h)	Brake Thermal Efficiency (%)	Brake Specification Consuption (MJ/kW-h)	Exhaust Gas Tempe-rature (K)	Carbon Monoxide (%)	Hydrocarbon (ppm)	Oxides of Nitrogen (PPm)
1000	2.45	2.30	105.23	508	0.537	161	30
1500	1.07	8.85	45.9	556	0.677	145	275
2000	0.439	16.80	18.9	615	0.587	94	316
2500	0.367	19.10	15.76	654	0.620	84	675
3000	0.594	14.10	25.51	704	0.591	68	1290

Graphs 1 (a)



Graphs 1 (b)

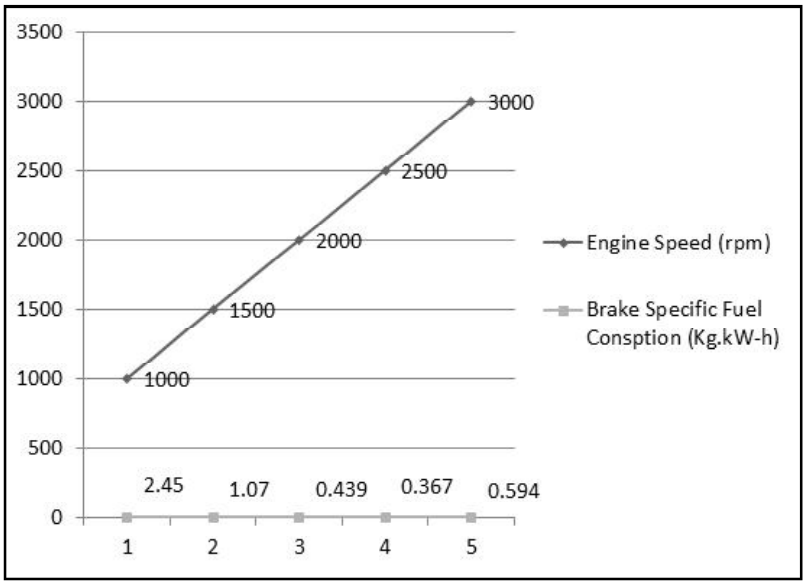
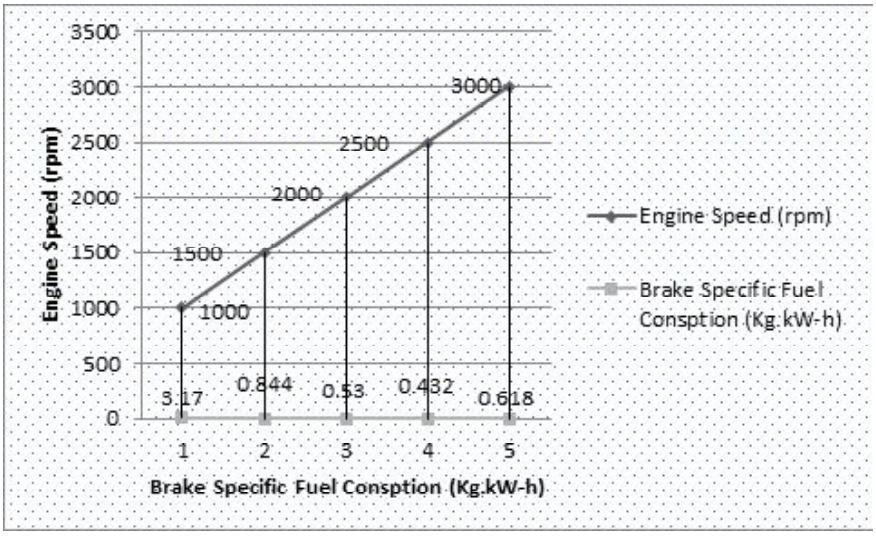


Table 2. Engine Performance Test Results of Hindustan Motor Make Ambassador Engine on 2.5% Butanol Additive – Gaoline Blended Fuel
Ambient Temperature: 24 ºC

Engine Speed (rpm)	Brake Specific Fuel Consption (Kg.kW-h)	Brake Thermal Efficiency (%)	Brake Specification Consuption (MJ/kW-h)	Exhaust Gas Temperature (K)	Carbon Monoxide (%)
1000	3.17	2.7	135.33	507	0.516
1500	0.844	10	36	527	0.590
2000	0.530	15.9	22.63	597	0.537
2500	0.432	19.5	18.44	645	0.587
3000	0.618	13.5	26.38	602	0.541

Graphs (2.a)



Graphs (2.b)

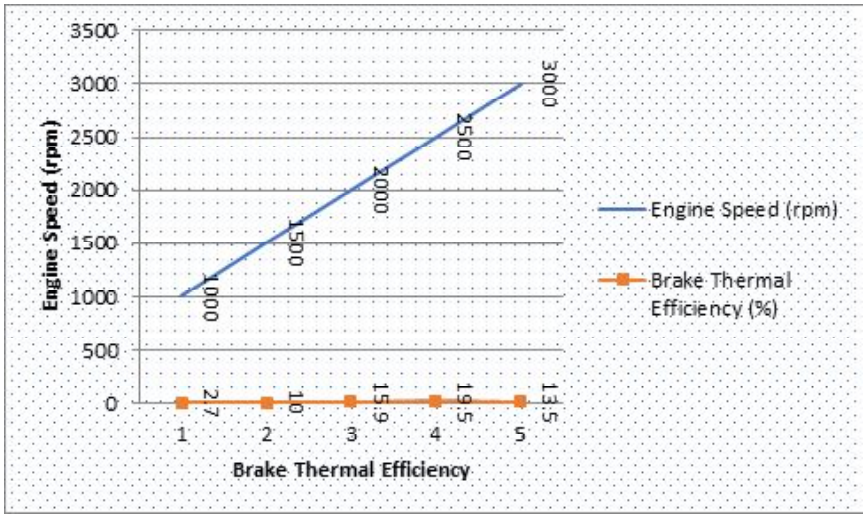
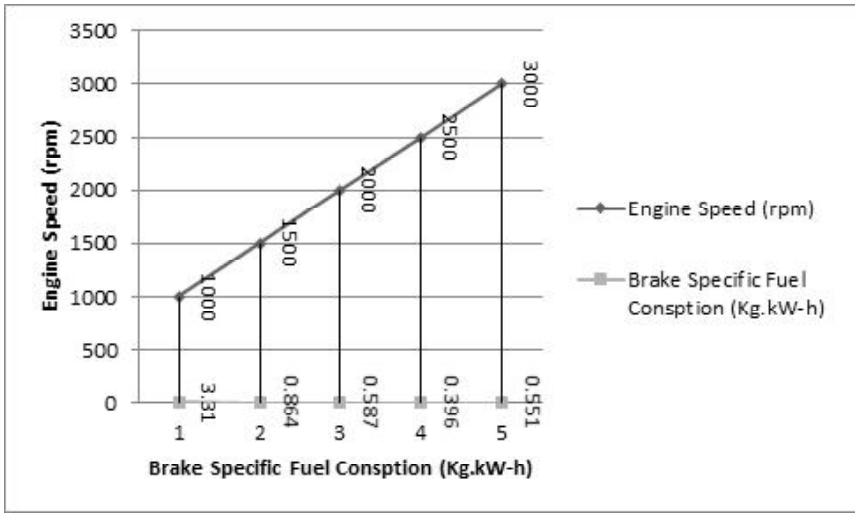


Table 3. Engine Performance Test Results of Hindustan Motor Make Ambassador Engine on 5% Butanol Additive – Gaoline Blended Fuel
Ambient Temperature: 24 ºC

Engine Speed (rpm)	Brake Specific Fuel Consption (Kg.kW-h)	Brake Thermal Efficiency (%)	Brake Specification Consuption (MJ/kW-h)	Exhaust Gas Temperature (K)	Carbon Monoxide (%)
1000	3.31	2.6	140.4	499	0.518
1500	0.864	9.87	36.7	525	0.560
2000	0.587	14.5	24.9	573	0.547
2500	0.396	21.5	16.7	650	0.570
3000	0.551	15.5	23.4	586	0.519

Graphs (3.a)



Graphs (3.b)

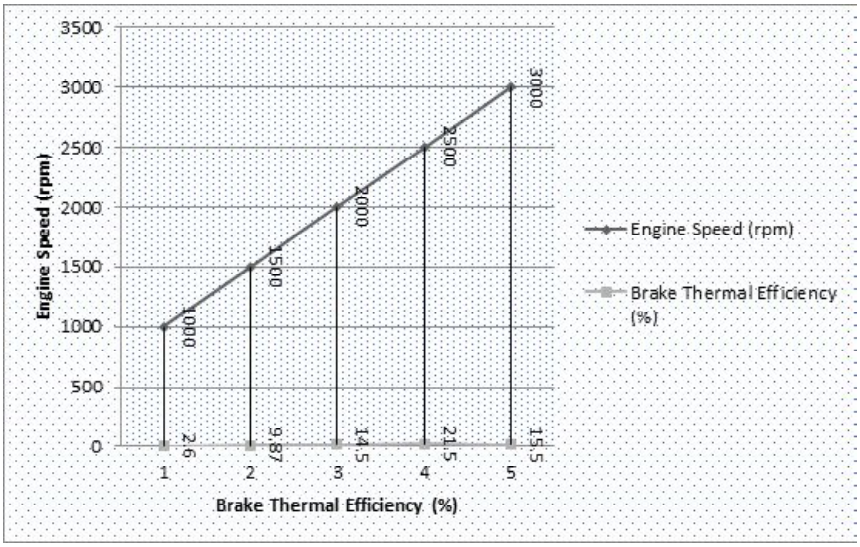
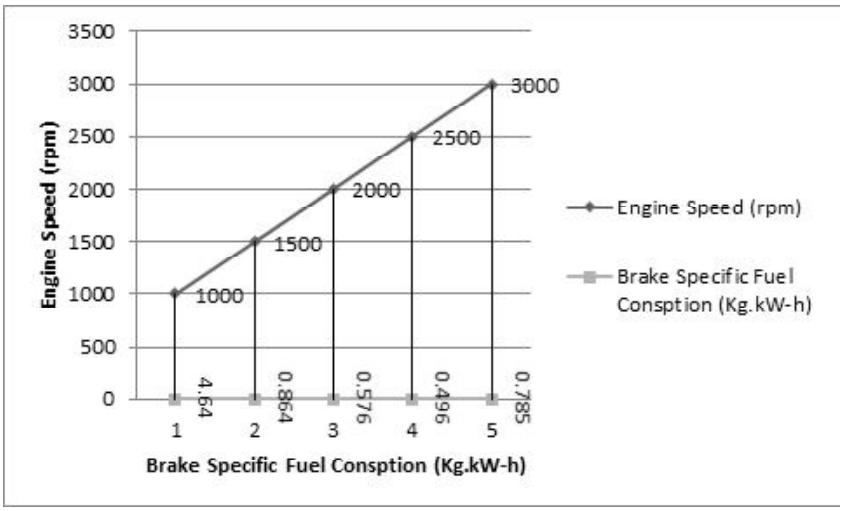
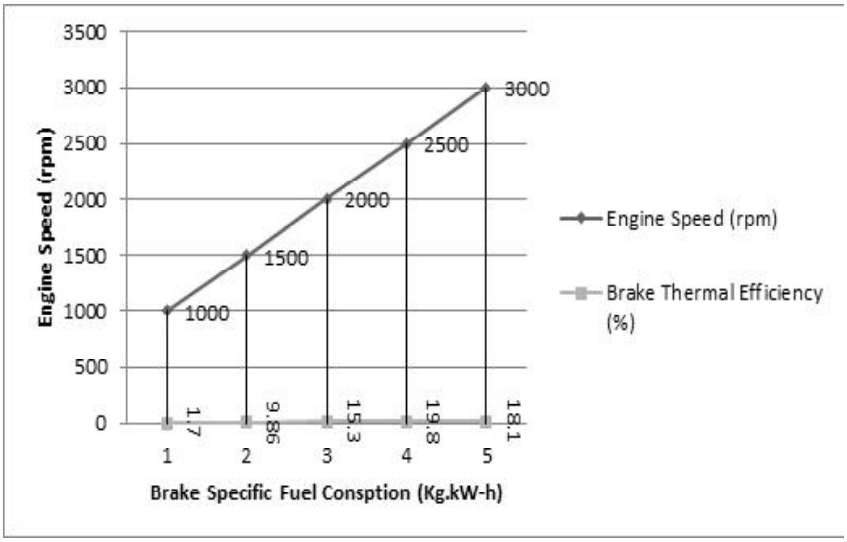


Table 4. Engine Performance Test Results of Hindustan Motor Make Ambassador Engine on 7.5% Butanol Additive – Gaoline Blended Fuel
Ambient Temperature: 24 ºC

Engine Speed (rpm)	Brake Specific Fuel Consption (Kg.kW-h)	Brake Thermal Efficiency (%)	Brake Specification Consuption (MJ/kW-h)	Exhaust Gas Temperature (K)	Carbon Monoxide (%)
1000	4.64	1.7	153.53	477	0.526
1500	0.864	9.86	36.44	515	0.542
2000	0.576	15.3	24.3	576	0.522
2500	0.496	19.8	19.78	637	0.547
3000	0.785	18.1	33.11	618	0.527



Graphs (4.a)

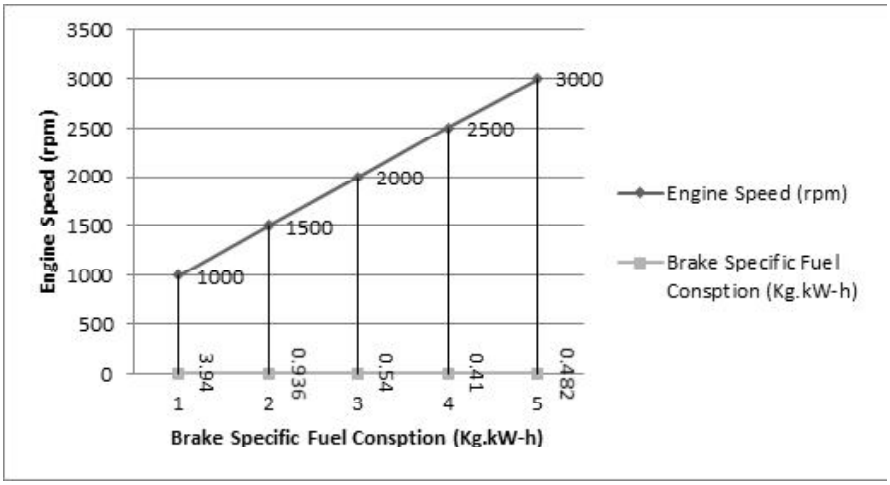


Graphs (4.b)

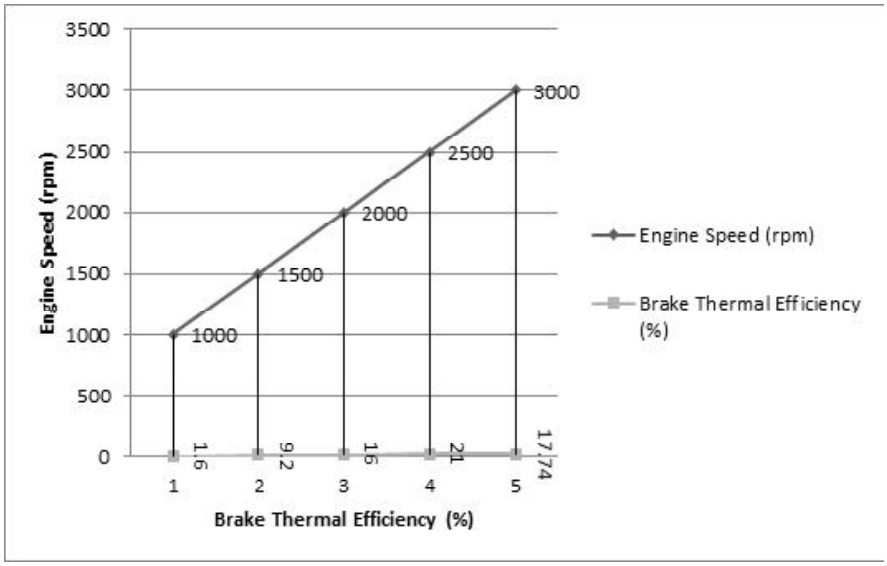
Table 5. Engine Performance Test Results of Hindustan Motor Make Ambassador Engine on 10% Butanol Additive – Gaoline Blended Fuel
Ambient Temperature: 24 ºC

Engine Speed (rpm)	Brake Specific Fuel Consption (Kg.kW-h)	Brake Thermal Efficiency (%)	Brake Specification Consuption (MJ/kW-h)	Exhaust Gas Temperature (K)	Carbon Monoxide (%)
1000	3.94	1.6	165.2	489	0.531
1500	0.936	9.2	39.24	531	0.583
2000	0.540	16	22.64	603	0.544
2500	0.410	21	17.2	630	0.576
3000	0.482	17.74	20.21	571	0.556

Graphs (5.a)



Graphs (5.b)



Conclusion

All the tested fuel was prepared on volume basis. The properties of the tested fuels were evaluated. Performance and emission evaluation of the engine on tested fuels was conducted. On the basis of the result obtained the following conclusions were drawn. The blends were prepared on the volume basis. The butanol-gasoline blends were prepared by adding 2.5, 5, 7.5 and 10 percent butanol to gasoline. The ethanol-gasoline blends were prepared by adding 10, 20 and 30 percent of ethanol (200º proof) to gasoline and butanol was used as an additive in the blends. The butanol was added in varying value of 2.5, 5, 7.5 and 10 percent by volume in E10, E20 and E30 blends. All the blends were found stable and there was no phase separation in the temperature range of -4 ºC and 28 ºC to 34ºC even after 30 days of blends formation.

Amongst E30 blends with or without additive, the maximum brake thermal efficiency of the engine was observed to be 22.6 percent on E30 blend with 2.5 percent butanol additive. The brake specific energy consumption of the engine was found to be lowest at the engine speed of 2500 rpm.The minimum value of brake specific energy consumption of the engine was found to be 15.76 Mj/kW-h on gasoline. Also lower than that of additive gasoline blends.

References

1. Prasad, S., Singh, A. and Joshi, H., C., Ethanol as an alternative fuel from agricultural, industrial and urban residues. *Resources, Conversion and Recycling. 50,* 1-39 (2007).
2. Gravalos, I., Moshou, D., Gialamas, T., Xyradakis, P., Kateris, D. and Tsiropoulos, Z., Emission characteristics of spark ignition engine operating on lowerhigher molecular mass alcohol blended gasoline fuels. *Renewable Energy. 50,* 27-32 (2013).
3. Sharudin, H., Abdulah, N, R., Mamat, A. M. I., Ali, M, O. and Mamat, R., An overview of spark ignition engine operating on lower-higher molecular mass alcohol blended gasoline fuels. *Journal Teknologi. 76 (5),* 101-105 (2015).
4. Attalla, M., Soliman,A.M.A. and Torky, M.A., Engine performance and exhaust emissions of an si engine using acetic acid, ethanol and gasoline blended fuel. *International Journal of Engineering and Technology. 3(5),* 91-97 (2013).
5. Bahattin Celik, M., Experimental determination of suitable ethanol-gasoline blend rate at high compression ratio for gasoline engine. *Applied Thermal Engineering. 28,* 396-404 (2008).
6. Balaji, D., Govindarajan, P. and Venkatesan. J., Influence of iso butanol blend in spark ignition engine performance and emissions operated with gasoline and ethanol. *International Journal of Engineering Science and Technology. 2(7),* 2859- 2868 (2010).
7 Bayraktar, H and Durgun, O., Investigating the effects of LPG on spark ignition engine combustion and performance. *Energy conversion and Management. 46,* 2317-2333 (2005).