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PERFORMANCE AND EMISSION CHARACTERISTICS OF SPARK IGNITION ENGINE FUELLED WITH GASOLINE/N-BUTANOL BLENDS

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ABSTRACT

The present study is the experimental investigation of performance and emission characteristics of spark ignition engine (SI) with gasoline-n-buatanol blends. In various properties n-butanol is almost equivalent to gasoline. Recently n-butanol can be manufactured from bio mass and it will be a renewable fuel in near future. Also the viscosity of n-butanol is higher than gasoline. Blends of n-butanol of proportions from 30 to 50% by volume along with gasoline were tested in a single cylinder SI engine in various speeds. The results shows that there was a considerable reduction in un burnt hydrocarbons (UBHC), Carbon monoxide (CO) emissions in all speeds. Brake thermal efficiency (BTE) of all blends were higher than gasoline in all the speeds. There was a slightly increase in brake specific fuel consumption(BSFC) and oxides of nitrogen(NOx). This study is giving an opportunity to reduce the dependency of gasoline which is a fossil fuel to certain extent.

Keywords: Gasoline, n-butanol, performance, emissions

INTRODUCTION

The consumption of fossil fuels was increasing day by day and there is a shortage in fossil fuels supply. The cost of fuel price getting hike Thereby, the study of alternate fuels are getting more attention [1-2]. At the starting stage of bio-fuels they are produced by using edible crops and vegetables that may leads to storage of food and increase in food price so production of bio-fuels are stopped by using edible products. Later the bio-fuels are produced from alternate lignocellulosic materials such as wood, vegetable waste and non-edible plants, these will not make any negative impact on food supply [3-5].

Alcohols comes under this category, alcohols such as Ethanol, Methanol, n-Butanol are used as bio-fuels. Among these alcohols, n-butanol is more suitable in spark ignition engines because its properties are closer to gasoline, n-butanol have several advantages over Ethanol and Methanol in transport sector. It can be easily transported through pipe lines same as gasoline and also n-butanol is closer resemblance in the air fuel ratio to gasoline which enables the usage of high percentage of n-butanol in gasoline blends than ethanol without impacting on fuel storage and fuel consumption. Auto-ignition temperature of n-butanol is lower when compared to ethanol and methanol so, n-butanol can ignite easier in gasoline engines. n-butanol has higher octane number, less corrosive. In addition, there will be no phase separation in n-butanol when blended with gasoline [6-8]

Ashraf Elfasakhany [9] conducted an experimental study for (B3, B7, B10) at different working speeds (2600-3400 r/min). The results shows that using n-butanol gasoline blends there is a slightly decrease in the output torque, power, volumetric efficiency and emissions CO, CO_2, and UHC decreases dramatically for blended fuel when compared to gasoline. Suraj bhan singh et al. [10] Tested five blended ratios (B5, B10, B20, B50 and B75)and results shows that the HC emissions of B5 and B10 are similar to gasoline at higher engine speeds and for B50 and B75 the Hc emissions are low compared to gasoline engine at all speeds. Butanol produces lower NO, CO and smoke. Bang-Quan He et al. [11] Conducted a test on HCCI engine with 100%gasoline, blends B30 and pure n-butanol, the results shows that the mean effective pressure decreases with increase in n-butanol blends and engine speeds. T. Venugopal et al. [12] Conducted a test on spark-ignition engine using n-butanol through a dual injection system, the experiments are conducted at different fuel ratios and throttle positions at equivalent ratio 1 and the results indicates that HC emissions will be reduces with proper selection of fuel ratios when compared to neat gasoline. Xialei Gu et al [13] conducted an experimental study on port fuel injection system engine fuelled with gasoline/n-butanol blends in combination with EGR and the results shows that

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there is decrease in emissions by using gasoline/n-butanol blends compare to neat gasoline, while using pure n-butanol there is an increase in HC and CO emissions and reduction in NO_X. Adrian Irimescu [14] conducted a test by using iso-butanol on spark ignition system without any modifications to engine components. The result shows that at full load the efficiency of the engine decreases up to 9% due to incomplete fuel evaporation.

Lot of researches conducted on gasoline/n-butanol blends, more percentage of experiments are conducted with fuel injection system, port injection system. There are only few experiments which are conducted by using carburetor fuel system. This paper concentrates on the performance and emissions of neat gasoline and gasoline/n-butanol blends. BU30, BU40 and B50 gasoline/ n-butanol blends were used in the engine running at various speeds at 3000rpm, 3300rpm and 3600rpm at various loads of 0%, 25%, 50%, 75% and 100% in a single cylinder four stroke engine with carburetor fuel system which may influence for better performance and reduction of emissions

EXPERIMENTAL SETUP

In this study, the experiment was conducted on a single cylinder four stroke vertical air cooled high speed spark ignition engine. The engine has a bore of 76mm, stroke 60mm and compression ratio of 4.8:1. The detail specifications of the engine were mentioned in table 1.

Engine parameters	**Specifications**
Engine type	Spark – ignition engine
Model	Honda GK300
Bore (mm)	76mm
Stroke(mm)	60mm
Compression ratio	4.8:1
Number of cylinders	1
Fuel delivery	Carburetor
Power (KW)	5

Experiments were conducted on a fully warmed engine. An AC dynamometer is coupled to the engine which is used to apply load to the engine, the speed of the engine is measured by using proximity sensor (pnp No 18). By using crypton five gas analyzer we can measure the exhaust emissions such as CO, CO_2, HC. The exhaust gases are measured while the engine is running at certain speed

Different types of fuels are tested in the engine the fuels that are used in the engine are neat gasoline (BU 0%), gasoline and n-buatanol blends of BU30%, BU 40%, BU50% which are blended in volume bases. The properties of the fuels are given in the table 2.

Table 2: poperties of test fuels

Fuels	Density (g/cm^3)	Kinematic viscosity @40^{0}C (cst)	Calorific value (Kcals/kg)
Gasoline	0.6025	0.71	12000
Butanol 30	0.6301	0.75	8760
Butanol 40	0.6523	0.96	8564
Butanol 50	0.6677	1.10	8268

The fuel was supplied through carburettor fuel system. The fuels are tested at three different speeds i.e, 3000 rpm, 3300 rpm and 3600 rpm at different loads. The experiment was done without any change or modification or tuning of the engine.

RESULTS AND DISCUSSION

The experimental results of this study discussed with performance characteristics and emission characteristic of spark ignition engine fuelled with gasoline-butanol blends and neat gasoline

3.1 Performance characteristics

3.1.1 Brake Thermal Efficiency

Brake thermal efficiency of all the blended fuels were increasing with increase in the load. Neat gasoline has lower brake thermal efficiency compare with the blends. Brake thermal efficiency is increases with increase in the n-butanol percentage.

Fig. 1 shows the relation between brake thermal efficiency of gasoline and butanol blends with respective brake mean effective pressure (BMEP). It clearly shows that there is increase in BTE of blends than the gasoline. It is observed that BU50 blend at 3600 rpm have higher BTE of 34.63% at full load, which was 19% higher than gasoline where as for BU30 and BU40 are slightly

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higher than gasoline. At high speeds, the temperature in the cylinder is high which helps in proper mixing of fuel with higher latent heat of vaporization which improves the brake thermal efficiency [10].

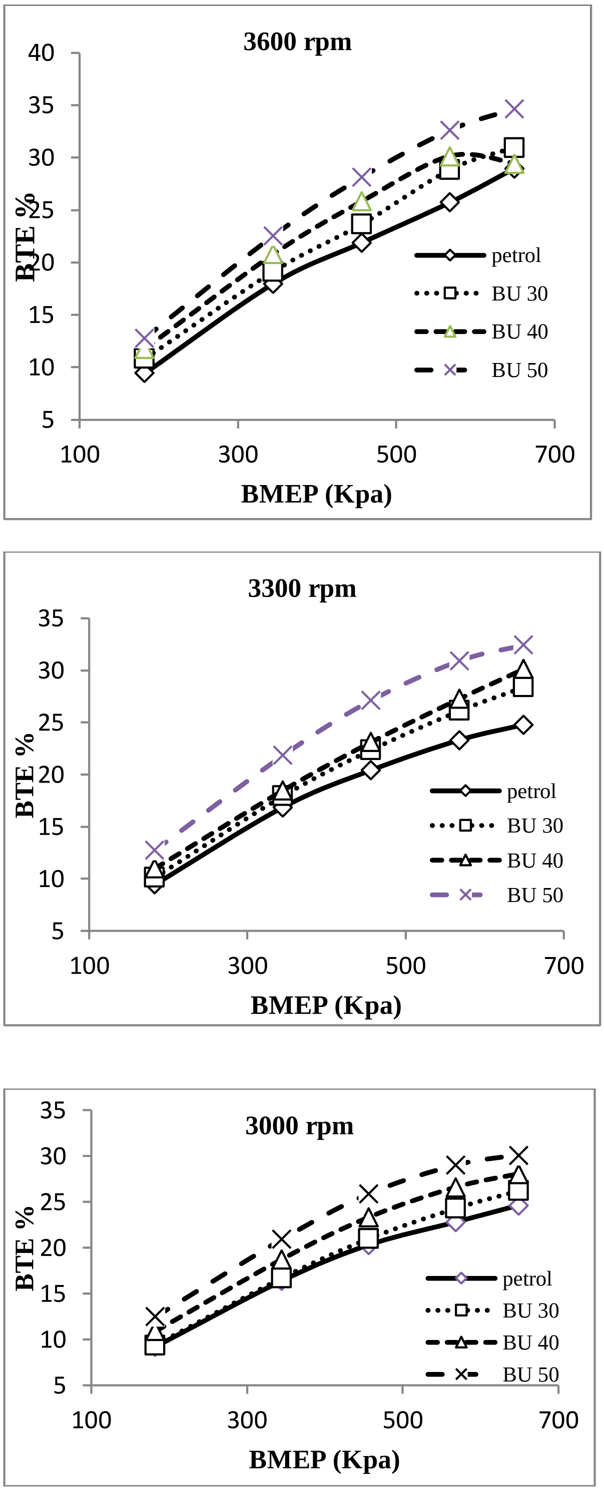
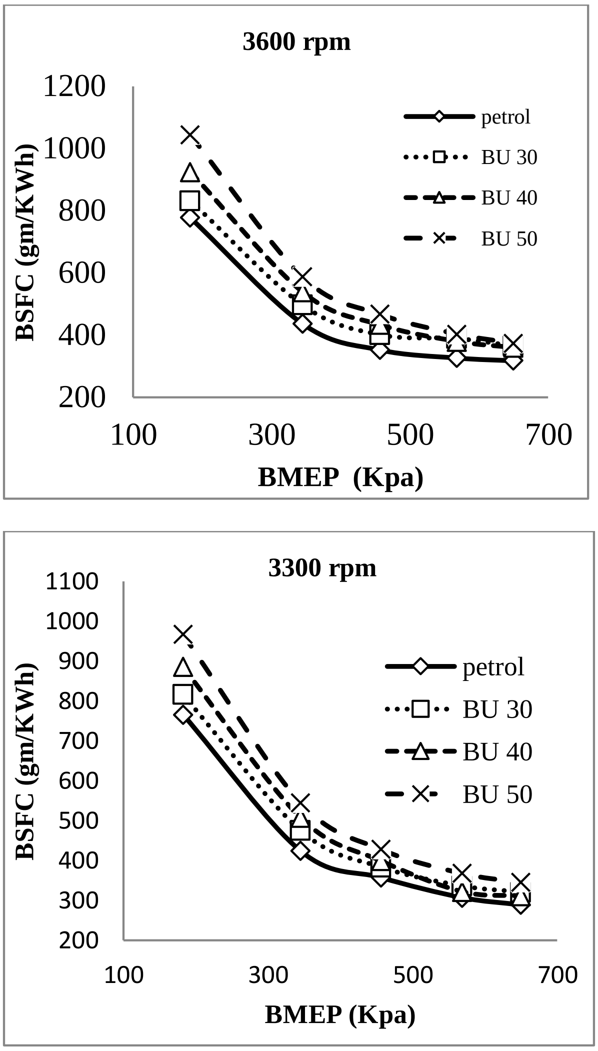


Fig.1. Variation of BTE with BMEP at different engine speeds and loads

3.1.2 Brake Specific Fuel Consumption

Fig. 2 shows that variation of Brake specific fuel consumption of gasoline and gasoline – butanol blends with respective to brake mean effective pressure at different speeds and loads. The brake specific fuel consumption is decreasing for all the blended fuels with increase in the load

BSFC is higher for n-butanol – gasoline blends when compare to gasoline because blends have lower calorific value than gasoline. Butanol contains 20% excess oxygen than gasoline which does not generate heat in the combustion chamber. As butanol percent increase brake specific fuel consumption also increases [13].



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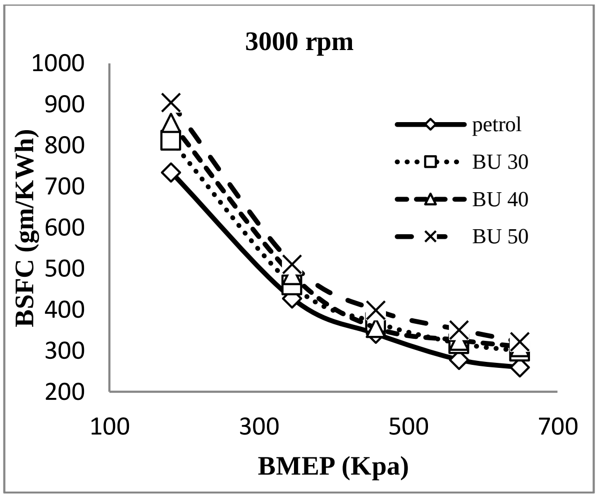


Fig.2. Variation of BSFC with BMEP at different engine speeds and loads

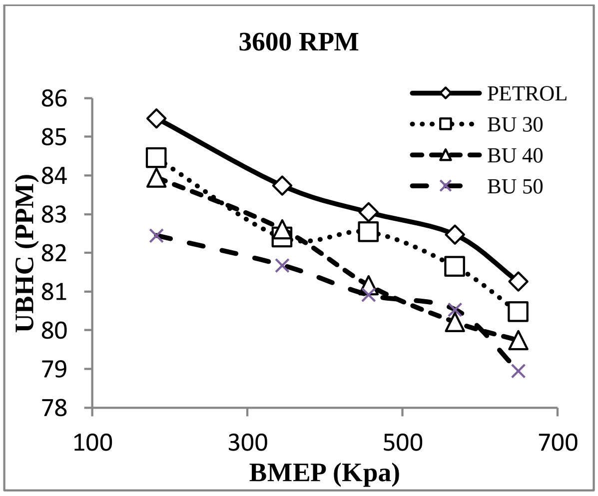
BU50 has higher BSFC because the oxygen contain in it is high compare to other test fuels. The blended fuels exhibits up to 7.68% to 19.54% more brake specific fuel consumption compared to gasoline from low load to full load condition

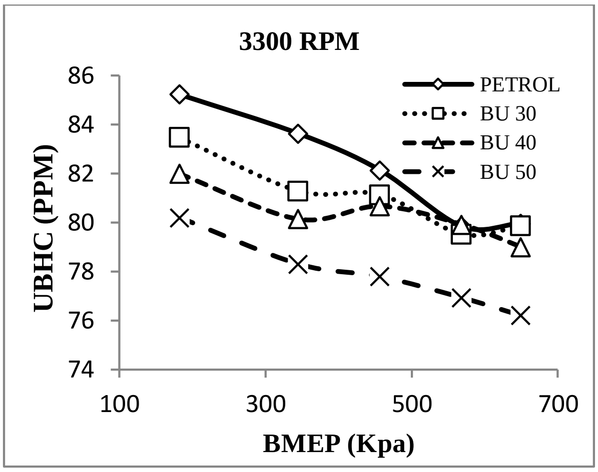
3.2 Emission characteristics

Emission characteristics were measured using crypton five gas analyzer at different speeds and loads. Emissions such as HC, CO and NOx were measured and plotted the variations of these emissions with brake mean effective pressure

3.2.1 Unburnt Hydrocarbon emissions

Unburnt hydrocarbons are formed due to in proper combustion and lack of oxygen availability during combustion.





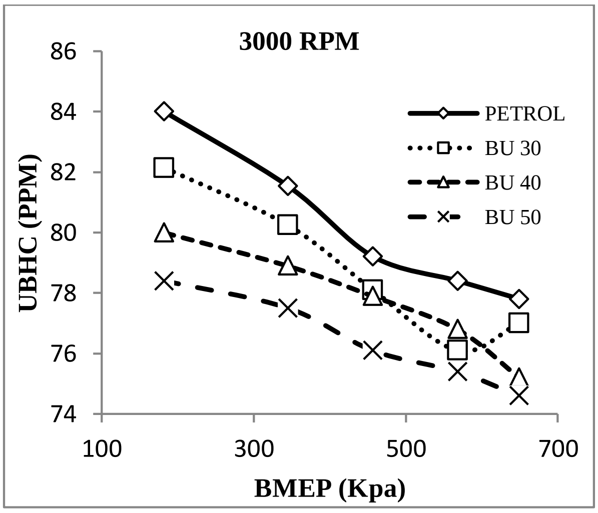


Fig.3. Variation of UBHC with BMEP at different engine speeds and loads

The fig.3 shows that variation of un burnt hydrocarbons with gasoline and n-butanol blends with respective brake thermal efficiency at different speeds and loads. The UBHC decreases with increase in the load this is because n-butanol contains higher oxygen which helps for richer combustion mixture. At high speeds and load due to the presents of oxygen and butanol have low heat of vaporization results in good combustion. It is absorbed that BU50 has lower UBHC emissions. BU30,BU40 have similar UBHC at low load, as the load increase UBHC emissions increases rapidly

3.2.2 carbon monoxide emissions

Fig.4 shows the variation of carbon monoxide with gasoline and BU30, BU40, BU50 with respective to brake mean effective pressure at different speeds and loads.

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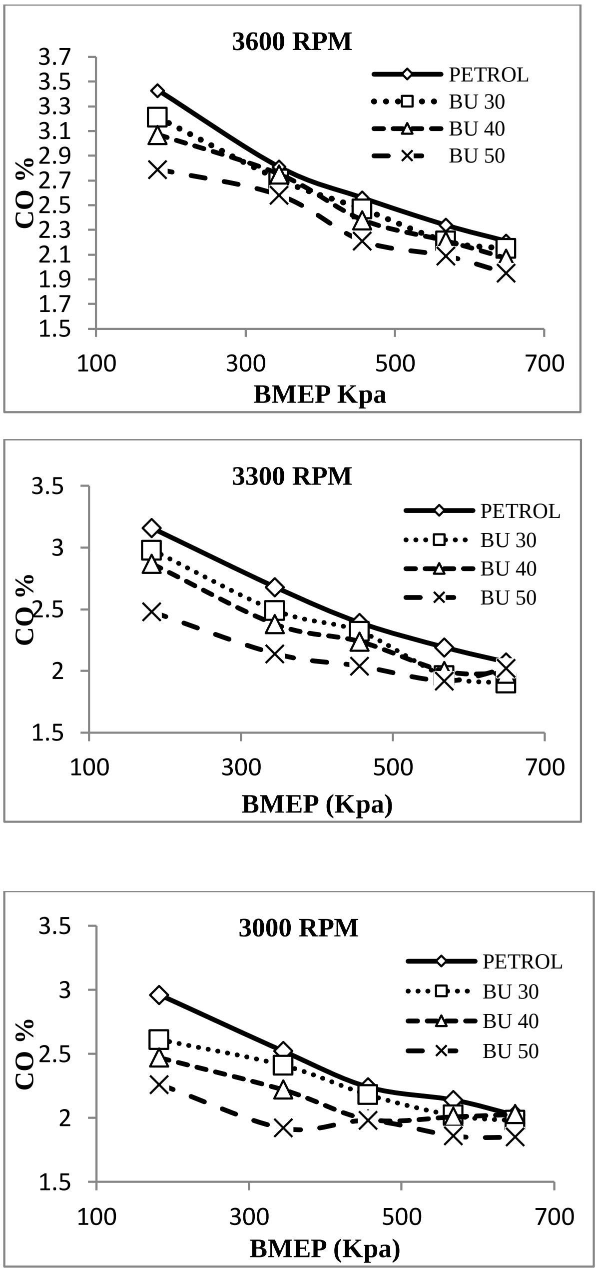

Fig.4. Variation of CO with BMEP at different engine speeds and loads

It is noticed from the fig.4 that carbon monoxide trends to decreases with increase in load of the engine. Carbon monoxide emission increases with the speed of the engine because at high speeds the combustion time is less. It is absorbed that BU50 has lower emissions because it have higher oxygen content

3.2.3 oxides of nitrogen

Formations of Oxides of nitrogen are due to availability of excess of oxygen and higher temperature in cylinder. Fig.5 shows that the NOx emissions are increases rapidly with increase in BMEP for all fuels. BU30, BU40, BU50 has high NOx compared to gasoline. Among the blends BU30 has lower NOx.

At low load condition gasoline – butanol blends have slightly higher NOx emissions where as the load increases the NOx emissions are gradually increases. At full load there is dramatically increase in the NOx emission for blended fuels

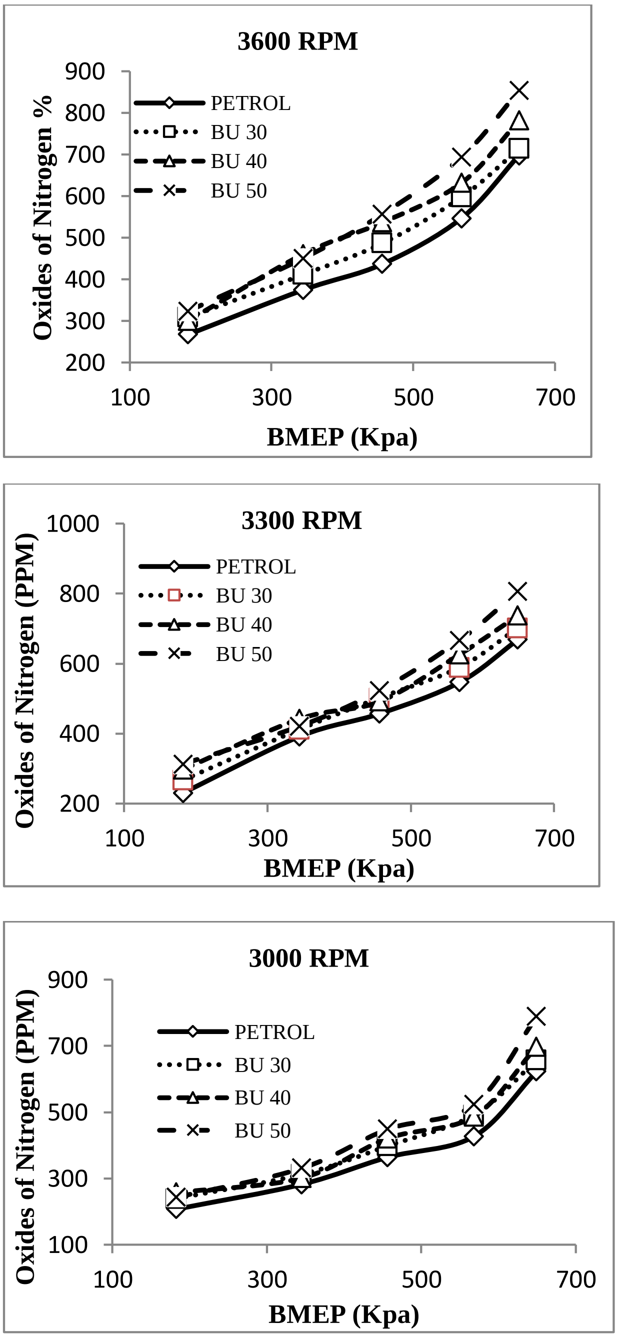

Fig.5. Variation of Oxides of nitrogen with BMEP at different engine speeds and loads

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CONCLUSION

Performance and emission characteristics of butanol – gasoline blends are experimentally evaluated in spark ignition engine without any modification or tuning the engine. The results that obtained are:

- Brake thermal efficiency of the blends increases with addition of n-butanol to gasoline due to lower calorific value of butanol blends. It is observed that BU50 have higher brake thermal efficiency of 19% at high speeds
- Brake specific fuel consumption of blends is higher than the gasoline as the heating value of butanol is lesser than gasoline.
- CO and HC emissions of gasoline-butanol blends are lower compared to neat gasoline. There is a reduction of emission along with the increase of load.
- NOx emissions of gasoline-butanol blends are higher compared to gasoline. As the load increases the NOx emissions are gradually increases
- This study gives an opportunity to utilise n-butanol, future renewable fuel to reduce the dependency of gasoline the fossil fuel to certain extent.

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