International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 04 | Apr 2023 www.irjet.net p-ISSN: 2395-0072

# Performance and Emission Analysis of Petrol Engine Fueled with Ethanol and Butanol Blended Gasoline Fuel

**Hari Charan Chourasia[1], Alka Bani Agrawal[2]**

*[1]Student, Master of Engineering, Heat Power Engineering*
*[2]Professor and HOD, Automobile Engineering,*
*Department of Mechanical Engineering, University Institute of Technology,*
*Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, Madhya Pradesh, India- 462033*

---

## Abstract

*Increasing population & continuous growth resulting the increasing number of vehicles and increasing demand of fuel leading the world towards the worst atmospheric conditions i.e. increasing pollution is one of the biggest problem through which most of the countries are struggling without having a significant solution. Increasing pollution & limited reserves for fossil fuel together with carbon emissions regulations have led to producing sustainable fuels made from renewable materials.*

*In recent years, the focus has been on using bio fuels as alternate energy sources. Blending bio-fuels with gasoline is one of the methods to be considered under the search for a new source of energy. Alcohols are an important category of bio-fuels. Butanol can be an alternative fuel since it is a liquid and has several physical and chemical properties similar to those of gasoline fuels. Butanol don't have many of the drawback associated with ethanol. Butanol has also a higher molecular weight than ethanol, and therefore, has reduced vapour pressure, lower water solubility, and higher energy density.*

***Keywords:*** *Alcohol, Ethanol, Butanol, Biofuel, Alternate fuel, Alcohol-Gasoline Blends.*

## 1. INTRODUCTION

Today's world is in the era of technology where a number of technological advancements are facilitating the modern world. Millions of inventions and their applications are upgraded a number of times and still in continuation by the research and development activities across the world but everything has its dark side as well. Among the enormous advantages of technology there are also a number of limitations that led to the world to face the critical problems related to technology and these problems if not meet to the solution, may become a great threat to the wellbeing and existence of a healthy society. One of the major problems associated with industry and automobiles is environmental pollution.

Increasing pollution & depletion of fossil fuel has led the interests of scholar to study about the reformulate of alternative fuel and after various researches after late 90's it has found that the blending of biofuel can be the best suited solution to this problem. According to previous study, the use of fuel alternatives that containing oxygen (oxygenates) was very important as the additive can increase the performance and efficiency of the fuel. Based on previous study, one of the best methods to improve the combustion behaviour is by blending base fuel with additives. Alcohol (Methanol, Ethanol, Butanol)-gasoline blends can reduce air pollution and at the same time offers excellent performance of the engine compared to unblended petroleum fuel . The effect of the alcohol gasoline blends on CO emissions for different engine speeds showed that when alcohol percentage increases, the CO concentration decreases. Carbon content in the blended fuel also plays a major part on the emission of CO due to the lower carbon content.

It has proven in many researches that alcohol reduces pollutant emission which resulted the use of alcohol specially ethanol for blending and as an alternative fuel. As the ethanol came in the practice it has found that it has its adverse effect i.e. corrosive effect on the engine materials and components due to that it cannot be used without engine modifications. Many government enforcing the regulatory to the automobile companies to manufacture engines with required modifications as they can withstand the corrosive effect of ethanol but still there is a large number of old vehicles are already in practice which cannot be made compatible for ethanol based fuel. Hence there is a requirement of an alternative fuel which can be used in the existing engines without modifications because modification and replacement of such a huge number of vehicles or engines is not practically possible. Many researchers have worked in this direction and butanol, which is also an isomer of alcohol, came into light. So, the present work is a comparative and competitive study of results to check the suitability of butanol over ethanol in order to find an alternative fuel for existing population of vehicles that cannot be modified to use ethanol based fuel. Under this study, experimental work has been done in which different

samples of ethanol and butanol blended fuel such as E10, E20, E30, B10, B20 & B30 has been tested on an older 2 stroke SI and their performance & emission characteristics have been compared.

## 2. MATERIALS AND METHODS

For this study, IOCL marketed gasoline was obtained from the City's filling station and fuel samples are prepared by mixing the alcohol with gasoline by volume percentage. Volume percentage of Ethanol and Butanol was kept from 10-30 percent by volume. Total six samples of blended fuel were prepared for the study. The ethanol fuel samples prepared by mixing 10%, 20% and 30% ethanol of 99.9% purity with gasoline by volume and these samples are named as E10, E20 and E30 respectively. Similarly, butanol fuel samples prepared by mixing 10%, 20% and 30% n-butanol of 99% purity with gasoline by volume and these samples are named as B10, B20, B30 respectively. In order to understand the behaviour of these blended fuel first of all we need to understand the properties of blended fuel.

After preparing the fuel samples it has been tested on a single cylinder two stroke petrol engine test rig at IC Engine Laboratory in Central Workshop under the department of Mechanical Engineering of University Institute of Technology, RGPV Bhopal (M.P.).

A schematic arrangements of various components of the experimental setup is shown in the figure 2.1. The important mechanical and electrical units involved in the testing are as follows:-

1. Two Stroke Petrol Engine
2. Fuel supply system with burette
3. Eddy Current Dynamometer
4. Dynamometer control unit
5. Digital Tachometer
6. Exhaust Gas Analyser with probe.

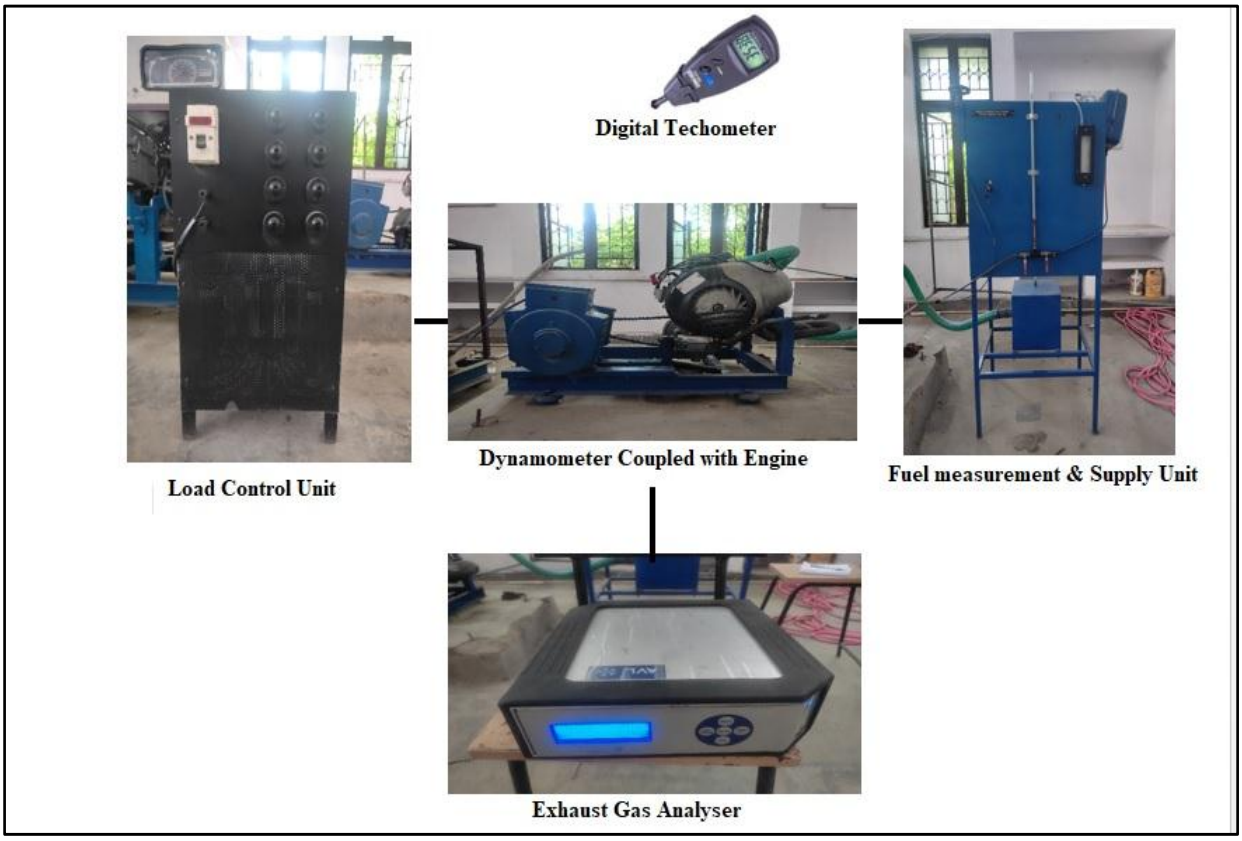


***Fig. 2.1*** *Experimental Set up*

## 4. CONCLUSION:-

On the basis of experimental results obtained it can be concluded that the Brake Thermal Efficiency of fuel blends is slightly lower as compared to the pure gasoline because of the lower calorific value and higher heat of vaporization of alcohols. If we compare individual blended fuel samples, butanol blends shows comparatively higher brake thermal efficiency than ethanol blends which is because of higher calorific value and lower heat of vaporization of butanol as compared to ethanol whereas B10 is the sample identified with maximum efficiency. The Specific fuel consumption is higher for gasoline-alcohol blends as compared to pure gasoline which is because of lower calorific value and higher heat of vaporization of alcohols which represent that the fuel consumption will be more for gasoline- alcohol blends as compared to pure gasoline. If we compare the BSFC of ethanol and butanol blends it is found lower for butanol blends and minimum for B10 due to its higher energy content which represent that butanol blended fuel is more economic than ethanol blended fuel.

If we discuss emission characteristics so it has found that the HC and CO Emission for fuel blends is lower than pure gasoline. The reason of lower HC & CO emission for alcohol fuel blends is the presence of oxygen molecules in the alcohol which aids to the better combustion of fuel whereas no oxygen is present in gasoline. HC & CO Emission for butanol blends is found lower as compared to Ethanol blends. The reason behind the lesser emission of butanol is the lower heat of vaporization and higher calorific value as compared to ethanol due to that butanol blends burns more efficiently as compared to ethanol blends Hence better combustion results decrease in unburnt hydrocarbon particles. On the other hand the $NO_X$ Emission for fuel blends is higher than pure gasoline. The reason of higher $NO_X$ emission for alcohol fuel blends is the presence of oxygen molecules in the alcohol which aids to the better combustion and results increase in cylinder temperatures which gives rise to the formation of $NO_X$ in the combustion products. $NO_X$ Emission for butanol blends is found lower as compared to Ethanol blends. The reason behind the lesser $NO_X$ emission of butanol is the lower amount of oxygen present in the atomic structure as compared to ethanol. Ethanol consists of 34.78% oxygen whereas butanol consists of 21.62% oxygen by weight due to which ethanol burns with comparatively high temperature than that of butanol and leads to the formation of more $NO_X$ in the exhaust.

The implementation of butanol blending may be a better alternative to reduce pollutants emission from existing older SI engines while ethanol is suitable for the new generation SI engines or existing engine with modifications. As a large number of vehicles are not possible to modify or replace with the new therefore, butanol blending can play a vital role to control the increasing pollution of the fossil fuels and can also save the petroleum using this green fuel.

## REFERENCES

[1] Iliev, S. A Comparison of Ethanol, Methanol, and Butanol Blending with Gasoline and Its Effect on Engine Performance and Emissions Using Engine Simulation. Processes 2021, 9, 1322. https:// doi.org/10.3390/pr90813.

[2]Manish Saraswat[1] , AnkurDixit[1] ,Abhishek Goel[1] and Nathi Ram Chauhan[2]. Performance and Emission evaluation of Butanol blends in SI Engine. IOP Conf. Series: Materials Science and Engineering 691 (2019) 012081. IOP Publishing doi:10.1088/1757-899X/691/1/012081.

[3]Praveen Kr. Rai[1] , Mohd Arif Khan[2] , Shubham Awasthi[3], To study the Performance and Emissions Characteristics of butanol blended Gasoline Fuel single cylinder Spark Ignition Engine. 3 rd International Conference on "Advances in Power Generation from Renewable Energy Sources" 2019. SSRN-Elsevier at https://hq.ssrn.com/conference=2019-APGRES

[4]Shashank S N, S Raviteja & Kumar G N. Comparison of Ethanol and n-Butanol Blends with Gasoline : A Computational Study. ISSN : 2319 – 3182, Volume-2, Issue-4, 2013.

[5]V. Hönig1,*, M. Kotek2 and J. Mařík2. Use of butanol as a fuel for internal combustion engines. Agronomy Research 12(2), 333–340, 2014

[6]Cristian Sandu1* , Constantin Pană1 , Niculae Negurescu1 , Alexandru Cernat1 , Cristian Nuţu2 , and Rareş Georgescu1. The study of the spark ignition engine operation at fuelling with n-butanol-gasoline blends. E3S Web of Conferences 180, 01010 (2020) https://doi.org/10.1051/e3sconf/202018001010.

[7] I. Veza* , M. F. M. Said and Z. A. Latiff. Improved Performance, Combustion and Emissions of SI Engine Fuelled with Butanol: A Review. International Journal of Automotive and Mechanical Engineering (IJAME) ISSN: 2229-8649 e-ISSN: 2180-1606 VOL. 17, ISSUE 1, 7648 – 7666 DOI: https://doi.org/10.15282/ijame.17.1.2020.13.0568.

[8]F. N. Alasfour, Butanol—A Single Cylinder Engine Study: Engine Performance. International Journal of Energy Research, Vol. 21, 21—30 (1997)

[9]Nithin H S, Comparative Study of Performance of Four Stroke Two Wheeler using Ethanol-Gasoline and Butanol Gasoline Blends. International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181. www.ijert.org. Vol. 4 Issue 03, March-2015. IJERTV4IS030488.

[10] Magín Lapuerta , Rosario Ballesteros and Javier Barba. Strategies to Introduce n-Butanol in Gasoline Blends. http://www.mdpi.com/journal/sustainability. Sustainability 2017, 9, 589; doi: 10.3390/su9040589.

[11]Tan Tien Huynh[1] ,Minh Duc Le[1] ,Dinh Nghia Duong, Efects of butanol–gasoline blends on SI engine performance, fuel consumption, and emission characteristics at partial engine speeds. International Journal of Energy and Environmental Engineering (2019) 10:483–492 https://doi.org/10.1007/s40095-019-0309-9 .

[12]Preeti Nair & H. N. Meenakshi, Review on the synthesis, performance and trends of butanol: a cleaner fuel additive for gasoline. International Journal of Ambient Energy. DOI: 10.1080/01430750.2021.1873849.

[13]Veloo, PS, Wang, YL, Egolfopoulos, FN, Westbrook, CK," A comparative experimental and computational study of methanol, ethanol, and n-butanol flames", Combustion and Flame.157 (10), 1989–2004 (2010).

[14]Tao L., and Aden, A., "The economics of current and future biofuels," In Vitro Cellular & Developmental Biology – Plant. 45(3): pp.199-217, (2009).

[15]M. Koc, Y. Sekmen, T. Topgul, H. S. Yucesu, "The effects of ethanol-unleaded gasoline blends on engine performance and exhaust emission in a spark ignition engine", Renewable Energy, vol. 34, pp. 2101-2106, (2009).

[16]J.Yang, XL Yang, "Experiment Study of the performance of the blended butanol gasoline fuel", SAE C2008A63,(2008).