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Abstract

Population and industrial growth have increased demand for energy to a very large extent. More panic is created due to Russia – Ukraine war since almost for two years and created a panic of energy crisis and political conflicts in the Gulf region [1]. Hence, there is an urgent need to find an alternative fuel environment friendly due to harmful effects of using traditional engine fuels on climate change and global warming. One of the most important alternative fuels is Ethanol as it is liquid and has a similar chemical property to that of conventional fuel properties. The present volume of this research paper discusses the past, present, and future of ethanol blended petrol. It discusses the government initiatives, need of ethanol blended petrol, current scenario, and future directives. The changes in production lines to produce compatible vehicles are also suggested to avoid adverse effects of ethanol blended petrol.

Keywords: Ethanol blended petrol (EBP), alternative fuel, E0, E10, E20, E40.

Introduction

Ethanol, an anhydrous ethyl alcohol having chemical formula of C_2H_5OH , can be produced from sugarcane, maize, wheat, etc. which have high starch content. In India, ethanol is mainly produced from sugarcane molasses by fermentation process. Ethanol can be mixed with gasoline to form different blends. As the ethanol molecule contains oxygen, it allows the engine to combust the fuel more completely, resulting in fewer emissions and thereby reducing the occurrence of environmental pollution. Since ethanol is produced from plants that harness the power of the sun, ethanol is also considered as renewable fuel.

Literature

A good number of title and literature by renowned authors are referred while preparing this work. Impact of ethanol blended gasoline (E20) on Engine Performance & Fuel economy with E20 Optimized Calibration highlighting the effect of both Calorific value and RON are discussed by Ankit Gupta, Ojase JAIN, Ranjeet Rajak affiliated to Maruti Suzuki India, Ltd. in a paper on “Study of Effect of Ethanol Blending on Performance & Fuel Economy of Naturally Aspirated Gasoline Engine and Engine Hardware Optimization Potential.” in 10TH SAE India International Mobility Conference [1]. Energy security in India can be increased by blending locally produced ethanol with petrol. Having increased to 8.1% in ethanol supply year 2020-21 (Dec-Nov) with target to achieve 10% ethanol blending in the ethanol supply year 2021-22, India is making steady progress in raising the share of ethanol. In future, Government of India is planning to start supply of 20% ethanol blended petrol from Apr’23 and to cover PAN India by Apr’25.. This paper also highlights the potential to recover some part of Fuel Economy loss due to lower calorific value of ethanol blended fuel by optimizing Compression Ratio and Gear Ratio.

In a paper on “Effect of ethanol-gasoline blends on SI engine performance and emissions” by Mortadha K. Mohammed et al., ethanol was mixed with gasoline in different proportions (10% ethanol + 90% gasoline, 20% ethanol + 80% gasoline, 30% ethanol + 70% gasoline, 40% ethanol + 60% gasoline) by utilizing ultrasonic bath to ensure perfect mixing which in turn will increase the fuel energy content [2]. The effect of ethanol’s/gasoline blend on power, efficiency and exhaust gases was studied using one-cylinder, four-stroke and spark ignition engine. Results showed that power, brake specific fuel consumption and thermal efficiency are improved with the increase of ethanol concentration but with negative effect on volumetric efficiency.



In the experimental investigation by Paolo Iodice, Giuseppe Langella, Amedeo Amoresano; ethanol obtained from grape pomace was used in fuels prepared by blending it in increasing ratios (10, 20 and 30 vol.%) with oxygen-free gasoline [3]. Assessment of emissions and energy consumption of a motorcycle equipped with a large displacement four-stroke SI engine was done using these ethanol/gasoline blended fuels.

Research on ethanol blended petrol started very early even though use is recent. The reasons for limited success of ethanol blended fuel in India was presented in very early stage by Mahesh K. Saini et al. [4].

The performance and emission characteristics of a 4 stroke, 4-cylinder spark ignition MPFI engine were investigated with different ethanol gasoline (Gasohol) blends by Amit Pal [5]. The low ethanol gasoline blends and gasoline (E0/G100) were tested on a Maruti Suzuki Wagon R engine with a SAJ eddy current dynamometer unit. The applicability of low ethanol blended Gasoline as clean fuel to reduce CO, HC and NO_x emissions was proved by results of experimental investigation. A marginal increase in BHP and thermal efficiency a little increase in specific fuel consumption, whereas the usefulness of the inherent oxygen content in the ethanol molecule has been proved through the occurrence of a higher peak cylinder pressure and a higher exhaust gas temperature.

A comprehensive study has been done on the stability of blends in ethanol-diesel and ethanol-gasoline engines with conclusion that ethanol in gasoline engines leads to phase separation due to the high affinity of ethanol for water and air humidity was presented by Ram Kunwer et al. [6]

Ravinanath Narenthra Rao et al. investigated the effect of ethanol and gasoline blending on the performance of a non-road small single cylinder engine [7]. The addition of ethanol to gasoline has improved the overall engine performance. Authors suggested the use of High ethanol-gasoline fuel blend (E40) for low engine speed and low ethanol-gasoline fuel blend (E10) can replace the neat gasoline without modification as their performance is very identical.

Use ethanol as a fuel in engines to provide a more sustainable, environment-friendly alternative to gasoline, diesel, and petroleum was discussed by Sparsh Sharma & Yash Sharma [8].

Ethanol Blended Petrol – Present, Past & Future

Why is ethanol added to petrol?

Ethanol is a biofuel, i.e. fuel produced by processing organic matter. The auto fuels we commonly use are mainly derived from the slow geological process of fossilization, which is why they are known as fossil fuels. Ethanol is obtained primarily from sugarcane via a fermentation process. Ethanol is rich in oxygen content, which therefore allows an engine to thoroughly combust fuel. Since it is bio derived, ethanol blend fuel is less polluting and offers equivalent efficiency at lower cost than petrol. Thereby, reducing the carbon footprint.

Ethanol Blended Petrol – Government initiatives

Ethanol . Blended Petrol (EBP) programme was launched in January, 2003. The programme sought to promote the use of alternative and environment friendly fuels and to reduce import dependency for energy requirements.

During 2001, pilot projects on Ethanol Blended Petrol started at 3 locations i.e. at Miraj, Manmad (Maharashtra) and Aonla / Bareilly in Uttar Pradesh. The Government of India decided to launch Ethanol Blended Petrol (EBP) Programme in January, 2003 for supply of 5% ethanol blended Petrol. Subsequent to this, Ethanol Blended Petrol programme was launched in January, 2003 in 9 States i.e. Maharashtra, Gujarat, Goa, Uttar Pradesh, Haryana, Punjab, Karnataka, Andhra Pradesh, Tamil Nadu and 4 Union Territories.

The Ministry of Petroleum & Natural Gas (MoP&NG) vide its notification dated September 20, 2006 directed the Oil Marketing Companies (OMCs) to sell 5% Ethanol Blended Petrol subject to commercial viability as per Bureau of Indian Standards specifications in notified 20 States and 4 UTs with effect from November 1, 2006. The additional 10 States included Delhi, Himachal Pradesh,



Madhya Pradesh, Chandigarh, Kerala, Rajasthan, West Bengal, Odisha, Bihar and Jharkhand. However, North - Eastern States, J&K, Andaman & Nicobar Islands and Lakshadweep Islands have not been covered under the programme.

This programme has been extended to whole of India except Union Territories of Andaman Nicobar and Lakshadweep islands with effect from April 01, 2019, wherein OMCs sell petrol blended with ethanol up to 10%.

During the ethanol supply year 2018-19, about 189 crore litres of ethanol was supplied by sugar mills and grain-based distilleries to OMCs thereby achieving 5% blending target and in the ethanol supply year 2019-20, efforts are being made to supply 190-200 crore litres of ethanol for blending with petrol to achieve 5.6% blending. In current ethanol supply year (ESY) 2020-21 (December to November) to achieve 8.5% blending target, about 325 Cr litres ethanol is required to be supplied to OMCs. As on 26.04.2021, about 349 crore litres ethanol have been allocated by OMCs to sugar mills/ distilleries. Also, in next ESY 2021-22, it is likely to supply more than 400 crore litres of ethanol to OMCs to achieve 10 % blending.

Ethanol Blended Petrol – Present & Future

The Government has 10% blending target for mixing ethanol with petrol by 2022 & 20% blending target by 2030. During recent revision Government has reduced the GST rate on ethanol meant for EBP Programme from 18% to 5%. In February 2023, prime minister launched "Roadmap for ethanol blending in India: 2020-2025". The scheme aims to use 20% ethanol blending compared to the present 10%. Hence a successful E20 programme can save the country \$4 billion per annum.

Current scenario of use of ethanol on consumers, OEM's and component manufacturers. (Source: ARAI, IIP, IOC (R&D))

Fuel efficiency:

While using E20 fuel, there will be drop in fuel efficiency by 6-7 % for four wheelers designed for E0 and calibrated for E10. 3-4% for 2 wheelers designed for E0 and calibrated for E10, and 1-2% for 4 wheelers designed for E10 and calibrated for E20. However, with the modifications in engines (hardware and tuning), the loss in efficiency due to blended fuel can be reduced.

Start ability:

In the E20 project, the results indicated that the test vehicles passed the start test and drivability test at hot and cold conditions with E0 and E20 test fuel. In all the cases, there was no severe malfunctioning or stall observed at any stage.

Ethanol Blended Petrol – Future Directives

The vehicle manufacturers need the following changes in production lines to produce compatible vehicles:

- Engines and components will need to be tested and calibrated with E20 as fuel.
- Vendors need to be developed for the procurement of additional components compatible with E20.
- There will be changes in the material of piston rings, piston heads, O-rings, seals, fuel pumps and allied parts. These parts can be produced in the country.
- The increase in the amount of ethanol could result in damage to some plastic, rubber and aluminum components. And this could affect the durability of fuel pipes, injectors, and hoses. Hence appropriate changes need to be incorporated in manufacturing of the above parts.
- Since the ethanol is hygroscopic, it absorbs water from the air, causing the fuel blend to separate. Ethanol can be extremely damaging to small engines, leading to corrosion of the engine and fuel system.



Conclusion

Engine requires some modification if pure ethanol is used as fuel, but any modification is not required in case of using ethanol and gasoline mixture as a fuel. Ethanol blended petrol will always have calorific value lower than that of petrol as pure ethanol has lower calorific value than petrol. This reduces fuel economy. On the other hand, ethanol blended petrol will have higher RON compared to petrol, which reduces knocking tendency and provides calibration optimization potential to optimize spark timing. Optimized spark timing can help in improving Full Load Torque by reducing Phasing losses and operating closer to MBT.

As evident from the above facts and figures it is imperative that to reduce the carbon footprint and for economical savings, ethanol blending is to be promoted at every nook and corner of the country. However, production of ethanol requires a large amount of land area to cultivate the biomass, thereby minimizing the land for food. Also, OEM's spend huge number of finances for research and development owing to cutting edge competition in the automotive market. As and when new pollution norms are introduced and such blending initiatives are taken, the companies will have to spend a lot of amounts in material research and development of new parts which ultimately is detrimental to reduced outputs in terms of production and increased costs.

A cumulative and inclusive growth strategy should be devised by the government in partnership with the public to facilitate production and use of ethanol for ultimate benefit to society.

References

- [1] Ankit Gupta, Ojase JAIN, Ranjeet Rajak. Study of Effect of Ethanol Blending on Performance & Fuel Economy of Naturally Aspirated Gasoline Engine and Engine Hardware Optimization Potential. 10TH SAE India International Mobility Conference. 2022..
- [2]Mortadha K. Mohammed, Hyder H. Balla, Zaid Maan H. Al-Dulaimi, Zaid S. Kareem, Mudhaffar S. Al-Zuhairy. Effect of ethanol-gasoline blends on SI engine performance and emissions. Case Studies in Thermal Engineering. June 2021, Volume 25.
- [3]Paolo Iodice, Giuseppe Langella, Amedeo Amoresano. Ethanol in gasoline fuel blends: Effect on fuel consumption and engine out emissions of SI engines in cold operating conditions. Applied Thermal Engineering, February 2018, Volume 130, 1081-1089
- [4]Mahesh K. Saini, Neelima Garg, Anil K. Singh, Ajay K. Tyagi, Utpal K. Niyogi and Rakesh K. Khandal. Ethanol Blended Fuel in India: An Overview. Journal of Biofuels. July - December, 2010, Vol.1 No.2, 209-219
- [5]Amit Pal. Blending of Ethanol in Gasoline:Impact on SI Engine Performance and Emissions. International Journal of Thermal Technologies. March 2014, Vol.4, No.1.
- [6] Ram Kunwer, Subrahmanya Ranjit Pasupuleti, Swapnil Sureshchandra Bhurat, Santhosh Kumar Gugulothu, Navjot Rathore. Blending of ethanol with gasoline and diesel fuel – A review. Materials today proceedings. 2022, Volume 69, Part 2, 560-563.
- [7] Ravinanath Narenthra Rao. Impact of Machine Learning Techniques in Precision Agriculture. In Proceedings of the 2020, 3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things, ICETCE, Jaipur, India, 7–8 February 2020; pp. 1–6.
- [8] Sparsh Sharma & Yash Sharma. Comparative Study of Ethanol-Blended Fuels Using a Stirling Engine Experimental Model. Recent Advances in Manufacturing and Thermal Engineering. March 2023.