COMPARISON OF S.I.ENGINE FUEL WITH GASOLINE AND GASOLINE ALCOHOL BLEND

Monika Bazzad[1], Hemant Upadhyay[2]
Department of Mechanical Engineering, Mahavir Swami Institute of Technology, Sonepat-131030, India

Abstract: Internal combustion reciprocating engines are vital in sustainability and ease of work in human life. They became the major role player in industries, power generation and agriculture, transportation (land, water and air). The major objective of this research study is to analysis the performance of S.I. Engine fueled by conventional fuels and fueled by renewable fuels (alcohols) and to find the economic feasibility and validation of the results. It will involve development and test performance on experimental results with Validation of experimental data.

I. INTRODUCTION

Heat engines have been serving human from last two centuries. Fuel for I.C. Engine is also the keen are of interest of researchers. Initially externally burnt gases are used external combustion Engines. During World War I major change in fuel burning and handling was discovered. During World War II lack of fossil fuel forced to introduce gasification technology to I.C. Engines. In 1970s increase in automobile and consumption of fossil fuel resulted in rising of price of fossil fuel. This was enough to pressurized researcher for sustainable improvement in efficiency. The continuous work increases the efficiency maximum up to 30%. The world reserves of primary energy and raw materials are, obviously, limited. According to an estimate, the reserves will last for 218 years for coal, 41 years for oil, and 63 years for natural gas, under a business-as-usual scenario. Increasing air pollution is one of the most important problems of developed countries today. Exhaust emissions from motor vehicles has a main role in this pollution. It is vital that the alternative fuel used must be produced from renewable resources and it must be usable directly without requiring any major changes in the structure of the engine.

Petrol fuel also known as gasoline is a complex mixture of hydrocarbon compounds. Gasoline is a liquid; it can be colorless, pale brown or pale pink. Gasoline is produced by refining petroleum, and it consists of a complex mixture of over 150 chemicals. The actual make-up of these chemicals varies by petroleum source, manufacturer, and even the time of year. Primary chemicals are benzene, toluene, ethyl benzene, xylenes; and oxygenates, including methyl tert-butyl ether (MTBE). Gasoline may also enter the environment without combustion, as liquid and as vapors, from leakage and handling during production, transport and delivery, from storage tanks, from spills, etc. Spark ignition engines are designed to burn gasoline in a controlled process called deflagration. Alcohols fuels are an attractive fuel because they can obtained from both natural and manufactured sources. The first four aliphatic alcohols (methanol, ethanol, propanol, and butanol) are of interest as fuels because they can be synthesized chemically or biologically, and they have characteristics which allow them to be used in current engines. One advantage shared by all four alcohols is their high octane rating. Alcohol's production is cheaper, simple and eco-friendly. This way, alcohol would be a lot cheaper than gasoline fuel. Alcohol can be produced locally, cutting down on fuel transportation costs. Alcohol can be used directly in an engine or it can be blended with gasoline or diesel fuels. Alcohol fuels can be successfully used as IC engine fuels. Methanol, just like ethanol, contains soluble and insoluble contaminants. These soluble contaminants, halide ions such as chloride ions, have a large effect on the corrosively of alcohol fuels. Butanol and propanol and butanol are considerably less toxic and less volatile than methanol.

To identify the new field of research works, and to know the state of the art, extensive literature is collected in all the diverse fields of Performance evaluation of multi cylinder Engine and improvement. To understand and interpret the previous works on different aspects related to the formulation of the present research problem, the literature available in various sub areas of Multi cylinder S.I. engine study are considered. An effort is made to review the literature based on defined broad objectives as well as identified literature features related to proposed work.

Numerous research papers have been published on this area of research. The sources for our study consisted of, scientific referred journals (international and national), text books, and doctoral dissertations and refereed conference proceedings. Publications other than English in language and non-refereed professional publications were not included. The keywords such as, Multi cylinder engine, S.I. Engine, Performance evaluation etc. were used to explore research articles. Rong-Horng Chen discussed that during the open-loop control of ECU on fuel injection rate in the cold-start period, the fuel injection rate is roughly the same for all fuels used. This made the percentage of excess air in the air/fuel mixture of E5, E10, E20, E30, and E40 to be 2%, 4%, 9%, 14%, and 19%, respectively. [1] Yoon and Lee investigate the effects of neat bio ethanol combustion on the performance and emission reduction characteristics of a spark ignition (SI) engine at various air temperature conditions. The investigated results show that as intake ambient air temperatures is decreased, the intake flow rates is increased by the increased density of the intake air. [2] B.M. Masum discussed that prospect of fuel ethanol as a gasoline substitute. Then it discusses comparative physicochemical properties of ethanol and gasoline. The slight differences in properties between ethanol and gasoline fuels are enough to create considerable change to combustion system as well as behaviors of SI engines. [3] Anirudha Ambekar discussed the complexities involved in the combustion process of nitro methane sprays, a more elaborate approach with detailed measurements and results is warranted. [4] Curto-Risso experimentally observed fluctuations of heat release in an Otto engine. The model relies on the first law of thermodynamics applied to open systems that allows to build up a set of first order differential equations for pressure and temperature inside the cylinder. [5] Yildiz studies the fuel-to-air ratio (FAR) control problem in port-fuel-injection (PFI) spark-ignition (SI) engine. Two controllers, an Adaptive Feed Forward Controller (AFFC) and an Adaptive Posicast Controller (APC), have been developed and implemented in a test vehicle. [6] Yousef discussed the effects of progressive combustion, valve timing, heat transfer, and friction on performance were obtained for both S.I Engine and CI Engine over a wide range of operating loads and speeds. Performances with gasoline and diesel fuels were compared over a range of operating speeds for the same engine. [7] Longhua Chen discussed the phenomenological model for the knock onset in the SI engine operated with both fuel enrichment and cooled EGR has been developed, and the methodology of the knock model calibration considering the effects of the temperature at IVC and the ratio of specific heats (c) on the temperature of end gas has be discussed in detail. [8] J. Arroyo founded that at a fixed ignition timing, presence of hydrogen in synthetic blends entailed an increase in maximum pressures and a reduction in the maximum pressure angle compared with methane and biogas at the same condition. [9] Bai and Wang discussed that the exhaust gas trap (EGT) for the part-load performance, including energy conversion, combustion and emission characteristics in a DISI engine. It is found that: EGT is an effective strategy for improving fuel economy in DISI engines. [10] Silveira describes that the fuel cell as a good alternative to urban transport, promoting environmental and life quality. Comparing with ICE buses, the FC buses have many advantages: Combustion process is not necessary, consisting in a direct energy conversion, decreasing pollutants emissions. [11] Internal combustion engines are seen every day in automobiles, trucks, and buses. The name internal combustion refers also to gas turbines except that the name is usually applied to reciprocating internal combustion (I.C.) engines like the ones found in everyday automobiles. Two different fuel samples were experimentally investigated during this study. Unleaded gasoline and Ethanol, with a purity of 99%, was used in preparing the blends. The unleaded gasoline was blended with ethanol to get 5 test blends ranging from 0% to 25% ethanol with an increment of 10 %. The fuel blends were prepared just before starting the experiment to ensure that the fuel mixture is homogenous and to prevent the reaction of ethanol with water vapor.

II. PERFORMANCE ANALYSIS

Equivalent A/F Ratio

The effect of the ethanol–unleaded gasoline blends on the equivalence air–fuel ratio is shown in Fig. 4.2. As shown from Fig. 1 the equivalence air–fuel ratio decreases as the E% increases to 20%. This effect is attributed to two factors: (1) the decrease in the stoichiometric air–fuel ratio of the fuel blends, since the stoichiometric air–fuel ratio of ethanol fuel is usually lower than that of the unleaded gasoline fuel and (2) the increase of actual air–fuel ratio of the blends as a result of the oxygen content in ethanol. For E% exceeding 20%, the behavior is reversed because the actual air–fuel ratio decreases. It is obvious from Fig.1 that as the engine speed increases to 3032 rpm, decreases, since the amount of air introduced into the engine cylinder increases i.e., the air–fuel ratio increases. This is due to the increase of the amount of air introduced to the engine cylinder (i.e., the actual air–fuel ratio increases). This is due to the increase in the pressure drop from atmospheric pressure to cylinder pressure. Therefore, a greater decrease in the cylinder pressure occurs. With a further increase in the engine speed beyond 3032 rpm, ϕ increases, since the air flow into the cylinder, during at least part of the induction process becomes choked. Thus, the amount of air decreases (i.e., the actual air–fuel ratio decreases).

Table Equivalent A/F Ratio at Variable Speed of Engine and Different Fuel Blends of Gasoline-Ethanol

Equivalent A/F Ratio					
Speed	E0	E10	E15	E20	E25
2084	12.77	12.18	11.99	11.82	12.85
3032	11.88	11.65	11.48	11.19	11.98
4057	11.98	11.69	11.58	11.30	12.03
5084	11.99	11.82	11.76	11.64	12.56

In this table explain Equivalent A/F Ratio at variable speed(2000-6000)rpm and different fuel blends of Gasoline-Ethanol (E0-E25).From this table we have seen that the value of Equivalent A/F ratio decreasing when ethanol percentage increases in fuel blends.

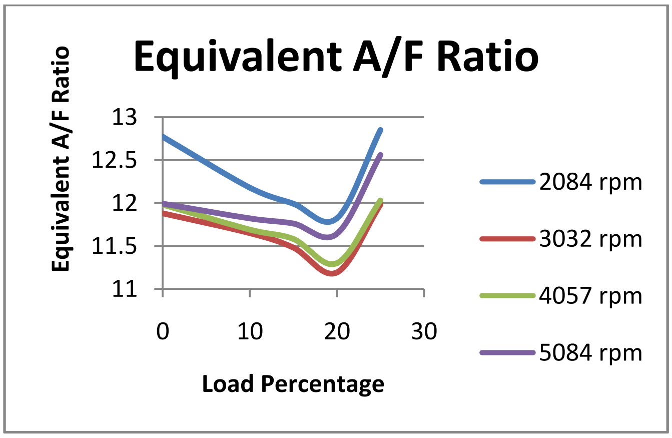

Figure: 4.2 Effect of the ethanol gasoline blends on the equivalence air–fuel ratio

Brake Specific Fuel Consumption

Fig. 8 shows the effect of using ethanol–unleaded gasoline blends on brake specific fuel consumption. As shown in this figure, the BSFC decreases as the E% increases up to 20%. This is a normal consequence of the behavior of the engine brake thermal efficiency shown in Fig.3.On the other hand, as the engine speed increases to 3032 rpm, the BSFC decreases. This is due to the increase ηb.th and decreases in equivalence air–fuel ratio (Figs. 4.2 and 4.4). A further increase in engine speed results in increasing BSFC, since ηb.th decreases and equivalence air–fuel ratio increases.

Table No-4.7 Brake Specific Fuel Consumption at Variable Speed of Engine & Different Fuel Blends of Gasoline-Ethanol

Brake Specific Fuel Consumption					
Speed	E0	E10	E15	E20	E25
2084	0.49	0.43	0.40	0.38	0.54
3032	0.53	0.42	0.39	0.36	0.51
4057	0.56	0.47	0.42	0.39	0.58
5084	0.58	0.54	0.49	0.47	0.68

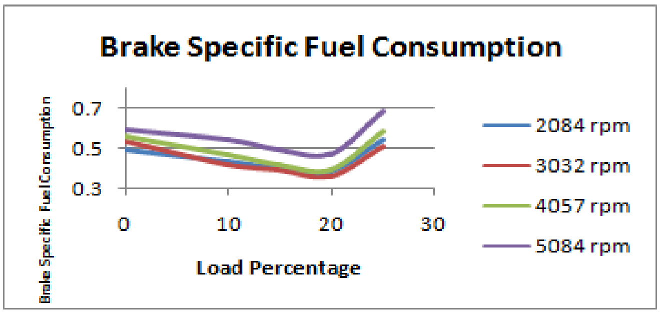

Figure: 4.7 Effect of the ethanol–gasoline blends on the Brake specific Fuel Consumption

The effects of ethanol addition to unleaded gasoline on SI engine performance at variable engine speeds were investigated. The average changes and the mean of the average changes in the values of the parameters of engine performance for all fuel blends and the five different engine speeds obtained from the experimental runs are summarized in Table 4.8.

The results are validated with Hsieh et al who studied the effect of ethanol-unleaded for Gasoline blends on engine performance and exhaust emission.

Table-4.8 The Summarized results of performance analysis at various speeds at different blends of fuels

Engine Parameter					**Mean Average Value %**
	2084	**3032**	**4057**	**5084**	
Equivalent ratio	8.037	6.166	6.017	3	5.805
Brake Specific Fuel Consumption	0.289	0.472	0435	0.255	3.628

III. CONCLUSION

From the research done on performance evaluation of multi cylinder S.I. engines, the conclusions can be deduced as the brake specific fuel consumption and equivalence air–fuel ratio decrease by about 3.628% and 5.805% mean average value, respectively. The 20% ethanol fuel blend gave the best results of the engine performance. The addition of 25% ethanol to the unleaded gasoline is achieved in our experiments without any problems during engine operation. Ethanol could reduce petroleum imports, improve the balance of payments, improve national energy security, and reduce the reliance on petroleum from unstable areas of the world. Bio ethanol if cheaply produced can reduce demands for fossil fuels and the growth in fossil fuel prices. The present work demonstrates that the use of ethanol–gasoline blended fuels will marginally increase the torque power and decrease the brake specific fuel consumption.

REFERENCES

[1] Rong-Horng Chen , Li-Bin Chiang , Chung-Nan Chen , Ta-Hui Lin,“Cold-start emissions of an SI engine using ethanol gasoline blended fuel.”Applied Thermal Engineering 31 (2011) 1463-1467.

[2] Seung Hyun Yoon, Chang Sik Lee,“Effect of undiluted bioethanol on combustion and emissions reduction in a SI engine at various charge air conditions.”Fuel 97 (2012) 887-890.

[3] B.M. Masum, H.H. Masjuki, M.A. Kalam, I.M. Rizwanul Fattah, S.M. Palash, M.J. Abedin, “Effect of ethanol–gasoline blend on NOx emission in SI engine.”, Renewable and Sustainable Energy Reviews 24 (2013) 209–222.

[4] Anirudha Ambekar, Ritesh Bhangale, Rik Chatterjee, Chinmay Kulkarni, Sudarshan Kumar, Arindrajit Chowdhury, “ Glow-plug-assisted combustion of nitromethane sprays in a constant volume chamber.” Applied Thermal Engineering 76 (2015) 462-474.

[5] P.L. Curto-Risso, A. Medina, A. Calvo Hernandez, L. Guzman-Vargas, F. Angulo-Brown, “On cycle-to-cycle heat release variations in a simulated spark

ignition heat engine." Applied Energy 88 (2011) 1557-1567.

[6] Yildiray Yildiz, Anuradha M. Annaswamy, Diana Yanakiev, Ilya Kolmanovsky, "Spark ignition engine fuel-to-air ratio control: An adaptive control approach." Control Engineering Practice 18 (2010) 1369-1378.

[7] Yousef S.H. Najjar, "Protection of the environment by using innovative greening technologies in land transport." Renewable and Sustainable Energy Reviews 26 (2013) 480-491.

[8] Yun-long Bai, Zhi Wang, Jian-xin Wang, "Part-load characteristics of direct injection spark ignition engine using exhaust gas trap." Applied Energy 87 (2010) 2640-2646.

[9] Jose Luz Silveira, Lucia Bollini Braga, Antonio Carlos Caetano de Souza, Julio Santana Antunes, "The benefits of ethanol use for hydrogen production in urban transportation." Renewable and Sustainable Energy Reviews 13 (2009) 2525-2534.

[10] Longhua Chen, Tie Li, Tao Yin , Bin Zheng, " A predictive model for knock onset in spark-ignition engines with cooled EGR." Energy Conversion and Management 87 (2014) 946-955.

[11] J.Arroyo, F. Moreno, M. Muǹoz, C. Monné, N. Bernal, " Combustion behavior of a spark-ignition engine fueled with synthetic gases derived from biogas." Fuel 117 (2014) 50-58.

