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Experimental Analysis of Gasoline-Ethanol-Methanol Blend at Various Conditions in Engine

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Abstract

Renewable resources are minimal throughout the world and considerable research work has been carried out to develop fossil-based options. Aim of the research work is to evaluate performance and engine exhaust emissions of varying blends at different conditions in engine. The experiments are conducted to analyze the performance of three distinct gasoline-alcohol fuel mixtures EM25 (10 percent ethanol-15 percent methanol-75 percent gasoline) in a computerized 1-cylinder, 4-stroke, VCR SI engine. The additional tests are conducted using regular gasoline fuel to compare performance and engine exhaust emissions. The engine performance using mixed fuel of ethanol-methanol-gasoline (GEM) has been evaluated under the various operating conditions in the range of 1200 to 1800 rpm, Spark Timings (ST's) 100, Air Fuel Ratio 0.9 at constant Compression Ratio (CR) 10:1. When the vehicles operated with ethanol-methanol- gasoline mixtures then it has found that there is the reduction in HC, CO_2, CO exhaust gases contents while 14% increments in NOx emission as compared with regular gasoline fuel. It is also observed that the brake power/brake torque is decreased when operated on ethanol-methanol-gasoline fuels as compared to pure gasoline. However, it has been revealed that BSFC is enhanced in comparison to regular gasoline.

Keywords: *Blend, Emission, Ethanol, Methanol, Performance, SI Engine*

1.0 Introduction

A higher octane rating may be without difficulty acquired through right ternary fuel mixing (GEM) formulations than binary ethanol, one GEM is greater reasonably priced than GE blends. Ternary fuel blend ought to enhance power security, lessen CO_2 emissions, and be reasonably priced on a cost- per-unit basis in comparison to fuel. As a consequence, everyday alcohol gasoline manufacturing extends for the duration of a bigger geographical area, imparting a much less sensitive supply of alcohol fuel to disruption. The excessive alcohol and gasoline additionally present a risk for a greater scattered, spiritedly allotted revenue source. The fine fossil fuel substitute is alcohol fuel. Because of the low value of biomass, coal, and natural gas acquired from alcohol, alternative gasoline production is drastically much less expensive. As both a basis, for nations that depend greater closely on fossil fuels, alcohol content material gasoline might be a greater essential substitute. Ethanol - gasoline is one of the finest opportunity fuels inside the transportation quarter for decreasing the poisonous sources of exhaustion into the environment. To enhance alcohols, experts have been examining the effects of Greenhouse Gases (GHG) on the vast amounts of natural land that are being converted to agriculture. For renewable development, energy plays an important role. The University of Minnesota early survey was completed regarding carbon debt and released the useful resources of use of changes for pristine land which

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are simple with present-day vegetation targeted towards producing alcohol-gasoline fuel.

All aspects of improvement in financial, societal, and health and environmental well as livelihoods, agricultural production, drinkable water, education, as well as physical and mental health are affected. The continuing upward push inside the sector's people in recent times is inflicting critical concerns. The provision of enough and affordable power performs a vital function in monetary improvement, converting from agricultural economies to superior commercial[1]. Gasoline and alcohol is presently the most often utilized sustainable octane enhancer. The addition of ethanol/ methanol to pure gasoline, to improve air quality by accelerating the fuel combustion of Alcohol, such as methanol/ethanol combined with gasoline to increase air quality. Furthermore, challenges such as phase separation in gasoline blends might occur however, this problem can be resolved by adding solvents. The corrosion issues with metallic fuel system components are also a possibility. One of the most severe consequences of incorporating alcohol is an increase in fuel instability. By utilizing tiny quantities of alcohol or adding another co-solvent, many of the issues caused by alcohol may be avoided[2]. The excessive emissions of Nitrogen oxides, Carbon dioxide (CO_2), Sulphur oxides, and Carbon monoxide (CO) come from the use of petroleum-based fuels in these engines. As a consequence, it appears that adopting an alternate fuel is vital. It will be extremely beneficial if this fuel is created from renewable resources and used without altering the engine's design or architecture.

Ethanol, which has been consumed since the late nineteenth century, is an adequate solution for this instance. Between mixtures, ethanol is the most often utilized in spark-ignition engines, and the most compelling cause forthis alternative is biofuel. In the automobile, alcohol burning creates far less Carbon monoxide and unburned Hydrocarbon. Because methanol (wood alcohol) is a renewable fuel, it burns more readily and produces less carbon monoxide due to the oxygen in its contaminant structure. It does not raise carbon dioxide levels and inhibits. The emission of this greenhouse gas. Methanol, on the other hand, is produced by combining carbon dioxide with hydrogen. When methanol is mixed with ethanol, its toxicity is lessened. Another advantage of this alcoholic fuel is that it evaporates more slowly than gasoline[3].

Replacement of conventional fuels is alternative fuels which are less pollutants, hazardous, reuse and eco-friendlier and have minimum production cost. Excellent alternative fuel is alcohol which is obtained from economical and unproductive sources, based on the prior qualities. In comparison to gasoline, it emits fewer pollutants into the atmosphere. It is a low-cost alternative fuel that may be generated in agricultural areas. Alcohol can also be made from household and industrial waste. So, they have greater flash points and ignition temperatures than gasoline, they are safer to handle and preserve. As a result, alcohol has a better octane number than gasoline. Adding alcohol to pure gasoline is a specific excellent option for improved economy, output energy, and fewer emissions. For these reasons, alcohol was combined into gasoline fuel with various concentrations, and its effect on engine performance was examined[4]. The concept of introducing a small portion of ethanol and methanol into fuel. Prior, alcohol was viewed as the most engaging fuel for use in gasoline. Dissimilar to gasoline, which is a non-environment-friendly energy source, alcohol might be produced using waste materials. Additionally, their flash aspect and auto-ignition temperature are better than gasoline, making them greater stable fuels. A variety of alcohols are applicable fuels to the gasoline engine but ethanol and methanol have phenomenal combustion characteristics. It is more to secure to hold and store the latent heat of evaporation of alcohol in between 2 to 3 instances to the baseline fuel, the temperature of the consumption manifold is drastically reduced, growing volumetric efficiency. Ethanol has a lower melting point than gasoline[5].

The mixing minor molecular mass of methanol or ethanol fuels into gasoline; they were employed as fuel extenders. Fermentation produces ethanol from sugars and starch. Charcoal, biofuel, or even natural gas can be used to make methanol at a reasonable cost. Alcohols are therefore preferable as alternative fuels, at least in terms of the origin requirement[6]. Alcohol, hydrogen, and natural gas are only a few of the candidates. The substitute fuel must have high thermal efficiency, minimum pollution, and be available for a long time. Natural gas and biogas are good fuels for Spark Ignition (SI) engines since they are comparable in many respects. Internal combustion engines have been able to run on these fuels with simple inlet manifold modifications. However, such fuels were mostly tested in stationary engines, with modest success in automotive engines. Ethanol and methanol, in particular, have shown significant promise as transportation fuels[7]. Alcohol production has expanded and become cheaper as a result of enhanced production technology, and they are also commonly accessible from biomass. Ethanol and methanol are blended with petroleum-based motor fuels to make a complete engine fuel. The less alcohol added, the easier it is to tackle common blending issues. Ethanol and methanol have nearly identical anti-knock properties. However, increasing the blend of alcohol content increases fuel consumption. As the usage of gasoline fuels in vehicles results in pollution, many countries are increasingly supporting the use of alcohol-gasoline blends in petrol pumps[8].

The rise in demand for petroleum-based fuels has stemmed from the world's expanding industrialization and motorization. A few reservoirs are capable of producing petroleum-based fuels. As a result, those countries lacking those supplies are facing an energy and foreign exchange crisis, owing mostly to crude petroleum imports. The alternative fuels must be sought that can be created using locally accessible resources such as vegetable oils, biodiesel, and alcohol. Blending modest volumes of alcohol with gasoline is a simple way to employ alcohol in IC engines. Butanol, ethanol, and methanol have received a lot of interest due to their lean operating capacity, which makes them extremely efficient and low-polluting future fuels. Blending modest volumes of alcohol with gasoline is a simple way to employ alcohol in IC engines. When compared with regular gasoline, alcohol burns with less CO, HC, and NOx. It lowers the maximum temperature in the combustion chamber, which results in lower NOx emissions and more power. Alcohol fuel contains oxygen, which results in soot-free burning with low particle levels[9].

In this research work deals with the combined ethanol and methanol with gasoline because it did not work. The use of biofuels is increasing due to the decline and exhaust of fossil fuels and also it releases the more amount of CO and other harmful gases which leads to environmental problems. The 'Aatma-Nirbhar Bharat Abhiyaan' blends ethanol with methanol with gasoline to reduce petroleum consumption. The SI engine while comparing engine performance analysis and fuel efficiency. Analysis of the alcohol blend and its compatibility in current vehicles or engines was being researched issues addressed by running various ethanol and methanol-gasoline mixtures through the engine. Here research objectives are (i) To identify the optimum ethanol and methanol mixture for gasoline in terms of performance and emissions. (ii) To estimate the reductions in emissions that various ethanol and methanol mixtures carry over gasoline. (iii) To examine how engine operating variables affect biofuel engines. India has discussed its biofuel strategy and is currently ready to employ more of them. GEM blends are strongly recommended in combination with gasoline-ethanol and blended fuels. GEM reduces the severity of single methanol blending vapor pressure as well as being more reasonably cheap than GE blends.

Globally many countries are planning to reduce emissions and increase and the fuel economy. The uses of commercial alcohols in the form of fuel blending, and suitable corrosion anticoagulant dosages are best suggested for Gasoline-Ethanol-Methanol (GEM) ternary mixtures. It was also observed that the use of 25% ethanol or methanol will lead to problems and below this, no modification in the vehicle engine is required. To deal with related issues and to overcome the problems associated with the use of more % use of ethanol and methanol, the blending of fuels like ethanol and methanol is proposed in this research work. The complete analysis is planned to reduce the emissions by using ethanol E10 and E25 without adding additives.

2.2 Literature Review

Stephen Sakai and David Rothamer[10]. This paper demonstrates that, despite, sometimes large changes in fuel characteristics, increasing ethanol percent results in a decrease in engine-out particulate. It was also found that engine running records can influence particulate data, which, if ignored, might have consequences for the study and optimal solution. Sebastian verhelst *et al.*,[11] study shows that the tank-to-wheel portion was primarily investigated in the current article since it emphasized the usage of methanol in combustion engines. To comprehend the higher engine efficiency of methanol than instance gasoline engines, it has analysed methanol's characteristics as an engine fuel. Narayanan Kannaiyan Geetha *et al*[12]. The paper presented that blends of gasoline and ethanol perform well with spark-ignition engines. It was revealed that BSFC was rising with increasing compression ratio and ethanol content in gasoline. Similarly, BTE rises as ethanol blend and compression ratio rise. NOx emissions decreased as the ethanol content in gasoline increased. With an increase in compression ratio, HC emission was minimized. So far, CO emissions have fallen as the compression ratio has risen. M. M. Namar *et al*[13].

This paper's findings reveal that the model can yield accurate data on engine performance over the whole range of fuel composition, from complete ethanol to pure gasoline. Also, when an engine is driven at 3000 rpm per minute, it produces the most power while using the least amount of gasoline. Moreover, the E-45 combination yields the optimum performance while increasing NOx emissions by 60% over pure petrol. As a result, it may be used as a design basis for the engine in the research study. Juan Tibaquira *et al*[14]. In this study collected data revealed that when cars run on a combination of 20% v/v ethanol and 80% v/v gasoline (E20) instead of gasoline, there are statistically no significant changes in these variables. The outcomes were constant for the first 100,000 kilometers that the cars were in use. Simeon Iliev[15] shows that the term "gasoline" refers to a type of fuel. When mixed gasoline was used instead of conventional gasoline, the engine Brake Power (BP) was reduced and the BSFC was raised. While emissions are decreasing, NOx levels are increasing. The percentage of mixed fuel rises CO and HC levels climb. When mixed fuel is utilised M30/E30 is a combination of M30 and E30. Emissions might climb by as much as 30% NOx emissions increase dramatically due to an increase in the proportion of ethanol and a reduction in the percentage of methanol when methanol is utilized.

Researchers found that the ethanol-methanol-gasoline fuel blends are appropriate for use. Common changes in BSFC, BP, and BTE for all speed ranges and different blends percentages with 4.92%, 4.62%, and 1.45% then a reduction in mean average of HC, NOx, and CO by 16.01%, 8.16%, and 7.55% for alcohol-gasoline blends. When increasing the percentage of methanol or ethanol fuel in mixtures there will be an increase in maximum cylinder pressure[16]. The results showed that regular gasoline has lower cylinder pressure as compared with fuel mixtures. The higher heat release rate is due to the rate of alcohol increase in the fuel blends that's why combustion duration becomes shorter with the addition of advanced spark timings for alcohol blends to get maximum brake torque. Abdulfatah A Y *et al*.,[17] have carried out a study comparison with pure Gasoline Methanol-gasoline (GM) mixtures showing as light rise in brake torque and brake power while BSFC is higher. Gasoline-Ethanol-Methanol (GEM) mixtures indicate that a decrease in emissions while improving the performance by using Gasoline-Ethanol (GE) mixtures, represents a lower BSFC and increment in BT as well as BP. The larger quantity of methanol with ethanol provides the more torque and brake power[18]. The exhaust emissions like carbon monoxide, and hydrocarbon decreased while engine Brake Power (BP), Volumetric Efficiency (Vol. Eff), and Brake Torque (BT) improved. It was a reduction in UHC as compared with other fuel mixtures i.e., using blends of Ethanol and Methanol (EM). It indicates a rise in efficiency than regular gasoline with lower emissions.

Mohammed Kamil and Ibrahim Thamer Nazzal[19] have studied the outcomes shown during the range of operating speed it has demonstrated increased BP and BTHE in comparison with regular gasoline fuel. Additionally, there was a decrease in emissions by exhaust gas temperature when the BSFC increased in comparison to the baseline fuel. Mainly enhancing engine performance and raising the mileage as well as decreasing the emissions of alcohol elements are strongly suggested. Ashrafelfasakhany[20], in this paper as compared to pure gasoline GEM mixtures have reduced exhaust gas emissions such as HC and CO although the motor was driven. CO and HC emissions are reduced while using GM fuel mixture representing moderate exhaust emissions occurring between both pure gasoline fuel as well as GEM mixtures. Highest Volumetric Efficiency (Vol. Eff) torque with GM mixtures. Further GM shows the highest BP during the time medium of BP, BT, Vol. Eff in comparison to baseline fuel but gasoline indicated minimum Vol. Eff, torque, and brake power among all other fuel blends. Ahmet Necati Ozsezen and Mustafa Canakci[21], in this paper, outcomes demonstrated that rise in THE, BSFC, combustion efficiency, BT, and BP by utilizing alcohol mixtures. An increase in CO_2 at the same time and reduction in the NOx, CO, and HC in addition to heat release rate and cylinder gas pressure primarily comes out. Ibrahim Thamer Nazzal *et al*.,[22] represent, that the Brake Power (BP) enhanced slightly by utilizing GM and GE mixtures in terms of speed and their effects in addition to BSFC, and THE was found enhanced than gasoline while Exhaust Gas Temperature (EGT) reduced concerning baseline fuel. Despite the substantial investigation, no literature has been determined evaluating how utilizing an ethanol-methanol-gasoline blend affects a systematic comparison of all performance and emissions characteristics. These two characteristics were also discussed in this paper. Most of these investigations have been done on engines that use either combustion engines or a port fuel injection system. It conducted several studies on a single-cylinder, four- stroke, variable compression ratio SI engine that covers a range of loads (from zero load to full load) while maintaining engine speed between 1200 rpm and 1800 rpm at a constant Compression Ratio (CR) of 10:1. The variation in previous literature meant that a more thorough and robust understanding of the effect of ethanol and methanol is required.

2. Experimental Methodology

The objective of the research is to acquire an understanding of engine exhaust emissions and performance with mixtures or combinations of Gasoline-Methanol-Ethanol (GEM). The emissions as well as performance analysis with various percentages of mixtures of GE, GM, and GEM at four different engine operating speeds ranging from 1200-1800 rpm. In this research, the experiment was conducted using various combinations of E10, M15, and EM25 fuel has been carried out at Apex Innovation Pvt. Ltd research laboratory. For this investigation, we employed "UN- 1170 Ethanol" as well as "UN -1230-Methanol" both of which were purchased from dealer Impression Chemicals Enterprises (ICE). Initially take 5-10 ml of water and mixed into commercial gasoline. The homogeneous mixture of fuel and water is done before the conduction of experiments. The ethanol and methanol are mixed into the gasoline to obtain mixtures containing 75% by volume of gasoline, 10% by volume of ethanol, and 15% by volume of methanol composition are designated EM25. The experiments are conducted on a computerized 4-stroke, Single cylinder, Variable Compression Ratio (VCR), and Spark Ignition (SI) gasoline engine. Testing is conducted at an optimal running speed of 1800 rpm by varying mixtures and speed from 1200 to 1800 rpm at a Compression Ratio (CR) 10:1. During tests spark timings, air-fuel ratio, and compression ratio for different types of mixtures and the analysis was carried out using AVL DIGAS 444 Gas Analyzer for the exhaust emissions analysis.

2.1 Experimental Setup

The test rig consists of a computerized 4-stroke, Single cylinder, Variable Compression Ratio (VCR), Kirloskar, make 4.5 kW (TV1) Spark Ignition (SI) engine operated on Ethanol-Methanol-Gasoline (GEM) fuel mixtures without modification in an engine is shown in Figure 1. Figures 2. Represents the details of a Test rig setup. Experiments are conducted by maintaining spark timings (STs) 10^0, air-fuel ratio (A/F) 0.9, and compression ratio CR 10:1, during the engine operation at a speed ranging from 1200 to 1800 rpm.

Figure 1. Computerized Variable Compression Ratio (VCR) gasoline engine.
Source: Apex Innovations Pvt. Ltd.

Before starting the engine made sure that the safety precautions of equipment are strictly followed. To check the power supply switch off and no load conditions are verified. Before starting an engine poured the blended fuel into the fuel tank. After reaching the engine steady-state conditions at a speed of 1800 rpm are attained. The position of the control panel knob operated to load the engine directly using an eddy current dynamometer. The time taken to consume fuel is recorded by using a stopwatch load for 12cc of fuel consumption. Emissions are measured using "AVL DIGAS 444" gas analyzer. For analysis of combustion and overall engine performance connect the computer with the installation of Labview software. The same experimental procedure is repeated under different engine operating conditions for Ethanol-Methanol-Gasoline (GEM), and regular gasoline fuel.

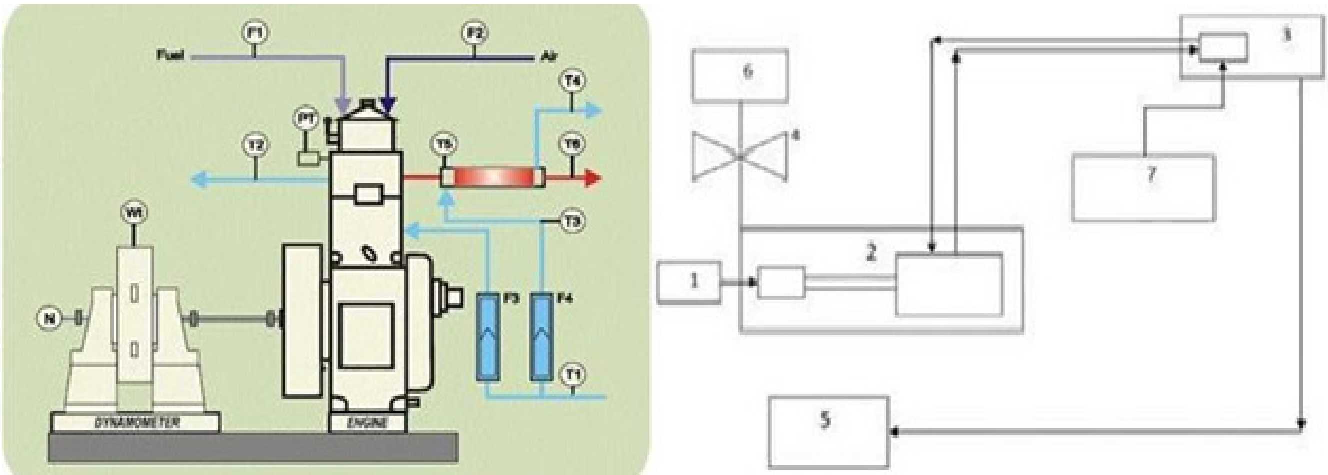

Figure 2. Block diagram of Experimental set up, **(a)** Diagram **(b)** Line diagram.

We have taken each reading four times for emissions and performance analysis.

3.0 Results and Discussion

In addition to exhaust emission and engine performance analysis with GEM mixtures on 4-stroke, 1-cylinder, VCR petrol engine. Research work was carried out with a petrol engine at various operating speeds during 1200 tom1800 rpm for E0, and EM25 mixtures. With constant CR 10:1 maintain AFR 0.9 and Spark Timing (STs) for 10 degree. For different operating conditions engine performance as well as emission characteristics for utilizing EM25 mixtures relative to E0 fuel. The following sections represent the effects of EM25 mixtures in varying percentages from 0% to 25% on performance parameters like BP, BSFC, BT, and emissions parameters like CO_2, CO, HC, and NOx relative to the engine speed.

3.1 Engine Performance Characteristics

The engine performance is assessed by considering torque, power, and Break specific Fuel consumption and their effects on speed by varying speed from 1200 to 1800 rpm. The effect on performance has been assessed by blending the gasoline + ethanol (E10), gasoline + methanol (M15), and gasoline + ethanol + methanol (EM25) the results obtained results are compared with pure Gasoline.

3.1.1 Brake Torque vs Speed

Figure 3 indicates the variation of brake torque with engine speed for E0, E10, M15, and EM25 mixtures with a rise in speed. Proportionally decreases in brake torque were noticed for all test fuels. Brake torque was decreased for M15, E10, and EM25 relative to E0. The outputs observed that we get the same engine torque for fuel blends of E10, M15, and EM25. Finally, the moderate level of engine torque of EM25 among the other two blends E10 and M15 was observed while the lowest brake torque was noticed among all other fuel blends.

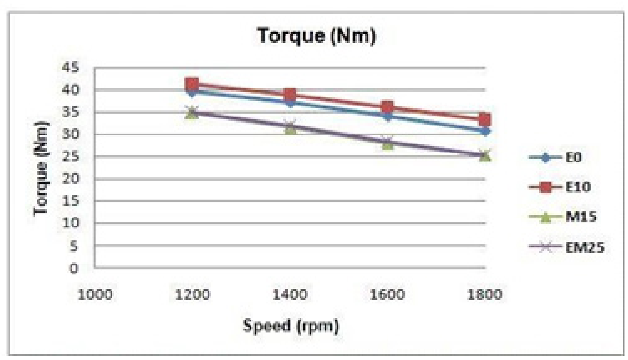

Figure 3. Effect of speed on torque.

3.1.2 Brake Power vs Speed

Figure 4 represents the variation of BP on engine speed for E0, E10, M15, and EM25 blends plotted graphically.

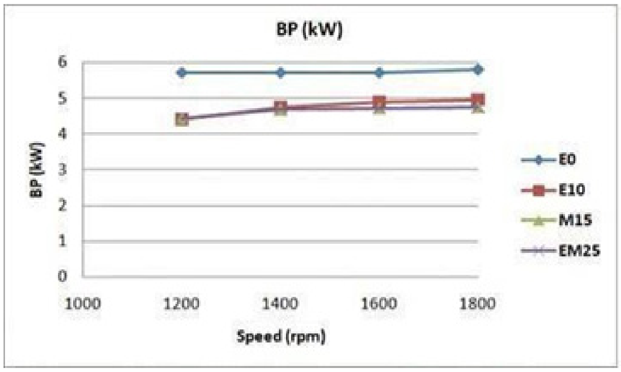

Figure 4. Effect of speed on brake power.

Decrease in brake power via employing E10, M15, and EM25 fuel blends relative to the E0 fuel with an engine speed of 1800 rpm. Fuel blends E10, M15 and EM25 show the lowest BP while E0 gives the highest among all test fuels.

3.1.3 Brake-Specific Fuel Consumption vs Speed

Figure 5 shows graphs of BSFC against engine speed for E0, E10, M15, and EM25 fuel blends. In graphs, it represents a rise in Specific Fuel Consumption (SFC) for fuel blends E0, E10, M15, and EM25 with higher engine speeds. Percentage increase in contents of alcohol will increase in BSFC relative to the baseline fuel because of LHV of blended fuel than gasoline. Improving the anti-knock properties of fuel due to the increasing amount of alcohol in the blends.

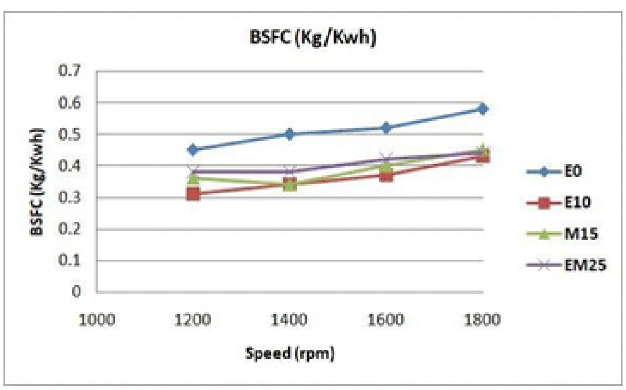

Figure 5. Effect of speed on brake-specific fuel consumption.

3.2 Engine Emissions Characteristics

3.2.1 Carbon monoxide vs Speed

Figure 6 indicates the carbon monoxide versus engine speed graph is plotted. As the increase in speed a reduction in the percentage of CO for E10, M15, and EM25 mixtures relative to pure gasoline. A moderate level of emissions showed in the E10 blend and pure gasoline while the lowest emissions occurred in the M15 blend. A decrease in CO emissions due to the percentage of ethanol and methanol fuel increase into pure gasoline is why to improve in combustion.

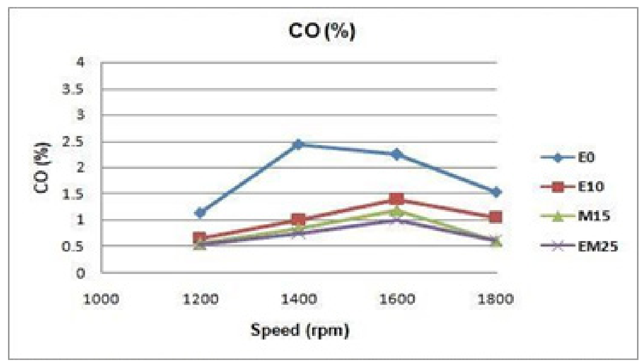

Figure 6. Effect of speed on Carbon monoxide.

3.2.2 Hydrocarbon Vs Speed

Figure 7 indicates graphs of HC versus engine speed. Decrease in the amount of hydrocarbon emissions even as a rise in speed we go from pure gasoline to gasoline-

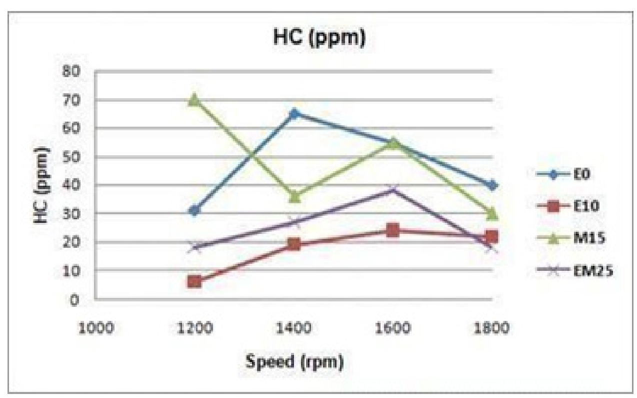

Figure 7. Effect of speed on Hydrocarbon.

ethanol-methanol mixtures. Among all test fuels M15 blend showed the lowest HC emissions while the E10 blend presented a moderate level of exhaust emissions. When the amount of ethanol and methanol is increased, the percentage of HC concentrations falls. Combustion improved due to a reduction in HC emissions are about 3.5%, 2.93%, and 3.06% for E10, M15, and EM25 at 1800 rpm relative topure gasoline.

3.2.3 Nitrogen Oxide vs Speed

Figure 8 shows graphs of NOx versus engine speed for different fuel blends. As we rise in speed there is a reduction of NOx emissions for fuel blends E10 and M15, while an increase in EM25 in comparison with E0. With declination in NOx emissions, we shift from pure gasoline to mixed blends. Minimum exhaust emissions NOx in comparison to speed and CR. The use of the E10 fuel blend has resulted in a significant reduction in NOx emissions. Values of NOx emissions have been reduced for different engine speeds. Fewer NOx emissions are produced by alcohol- gasoline fuel blends as compared to E0. The flame temperature of methanol is lower than E0 which gives better combustion and reduces NOx concentration. Nox concentration is reduced depending on the content of higher alcohol.

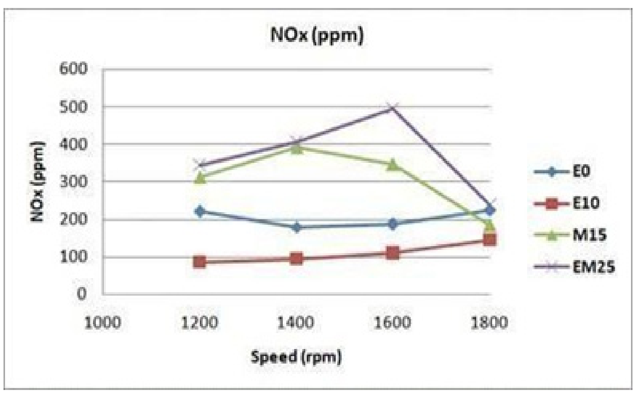

Figure 8. Effect of speed Nitrogen oxide.

3.2.4 Carbon dioxide vs Speed

Figure 9 shows the effects of E0, E10, M15, and EM25 fuel mixture on CO_2 emissions with various engine speeds. Lower in CO_2 emissions as a result of an increase in the amount of alcohol in the gasoline. There is a significantly reduced problem of emissions induced by gasoline in IC engines using ethanol and methanol as alternative fuels which can result in the safety of the environment and people's health. Outcomes showed that CO_2 emissions decreased by about 3.06% for EM25 fuel blends relative to the E0 fuel. With lower to medium engine speeds and higher at a maximum speed of 1800 rpm, CO_2 emissions are reduced for E10, M15, and EM25. For E0 as speed increases CO_2 emissions are reduced.

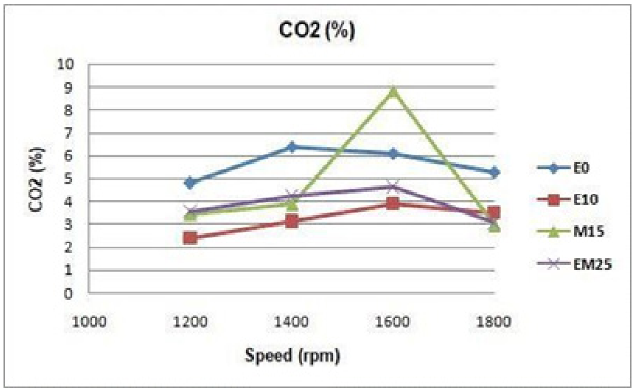

Figure 9. Effect of speed on Carbon dioxide.

The influence of EM25, E10, and M15 fuel mixtures on engine torque when compared to pure gasoline (E0). For E10 when compared to E0, there was a significant rise in engine torque a maximum of 16.66% increase was found at 1800 rpm. The anti-knocking characteristic of ethanol fuel blends is improved by their higher octane number, which enables more advanced timing, which raises combustion pressure and enhances engine torque. The experimental results revealed that using the gasoline blend E10 enhanced brake torque in comparison to E0. Ethanol-methanol-gasoline blends had a medium amount of torque related to methanol-gasoline as well as ethanol-gasoline blends, while pure gasoline had the least torque of all fuel blends. Brake power was enhanced for EM25, E10, and M15 as compared to E0. At 1800 rpm, a rise of 1.64%, 1.45%, and 1.39% was found for EM25, E10, and M15, respectively, as relative to E0. Because of their greater heat of vaporization as well as lower stoichiometric AFR ratios, alcohol blends reduce the fuel-air charge to a great extent, increasing the charged density and, as a result, their Brake Power (BP) relative to gasoline. Also, the use of an ethanol-methanol combination with gasoline raises fuel density, which optimizes engine volumetric efficiency and consequently brake power. Moreover, the anti-knock effects of alcohols allow for a larger compression ratio and hence a better brake power. When comparing blended fuels EM25 and M15 to gasoline, a slight rise in brake-specific fuel consumption has been noted E0. At 1800 rpm EM25 as well as M15 has a maximum increment of 0.44 Kg/Kwh and 0.43 Kg/Kwh. This is caused by the EM25 As well as M15 reduced heating values compared to E0. Because the heating value and air-fuel ratio of the fuel blends change. EM25's increase in BSFC was 1% more than that of M15. Furthermore, the brake-specific fuel consumption marginally rose with mixtures M15 and EM25, however, it gradually declined up to the mixture E10, which led to a modest fall in the brake-specific fuel consumption of E10 relative to pure gasoline E0.

The absence of air in the air-fuel ratio or enough time to complete the combustion cycle, CO is a consequence of incomplete combustion. Its usage of alcohol-containing combined fuels has effectively diminished Carbon monoxide emissions relative to gasoline. It would be because ethanol and methanol are fuels that include oxygen, and the combustion process can increase their oxygen concentration in the combined fuels, affecting the properties of the blended fuels. The CO emissions of the E10, M15, and EM25 have, accordingly, declined by nearly 1.1%, 0.6%, and 0.7%. HC is mainly unburned exhaust gas produced by incomplete combustion. The use of methanol and ethanol in gasoline boosts combustion slightly, enhancing the completion of burning and thus minimizing HC emissions. With increasing engine speeds as well as the percentage of ethanol, and methanol in ethanol-methanol-gasoline blends, HC emissions were greatly reduced for all test fuels. As compared to regular gasoline, the HC emissions of E10, M15, and EM25 are reduced by almost 3.5%, 2.93%, and 3.06% at 1800 rpm, accordingly. With increasing engine speeds as well as the percentage of ethanol, and methanol in ethanol-methanol-gasoline blends, HC emissions were greatly reduced for all test fuels. As compared to regular gasoline, the HC emissions of E10, M15, and EM25 are reduced by almost 3.5%, 2.93%, and 3.06% at 1800 rpm, accordingly. Reduce NOx emissions by increasing the proportion of methanol in gasoline fuel. In comparison to pure gasoline, the estimated reduction in NOx emissions for all engine speeds was 1.96%, 2.53%, and 1.12% for GM, GE, and GEM combinations, respectively related to E0. Dual fuel mixtures can lower CO_2 emissions more than pure gasoline. CO_2 is non-toxic, although it adds to greenhouse gases. CO_2 concentrations were reduced utilizing alcohol with gasoline blends at 1800 rpm at full throttle valve opening with comparison to gasoline fuel. Because both methanol and ethanol contain fewer C atoms than gasoline, they emit less CO_2. CO_2 emissions from M15, E10, and EM25 were reduced by approximately 4.16%, 1.82%, and 3.35%, respectively, when compared to E0. Due to low engine exhaust emissions, we chose an air-fuel ratio of 0.9 at Spark Timings (STs) of 100 at constant CR 10. Therefore, it is ideal spark timing.

4.0 Conclusions

Material changes occur for mixtures greater than 25%. Tendency to rusting. Long-term storage for biofuel is not feasible with additives or inhibitors. Due to its lower calorific content, ethanol does not go as far and loses power. It was noted that EM25 burns cleaner than both E10 and M15 fuel blends. Among all blended fuels, M15 provides the lowest carbon monoxide and Hydrocarbon emissions. M15, EM25, and E10 show minimum CO and HC exhaust gases by about 0.6%, 15%, 0.611%, 1.04%, and 45% respectively relative to the E0. Even as a percentage of alcohol i.e., ethanol or methanol increased BSFC increased. Blended fuel gives higher BSFC relative to pure fuel. Fuel blended outcomes represented increases in BSFC for E10, M15, and EM25 than E0. As a consequence increments in Nox emissions by 14% increase as blended fuel relative to the E0. In overall outcomes, CO_2 emissions are lower for E10, M15, and EM25 fuel blends while for E0 at 1800 rpm there is a reduction in CO_2 emissions as engine speed increases.

5.0 Research Limitations

The BS4 engine is employed in experiments conducted. For blends of more than 25%, material changes. Corrosion tendency. For biofuel, long-term storage is not practical. Additives or inhibitors. Since ethanol has a lesser calorific value, it does not go as far and loses power. Corrosion issue along with well as non-starting engine due to water contamination through fuel. Gasoline and ethanol are hydrophobic and hygroscopic by nature. Separating water as well as the alcohol blend from the gasoline phase separately when the solution contains a minimal quantity of water above 10% ethanol fuel content. Without engine modification mixed with ethanol's basic features, the amount of ethanol that may be blended with gasoline cannot exceed 25%. We kept through that framework and ran as much as we could because ethanol may particularly damage mechanical and rubber parts like O- rings and gaskets causing leaking.

6.0 Future Scope of this Research

To work for higher blends above 25% like flex-fuel, E100, E85, and M100. To develop additive. To work on butanol. To increase the Compression Ratio (CR) of vehicles. To do research work on different vehicle models. To do work on the BS6 engine model. 25% add gasoline is highly dependable and may be utilized in more advanced and proven applications. The ideal concentrations of ethanol and methanol can be adjusted to assess for better analysis. For future development, such as the value of Lower Heating Value (LHV), it is crucial to refine and improve specific alcohol features by adding another biofuel source.

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