

Exhaust Emission Level Reduction Process in SI Engine by Isopropyl Alcohol as Gasoline Additive

Arul Thayammal Ganesan, Varatharaju Perumal, M. Abdul Kareem, Getachew Totsa Bisam



ABSTRACT: Alcoholic fuels have some significant advantages over other alternative fuels. The alcoholic fuels can be implemented in existing engines and they have the capability of reducing greenhouse gas emissions. In this experimental analysis, the performance and emission characteristics of Spark Ignition (SI) engine using isopropyl alcohol as additive to petrol and kerosene. This experimental evaluation deals with strategically analysis of SI engine by using two different combinations of fuels. Isopropanol has been doped with unleaded gasoline and kerosene in the volumetric ratio of 10%, 20%, 30% and 40% (IPA10, IPA20, IPA30 and IPA40). It has been observed that considerable reduction in carbon monoxide and hydrocarbon emission and increased Brake Thermal Efficiency (BTE) while the NOx emission was increased. Electrical loads have been applied in the engine with bulbs of different wattages of 15 Watts and 60 Watts. In each test one fuel will be supplied and the amount of electrical load that the engine may bear will be analyzed. The performance characteristics of the engine and efficiency have been analyzed. From the result obtained it has been observed that isopropyl additive mixture will give more efficiency and more economical.

Keyword: alcoholic, emissions, reducing greenhouse gas emissions.

NOMENCLATURE

CO	Carbon Monoxide	IPA	Isopropanol or Isopropyl Alcohol
CO ₂	Carbon Dioxide	ELPI	Electrical Low-Pressure Impactor
NOx	Oxides of Nitrogen	HC	Hydrocarbon
EGR	Exhaust Gas Recirculation	TDC	Top Dead Centre
GHG	Greenhouse gases	IC	Internal Combustion
SI	Spark Ignition	GHG	Greenhouse gases

I. INTRODUCTION

In this test evaluation, an exploratory assessment of SI motor utilizing alcohol fills from the essential aliphatic alcohol family isopropyl alcohol has been done.

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Formative and investigate rehearses for execution and overflowing improvement of IC motor had started in late 1800s. The rising of vehicle specialists between the long stretches of 1800–1930 to be unequivocal; Nicolaus Otto, Karl Benz, Gottlieb Daimler, Henry Ford and Rudolph Diesel encouraged to the headway of shine and weight start motor [1, 2]. For a great timeframe, their remarkable divulgements appeared to anticipate an essential work and didn't locate an other power source in vehicular frameworks straight up until this moment.

The IC motor has been the establishment for the profitable accomplishments for some bleeding edge advancements particularly in the utilizations of power age, transportation, development, at the sea debilitating, military and marine [3, 4]. Regardless, the brisk advancement in IC motor duty and movement wide colossal vitality use and certainly utilizes the vast majority of the incapacitating oil backup centrality [5, 6]. This brings negative effects on the proximity of condition, ecosphere, hydrosphere, geosphere, exosphere and ecosphere of the planet Earth [7]. Most importantly, the transportation region is subject for a goliath and making fragment of discharges that effects worldwide natural change [8, 9]. Attributable to the making worry of the inauspicious impact accomplished by fumes floods from IC motors towards climatic and natural issues, an International summit was held in Kyoto, Japan in 1997. The key issue considered is to discover a way to deal with settle the air centralization of ozone debilitating substances which causes an unnatural environmental change. One of the basic factors apparent by the steady ask about is the expending of hydrocarbon from oil auxiliary [10, 11]. In the advancing scene's natural change meeting (COP21) in December 2015, a noticeable understanding among 195 nations among the individuals from United Nation (UN) and European Union (EU) had been made an acclimation to control the discharge levels from IC motors. Propanol is a three-carbon structure, straight chain alcohol type that exists as two isomers; 1-propanol routinely known as n-propanol and 2-propanol which is by and large named as isopropanol/isopropyl alcohol [12]. These two isomers are seen as the potential choices to lighter alcohols like methanol and ethanol as mixing a manager in with diesel. It is for the most part in fluid structure and dry like different alcohols and is extraordinarily ignitable [13]. The economies of rich nations and the lifestyle of most of the residents depend on cars and light trucks. These vehicles contribute most of the carbon monoxide (CO), carbon-di-oxide (CO₂), volatile organic compounds (Hydrocarbons, HC), and Nitrogen oxides (Nox) emitted in cities. It is clear that motor vehicles are important to the economy and lifestyle. Importance goes well beyond the direct consumer expenditures and indirect (support) expenditures, such as roads, suburbs, oil wells, refineries, and service stations [14].



The oxo-blend process has been expected to pass on propanol from petrochemicals since it is the most down to earth technique [15]. There were not very different assessments that study the presentation attributes of propanol in IC motor to the degree motor execution and fumes discharges. Creation expenses of propanol have been perceived as the crucial explanation for the nonattendance of vitality for using propanol in IC motor [16]. Light oil is an ignitable hydrocarbon fluid. Light Company and the Downer Company were permitted to call their light oil "Light oil" in the United States. It finally changed into an outlined trademark. It is every once in a while spelled light oil in reasonable and mechanical utilization. The enunciation "light oil" is essential in a lot of Canada, the United States, Australia and New Zealand. It may be recommended conversationally as "kero". Light oil is all things considered called paraffin in the UK, Southeast Asia and South Africa. The most thick paraffin oil is utilized as a purgative. A waxy strong removed from oil is called paraffin wax. Light oil is all around utilized as fuel to control fly motors of transporter and some rocket motors, yet on the other hand is ordinarily utilized as a cooking and lighting fuel and for fire toys, for example, poi. In parts of Asia, where the cost of light fuel is upheld, it powers divisible engines on little computing vessels [17]. Oil a burnable fluid generally open in the Gulf area contain hydrocarbons with various atomic loads implanted with different other fluid regular mixes. Oil exists commonly and is found in geologic approaches underneath the Earth. Oil hints the trademark foul oils and other chose eventual outcomes of oil that are passed on by dealing with the refined raw petroleum. It is an oil subordinate formed by spoiling dead life structures for a critical timeframe, everything considered green advancement and zooplankton which are verified underneath sedimentary shake and experience certified warmth and weight [18]. Oil has been recuperated from its stock by and large by oil debilitating. This can be seen from the assessment of aide geology (at the chronicle scale), sedimentary bowl evaluation and store delineation (chiefly to the degree porosity and penetrable structures). The arrangement in point of confinement of various oil based items are utilized for its refining and partition into continuously number of purchaser things like oil, diesel and light fuel, dim top and the other compound reagents things utilized for making plastics and pharmaceuticals. Oil is utilized in gathering a wide blend of materials, and it is surveyed that the world eats up around 88 million barrels each reliably [19].

II. SINGLE CYLINDER FOUR STROKE SI ENGINE

A solitary chamber four stroke oil engines have been utilized for isolating in this paper is an IC engine. A stroke has been recommended here is the full thermodynamic assessment of the ensured four-stroke and two-stroke cycles isn't a clear task. Regardless, the assessment can be streamlined completely if air standard suppositions are used. [20] The following cycle, which anxiously looks like the genuine working conditions, is the Otto cycle. During typical development of the engine, as the air/fuel blend is being squeezed, an electric gleam is made to touch off the blend. At low rpm this happens close TDC. As engine rpm rises, the speed of the fire front doesn't change so the flash

point is progressed before in the cycle to permit an undeniably prominent level of the cycle for the charge to combust before the power stroke starts. This favored position is reflected in the differing Otto engine plans; the air (non-pressure) engine works at 12% ability anyway the compacted charge engine has a working productivity around 30%. The issue with squeezed charge engines is that the temperature ascending of the compacted charge can cause pre-start. The procedure of Engine game-plan with barricade appeared in Figure 1.



Figure 1 Single Cylinder 4 Stroke SI Engine Assembly with Electrical Load Test

The affinity for the compacted fuel blend to light early is obliged by the fabricated arrangement of the fuel. There are a few appraisals of fuel to oblige separating execution levels of engines. The fuel is modified to change its self starting temperature. There are two or three different ways to deal with do this. As engines are orchestrated with higher weight degrees the outcome is that pre-start is essentially progressively in danger to happen since the fuel blend is squeezed to a higher temperature going before conscious start. The higher temperature much more adequately vanishes empowers, for example, gasoline, which expands the reasonability of the weight engine. Higher pressure degrees in addition propose that the parcel that the chamber can push to pass on control is progressively observable (which is known as the Expansion degree). The octane rating of a given fuel is a degree of the fuel's confirmation from self-start. The particular of the engine subtleties is given underneath Table 1. A fuel with a higher numerical octane rating thinks about a higher weight degree, which ousts more noteworthy centrality from the fuel and much more sufficiently changes over that noteworthiness into critical work while simultaneously averting engine hurt from pre-start. High Octane fuel is in like way logically over the top.

Table 1. Technical specification

SL. No	Description	Detail
1	Manufacture	HONDA
2	Model No	1000k
3	Type of engine	Four stroke, single cylinder air cooled petrol engine
4	No. of cylinder	Single cylinder
5	Max B.P	750VA
6	Tank capacity	5litre
7	Direction of rotation	Clock wise
8	Phase	Single
9	Fuel used	Petrol, kerosene
10	Frequency/ Speed	50HZ/3600 RPM
11	Rated current	8.3 Amps 12 volt
12	Ammeter/ Voltmeter	0-5A/0-300v
13	Bulb Rating	625W

2.1. FUEL USED – PETROL

An oil treatment office, the crude oil being managed is detached into different 'cuts' thinking about their saturating degree. In barometrical refining, which is the fundamental time of this reliable strategy, the crude oil is warmed to 300°C-350°C and the more insecure zones, for instance oil and light fuel, are refined off. This leaves a progression called air improvement, which is then other than refined under vacuum. The guaranteed getting ready temperature of the improvement is 350°C-390°C, in any case since of the applied vacuum, the further convincing refining cut point is 500°C-560°C. This vacuum refining process yields further erratic things known as vacuum distillates and leaves a non-sensitive improvement of high thickness, which is called vacuum progression. For money related improvement of any country these two territories are fundamental. It is discovered that a minor piece at a time the development famous of non-down to earth control sources prompts vapor of oil based item in not very ousted future. It consolidates hydrocarbons of various sub-nuclear loads and other standard blends. Oil which proposed for the fundamental grungy oil and the subordinates procured from oil based items by refined foul oil and the constituent bits of crude oil are clarified in Table 2.

Table 2. Composition by weight

Element	Percent range
Carbon	83 to 87%
Hydrogen	10 to 14%
Nitrogen	0.1 to 2%
Oxygen	0.05 to 1.5%
Sulfur	0.05 to 6.0%
Metals	< 0.1%

2.2. FUEL USED – KEROSENE

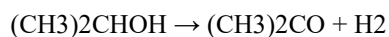
Oil results have been used since old events as pastes and water fixing officials. Over 2,000 years sooner, Arabian inspectors researched ways to deal with oversee distil oil into explicit parts that could be used for express purposes. As new uses were discovered, energy for oil extended. Light oil was found in 1853 by Abraham Gesner. A British ace, Gesner developed a system to separate the inflammable liquid from diminish top, a waxy oil mix. The term light oil is, really, gotten from the Greek word for wax. Once in a while spelled light oil or light oil, it is in like way called coal oil because of it's diminish top sources. The properties of Kerosene are given cry in Table 3.

Table 3. Properties of Kerosene

Molecular Weight	170 (approximately, C ₉ to C ₁₆ hydrocarbons)
Melting Point	-51 °C
Boiling Point	175-325 °C
Appearance	Colorless to pale straw
Density	0.8 - 0.81g /ml
Odor	Odorless
Flash Point	65-85 °C
Molecular Formula	C ₉ to C ₁₆ hydrocarbon
Synonyms	kerosene; coal oil; fuel oil no.1; range oil
Solubility	Insoluble in water, miscible in all petroleum solvents

2. 3. Isopropyl Alcohol

Isopropyl alcohol (IUPAC name propan-2-ol; by and large called isopropanol) is a compound with the engineered condition C₃H₈O. Isopropanol of various sorts is an on a very basic level ignitable dull made compound with a strong fragrance. As the isopropyl pack has been connected with a hydroxyl family, it has been suggested as the least marvelous model for a discretionary alcohol. For isopropanol the alcohol carbon molecule has been incorporated with two other carbon particles. It is an accomplice isomer of 1-propanol. It has been made in different strategy of mechanical and nuclear family contraptions and is a traditional fixing in engineered mixes like manufactured creations, disinfectants and germ-executioners. Isopropyl alcohol has similarities with 2-propanol, sec-propyl alcohol, IPA, isopropanol or scouring alcohol will be successfully miscible in chloroform, ether, water and ethanol. It can master minded to crumble all sort of alkaloids, ethyl cellulose, gums, polyvinyl and standard saps [21]. As opposed to the characteristics of ethanol and methanol, isopropyl alcohol can't be miscible in the salt plans and can be viably insulted from watery systems by get-together of a salt like sodium chloride and potassium chloride. This system for salt releasing procedure is coolly named as salting out and causes improvement of concentrated isopropyl alcohol which can be isolated out a specific layer [22]. Isopropyl alcohol will prompts the methodology of an azeotrope with water having a most distant purpose of around 81.05 °C (177.26 °F) with a blend of 88.01 wt % (90.9 vol %) isopropyl alcohol. Water and isopropyl alcohol compound have low dissolving point [23]. The taste is take off and authentic taste and not consistently affirm one for drinking [24, 25]. Isopropyl alcohol is everything considered having the property of growing consistency with diminishing temperature and will bond at the temperature of around -90° C (-130 °F). Isopropyl alcohol has a most extraordinary absorbance of 207 nm in a mind blowing apparent range [26]. Isopropyl alcohol can be adequately oxidized to CH₃CO, which is the separating ketone. This can be practiced by the reaction of oxidizing specialists like chromic hazardous or dehydrogenation of isopropyl alcohol in a warmed copper improvement.



Isopropyl alcohol has been reinforced as a dissolvable and hydride source in the Meerwein-Ponndorf-Verley rot and other trade hydrogenation reactions. Isopropyl alcohol can be adequately changed over into 2-bromopropane with the help of phosphorus tribromide or got dried out to propane by warming with sulfuric perilous. Practically identical in characters like various alcohols, isopropyl alcohol reacts with dynamic metals like potassium to shape alkoxides that can be called isopropoxides. The property of Isopropanol and Gasoline has been referenced in Table 4. Aluminum isopropoxide has been set up as the principle impulse by the reaction with aluminum which was begun by a trace of mercury [27].

Table 4. Comparison of petrol and isopropyl alcohol

S. No.	Property	Gasoline	Isopropanol
1	Chemical Structure	C ₄ -C ₁₂	C ₃ H ₇ OH
2	Density (kg/m ³)	737	789
3	Calorific value (KJ/kg)	43.5	30.6
4	Oxygen (wt %)	-	26.53
5	Stoichiometric air fuel ratio	14.7	10.4
6	Auto ignition temperature (LC)	258	397
7	Octane number	92	114
8	Volume temperature	38-204	84
9	Laminar flame speed (cm/s)	33 - 44 ^a	45 ^b
10	Latent heat of vaporization (KJ/kg)	349	758

2. 4. General Safety Information For Isopropyl Alcohol

Safety Data Sheet According to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations, the safety information code about Isopropyl are given in Table 5.

Table 5. General Safety Information for Isopropyl Alcohol

H225	Highly flammable liquid and vapor
H319	Causes serious eye irritation
H335	May cause respiratory irritation

III. EXHAUST EMISSIONS CHARACTERISTICS

Experimental results obtained for the emission characteristics of the test engine for the varying operating conditions with different loads and combination of varying percentages of fuels of isopropyl alcohol has been compared with gasoline are discussed as follows. Emission characteristics have been improved while implementing additive isopropyl alcohol compared to petrol. But, the emission level of NO_x which has been comparatiely higher than that of gasoline.

From this it was enlistment that the starting capacity has been more for included substance joined gasoline. The happenings of the comprehensive savage including ozone abundance, average regular heads have been reviewing for the chances of a cleaner fuel for vehicles. By and by, the undeniably reinforced fuel goes to the thought is isopropyl alcohol. In need, confirmation to isopropyl alcohol, versatile filled vehicles organized handling two fold powers of gasoline correspondingly as isopropyl alcohol has been made. During the test evaluation, despite the stipulated outpourings and proficiency, release level of isopropyl alcohol, aldehydes and incalculable hydrocarbon blends has been for the most part reviewed. The yield results revealed that building up the fuel's isopropyl alcohol substance would not change the exhaust standard transmission rate (studied by the stipulated guideline) from adaptable twofold controlled vehicles,

yet formaldehyde and isopropyl alcohol contain persistently substance of the ordinary blends while hydrocarbons the substance is less. Widened isopropyl alcohol content in the fuel doesn't show any basic effect on exhaust administered release levels (carbon monoxide, common compound and nitrogen oxides) nor on the relationship of overwhelming hydrocarbons, except for methane, which grows in this manner. The outcome of recalling temperature for the exhaust and evaporative outpourings has been similar to that of gasoline engines. Fundamental compound and carbon monoxide outpourings increase incredibly at the lower temperatures while the evaporative spreads have been creating in a foreseen manner with increases in temperature.

3.1. Isopropyl Alcohol And The Environment

Accurately when used in a sensibly engineered engine, isopropyl alcohol methanol could combust more absolutely than gasoline. This would recognize lower levels of the vapor floods that add to urban contaminating and an Earth-wide temperature support. Isopropyl alcohol contains non-sweet-smelling blends and along these lines makes no benzene outpourings. Full appraisal of the total of the essentialness and materials required to pass on and disperse isopropyl alcohol must be done, in any case, before the certified fundamental impact of beast scale isopropyl alcohol use can be settled.

3.2. Carbon monoxide emissions

It has been seen that CO radiation level was widened while there was a development in load for all relationship of Isopropyl alcohol. In case level of isopropyl included substance content additions in the fuel the CO release is getting reduced. This was an eventual outcome of the absolute start of gasoline by mixing Isopropyl alcohol as an additional substance. The level of CO spread abatements with the growth in level of Isopropyl alcohol in the fuel. This may be credited to the region of O₂ in Isopropyl alcohol, which gives sufficient oxygen to the differentiation in carbon monoxide (CO) to carbon dioxide (CO₂). CO is a concealing less and unscented gas when taken in replaces oxygen in the circulatory framework and impacts the body's assimilation [28].

Carbon monoxide is molded thinking about inadequacy of oxygen. Since IPA has higher oxygen content than UG, henceforth the improvement of IPA to gasoline will incite reduced methodology of CO. It might be seen from Fig 2, that CO spread reduces with increase in centralization of IPA in UG. It will when in doubt be irrefutably seen from the plot that at a most strange speed of 2800 rpm, the CO release grows to some degree meandered from that of CO flooding at 2600 rpm. This is thinking about the route that at higher paces, only a compelled degree of time is open for start to be done, which isn't the circumstance at lower speeds. Looking whole speed run, CO release for IPA blends was more little than UG. The decreased CO flood is a quick result of slanting effect caused due to oxygen content in IPA. IPA has lower air-fuel degree than gasoline and will recognize less slick mix. This results in complete starting which is in like way the clarification behind bringing down of CO and HC releases.

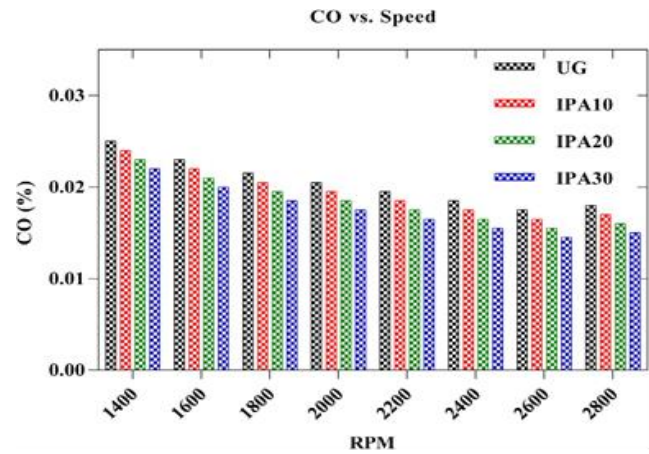


Figure 2. CO vs speed

3.3. Nitrogen oxide emissions

Ox diminishes with broadening load for all the level of Isopropyl alcohol. In the event that level of included substances broadens, NO_x increments. The evaluation of NO_x spreads for gasoline and included substances. It may be seen that NO_x transmissions increment with increment in level of Isopropyl alcohol in the oil. The NO_x increment for included substance of Isopropyl alcohol might be associated with the oxygen substance of the Isopropyl alcohol, since the fuel oxygen may develop in giving extra oxygen to NO_x strategy. Also, the higher estimation of pinnacle chamber weight and temperature for Isopropyl alcohol when showed up distinctively in connection to oil might be another explanation that may clarify the expansion in NO_x headway. Nitrogen oxides (NO_x) is the nonexclusive term for a social event of exceptionally responsive gases containing nitrogen and oxygen in moving wholes, including nitric oxide (NO), nitrous oxide (N₂O), nitrates (NO₃⁻), and nitrogen dioxide (NO₂). NO_x and unusual normal mixes, inside observing hot, slow air and daylight, convert to ozone. NO_x are named dangerous airborne harmful substances in context on their vindictive success and typical impacts. The U.S. Ordinary Protection Agency (EPA) has seen that NO_x is a basic reason behind ground-level ozone (a.k.a. exhaust cloud), dangerous downpour, respiratory infirmity (emphysema and bronchitis), water quality attestation, and an unnatural environmental change. The trademark direct of the SI engine for the NO_x floods were in like way talked about for UG, IPA10, IPA20 and IPA30 with the guide of Figure 3, exhibiting combination of NO_x spread at different paces. IPA mixes made higher NO_x radiations than UG. IPA30 mixes passed on most raised NO_x radiation at any relating rate. It is seen that with increment in mixing rate and speed, NO_x transmissions broadened. Closeness of oxygen in isopropanol might be the purpose for this lead. The explanation behind expansion in NO_x overflowing with increment in speed is, when speed is broadened more extent of fuel is embedded into the chamber. The engine thusly certifications more extent of air, which develops the oxygen content further. This prompts hard and fast expending understanding a higher in-chamber and fire temperature,

Which accomplishes improvement of Thermal NOx. Warm NOx pathways for the most part open at temperatures more fundamental than 1800 K and become instructing at essentially higher temperatures [29, 30, 31]. Higher Octane number of isopropanol construes shorter devouring length of fuel is a calculate that like way adds to expand in NOx overflowing [26].

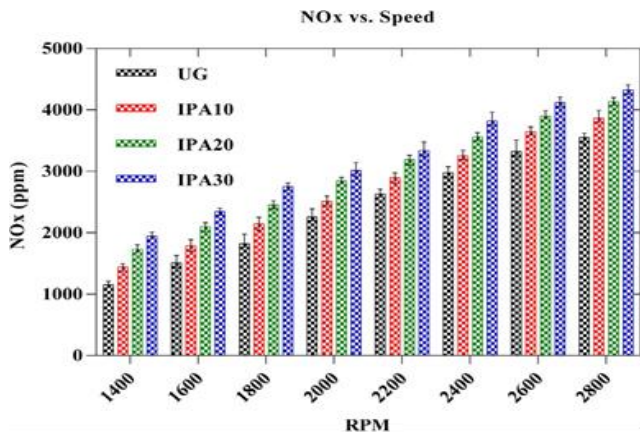


Figure 3 NOx vs speed

3.4. Hydro carbons (hc) emissions

It is seen that hydro carbon (HC) diminishes with expanding load for all the level of Isopropyl alcohol. In the event that degree of included substance of Isopropyl alcohol develops, HC diminishes. The hydrocarbon discharges are then again relative with the level of Isopropyl alcohol joined the fuel. The oil fuel activity exhibited the genuinely higher centralizations of HC in the fumes at all stacks. Since Isopropyl alcohol is an oxygenated fuel, it improves the expending capacity and along these lines diminishes the centralization of hydrocarbon outpourings (HC) in the engine fumes. Mixing 10% included substance with gasoline basically reduces HC radiations particularly at all store condition. Most Hydrocarbons are not ghastrly to flourishing at focuses found in the fusing air [32]. Their levels are changed by the vehicular transmissions and along these lines their total released into the environment is fundamental to appreciate. These unburnt hydrocarbons are bound on account of partitioned expending. The feeble trademark mixes present in these hydrocarbons blends in with sulfur dioxide and nitrogen oxides to plot exhaust cloud. Without a

doubt, even minor preface to incapacitate cloud may cause troublesome issues like asthma and on occasion can in addition cause frightening setbacks [33]. Figure 4 shows combination of HC arrival of UG, IPA10, IPA20 and IPA30. It will as a rule be seen that at all paces IPA mixes made lower HC flood than UG. This decreasing in HC discharge is an immediate aftereffect of oxygen substance of IPA. Additionally, HC discharge diminished with increment in IPA content in the mix comparatively in like manner with increment in speed. This is considering the way that oxygen content growthes with increment in IPA substance and prompts full scale devouring which thusly increases in-chamber temperature, because of which the fuel stuck in the separated will effectively com-bust.

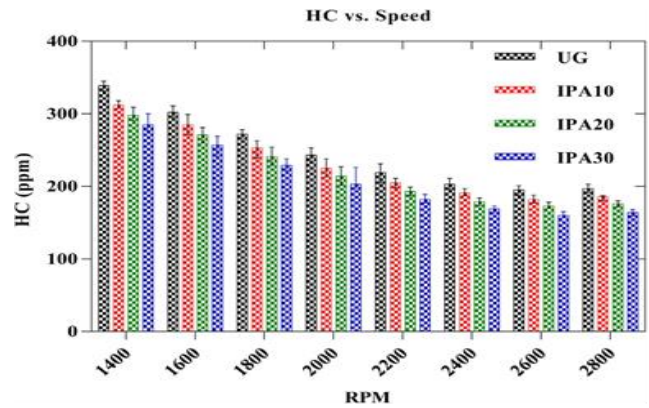


Figure 4 HC vs speed

Similarly, the lower auto-start temperature of IPA will stall the fuel sufficiently at lower temperatures obliging unburnt and not so much ate up fills. As the speed produces, the wide-spread fire will try to wreck the greater part of the hydrocarbons neglecting just a couple, and getting out the issues related with fragmentary eating up [29]. This is considering the way that with increment in speed more extent of fuel is embedded into the beginning burden and at high speeds the air-fuel blend blends well and along these lines updates the devouring system. Notwithstanding, in our test the HC overflowing at a speed of 2800 rpm expanded scarcely. This is a prompt delayed consequence of the restricted extent of time open for the fuel to eat up totally.

IV. RESULT AND DISCUSSIONS

Table 6 Petrol with Isopropyl Alcohol

Sl. No.	Alcohol %	(V)	(I)	Power (W)	Time10 sec (t)	BP (KW)	(Kg/h TFC r)	(Kg/k SFC w-hr)	BT-η %
1	Without Alcohol	220	0.5	110	27	0.14	1.02	7.28	16.54
2		205	1.2	246	25	0.32	1.1	3.43	37.81
3		190	1.9	361	23	0.48	1.2	2.5	56.72
4		220	0.4	88	23	0.11	1.22	11.09	12.9
5		205	1.4	287	18	0.38	1.56	4.1	44
6		10	190	2.1	399	14	0.53	2	3.77

7	20	220	0.6	132	23	0.17	1.22	7.17	20
8		205	1.6	328	18	0.43	1.54	3.58	50
9		190	2.2	429	14	0.57	1.98	3.47	67.35
10	30	220	0.7	154	23	0.2	1.22	6.1	23.6
11		205	1.8	378	18	0.5	1.56	3.12	59
12		190	2.4	468	14	0.62	2	3.22	73.2
13	40	220	0.8	176	23	0.23	1.22	5.3	27.1
14		205	1.9	399	18	0.53	1.56	2.94	62.62
15		190	2.6	520	14	0.69	2	2.89	81.5

Figure 5 Brake Power vs Total Fuel Consumption

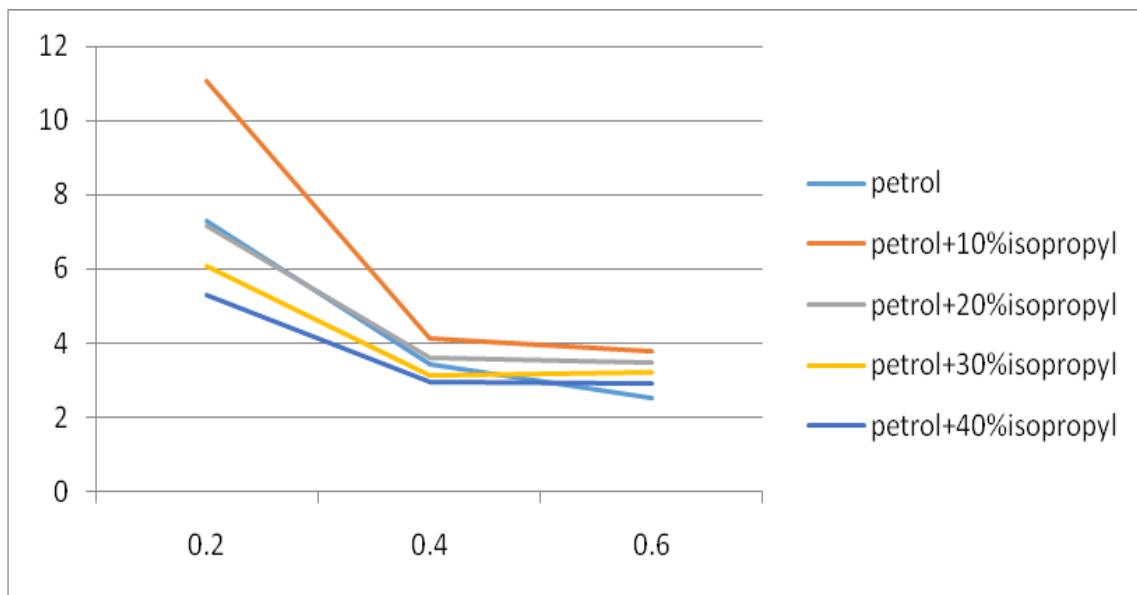


Figure 6 Brake Power vs Specific Fuel Consumption

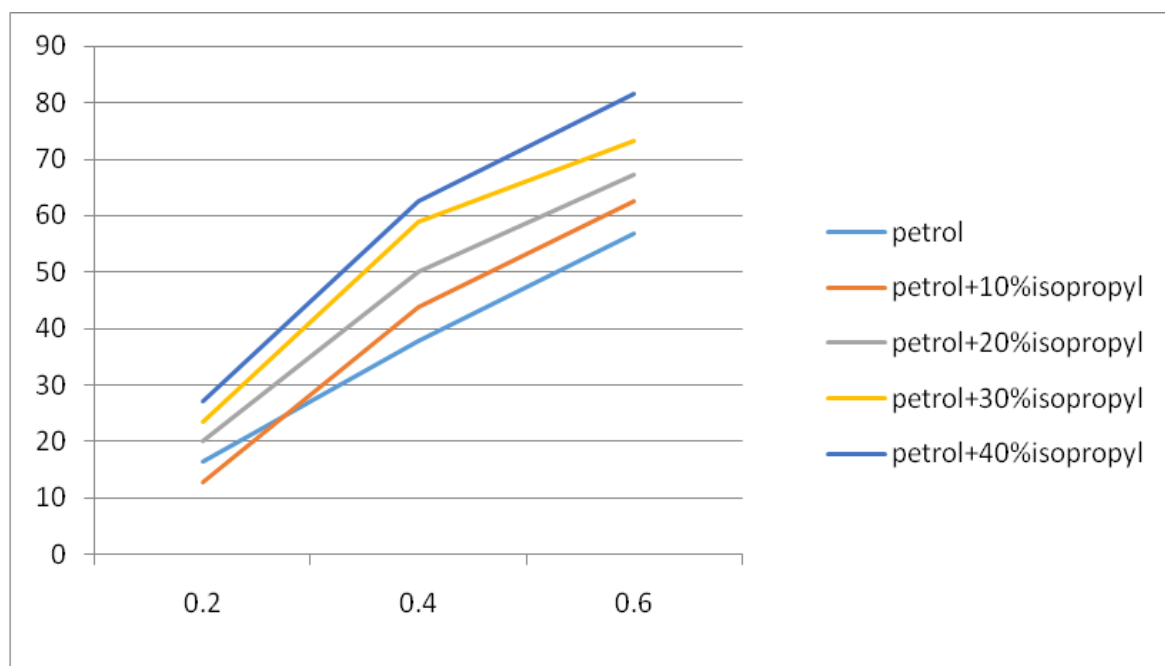


Figure 7 Brake power vs

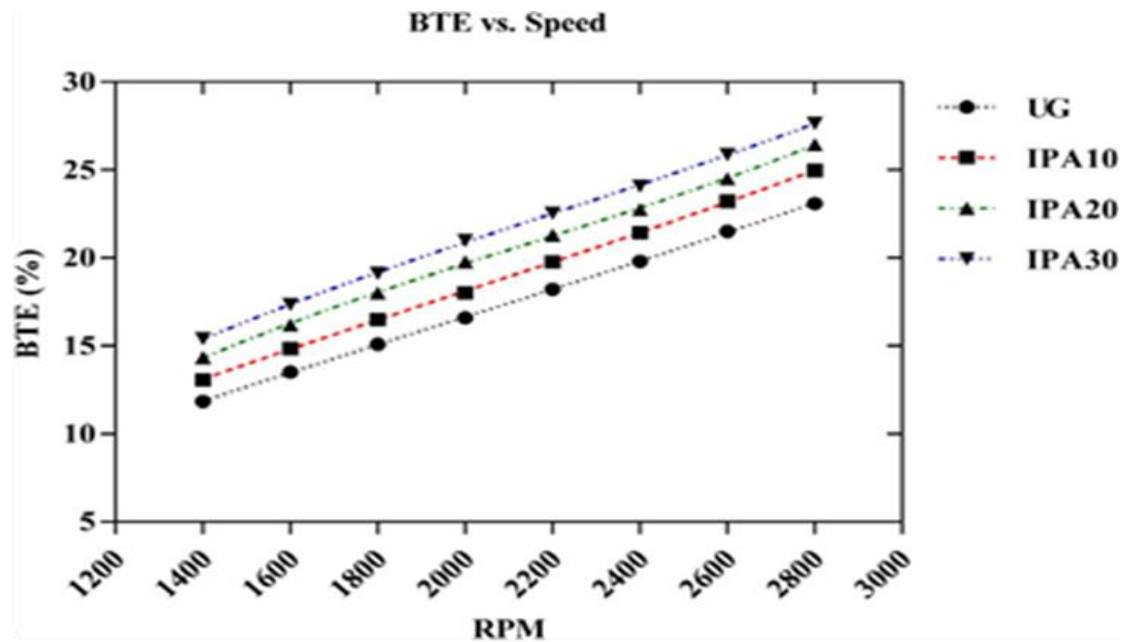


Figure 8 Speed Vs Brake Thermal Efficiency

Table 7. KEROSENE WITH ISOPROPYL ALCOHOL

Sl. No.	Alcohol %	(V)	(I)	Power (W)	Time 10 sec (t)	BP (KW)	TFC (Kg/hr)	SFC (Kg/kw-hr)	BT-η %
1	Without Alcohol	220	0.1	22	23	0.02	1.26	63	3.0
2		205	0.5	102.5	18	0.13	1.62	12.46	23
3		180	0.8	144	14	0.19	2.08	10.94	34.0
4	10	220	0.2	46	23	0.06	1.26	21.0	11.0
5		205	0.6	120	18	0.16	1.62	10.125	29.0
6		180	1.0	180	14	0.24	2.08	8.66	44.08

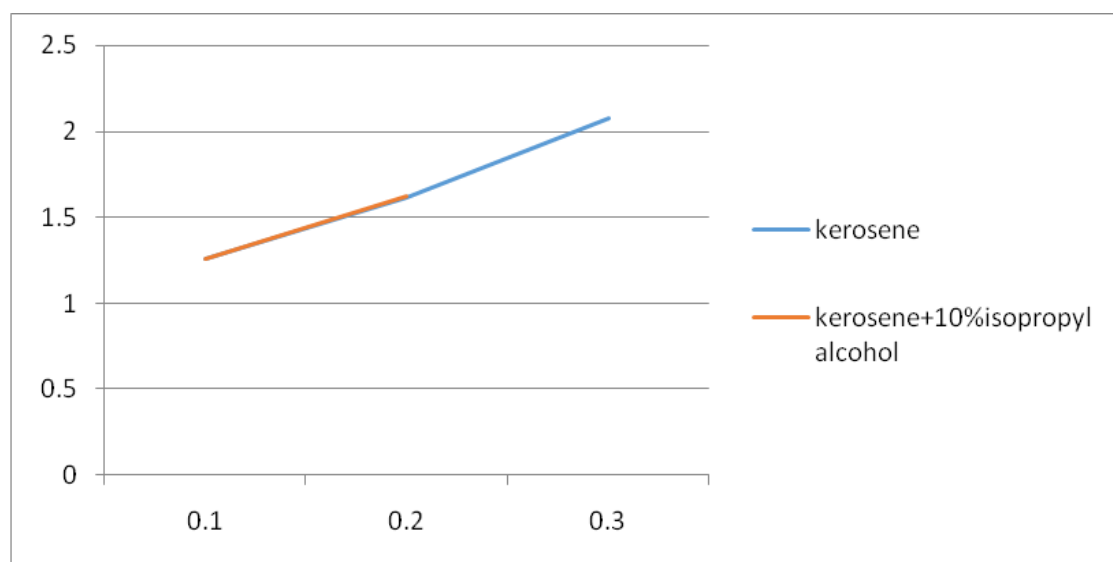


Figure 9 Brake Power Vs Total Fuel Consumption

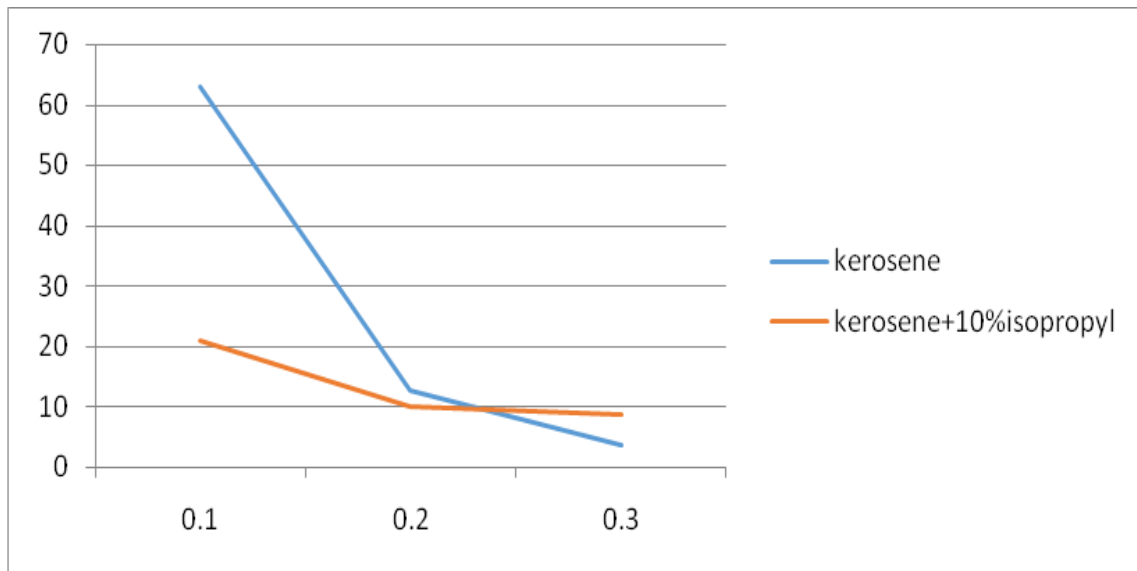


Figure 10 Brake Power Vs Specific Fuel Consumption

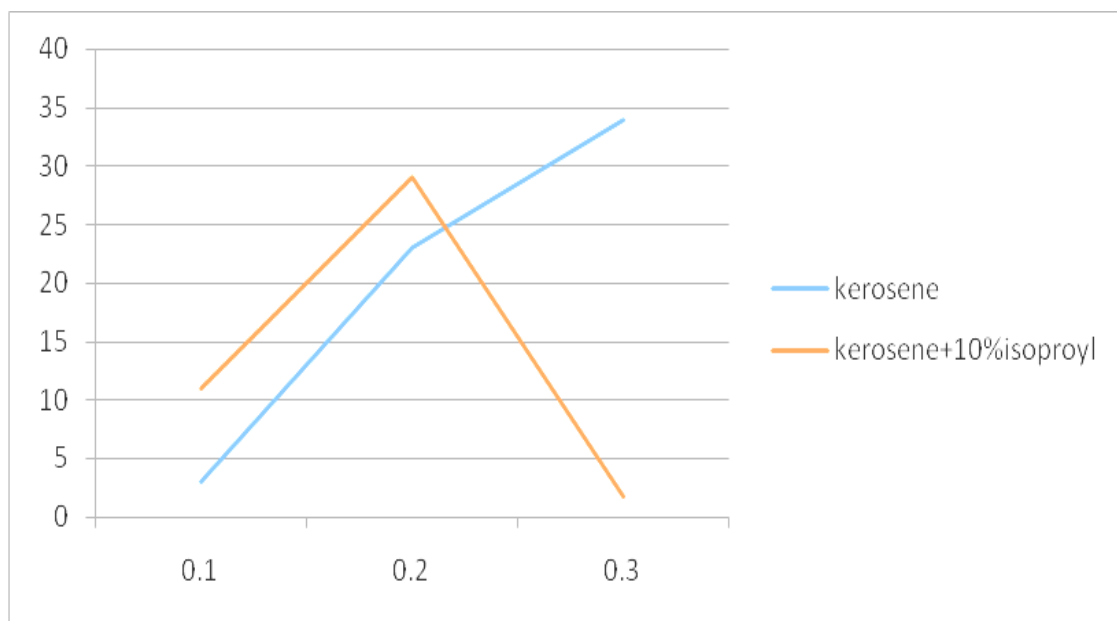


Figure 11 Brake power vs Brake Thermal Efficiency

V. CONCLUSION

From the experimental results the attributes of IPA consists of performance characteristics at various loads. The brake thermal efficiency 10%, 20% and 30% were examined and the following are the concluding outcomes. Use of Isopropanol as a fuel in MPFI gasoline engine, will develop the Brake Thermal Efficiency pervasively in context on its higher dormant warmth of vaporization and oxygen content than UG. Isopropanol additive in gasoline fuel has considerably brought down hydrocarbon and carbon monoxide emissions. IPA30 mixture assisted in significant reduction of HC and CO emission in all operating conditions. At the engine speed of 2800 rpm, both HC and CO has drastically brought down compare to 2600 rpm. Adaptation of Isopropanol additive added gasoline reduces NOx emission as like HC and CO discharge similarly as expanded outpourings. IPA 30 mix leads to more NOx emissions compared to other mixers. The NOx emission from the engine had diminished between the ignition timings 14° BTDC to 12° BTDC. In perspective on higher oxygen substance of isopropanol, top heap of IPA mixes was higher than UG. Comparable results were increased even due to Heat discharge rates. The engine operating

parameters Brake power, Fuel consumption, indicated thermal capacity, brake thermal efficiency have been shown improved efficiency considerably increased with the addition of increase in isopropyl alcohol percentage. Hence, isopropyl alcohol may be suitably adopted as additive for gasoline fuelled engine.

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