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Review of Effect of Composite Additives on Performance and Emission Characteristics of Petrol Engine

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Abstract*—One of the major drawbacks of IC engines is low efficiency and pollution resulting from incomplete combustion. In order to improve the emission properties and performance an additive is blended with gasoline. The main objective of this paper was preparation of premium gasoline. Through the study of literature survey, effect of different additives has been studied, it is found that different additive had some negative effect when used individually which conclude that there is need for new composite additives having better performance in respect of engine performance and emission control.*

Keyword*—Additives, SI Engine Performance, Emission*

I. INTRODUCTION

The rise in civilization is closely related to improvements is transportation. In the development of transport the internal combustion engines, both petrol and diesel engines, occupy a very important position. As per the All India study report submitted to PPAC 70% of diesel and 99.6% of petrol is consume in transport sector alone .However, in recent days IC engines comes with lot of serious problems created by them and one of these problem is air pollution. Air pollution is the addition of material to atmosphere which is deleterious to life span of living being. The main emissions from automobiles which contribute in air pollution are unburned hydrocarbon (HC), carbon monoxide (CO), oxides of nitrogen (NOx), sulphur oxides (SOx) and other particulate matter. These emissions can be reduced up to certain extent by adding additives. Additives are the compounds which are added in fuel in small concentrations. Fuel additives are classified as octane number enhancer, cleaning agents, combustion process promoters and oxygenates. These additives can alter physical and chemical properties such as density, appearance, volatility, solubility, melting point and boiling point. Oxygenates are added to obtain more efficient combustion of fuel. These additives contain oxygen which results in complete burning of fuel. Antiknock agent is gasoline additives which reduce the knocking tendency of engine and trying to enhance octane rating of fuel. Antioxidants are act as a stabilizer in fuel to prevent oxidation. When these additives are used individually they show improvement in certain properties, but if they are used in combination it improves many other properties without affecting performance.

II. LITERATURE SURVEY

The investigation was carried out by D.B. Sivakumar, M. Arulmozhi, T. Senthil Kumar, 2012 to improve the performance and emission of S.I engine with oxygenated fuel The use of oxygenates to replace the lead additives in gasoline are being considered as an alternative. In this work, oxygenated fuel is prepared by mixing 80% of gasoline with 10%, 5% and 5% (composition I) and mixing 80% of gasoline with 15%,2.5% and 2.5% (composition II) on volume basis of additives like Ethanol, Isopropyl alcohol, and Diethyl ether respectively. The study offers a comparison between the oxygenated fuel and gasoline in terms of engine performance and emission characteristics under varying load conditions. Experimental results of oxygenated blends of different composition show that the use of oxygenated fuels, without compromising the performance, the engine emission reduces to a higher extent.[1] The paper prepared by Kameoka, A. and Tsuchiya, K. explain the influence of ferrocene on engine and vehicle performance. To clarify the influence of one metal additive, ferrocene, on engine, following experiments were carried out. The insulation resistance of spark plugs was measured, deposits in the engine were analyzed, and exhaust emission and fuel economy tests were conducted using gasoline containing ferrocene. The deposit, which contained iron oxides, adhered to the combustion chamber, spark plugs, and exhaust pipe when the engine operated with gasoline containing ferrocene. When vehicles operated with gasoline containing ferrocene, fuel consumption increased and the exhaust temperature rose. These results indicate that ferrocene decreases the insulation resistance of spark plugs.[2] The research was carried out by S.Babazadeh Shayan, F.Ommi, S.M.Seyedpour, M.Alizade, to study the effect of oxygenate

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additives into gasoline for the improvement of physicochemical properties of blends. Methyl Tertiary Butyl Ether (MTBE), ethanol, Tertiary butyl alcohol (TBA), and Di-isopropyl ether (DIPE) have been blended into unleaded gasoline with various blended rates of 2.5%, 5%, 7.5%, 10%, 15%, and 20%. Physicochemical properties of blends were analyzed by the standard American Society of testing and Materials (ASTM) methods.[3] Machado, G., Barros, J., Braga, S., and Braga, C has prepared the paper on influence of Toluene and Iso-Octane on combustion and performance parameters of spark ignition engines. The aim of this paper is to present further results on the effect of individual components and fuel fractions on the combustion and performance parameters of spark ignition engines. SI engine dynamometer tests were conducted using ten mixtures of iso-octane, toluene, n-heptane and ethanol. [4]The experiment was carried out by C.Anish Raman, Dr.K.Varatharajan, P.Abinesh, Dr.N.Venkatachalapathi, to improve the emission properties and performance an oxygenated additive MTBE (Methyl tertiary butyl ether), is blended with gasoline. A four cylinder, 1817 cc engine was used for analysing both emission and performance characteristics. Tests were carried out with 100% pure gasoline and MTBE –blended gasoline (M5, M10). The BSFC and BTE of MTBE blended gasoline were observed to increase when compared to pure gasoline. Significant reduction in HC and CO emissions were observed with MTBE blended gasoline; however, CO2 and NOX emissions were increased. [5]The paper prepared by D.Balaji, Dr.P.Govindarajan, J.Venkatesan study the effect of using unleaded gasoline and isobutanol blends on spark ignition engine (SI engine) performance and exhaust emission. A four stroke, single cylinder SI engine was used for conducting this study. Performance tests were conducted for fuel consumption, volumetric efficiency, brake thermal efficiency, brake power, engine torque and brake specific fuel consumption, while exhaust emissions were analysed for carbon monoxide (CO), Hydrocarbon (HC), and Oxides of nitrogen (NOx) using unleaded gasoline and additives blends with different percentages of fuel at varying engine torque condition and constant engine speed. The result showed that blending unleaded gasoline with additives increases the brake power, volumetric and brake thermal efficiencies and fuel consumption. The CO and HC emissions concentrations in the engine exhaust decreases while the NOx concentration increases. The addition of 5% isobutanol and 10% ethanol to gasoline gave the best results for all measured parameters at all engine torque values.[6]

III. FUEL ADDITIVES

Fuel additives are chemical compound which helps in improving engine performance and control emission characteristics. Fuel additives are largely associated with additives to gasoline and oil based fuels in the interest of environmental protection ,curbing emissions and increasing mileage, the innovation around additives has a broader impact of being able to change ,alter or enhance specific attributes of a fuel whether liquid ,solid or gas .Additives have been developed to increase combustion rates, as anti oxidants, to effect burn rates ,to enable fuels to work under extreme temperatures, reduce harmful emissions and more. Over the years various hybrid compounds and blends have been engineered to create better fuels for industries commercial use and end consumers alike.

3.1 Comparison Of Properties Of Additives

Table 3.1.1 Comparative Additive properties

ADDITIVES	MOLECULAR FORMULA	MOLAR MASS (g/mol)	APPEARANCE	DENSITY (g/cc)	MELTING POINT (°c)	BOILING POINT (°c)	SOLUBILITY IN WATER (g/l)	MAIN HAZARD	FLASH POINT (°c)
Di-Methyl Carbonate	C3H6O3	90.08	Clear liquid	1.069-1.073	2-4	90	13.9	Flammable	-
Methyl-tertiary butyl ether	C5H12O	88.55	-	0.7404	-109	55.20	26	-	-10
Ethanol	C2H6O	46.07	Colorless	0.789	-114	78.37	Miscible	-	16
Isopropyl alcohol	C3H8O	60.10	Colorless	0.786	-89	82.60	Miscible	-	11.7
Ferrocene	C10H10Fe	186.04	Light orange powder	1.107	172.5	249	Insoluble	-	81
Toluene	C7H8	92.14	Colorless liquid	0.87	-95	111	0.52	Highly flammable,toxic	6
Iron pentacarbonyl	Fe(CO)5	195.90	Straw yellow liquid	1.453	-21	103	Insoluble	Very toxic, Highly flammable	-15
Isooctane	C8H18	114.23	Colorless liquid	0.692	-107.44	99.1	-	Flammable, dangerous to health	-12
Methylcyciopentadienyl manganese tricarbonyl	C9H7MnO3	218.09	Pale yellow liquid	1.38	-1	233	Low soluble	Low toxicity	96
Phenylene diamine	C6H8N2	108.14	White crystalline solid	1.031	147	267	100% at 140°c	Toxic	-
Butylated hydroxyl toluene	C5H24O	220.35	White powder	1.048	70-73	265	1.11	Flammable	127

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3.2 Types of additives

3.2.1 Oxygenates Additives:

3.2.1.1 Di-methyl carbonate (DMC) :-

Dimethyl carbonate is an organic compound with the formula C3H6O3. It is a colourless, flammable liquid. It is classifie d as a carbonate ester. This compound has found use as a methylating agent and more recently as a solvent that is exempt from classification as a volatile organic compound (VOC) in the US. Dimethyl carbonate is often considered to be a green reagent.[7]

3.2.1.2 Ethyl tert-butyl ether (ETBE):-

ETBE can be synthesized by reacting bio-ethanol (47% v/v) and isobutene (53% v/v) with heat over a catalyst, It can be considered a „„bio-fuel", therefore ETBE helps to reduce the vehicle-out carbon dioxide (a green house gas) introduced to the atmosphere. As an additive to gasoline, ETBE has been extensively examined with regard to its impact on exhaust emissions, exhaust gas after treatment systems, evaporative emissions, cold storability, materials used in the fuelling systems and others in spark ignition engine-powered vehicles.[8]

3.2.1.3 Methyl tert-butyl ether (MTBE) :-

Methyl tert-butyl ether (also known as MTBE, tert-butyl methyl ether, tertiary butyl methyl ether and tBME) is an organic compound with molecular formula (CH3)3COCH3. MTBE is a volatile, flammable, and colorless liquid that is sparingly soluble in water. It has a minty odor vaguely reminiscent of diethyl ether, leading to unpleasant taste and odor in water. MTBE is a gasoline additive, used as an oxygenate to raise the octane number. Its use is controversial in the US and declining in use in part because of its occurrence in groundwater and legislation favoring ethanol. However, worldwide production of MTBE has been constant at about 18 million tons/y (2005) owing to growth in Asian markets which are less subject to ethanol subsidies.[10]

3.2.1.4 Ethanol :-

Commonly referred to simply as alcohol or spirits, ethanol is also called ethyl alcohol, and drinking alcohol. It is the principal type of alcohol found in alcoholic beverages, produced by the fermentation of sugars by yeasts. It is a psychoactive drug and one of the oldest recreational drugs used by humans. It can cause alcohol intoxication when consumed in sufficient quantity. Beyond being consumed, it is used as a solvent, as an antiseptic, as a fuel and as the active fluid in modern (post -mercury) thermometers. It is a volatile, flammable, colourless liquid with the structural formula CH3CH2OH, often abbreviated as C2H5OH or C2H6O.[9]

3.2.2 Antiknock Agent:

3.2.2.1 Ferrocene :-

Ferrocene is an organometallic compound with the formula Fe(C5H5)2. It is the prototypical metallocene, a type of organometallic chemical compound consisting of two cyclopentadienyl rings bound on opposite sides of a central metal atom. Ferrocene and its derivatives are antiknock agents used in the fuel for S.I. engines; they are safer than tetraethyllead, previously used. It is possible to buy at Halfords in the UK, a petrol additive solution which contains ferrocene which can be added to unleaded petrol to enable it to be used in vintage cars which were designed to run on leaded petrol. The iron containing deposits formed from ferrocene can form a conductive coating on the spark plug surfaces.

3.2.2.2 Toluene :-

Toluene is a clear, water-insoluble liquid with the typical smell of paint thinners. It is a mono-substituted benzene derivative. Toluene can be used as an octane booster in gasoline fuels used in internal combustion engines. Toluene is another in a group of fuels that have recently been used as components for jet fuel surrogate blends. Toluene is used as a jet fuel surrogate for its content of aromatic compounds.

3.2.2.3 Iron pentacarbonyl:-

Iron pentacarbonyl, also known as iron carbonyl, is the compound with formula Fe(CO)5. Under standard conditions Fe(CO)5 is a free-flowing, straw-colour liquid with a pungent odour. This compound is a common precursor to diverse iron compounds, including many that are useful in organic synthesis. Fe(CO)5 is prepared by the reaction of fine iron particles with carbon monoxide.

3.2.2.4 Iso-octane:-

2,2,4-Trimethylpentane, also known as isooctane or iso-octane, is an organic compound with the formula (CH3)3CCH2CH(CH3)2. It is one of several isomers of octane (C8H18). This particular isomer is the

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standard 100 point on the octane rating scale (the zero point is n-heptane). It is an important component of gasoline, frequently used in relatively large proportions to increase the knock resistance of the fuel.

IV. OBSERVATION

Fig No. 4.1 Comparison of effect of additives on C I Engine

Additive	CO	HC	CO_2	NO_X	BSFC	BTE
MTBE	↓	↓	↑	↑	↑	↓
DMC	↓	↓	↑	↑	↓	↓
N-BUTANOL	↓	↓	↑	↑	↑	↓
ETHANOL	↓	↓			↓	↓
TOLUENE	↓	↓	↑	↑		
MMT	↓	↑	↓	↓		

V. NEED OF COMPOSITE ADDITIVES

From above table we observed that when additive used individually they shows improvement in some properties but have adverse effect on other properties. For example, when N-butanol is used as additive in petrol engine there is reduction in CO and HC emission, improvement in break thermal efficiency .but when we compare it with DMC there is improvement in other values as well as BSFC value. [7]

VI. CONCLUSION

The characteristics of performance and emission of a spark ignition engine fuelled with different fuel additive blends were investigated and compared with those fuelled with petrol. It is observed that most of additive with individual effect particular parameter while hampering the other. So there is needed to combine different additive together so it will have positive effect on all parameter. After doing detail review, it concluded that the resultant composite should contain Oxygenate are used to reduce CO, HC, smoke Antiknock agent reduce the knocking and improve the performance of S.I. engine. Octane number improver to compensate loss of octane number due to addition of additive and also improve thermodynamic properties. From oxygenates we selected ethanol as it is an organic by-product which is easy to manufacture.[9] From antiknock agent we selected MMT over toluene, as toluene has hazardous effect on living being and have limitations on its use.

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