USE OF ETHANOL AS AN ALTERNATIVE FUEL FOR I.C. ENGINE

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Abstract— *As the world's population goes on increasing and the standard of human living improving day by day, increases the need of energy. The increase in energy consumption particularly in past several decades has raised the fears of exhausting vital natural resources. As India having large number of automobile sector the cost of petroleum fuel goes on increasing. Also in concern of environmental effect due to emission of harmful gases such as CO, CO2, NOx, SOx, lead and other particulates which lead to air pollution and adverse affect on human beings, as vehicles using fossil fuel. My present paper focuses on the use of ethanol as an alternative fuel for internal combustion engine. Using the ethanol as a fuel in IC engines reduces greenhouse effect effectively by reducing CO, CO2, NOx, SOx. Ethanol can be used as a fuel in internal combustion engine in two ways, as a straight fuel and as a blended fuel. For low blends of ethanol there is no need of engine modification. Thus use of ethanol provides great hands in reducing dependent on petroleum fuel.*

Keywords— Ethanol fuel, Emission, Alternative fuel, Gasoline

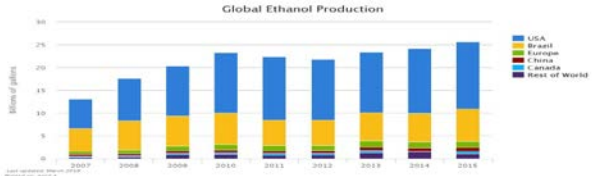
1. INTRODUCTION

Currently there are a lot of researches to find and develop alternative fuel so that the dependency on fossil fuel reduces in some concerns. The use Ethanol as an alternative fuel for fossil fuel has been one of the way to reduce emission and to improve engine efficiency as there is complete combustion. Ethanol is simple, renewable, alcoholic fuel same as that used in beverage. In 1925, Henry Ford quoted ethyl alcohol, ethanol as "the fuel of the future". Ethanol fuel is produced primarily from starch crops, such as corn or sugarcane, or from biomass.

Currently, motor vehicles are estimated to contribute about 14% of the global CO2 emissions, 50-60% of the CO, Hcs and lead, 30% of the Nox and about 10-20% of the particulate emissions. India is the fourth largest consumer of energy in the world. India's average oil and liquids production for 2011 is estimated at 1.04 million barrels per day (B/D) which will touch the peak production at 1.06million B/D in 2012. Further, giving its demand outlook, BMI projects consumption to rise sharply to4.29 million B/D by 2016 from 3.44 million B/D in 2011(Business Monitor International) BMI's India Oil and Gas Report for first quarter of 2012).

The following chart shows global ethanol production by country or region, from 2007 to 2015. Global production peaked in 2015 after a dip in 2012 and 2013. The United States is the world's largest producer of ethanol, having produced nearly 15 billion gallons in 2015 alone. Together, the U.S. and Brazil produce 85% of the world's ethanol. The vast majority of U.S. ethanol is produced from corn, while Brazil primarily uses sugar.

Table1. Global Ethanol Production



India's oil production and consumption shown in following figure:

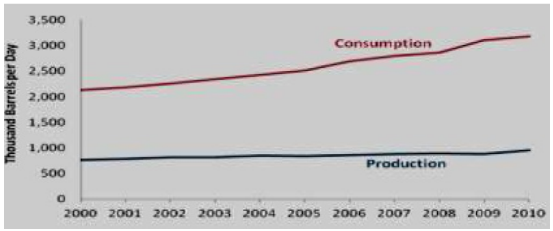


Fig.1 Courtesy: US Energy Information Administration, International Energy Statistics.

India is the second in production of sugarcane after Brazil. Wide range of properties of ethanol which helps it to burn it cleanly when used as alternative fuel for IC engine.

2. PRODUCTION

2.1 Raw Material

Ethyl alcohol produced by the fermentation process from three basic types of raw materials, called feedstock. The three basic types of feedstock are:

2.1.1 Saccharine:

Sugar containing main component as carbohydrate is present in the form of simple, directly fermentable six and twelve carbon sugar molecules such as glucose, fructose, and maltose. Such materials include sugar cane, sugar beets, fruit (fresh or dried), citrus molasses, cane sorghum, whey and skim milk.

2.1.2 Starchy Materials:

Such materials include corn, grain sorghum, barley, wheat, potatoes, sweet potatoes, Jerusalem artichokes, cacti, manioc, arrowroot, and so on. That contains more complex carbohydrates such as starch and insulin that can be broken down into the simpler six and

twelve carbon sugars by hydrolysis with acid or by the action of enzymes in a process called malting.

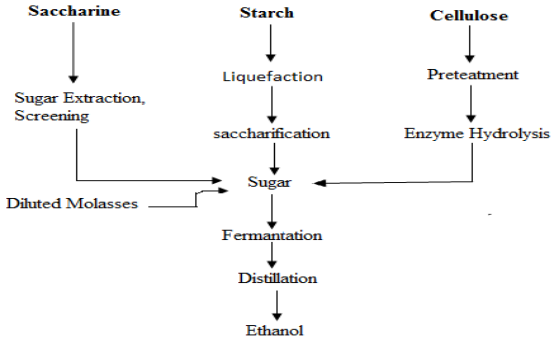
2.1.3 Cellulose Materials:

Such as wood, wood waste, paper, straw, corn stalks, corn cobs, cotton, etc. These materials then converted into fermentable sugar by enzyme hydrolysis process.

2.2 Steps in Production

The various production process steps using different feedstock is shown in following layout.

Fig2. Process flow chart of ethanol production



- Milling: The raw material goes through a series of mill thus the juice is extracted from that.
- Sterilization: in this process biological agents, micro organisms and pathogens are removed from the extracted juice by heating them up to 1000C
- Clarification: The suspended matters sink at bottom using the rotary vacuum filter
- Liquefaction: slurry is cooked in jet-cookers which inject steam into the grain flour slurry at 100oc. The cooked grain mash is allowed to cool to 80-90oC. Then (α-amylase) is added to it
- Saccharification: grain mash is cooled to 30oC. A second enzyme (glucoamylase) is added which breaks starch into glucose
- Fermentation: This is a metabolic process in which sugar is converted into ethanol in the presence of yeast. It is an internally balanced oxidation-reduction reaction.

$$\text{Glucose} \xrightarrow{\text{Yeast}} \text{Ethanol} + \text{Carbon dioxide}$$

$$(C_2H_{12}O_6) \longrightarrow 2(C_2H_5OH) + 2(CO_2) + \text{Heat}$$

- Distillation: It is a purification process in which water is separated - the concentration of ethanol increases to 95%.
- Dehydration: the concentration of ethanol increases to 99.6%.

3. FUEL ETHANOL

3.1 Utilization of Ethanol Fuels:

Ethanol fuels may be utilized in three basic ways: as a blend with gasoline; as a straight, unblended fuel; or as an alcohol/water mixture in an injection system. Each method has certain advantages and disadvantages.

Although ethanol has been traditionally thought of as a beverage product for use in spirits, beer and wine, ethanol is an important, viable alternative to unleaded gasoline fuel. Ethanol is used as an automotive fuel; it can be used alone in specially designed engines, or blended with gasoline and used without any engine modifications. Motorboats, motorcycles, lawnmowers, chain saws etc. can all utilize the cleaner gasoline/ethanol fuel. Most importantly, the millions of automobiles on the road today can use this improved fuel. Fuel ethanol what has been called "gasohol" The most common blends contain 10% ethanol mixed with 90% gasoline (E10). Because the ethanol is a high-octane fuel (2.5 - 3 points above the octane of the blending gasoline) with high oxygen content (35% oxygen by weight), it allows the engine to more completely combust the fuel, resulting in fewer emissions. Also E85 i.e. blend of 85% ethanol and 15% unleaded gasoline also used in flexible fuel vehicles (FFVs). E85 is a high octane, high performance fuel and is classified as an alternative fuel by the U.S. Department of Energy.

3.2 Fuel Properties of Ethanol

Ethanol may be used as a fuel itself or in blends with petrol or diesel. It has a lower energy density than petrol or diesel, a higher octane number than petrol, and a much lower cetane number than diesel. It is highly miscible with petrol but not miscible with diesel. Ethanol-diesel blends use cetane enhancers and solubility improvers. Table 1 list the important fuel properties of ethanol and compares these with petrol and diesel fuel.

TABLE1. PROPERTIES OF ETHANOL FUEL

Property	Ethanol	Petrol	Diesel
Composition, Wt %			
Carbon	52.2	85-88	84-87
Hydrogen	13.1	12-15	13-16
Oxygen	34.7	0	0
Density, Kg/m^3	794	750	825
Lower Heating Value, MJ/kg	26.7	42.9	43
Octane Number	100	86-94	15-20
Cetane Number	8	5-20	40-55
Reid Vapour Pressure (KPa)	15.6	55-103	1.4
Stoichiometric Air/Fuel Ratio,Weight	9:1	14.7:1	14.7:1
Flash Point, closed temp ^{0}C	13	-42	74
Boiling Temperature ^{0}C	78	80-223	188-343

3.3 Principal Advantages of Ethanol Blended Gasoline as an Automotive Fuel

1. Higher latent heat vaporization
2. Uniform composition.
3. Higher flash point.
4. Very high octane rating.
5. No hazardous component.
6. Higher compression operation of the engine.
7. Reduced particulate emissions.
8. Enhanced engine power output

4. RESULT AND DISCUSSION

Presence of oxygen within fuel make fuel to burn clearly with better performance and lower emission and also provide higher octane rating of fuel which allows us to use higher compression ratio, CO and unburned HC emission

levels with Ethanol blend fuel and with ETBE was much lower compared to those with the base gasoline and the NOx emission levels were increased slightly with the oxygenated fuels and was increasing with the increase of the oxygen content in the blended fuels which is related to the greater availability of oxygen and the leaning effect of those oxygenated fuels provides complete combustion of fuel. Carbon content of any substance directly deal with its heating value, higher the number of carbon higher the calorific value of substance and thus blends of ethanol has less calorific value as compared to gasoline and diesel.

4.1 Performance of Engine Power:

The following fig. shows the effectiveness of the E10 and the commercial fuel on the gasoline engine performance. The efficiency of the engine is improved when the E10 is used because E10 contains oxygen which improves the combustion process of the engine. Percentage the density of the blend and the engine volumetric efficiency increased and this caused an increase in power any substance directly deal with its heating value, higher the number of carbon higher the calorific value of substance and thus blends of ethanol has less calorific value as compared to gasoline and diesel.

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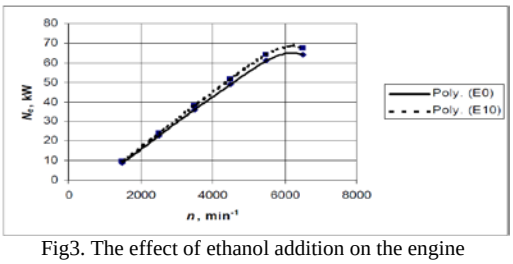

Fig3. The effect of ethanol addition on the engine

4.2 Specific Fuel Consumption:

Due to oxygen in ethanol composition the combustion process improves in the engine cylinders. However, specific fuel consumption slightly increases, approximately by 1-2%. It is obvious because the heating value of ethanol is 1.6 times less than that of gasoline.

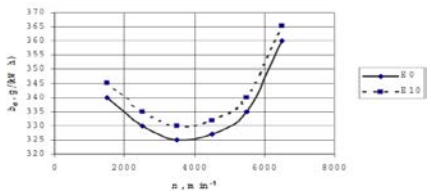

Fig4. The effect of ethanol addition on the specific fuel consumption

4.3 CO Emission:

When E 10 blend is used, the amount of carbon monoxide in exhausts greatly decreases. In the beginning, when the engine power and revolutions are little, the amount of CO decreases by 15%, when we use E 10 blend in comparison with conventional fuel. When the power and revolutions increase, the difference of CO emission increases by 30%

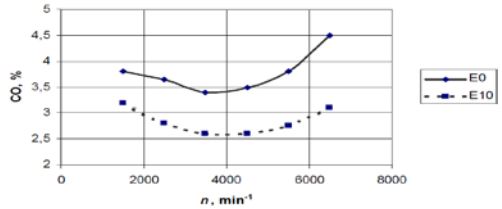

Fig5. The effect of ethanol addition on the CO emission

4.4 CO2 Emission

Ethanol increases the amount of carbon monoxide emission in the engine exhausts because the fuel mixture combusts better and the amount of incomplete combustion products decrease.

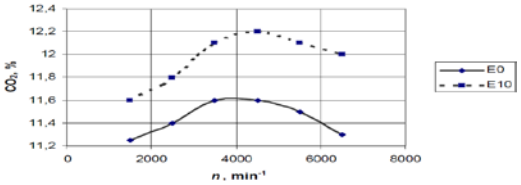

Fig6. CO2 emission characteristics

4.5 HC Emission

The hydrocarbons emission decreases when the engine load is little and medium. When the load reaches the maximum value, the amount of HC slightly increases, if E10 blend is used.

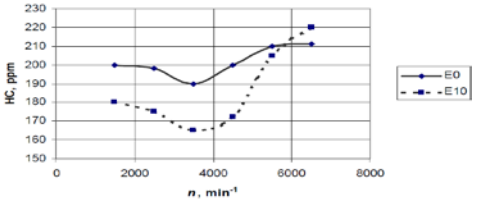

Fig7. The effect of ethanol addition on the HC emission

5. FUTURE PROSPECTS

Ethanol production and consumption have begun to spread to all corners of the globe. The issues surrounding the future of ethanol comes from the prospect of international trade in ethanol. While one of the major justifications for ethanol fuels seems to be a desire to maintain a secure domestic supply, importation of ethanol could provide the fuel to many countries at a greatly reduced cost and on the other hand it ensure poor food crops yields as farmers turned to produce fuel crops . However, most countries have high importation tariffs on ethanol to make imported fuel uncompetitive with the domestic supply. Developments in ethanol fuel technologies are also likely to reduce costs and make ethanol an increasingly attractive option to consumers and governments.

Another reason why ethanol fuels are so attractive is that they represent an environment-friendly technology that is available today. While ethanol fuelled automobiles are probably not likely to be the permanent solution to environmental concerns in automotive fuels, in the very

least, they provide a temporary solution while research into fuel cells and other advanced technologies are under development. By investing in such practical technologies today, governments around the world enjoy significant environmental progress as well as domestic economic development, and realize two goals that often appear at odds with one another.

6. CONCLUSION

From the study it is concluded that with the use of ethanol as an alternative fuel reduces dependent on crude oil and it also useful in concerns of reduction in harmful gases. With the use of blended ethanol harmful emissions like CO and HC can be reduced.

The Proper proportion of ethanol with gasoline leads to the increase in fuel efficiency and also considerable reduction in harmful exhaust gases. Since the cost of ethanol is much less as compared to gasoline, ethanol fuel can substitute gasoline in future.

REFERENCES

[1] Srinivasan V., Francis Luther King M. and Purushothaman T., 2014 “Alternative Fuel- A Literature Review’.

[2] Anshu Srivastava, Shakun Srivastava, Nigam A.C., Journal Of Environmental Science Volume 1, No 2, 2010, “Alternative fuel for transportation”.

[3] A.D. Bhetalu, Dr. S.S. Patil, Dr. N.W. Ingole, Journal and engineering research study, AN OVEVIEW ETHANOL AS MOTOR FUEL.

[4] Arnbuj D. Sagar, 1995. “Automobiles and global warming: “Alternative fuels and other options for carbon dioxide emission reduction”.

[5] E.I. Williamson, R.C.M. Longley 2011. Alternative fuels for automobiles the medium term realities.

[6] Mr. Naiman ali, Mazharuddin khan mohd, Majid mohiuddin, Apr 2011 “Ethanol Fuel Production Through Microbial Extracellular Enzymatic Hydrolysis and Fermentation from Renewable Agrobased Cellulosic Wastes”.

[7] Lin Tanaka 2006 “Ethanol Fermentation from Biomass Resources: Current state and Prospects”.

[8] Geller H.S., 1985, Ethanol fuel from sugar cane in Brazil, Ann. Rev. Energy, 10: 135-164.

[9] C.Argakiotis, R.Mishra,C.Stubbs and W.Weston, International Conference on Renewable Energies and Power Quality,April 2014, “The Effect of using an Ethanol blended fuel on Emissions in an SI Engine”.

[10] Sumit Sharma, Ashish Nayyar, International Journal of Science and Research, “A Review on Available Evidence for Effects of Ethanol Fuels on Air Pollutant Emissions from Motor Vehicles”.

[11] Uduak George AKPAN, Adamu Ali ALHAKIM, and Udeme Joshua Josiah IJAH, 2008, “Production of Ethanol Fuel from Organic and Food Wastes”.

[12] Jitendra kumar, N.A Ansari, Vikas Verma, Sanjeev Kumar, American Journal of Engineering Research, “Exhaust Gas Analysis and Parametric Study of Ethanol Blended Gasoline Fuel in Spark Ignition Engine”.

[13] N. Seshaiah, Apr 2010, “Efficiency and exhaust gas analysis of variable compression ratio spark ignition engine fuelled with alternative fuels”.

[14] Lim Soo King, Low Chong Yu and Chan Jiun Khin, 2014, “Peformance And Emission Analysis Of Ethanol Gasoline Blended Fuel”.

[15] Iman K. Reksowadojo, Long H. Duong Duc Ng. Pham, April 2014, “Review Of Typical Biofuel for Aviation Alternative Fuel Purposes”.

[16] MartinVoráček, Jakub Kraus, “Production and properties of alternative aviation fuels”.

S. Prasad, Anoop Singh, H.C.Joshi, 2006, “Ethanol as an alternative fuel from agricultural, industrial and urban residues.

[17] AshishS.Lanje, M.J.Deshmukh, Oct 2012,“Performance and Emission Characteristics of SI Engine Using LPG-Ethanol Blends”.

[18] V.Balaji Raman, X.Alexander, June 2013, “Emission and Performance Test on Petrol Engine Using Fuel Modification”.