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"USE OF ALCOHOL AS AN ALTERATIVE FUEL IN I. C. ENGINES (Ethanol)"

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Abstract – *This work describes the effect of Ethanol (ethyl alcohol) as an alternative fuel in IC engines. Alternative fuels research has been going far well over many years at a number of institutions. Since Ethanol possesses characteristics, properties that have positive influence on engine performance as well as exhaust emissions. The increase in engine performance could be attained with an increased compression ratio along with the ethanol which has higher octane value. Furthermore, ethanol burns very cleanly and produces lesser carbon monoxide (CO) and nitrogen oxide (NO_x). On the other hand, energy value of Ethanol is approximately 30% lower than gasoline, thereby specific fuel consumption (SFC) will increase simultaneously when the alcohol (Ethanol) is used as fuel. So, this seminar is based on the technical as well as quantitative data available from different researches which include impact of Ethanol on engine vibrations, engine noise and it can be used as a pure fuel in SI engine but it requires some modifications in the engine.*

***Key Words*: Ethanol, Compression ratio, Alternative Fuel, Specific fuel consumption (SFC).**

1. INTRODUCTION

Internal Combustion Engines (ICEs) are machines that convert the heat produced from combustion into mechanical work. The important subjects of this paper are reciprocating engines, such as spark-ignition (SI) and compression-ignition (CI) engines i.e., internal combustion engine. They have been greatly adopted as power sources for passenger and commercial vehicles, electricity power generation, and in other industrial fields, due to their high-power density and high efficiency. The combustion process is one of the most important energy conversion methods where the chemical energy of fuel is directly converted into heat. Therefore, it is possible to say that human activities are greatly driven by and rely on fossil fuel energy.

Liquid fuels are over the past 100 years evolved as the fuels of choice for transport because of their high energy density and in the effortless of transport, storage and handling. Conventional fuels are complex mixtures that typically contain more than hundred chemical components whose composition has changed and evolved over time and in connection to engine development. The development has been done in correlation and in order to meet the engine development demand on power, efficiency and drivability. Over the last decades ever more stringent emissions legislations have been added to the demands on the fuel and engine combination. When discussing alternatives to current fossil fuels for propulsion and power generation fuel properties are important criteria from point of view to take into consideration, since the combustion behavior relates to the main purpose of the heat machine, i.e., to convert chemical power to mechanical power. Alternative fuels research has been ongoing for well over many years at a number of institutions. Driven by oil price and consumption, engine emissions and weather change, along with the lack of sustainable fossil fuels, transportation sector has generated an interest in alternative, renewable sources of fuel for internal combustion engines.

1.1 What is Alternative Fuels?

The definition of alternative fuels may vary depending on the context. The current study defines alternative fuels of those other than conventional gasoline and diesel fuels, covering a great variety in terms of the final forms and manufacturing sources. For example, ethanol fuel is considered an alternative for SI engines, regardless of its original source from either conventional crude oil or any renewable biomass. The alternative fuels defined by the Energy Policy Act (EP Act) also cover a vast amount of the non-conventional fuels, including alcohols, such as ethanol (including blends with gasoline over 85%); natural gas and liquefied fuels domestically derived from natural gas; liquefied petroleum gas (LPG); coal-derived liquid fuels (CTL); hydrogen (H 2) biodiesel (B100); fuels, other than alcohol, derived from biological materials; and fuel that is substantially non-petroleum that yields substantial energy security and environmental benefits.

The significance of using alternative fuels can be attributed to the following aspects

(1) Pursuing energy sustainability through the extended usage of those fuels derived from the renewable energy sources and mitigating the concerns of limited fossil fuel energy.

(2) Improving engine efficiency and engine-out emissions with the aid of superior physical or chemical properties of the alternative fuels compared to those of conventional fuels.

(3) Relieving the unbalanced usage of the conventional petroleum-based fossil fuels.

1.2 Alcohol (Ethanol) As Fuel

Ethanol is a cheap non-petroleum-based fuel. As with methanol, E-85 is the predominant ethanol alternative fuel. The use of ethanol in automobiles is not a new innovation. In the 1880s, Henry Ford built one of his first automobiles to run on ethanol. Ethanol (ethyl alcohol, grain alcohol, EtOH) is a clear, colourless liquid with a characteristic, pleasant odour. In dilute aqueous solution, it has a somewhat sweet savour, but in more concentrated solutions it has a burning taste. Ethanol (CH3CH2OH) is a group of chemical compounds whose molecule contains a hydroxyl group, -OH, bonded to a carbon atom. Ethanol made from cellulosic biomass materials instead of traditional feedstock (starch crops) is called bio-ethanol.

The Clean Air modification of 1990 mandated the sale of oxygenated fuels in areas with unhealthy levels of carbon monoxide. Since that time, there has been strong demand for ethanol as an oxygenated combined with gasoline. In the United States each year, more than 1.5 billion gallons are added to gasoline to increase octane and improve the discharge quality of gasoline. In some area's ethanol is blended with gasoline to form an E10 blend (10% ethanol and 90% gasoline), but it can be used in higher concentrations such as E85 or in its pure form.

Ethanol is produced almost entirely from the renewable sources from fermentation of carbohydrate containing biomass like sugar, grains, tapioca etc. Neat ethanol (95% ethanol + 5% water) and anhydrous ethanol blended up to 20% in Gasoline have been widely used in Brazil during 1980s. In the USA, use of ethanol initially

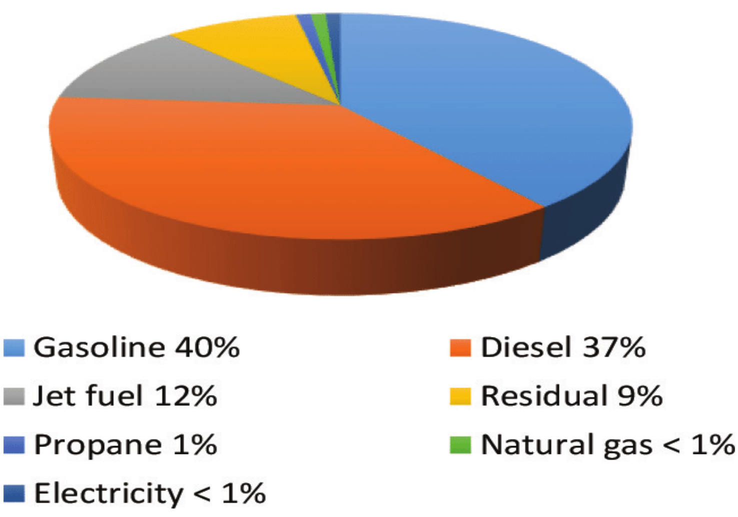

Chart-1: **Global Transportation Demand by Fuel**

started in the agricultural excessive states like Nebraska for blending in the rephrase Gasoline as oxygenate. Now, ethanol is the preferred oxygenate replacing methyl tertiary butyl ether (MTBE). The 10% ethanol-Gasoline blends used in the USA are commonly referred as „Gasohol‟. Sweden, New Zealand and California mainly concentrate on the methanol as an automotive fuel due to its potential near the natural gas field and it being liquid can be more easily processed and transported compared to natural gas.

Properties	Gasoline	Ethanol
RON	92	111
Stoichiometric A/F ratio	14.3	9
Density(g/cm3)	0.74	0.79
Boiling Point (ºC)	20-300	78.5
Heat of Combustion (MJ/kg)	42.4	26.8
Enthalpy of vaporization (kJ/kg)	240	845

Table-1: Ethanol and Gasoline Properties

Ethanol (C2H5OH) is a high performance, biomass fuel, which is produced mainly from biomass transformation, or bioconversion. It can also be manufactured by synthesis from petroleum or mineral coal. It is considered the most suited alcohol to be used as a fuel for spark ignition engines. It has a high-octane quantity and a high laminar flame speed. It has a neutral CO2 cycle. Current fuel standards (e.g., ASTM D4814) have already allowed up to 10% ethanol content for regular gasoline and the use of E85 (85% ethanol and 15% gasoline in volume). Today's Flexible-fuel vehicles (FFV) have been equipped with the capacity of running on any ethanol-gasoline blend from E0 to E85. However, devoted engine control schemes are yet to be developed to exploit some of the advantageous fuel properties of ethanol and thus improve fuel economy and engine performance. For instance, since ethanol has a higher-octane number, the ignition timing could be regulating accordingly to take advantage of its higher knock resistance and thus maximize the engine output power. Table-1 compares the most relevant ethanol and gasoline properties. Such engine control optimization or more basic adaptations, such as cold-start fuel injection amount, require the knowledge or estimation of the ethanol concentration in the fuel Drawbacks include its relatively low heating value and the fact that it is corrosive to metal and rubber parts of the engine. Also, high production of ethanol would create a food-fuel competition, resulting in higher costs for both. Thus, the use of 100% ethanol in internal combustion engines on a wide scale is not possible.

2. METHODS OF PREPERATION

2.1 Substrates: Ethanol is produced from various kinds of coatings. The substrate coating used for ethanol production is chosen based on the regional availability and economical efficiency. The substrate for ethanol fermentation is discussed in this part.

Sucrose containing materials: Ethanol is produced by fermentation. Fermentation process is a process to convert sugar to ethanol. Sucrose containing materials converted to the ethanol by the production process.

• **Sugarcane:** Brazil is the world second biggest ethanol manufacturer. In Brazil, sugarcane is the massive substrate for ethanol. Countries in Central America and Caribbean are suitable for sugarcane cultivation, and their ethanol production is increasing now days.

• **Sugar beet:** Sugar beet is mainly cultivated in European countries since it grows under cold climate.

• **Sugar sorghum:** Sugar sorghum is also a sucrose containing crop. It yields large amount of biomass and sugar due to its high photosynthetic efficiency.

Starchy materials: Starch is converted to sugar by saccharification followed by fermentation. Today, saccharification and fermentation are done simultaneously (SSF: simultaneous saccharification and fermentation).

• **Corn:** It is relatively easy to obtain high purity starch from corn. As the world largest corn producer, the United States mainly produces ethanol from corn, and this also makes the United States the world biggest ethanol manufacturer.

• **Other starchy materials:** Any kind of starch containing crop can be used to produce ethanol. Many researches on ethanol production from various starchy materials, such as potato, sweet potato, cassava and wheat, have been investigated.

2.2 Production process: Starchy materials are converted to ethanol by two major processes, dry milling and wet milling.

Dry milling: Dry milling, the presiding and more efficient ethanol production process than wet milling. It produces about 2.8 gallons of ethanol per bushel of corn. The schematic of dry milling is shown below (Figure-:1).

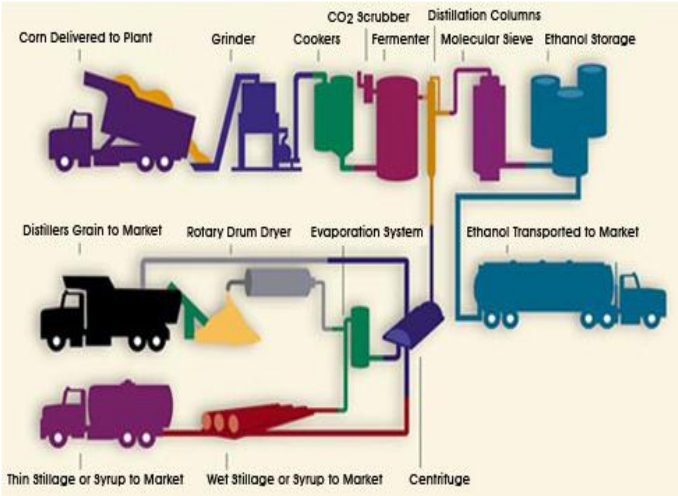

Fig-1: Schematic of dry milling ethanol production

Wet milling:

The sections of grain are separated in wet milling before saccharification. Produces various high value products such as corn gluten meal (CGM) and corn gluten feed (CGF) are produced though wet milling. It manufactures about 2.7 gallons of ethanol per bushel of corn. The schematic diagram of wet milling is shown below (Figure-:2).

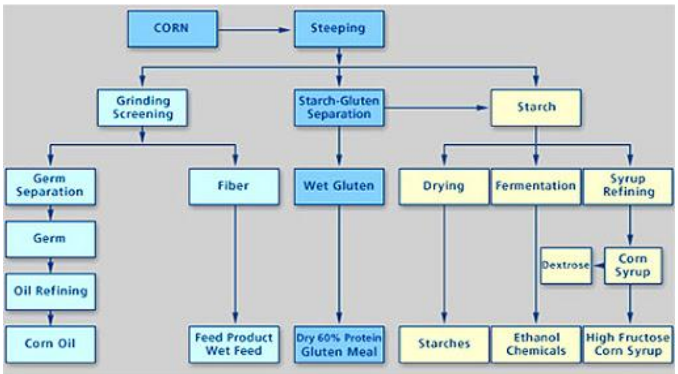

Fig-:2 Schematic of wet milling ethanol production

3. CONCLUSIONS

- It is understood that there are slight increases or decreases in Engine performance when the ethanol and ethanol–gasoline blends are used at the original compression ratio in the engines, Emissions like CO, HC, and NOx decrease.
- Ethanol is the most widely used renewable fuel with up to 10% by volume blended into gasoline for regular spark ignition engines or up to 85% for use in Flex-Fuel vehicles designed to run with higher concentrations of Ethanol.

- At higher compression ratio, power increases and fuel consumption decrease, and increase in thermal efficiency when hydrous ethanol was used.
- Reducing fossil fuels in the near future would be a great loss to mankind if we are not able to find out any alternative for it and I found a record to be effective as it can produce easily and the flexible fuel vehicle will be proved to be of great advantage.
- Significant improvements can be obtained in power and efficiency if the small engines with low compression ratio can be run at higher compression ratios using fuels resistant to the knock.

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