Extraction of Ethanol using Sugarcane Waste and using it as an Alternative Fuel in IC Engine

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***Abstract*—Ethanol is a renewable resource of energy and is potentially cleaner alternative to fossil fuels. Production of ethanol is growing day by day at a great extent for its versatile application and demand. During recent years, production of ethanol by fermentation on a large scale has been of considerable interest to meet to increased demand. Fermentation is a biological process in which sugars such as glucose, fructose, and sucrose are converted into cellular energy and thereby produce ethanol and carbon dioxide as metabolic waste products. It has long been recognized that molasses from sugar-cane or sugar provide suitable substrates for ethanol production. Ethanol has been part of alcoholic beverages for long time, but its application has expanded much beyond that during the 20th Century. Much of the recent interest is in the use of ethanol as fuel. Ethanol produced by fermentation, called bioethanol, accounts for approximately 95% of the ethanol production**

Keywords—Ethanol; Bagasses;Blend; Efficiency; Gasoline.

I. INTRODUCTION

Over the last one hundred years of automobile technology there have been a number of advancements in size, power, speed, efficiency . Of course people want to get from initial point to final point faster, so that’s a good reason for advance. Maybe you move something heavier from initial point to final point, so that’s also a good reason for change. In the beginning, it seemed like the sky was the limit, building engines bigger and faster had no discernible cost. Ethanol also commonly called alcohol, spirits, ethyl alcohol and drinking alcohol, is the principal type of alcohol found in alcoholic beverages, produced by the fermentation of sugars by yeasts. The present work is based on the production of ethanol using sugarcane bagasses as a raw material and to use it as an alternative fuel in internal combustion engine. In a country like India where sugarcane production is high, it is very difficult to dispose the waste generated after extracting sugarcane juice. If this waste can be utilized to extract ethanol, it would be highly economical and beneficial for a developing country. Ethanol is mostly used as fuel and has become an alternative of renewable energy source now-a-days. Ethanol is an eco-friendly alternative to petroleum-based fuel as it has fewer greenhouse gas emissions. As the supply and price of oil and gas worldwide has become a major problem, ethanol is taking place as an alternative. Hence it is environment friendly and can be future source of energy for automobile.

II. PROBLEM STATEMENT

Nowadays the petroleum products are running out of race due to unbalanced relation between supply and demand besides air pollution of sources. The known worldwide reserves of petroleum are about 1000 billion barrels and these petroleum reserves are predicted to be consumed in about 30 years. The hike in petrol cost is mainly due to shortage of resources which leads to search for alternate fuel to replace fossil fuels. Alcohols are advocated as the prospective fuels because they can be manufactured from natural products or waste materials, unlike gasoline which is a non-renewable energy resource. An eco-friendly bio-ethanol is one such alternate fuel that can be used in unmodified petrol engines with current fueling infrastructure and it is easily applicable in present day combustion engine, as mixing with gasoline Ethanol was the first fuel among the alcohols used to power vehicles in the 1880s and 1890s . Combustion of ethanol results in relatively low emission of volatile organic compounds, carbon monoxide and nitrogen oxides. The emission and toxicity of ethanol are lower than those of fossil fuels such as petroleum, diesel etc. Hence in this present research an attempt has been made to optimize the variables which affect the bio-ethanol production from sugar molasses and the experimental results are compared with the available reaction kinetics.

III. METHODOLOGY

The process of production of ethanol from sugarcane bagasses involves fermentation using yeast. Then the process is carried out by further distillation. Then the prepared ethanol is blended with a fossil fuel in appropriate ratios. The physical properties such as density, viscosity, calorific value etc, of such prepared blends are determined. Then the blends are supplied to engines to evaluate performance of the engine. The study will be carried out at variable load conditions for different engine speeds.

There are three different stages involved in the Extraction of Ethanol which includes

- Pre-treatment of Sugarcane waste
- Fermentation using yeast (Saccharomyces Cerevisiae)
- Distillation.
- Extraction of ethanol
- Blending with fossil fuels
- Testing the prepared blend on IC engine

A. *Pre-treatment of sugarcane waste*

Sugarcane bagasses is a fibrous residue obtained after the extraction of sugar from sugarcane. Traditionally it has been used as fuel for sugar mills. But this bagasses contains significant amount of hemicellulose material that can hydrolyzed to its constituents carbohydrates easily. The hydrolysis product contains a mixture of xylose as a major component. These cellulose and other sugars obtained can utilized for fermentation to obtain many useful products.

In order to prepare a solution suitable for fermentation, sugarcane waste should be immersed in appropriate quantity of de-ionised water. This solution should be kept aside for around 4-5 days. After this period, the liquid content is filtered out using filtration techniques and should be further checked for ideal pH value (4-5). Once the ideal pH value is obtained, the solution should be acidified using sulphuric acid to get rid of various kinds of bacteria's and micro-organisms.

B. *Fermentation by yeast*

Fermentation is a metabolic process thatconverts sugar to acids, gases and or alcohol. It occurs in yeast and bacteria, but also in oxygen-starved muscle cells, as in the case of lactic acid fermentation. Fermentation is also used more broadly to refer to the bulk growth of microorganisms on a growth medium, often with the goal of producing a specific chemical product.

$$C_6H_{12}O_6 + \text{yeast} \rightarrow 2C_2H_5OH + 2CO_2$$

C. *Distillation*

Distillation is the separation of a mixture into its component parts, or fractions, such as in separating chemical compounds by their boiling point by heating them to a temperature at which one or more fractions of the compound will vaporize.The operation of Distillation is employed for the purification of liquids from non-volatile impurities. The impure liquid is boiled in a flask and the vapours so formed are collected and condensed to give back the pure liquid in another vessel. The non-volatile liquid are left behind in the flask.

Fig 1: Distillation Unit.

D. *Extraction of ethanol*

Extraction in chemistry is a separation process consisting in the separation of substance from matrix. There are two main types of extraction.

a) Liquid-liquid extraction.
b) Solid phase extraction.

Extractions often use two immiscible phases to separate a solute from one phase into the other. Typical lab extractions are of organic compounds out of an aqueous phase and into an organic phaseIn fermentation process, *Saccharomyces cerevisiea* (baker yeast) was used to ferment the simple sugar to ethanol and carbon dioxide. To determine the effects of pH on ethanol yield, the temperature was kept constant at 37^0C while the pH was varied from 3, 3.5, 4, 4.5 and 5. To determine the effect of temperature on ethanol yield, the pH was kept constant at 4.5. The fermentation process continued for 48 hours. After 48 hours, the sample was filtered using Watsman Filter Paper to separate the ethanol from the residue. The bio ethanol was distilled using rotary evaporator. The sample was heated at 80^0C to get the bio ethanol.

E. *Blending with fossil fuel*

Ethanol is blended with gasoline in four different ratios each ratio is volumetrically different from one another and is referred to as blends

- Blend 1 (90% gasoline, 10% ethanol)
- Blend 2 (80% gasoline, 20% ethanol)
- Blend 3 (75% gasoline, 25% ethanol)

F. *Testing the prepared blend in an IC engine*

The table shown below summarizes the important technical details about the engine. All tests were performed on this engine. The engine is connected dynamometer, which provides an external load and absorbs the engine power.

Fig 2: 4-stoke SI Engine.

G. *Engine specification*

Table-1: Engine Parameter Table.

Cycle	4 stroke
Ignition	Spark
Bore	87.5mm
Stroke	83 mm
Displacement	150 cc
Torque	12.5 Nm
Number of cylinders	1

IV Result And Discussion

➢ Blend 1 (90% gasoline, 10% ethanol)

Table-2: Specific Fuel consumtion (blend 1).

Sr.no	Load	Specific fuel consumption	Brake thermal efficiency
1	1.5	3.71	2.16%
2	3	1.93	4.08%
3	4.5	1.61	4.98%

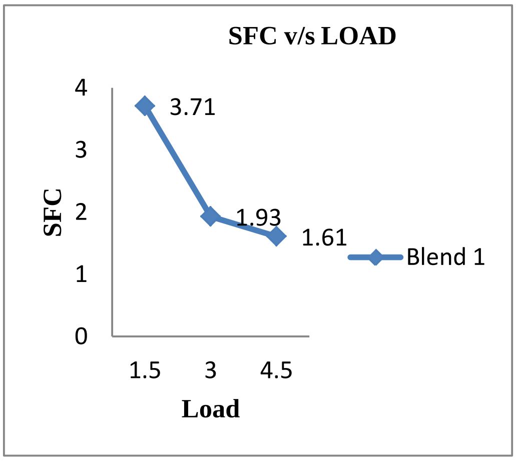

Fig 3: Specific Fuel consumtion (BLEND 1).

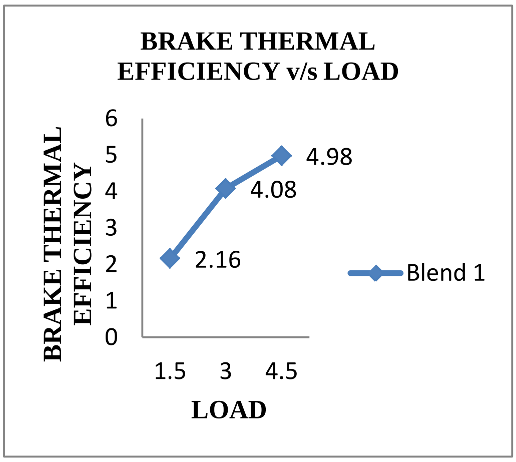

Fig 4: BTE v/s LOAD (BLEND 1).

➢ Blend 2 (80% gasoline, 20% ethanol)

Table 3: Specific Fuel consumtion (BLEND 2).

Sr.no	Load	Specific fuel consumption	Brake thermal efficiency
1	1.5	3.278	2.52%
2	3	1.926	4.29%
3	4.5	1.372	6.03%

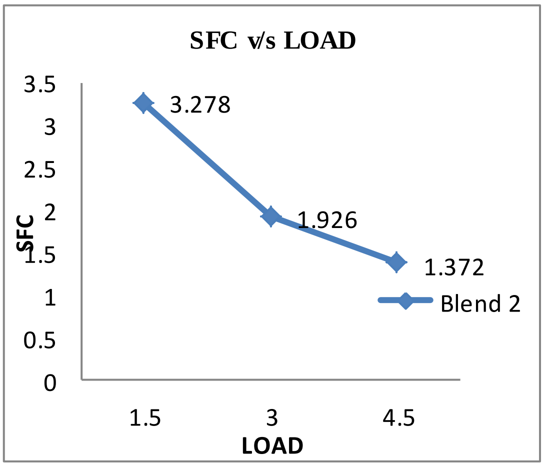

FIG 5: SFC V/S LOAD (BLEND 2).

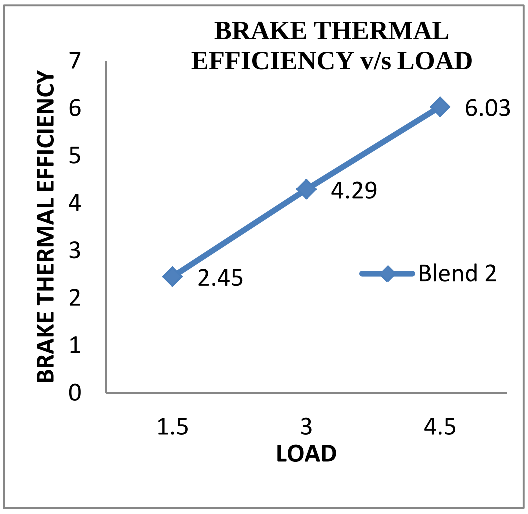

Fig 6: BTE v/s LOAD (blend 2)

➢ Blend 3 (75% gasoline, 25% ethanol)

Table 4: Brake Thermal Efficiency (BLEND 3)

sr.no	Load	specific fuel consumption	Brake thermal efficiency (BTE)
1	1.5	3.435	2.45%
2	3	1.811	4.65%
3	4.5	1.38	6.09%

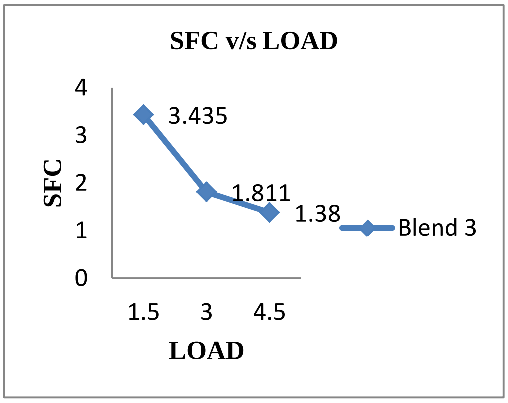

Fig 7: SFC v/s LOAD (BLEND 3).

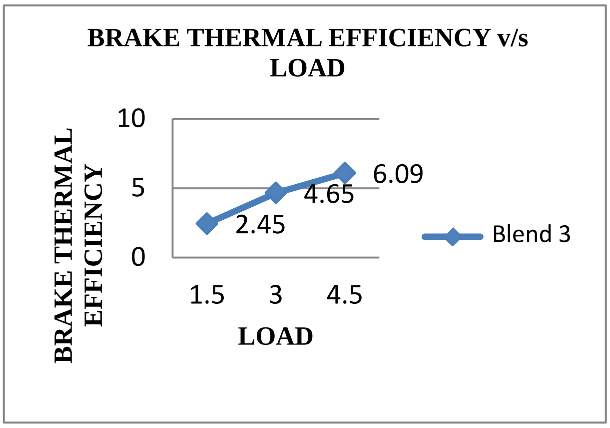

Fig 8: BTE v/s LOAD (BLEND 3).

CONCLUSIONS

This paper is based on the production of ethanol using sugarcane bagasses as a raw material and to use it as an alternative fuel in internal combustion engine. In a country like India where sugarcane production is high, it is very difficult to dispose the waste generated after extracting sugarcane juice. If this waste can be utilized to extract ethanol, it would be highly economical and beneficial for a developing country. Ethanol is mostly used as fuel and has become an alternative of renewable energy source now-a-days. Ethanol is an eco-friendly alternative to petroleum-based fuel as it has fewer greenhouse gas emissions. As the supply and price of oil and gas worldwide has become a major problem, ethanol is taking place as an alternative. Hence it is environment friendly and can be future source of energy for automobile.

➢ 10% ethanol-gasoline blends can be used in spark ignition engines without any major modifications to the air/fuel system. The 10% ethanol blend produces similar fuel conversion efficiency, brake work, and bsfc to that of pure gasoline. CO emissions for 10% ethanol blends are much lower than CO emissions from gasoline. NOx and CO2 emissions for 10% ethanol blends and gasoline are similar. 10% ethanol blends can be effectively used without modification in air/fuel system. CO,HC emissions can reduced by using different % of blends of ethanol in gasoline. Among which 10% is the best one to be used in multi cylinder engines without any alteration to reduce exhaust. A little attention has to be taken on pressure rise in the engine.

- 20% ethanol-gasoline blends do not perform as well as pure gasoline does in spark ignition engines that are calibrated to run on gasoline. The fuel conversion efficiency and brake work both decrease for an engine operating on a 20% ethanol blend, while bsfc increases. CO emissions for 20% ethanol blends are much lower than CO emissions from gasoline. The NOx emissions for 20% ethanol are similar to those of pure gasoline. CO_2 emissions are higher for 20% ethanol blend than for what is produced by gasoline.

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