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EXPERIMENTAL ANALYSIS OF PERFORMANCE AND COMBUSTION CHARACTERISTICS OF CI ENGINE USING ETHANOL WITH DIESEL BLENDS AS FUEL

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Abstract :Increase in popularity of ethanol as a liquid fuel or as a fuel source has emerged both federal restrictions and, in certain situations, economic incentives based on environmental concerns as well as a desire to decrease dependent on imported oil. After this, several nations are developing their own domestic markets for the utilization of biofuels like ethanol. Bioethanol is manufactured almost completely from grain or sugarcane. The research's true goal is to mix ethanol and biodiesel with traditional diesel fuel and utilise the mixture in a compression ignition engine to reduce emissions. A single-cylinder water-cooled diesel engine was used to conduct this experiment, this included using pure diesel (D100), 10 percent high ethanol B10 (E10D90), % high ethanol B20 (E20D80), and ethanol-diesel blend B30 (E30D30) (E30D70). The performance and combustion characteristics of the test engine have been investigated via comparisons with a number of pollutants that are already reported in the scientific literature. This study explores the performance and combustion characteristics of an internal combustion engine that was infused with ethanol and diesel fuel in it.? In the first phase, the different part loads are applied on the neat diesel fuel loads are 3kg, 6kg, 9kg, 12 kg and in the second phase which is 10% of ethanol-blended fuel and further 20% and 30% blending of ethanol. The application of load in the engine is performed via the use of an eddy current dynamometer, and the engine is maintained at a constant speed of 1500 rpm and a constant compression ratio of 17.5:1. The results are compared by data from the electronic system coupled to the engine. At a higher load of the condition of the blend, the B30 engine was stopped at work.

***IndexTerms* -Engines of tLV, Ethanol, Oxygenates, Combustion, Performance etc.**

I. INTRODUCTION

The global fuel crises in the 1970s triggered awareness amongst many countries of their vulnerability to oil embargoes and shortages discovery of alternate fuel sources, particularly alcohols, received a lot of interest. E10, a blend of 10% dry ethanol and unleaded gasoline, was commercially introduced in the United States and is still mostly sold in the Midwest. As researcher looks into the use of ethanol mixed with diesel in the 1980s, they found that ethanol–diesel blends were fairly flexible for diesel engines that were on the sale. Because of the relatively expensive cost of ethanol production at the time, it could only be considered in the event of a gasoline shortage. The economics of ethanol production has recently improved dramatically. It's also capable of competing with conventional diesel. There has indeed been a renewed interest in fuel operation, with a special focus on the potential to lower carbon pollution. To address these issues, researchers are looking at alternative fuel sources for various modes of transportation. As a result, efforts are being done all over the world to develop nonconventional fuels for use in diesel engines. Researchers also pay close attention to methods to reduce fuel use. in the automobile industry and the development of new technology Because biofuels have similar qualities to diesel, they are the ideal alternative to diesel engines. Many tests on the diesel engine were conducted in the earlier research work to determine the best efficiency power and other parameters. Furthermore, pollution must be taken into account as a significant context. Gas fuels cause pollution that have a substantial deleterious impact on both the environment and human health. Renewable fuels were adopted to combat rising pollution levels and the depletion of fossil fuel sources. Renewable fuels are readily available and may be mass-produced. Renewable fuels include biodiesel and bioethanol. Biofuels can meet the requirements for diesel engine fuel. The production of these fuels is both cost-effective and environmentally friendly. Because of the increased viscosity and phase separation issues, using neat biodiesel can When compared to diesel engines, gas engines emit much lower levels of nitrogen gases. Because ethanol has a low cetane, a high water content, and a high latent heat of evaporation, it cannot be used directly in a diesel engine due to its low cetane number, high water content, and high latent heat of evaporation. To address this disadvantage, biodiesel and bioethanol were blended with diesel, and the resulting mixture proved to be a great alternative and renewable fuel. The Indian government announced on Biofuel Day 2018 that environmental protection is a very high priority in our customs, culture, and celebrations. In nature, this is biodegradable. Because of the increased viscosity and phase separation issues, using neat biodiesel can result in higher nitrogen oxide emissions when compared to diesel engines. Because ethanol has a low cetane number, a high water content, and a high latent heat of evaporation, it cannot be used directly in a diesel engine due to the low cetane number, high water content, and high latent heat of evaporation.. To address this disadvantage, biodiesel and bioethanol were blended with diesel, and the resulting mixture proved to be a great alternative and renewable fuel. The Indian government announced on Biofuel Day 2018 that environmental protection is a very high priority in our customs, culture, and celebrations.

1.1 Alternative sources of energy

Alternate fuel is defined as a fuel that can be used straight or combined with conventional fuel. Various types of alternative fuels are now being investigated for future use because future crises of traditional fuels such as diesel and gasoline will occur. We will cover some alternative fuels below, one of which is ethanol.

1. Production of ethanol

Biotechnology is currently responsible for the majority of ethanol production around the globe. Agricultural products account for almost 95% of ethanol production. Ethanol sugar and sugar crops such as sugarcane and sugar beet accounts for around 40% of world supply, with the balance 40% coming from starch crops such as maize.

Three steps are involved in the manufacturing of ethanol

1. Obtaining a fermentable sugar solution
2. Sugar fermentation into ethanol
3. Distillation - rectification - dehydration – Ethanol separation and purification

Another significant distinction between ethanol generation from simple sugar, starch, or other cellulosic material is the method used to extract fermentable sugar. Given the fact that sugar crops just require a milling operation to extract the sugar for fermentation (hydrolysis is not needed), the act of manufacturing ethanol is simplified. In this method, ethanol may be produced directly from cane and beet juices, or it can be obtained from molasses, which is obtained after sugar extraction. Mostly during act of manufacturing ethanol from grains, the milling and hydrolysis of starch have also been entirely broken down into glucose by a combination of two enzymes before the glucose is fermented to yeast. These are mostly used in the manufacturing of ethanol from corn and wheat. The basic steps in producing ethanol from the cellulosic biomass are as follows:

1- With cellulose pretreatment to be efficient, a mechanical method to lower particle size and a chemical procedure to make the biomass accessible are used in tandem with others.

2 - Hydrolysis of polysaccharides to simple sugars using acid or enzymes.

3 – The macro organism is used to ferment the sugar into ethanol.

4 - Distillation -rectification -dehydration produces ethanol, which must be separated and concentrated.

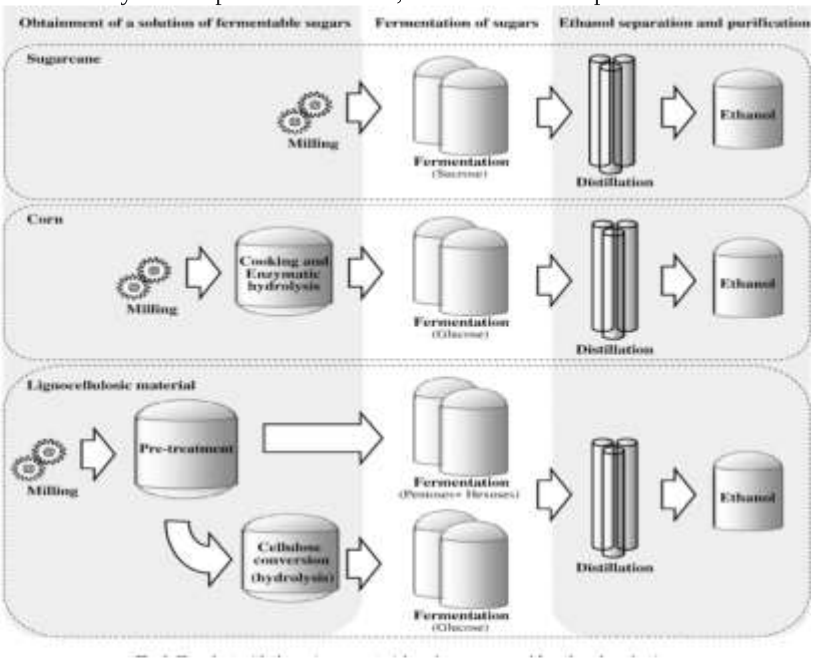

Fig 1. Production of Ethanol

II. USES OF ETHANOL

2.1.1 Personal care products: Ethanol is a frequent ingredient in many cosmetic products. It works as an astringent to clean the skin and as a lotion preservative to keep the ingredients from separating. Because ethanol is good at eliminating microorganisms such as bacteria, fungi, and viruses, it is also used in hand sanitizers. In this period of corona pandemic, ethanol plays a critical role in keeping hands clean and preventing the spread of corona.

2.1.2 Product for the home: Ethanol's ability to mix well with water and a wide range of organic compounds makes it an efficient solvent in paint and cleaning goods, as well as a preservative.

2.1.3 Additives to food: Ethanol, as a food additive, can aid in the distribution of food coloring and enhance the flavor of foods. Vanilla extract, a popular food flavor, is prepared by soaking vanilla beans in a solution of water and ethanol.

2.1.4 As fuel: Ethanol can also be used as a substitute for petroleum fuel. It can be used directly in the engine or blended in various proportions. In the United States, more than 97 percent of gasoline is blended with ethanol, which is made up of 10% gasoline and 90% gasoline. Because ethanol has a higher octane rating than gasoline, correct blending is required.

2.2Biofuels: Biofuels are fuels that differ from conventional fuels in the manufacturing process. Biofuels are simply made from agricultural crop residues and other waste products. Ethanol can also be made from the leftovers of many crops. Biofuels are readily available in nations such as INDIA, which is entirely reliant on oil imports from the Arabian Peninsula. They may raise the price of crude oil whenever they choose, which influences India's economy. In comparison to traditional fuel, biofuels emit fewer pollutants.

III. METHODOLOGY

3.1 Blending of fuel: Blending was performed for the ethanol and pure diesel and made multiple blends of different fractions. For each of the ethanol is mixed with diesel in the following ratios10:90 which is called E10D90 contain 10% ethanol and 90% of pure diesel.20:80 which is called E20D80 contain 20% ethanol and 80% of pure diesel.30:70 which is called E30D70 contain 30% ethanol and 70% of pure diesel.

Table1: Properties of fuel

Properties	Units	Diesel	Ethanol
Density at15°C	Kg/m^3	836.8	799.4
Viscosity at 40°C	mm^2/s	2.719	1.10
Lower heating value	MJ/kg	43.96	28.18
Cetane number	-	55.8	8
Flashpoint	°C	55	12
Oxygen content	wt%	0	34.3
Hydrogen content	wt%	13.0	13.1
Carbon content	wt%	85.7	52.2

3.2 Engine operation: The aim of the research is to examine the impact of blending ethanol and diesel in a stationary single-cylinder four-stroke diesel engine operating at a constant speed of 1500 rpm while using a variable ratio of ethanol and diesel. The research was done in a stationary single-cylinder four-stroke diesel engine working at a constant speed of 1500 rpm while using a variable ratio of ethanol and diese. In this study, a part loading condition was applied for the testing.

IV.EXPERIMENTAL SETUP AND MEASUREMENTS:

An experimental work on a diesel engine was implemented in order to explore different operating circumstances, and the experimental data was then evaluated using effective methodology to interpret the results. In total, the set consists of a single-cylinder, four-stroke diesel engine that is connected to an eddy current dynamometer for the goal of calculate the magnitude of stress applied to the engine. It is supplied with all of the equipment required for determining the crank angle of the combustion sealed chamber in needed to conduct properly. These signals are attached to a computer, which further receives the data.These are extremely well connected to the system, allowing them to display accurate data in the system. The system also includes a stand box with an air tiny package, a fuel tank, and a manometer. For the application of load, there is a fuel measurement factor transmitter for air and a fuel flow pointer for fuel flow. Rotameters are used to measure the flow of cooling water in a cooling system. It is possible to quantify engine design parameters such as flow rate, indicated power, frictional power, brake mean effective pressure, indicated mean effective pressure, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, volumetric efficiency, specific fuel consumption, air-fuel ratio, and net heat release data using this complete setup. When describing how well something works, phrases like as efficiency, specific fuel consumption, air-fuel ratio, and net heat release are often used to describe how well something operates.

Fig. 2 Experiment setup

4.2Engine specification: As per Quantitative Ethanol-Diesel Blends, ethanol alternative fuel can be partially substituted for diesel fuel under the majority of operating conditions in terms of performance and combustion parameters without the need for engine modifications, resulting in improved engine performance and power emissions. Complete the activity in a diesel power generator running on a diesel-Ethanol combination. And the findings reveal that burning a specific fuel boosts the brake thermal efficiency. Even when the braking power is considerable, the total fuel consumption is rather low. KIRLOSKAR OIL ENGINE LTD.INDIA manufactures a compression ignition engine with a rope brake dynamometer.

Fig 3. Engine

Table 2: Engine specification

Name of Diesel engine	KIRLOSKAR
Engine type	4-stroke 4-valve
Rate of speed	1500 RPM
Brake power	5.2 kW
Swept volume	654.1 cm
Specific fuel consumption	252 g/kw-h
Fuel use	Diesel
Stroke Length	110 MM
Cylinder diameter	87.8 MM
Number of cylinders	ONE
Compression ratio	17.5:1

V.TEST PROCEDURE: In order to gather data for the computation of characteristics such as indicated thermal efficiency, net heat release, specific fuel consumption, maximum average pressure, and exhaust gas temperature, the engine is equipped with an electronic data collection system . The engine was connected by a dynamometer by a propeller shaft and these setups were attached to the standing fuel tank and fuel measuring gauge. The thermocouple and other various devices are attached to the system so that they can easily measure the data provided by the engine Engine performance were tested different load which was controlled by a dynamometer and different parameter are obtained in the computer setup load were applied of 3kg,6kg,9kg,12kg these are the part load which is applied.

VI. RESULT AND DISCUSSION

6.1 Performance characteristics

6.1.1 INDICATED THERMAL EFFICIENCY (ITE)

This graph shows the variation of indicated thermal efficiency with the application of the part-load condition which is 3kg, 6kg, 9kg, 12kg. On the application of these loads with the help of a dynamometer performance is shown. In the graph, diesel shows the maximum indicated thermal efficiency at the higher loads and at the lower loads 3kg indicated thermal efficiency have maximum value due to the fast burning of the blended fuel due to the lower flame temperature of the ethanol which helps in fast burning of the fuel which increases the value of ITE .b20 blend shows a slight increase of efficiency with the increasing of the load.

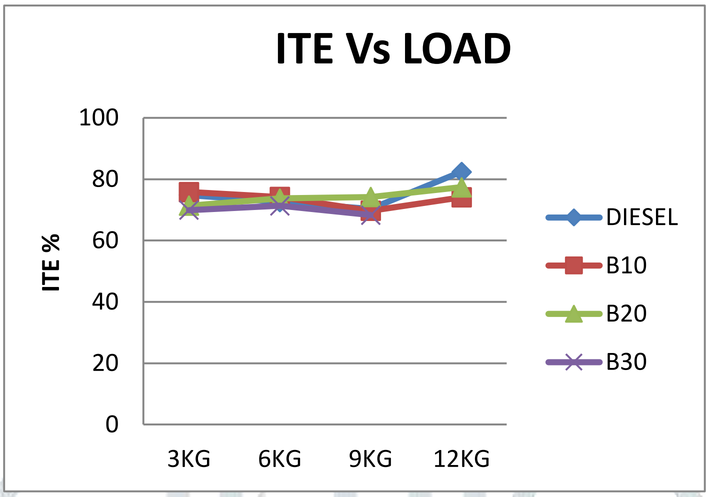

Fig. 4 Indicated thermal efficiency vs load

6.1.2 BRAKE THERMAL EFFICIENCY(BTE)

With the use of foreign stock circumstances on raising the load brake thermal efficiency of all blended fuels and pure diesel, this graph depicts the fluctuation of brake thermal efficiency on increasing the load brake thermal efficiency. Pure diesel shows the maximum efficiency due to the highest density of the entire load. On the increasing of the load B20 blend have the same brake thermal efficiency as compare to diesel at 6kg load condition. B10shows the lowest BTE value than other fuels because of less density of the fuel so mixing of ethanol with diesel at lower load better brake thermal efficiency can be achieved. And at B30 blend engine top working at the 12kg load engine was unable to perform more than 10kg of load at B30 blend.

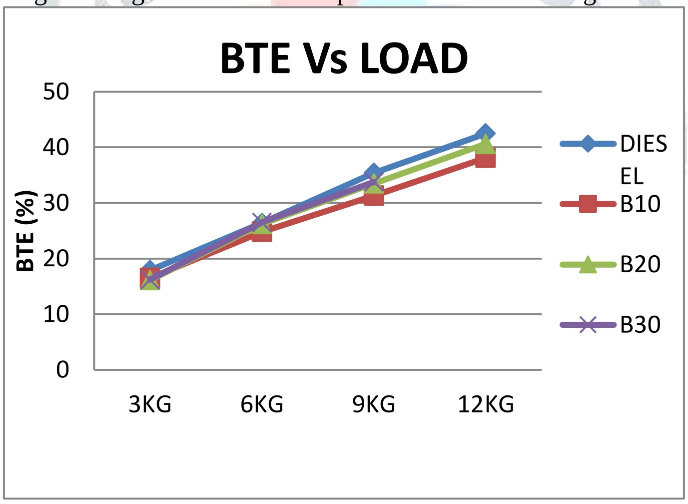

Fig.5 brake thermal efficiency vs load

Combustion Characteristics

6.2.1 MAXIMUM NET HEAT RELEASE

In this graph the variation of maximum net heat release with the application of the load. According to the rule of thermodynamics, the heat produced by the engine will be released to the sink, and some of the heat will be used in the creation of the work from the engine. According to this graph at lower load condition diesel have the highest net heat release but on the increasing the load net heat release of diesel decreases and at highest load, the net heat release of diesel has the lowest value because of the flashpoint of the ethanol which has very less value compared to the diesel which increases the heat contained in the cylinder. And at b30 shows the maximum net heat release value at higher loads.

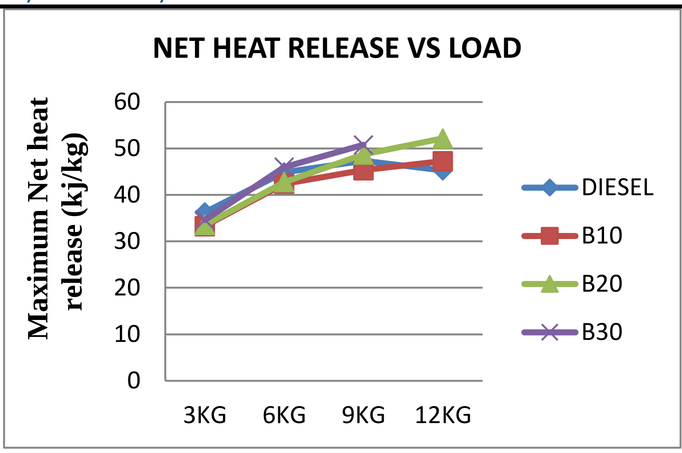

Fig.6 net heat release vs load

6.2.2 RELEASE OF THE MAXIMUM AMOUNT OF CUMULATIVE HEAT

This graph shows the variation of cumulative heat release of the engine with changes in the load condition of the engine. Here we apply the part loading condition for checking the variation in cumulative heat release. At lower load maximum cumulative heat release diesel has less value as compared to the blended fuel. B10 shows the maximum cumulative heat release because of the lower flash point temperature of the ethanol which burns the diesel very fast then heats release increases. At highest load, 12kg cumulative heat release rate of diesel and b20 blend is the approximately same value so at higher load b20 gives the more value of cumulative heat release than another blend.

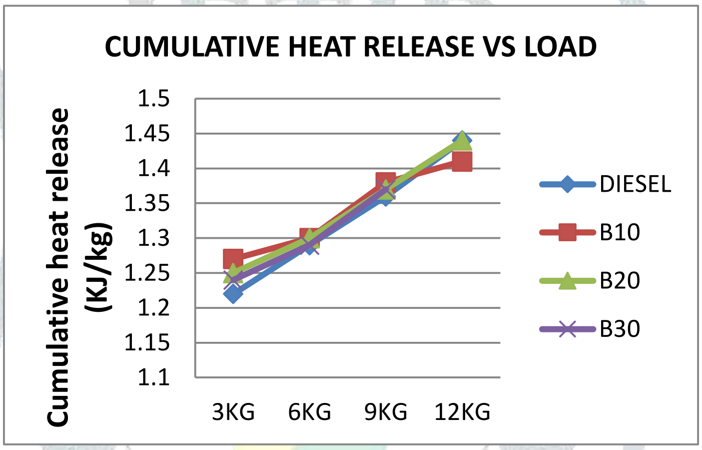

Fig.7 cumulative heat release vs load

6.2.3 MAXIMUM CYLINDER PRESSURE

This graph shows the variation in maximum cylinder pressure as a consequence of the change in the applied force. On the applying, the part load on engine cylinder pressure varies. According to this graph maximum pressure is generated in the diesel. Maximum cylinder pressure is generated in the different blend are lower than diesel. Lowest pressure generated in B30 blend. At 12kg load engine stops working so we can prefer lower blending for the higher load application.

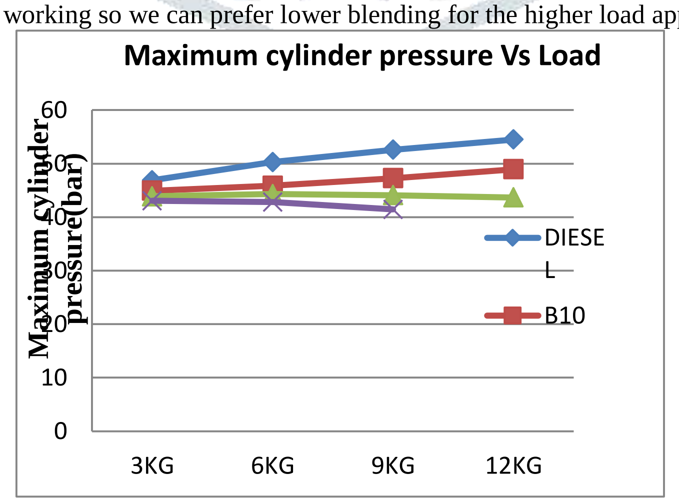

Fig.8 maximum cylinder pressure vs load

VII. CONCLUSION

After analyzing the data which are obtained based on an experiment performed on the engine setup. In the first phase of experiments were performed on the diesel and then different blends of ethanol and the diesel. In the following order: B10, B20, and B30, respectively. In light of the results obtained, it is possible to make the following conclusions: thermal efficiency, brake thermal efficiency, maximum net heat release, maximum cumulative heat release, and maximum cylinder pressure are all higher than expected.

- Indicated thermal efficiency of the B10 blend was better than diesel at the lower loads and higher loads condition indicated thermal efficiency of neat diesel better than ethanol-blended fuel.
- The thermal efficiency of the diesel fuel brake is greater at lower as well as higher loads while using the fuel. B30 blend shows approximately the same value as diesel and other blends show less brake thermal efficiency than pure diesel.
- Net heat release has a higher value for the diesel at the lower load and the B30 blend has the highest net heat release at the higher load. B10 shows more net heat release than diesel at 12 kg load condition.
- Maximum cumulative heat release is more for the B10 blend and shows maximum cumulative heat release at the lower load condition. Diesel has the lowest cumulative heat release at lower load and at the higher load, B20 and diesel have the approximately same value for 12kg of load.
- Maximum cylinder pressure is an all-time high in diesel fuel. B30 shows a very less value of maximum cylinder pressure and B10, B20 shows the moderate value of maximum cylinder pressure.

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