Experimental analysis of Effect of Biodiesel on performance and Emission of I.C.Engine.

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Abstract-*Today in this fast developing world the need of various transportation system is increasing day by day, in the result of this number of vehicles and engines are increasing, but the conventional fuel used in the vehicles (like diesel and petrol) are limited and decreasing gradually with time. So there is a requirement of various means to drive these vehicles without a heavy modification in the engine of these vehicles. This situation leads to requirement of alternative fuels for engines. Biodiesel is the best substitute of the Diesel in the Diesel Engine. The main advantage of Bio-diesel over the conventional fuel (as diesel in the diesel engine) is of reducing the cost and able to reduce net* CO_2 *and CO emissions to atmosphere due to their agricultural origin. In this paper we investigate the prospective of Palm oil to use as a Bio-diesel in the conventional diesel engine. Palm oil is derived from an oleaginous tropical plant, has the highest oil productivity per unit of land on earth. Which has been considered as a sustainable alternate fuel for diesel engine and also Palm plant is renewable and non-edible. However several durable and operational problems of using straight palm oils in the diesel engine are occurred due to their higher viscosity and low volatility as compare to diesel fuel. In this experimental work, performance of diesel engine operating on certain load with Palm oil was evaluated and compared with diesel operation. The performance parameter considered for comparing is brake specific fuel consumption, volumetric efficiency. This study targets on investigating the effect of bio-diesel on performance and emission of diesel engine.*

Keywords:-Biodiesel, Diesel, Emission, Engine performance, Palm oil.

I. INTRODUCTION

A. History of Diesel Engine

Diesel’s first engine was an external combustion engine that used ammonia vapours instead of steam to drive the piston. The low boiling point of ammonia meant that less heat was required for vaporization. Diesel also device system in which glycerine absorbed the ammonia vapour asset was expelled from the cylinder. The glycerine held the vapour’s heat so that it could be recycled to heat more ammonia. The goal was a super-efficient engine that could run for hours after a short initial warm-up period. Although his model worked, problems with heat exchange, leaks, and power output led Diesel to abandon the design in April of 1889.Diesel’s experiments led him to two important conclusions. The first was that the difference between the pressure of the compressed gas at the start of the power stroke and the pressure of the expanded gas at the end of the power stroke should be as great as possible. This would provide an equally wide heat range difference, with the maximum amount of heat being converted to usable power. To accomplish this,

Diesel estimated that pressures of fifty to sixty atmospheres would be needed inside the cylinder. Diesel second conclusion was that both ammonia vapour and steam were too difficult to handle at such high pressures. The best gas for the job was simply air. In the ammonia vapour engine, both the ammonia and glycerine had to be heated and cooled from external sources. For a short time, Diesel approached his high compression air engine in the same way, considering the use of an external source to heat the air. The Beginning of the First Diesel Engine Diesel was driven in his work by Carnot’s vision of a perfectly efficient heat engine. He had not set out to build an internal combustion engine. Finally, in his own words, Diesel formulated “the idea of using air not only as a working medium, but also as a chemical medium for combustion.”

B. Background of the study

A diesel engine is internal combustion engine. The cycle of the cylinders is the same in a diesel engine as it is in a gasoline engine, assuming it is a four-stroke engine. Aside from the fuel type, the major difference between the two engines is the combustion itself. A gasoline engine uses a spark plug to initiate combustion. A diesel engine compresses the air then injects the fuel into the cylinder at the top of the stroke. The high temperature of the compressed air ignites the fuel. The hot gases expand, force the piston down, and create a torque on the crankshaft. The final stroke is the exhaust stroke, which releases the hot gases into the exhaust system.

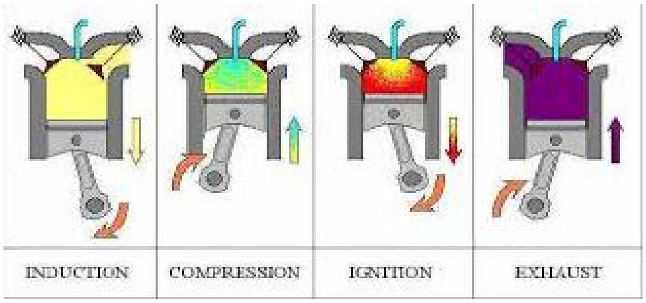

Fig. 1.1-Working of diesel Engine

Also as per new trend, to reduce emissions biodiesel are widely used. Various biodiesel are combined together with various blends to get better results. In this study also with normal diesel, biodiesel is mixed to get better results about reduction in emission.

C. Bio-diesel

The name bio-diesel was introduced in the United States in the year 1992 by the National Bio-diesel Board which has pioneered the commercialization of bio-diesel. Bio-diesel which can be used as an alternative diesel fuel is made from renewable biological sources such as vegetable oil and animal fats. It is bio-degradable, non-toxic and possesses low emission profile. Also, the use of bio-fuels is environment friendly. Biodiesel production increased by 85% making it is the fastest growing renewable energy source in 2006. Over 50% of the world’s biodiesel is produced in Germany.

World’s energy consumption has only increased continuously since decades except for a brief period like the oil crisis in 1970’s in which the growth slowed down. Energy consumption has increased by more than 5% in 2010, after a slight decrease in 200. This strong increase result of two converging trends. On the one hand industrialized countries, which experienced sharp decreases in energy demand in 2009, recovered firmly in 2010. Oil, gas, coal, and electricity markets followed the same trend. On the other hand, India and china, which showed no signs down in 2009 continued their intense demands for all forms of energy.

In 2008, the energy supply by fossils fuels was nearly 81% of the total world’s energy demand. This constitutes 33.5% by oil, 26.85 by coal and 20.8% by gas. The renewable energy sources like hydropower, solar power, wind power, geothermal power and biofuels contributed to about 13% of the world’s energy supply and nuclear power contributes to 5.8%. The facts show that oil is the most popular energy fuel. Since their exploration, the petroleum fuels continued as a major conventional energy source. On the other hand, they are limited in reserves and highly concentrated in certain parts of the globe. Those countries not having these resources are facing energy / foreign exchange crises due to heavy import bill on crude petroleum. This all above factors have been contributed to sharp increases in petroleum prices.

Biodiesel is greener to the environment, biodegradable, renewable, indigenous and have properties to that of conventional diesel oils. Hence it can be act as a potential diesel fuel supplement in the near future. They help a country to attain energy self-sufficiency in transport, power, agriculture and other related sectors and also boosts to rural economy by generating employment. The most important advantage of biodiesel is that its mass scale production and implementation on a large scale requires less expenditure in terms of cost and time compared to all others possible alternative energy source. Hence it will be easily used as an alternate diesel fuel. In a country like India having a huge agriculture potential, vegetable oil proves a promising alternate for petroleum (diesel) fuel. Today India has 17% of the world’s population, and just 0.8% of the world’s known fossil fuel and natural gas resources. India’s annual requirement of oil is 120 million metric tonnes.

India produces only about 25% of its total requirement. The import cost today of oil and natural gas is over Rs.2, 00,000 crores. Oil and gas prices are escalating; the cost of a barrel of oil has doubled within year. We have nearly 60 million hectares of wasteland, of which 30 million hectares are available for energy plantations like Jatropha, Honge etc. Once grown, the crop has a life of 50 years. Each acre will produce about 2 tonnes of biodiesel at about Rs.20/lit. As per mentioned above, biodiesel is also used to check its effect on emissions.B40 type of biodiesel is used for this work that is 60% of normal diesel and 40% Biodiesel. Palm oil used as biodiesel for current work. Results showed that using blend proportion and biodiesel blends has improved the CI engine performance with reduction in emission of carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO2). This study will focus on usage of biodiesel derived from normal diesel and Palm Oil. The existing IC engines are not efficient when operated with natural gas fuel due to its different physiochemical properties.

The continuously increasing cost of petroleum along with their rising pollution levels from diesel engines has caused an interest in finding alternate fuels to diesel. Emission control and engine efficiencies are the important parameters in current engine design.Oil palm, an oleaginous tropical plant, has the highest oil productivity per unit of land on earth. In terms of its usage, palm oil has various uses as a food, (oils, margarines, bread, mayonnaise, feeds, ice cream, cookies etc.), in industry (soap, lubricants, detergents, plastics, cosmetics, rubber etc.), in steel making, the textile industry, pharmacology etc. Among other crops for producing fuel, palm oil demonstrates good competitiveness.

II. LITRETURE REVIEW

Jinlin et al., it was analysed that use of biodiesel favours reduction in carbon deposit and wear of key engine parts, PM emissions are reduced, CO emissions are reduced, HC emissions are reduced but NOx emissions are increased [1].As a renewable, sustainable and alternative fuel for compression ignition engines, biodiesel instead of diesel has been increasingly fuelled to study its effects on engine performances and emissions the recent 10 years. But these studies have been rarely reviewed to favour understanding and popularization for biodiesel so far. In this work, reports about biodiesel engine performances and emissions, published by highly rated journals in scientific indexes, were cited preferentially since 2000 year. From these reports, the effect of biodiesel on engine power, economy, durability and emissions including regulated and non-regulated emissions, and the corresponding effect factors are surveyed and analysed in detail.

Williams et al.[2]analysed that transient emission test show a 24% PM reduction for B20 without the DPE installed [2].The call for the use of biofuels which is being made by most governments following international energy policies is presently finding some resistance from car and components manufacturing companies, private users and local administrations. This opposition makes it more difficult to reach the targets of increased shares of use of bio-fuels in internal combustion engines. One of the reasons for this resistance is a certain lack of knowledge about the effect of bio-fuels on engine emissions. This paper collects and analyzes the body of work written mainly in scientific journals about diesel engine emissions when using biodiesel fuels as opposed to conventional diesel fuels. Since the basis for comparison is to maintain engine performance, the first section is dedicated to the effect of biodiesel fuel on engine power, fuel consumption and thermal efficiency.

Agarwal et al.,analysed that higher NOx emission can be effectively controlled by employing EGR [3]. Emission such as HC and CO are also found to have decreased. The use of biodiesel is rapidly expanding around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process and pollutant formation. Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feedstocks, such as, vegetable oils or animal fats, for use in compression ignition engines. Different parameters for the optimization of biodiesel production were investigated in the first phase of this study, while in the next phase of the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Biodiesel was made by the well-known transesterification process. Cottonseed oil (CSO) was selected for biodiesel production. Cottonseed is non-edible oil, thus food versus fuel conflict will not arise if this is used for biodiesel production. The transesterification results showed that with the variation of catalyst, methanol or ethanol, variation of biodiesel production was realized.

Nabi et al., suggested that the use of biodiesel is rapidly expanding around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process and pollutant formation [4]. Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feed stocks, such as, vegetable oils or animal fats, for use in compression ignition engines. Different parameters for the optimization of biodiesel production were investigated in the first phase of this study, while in the next phase of the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Biodiesel was made by the well-known transesterification process. Cottonseed oil (CSO) was selected for biodiesel production. Cottonseed is non-edible oil, thus food versus fuel conflict will not arise if this issued for biodiesel production. The transesterification results showed that with the variation of catalyst, methanol or ethanol, variation of biodiesel production was realized. However, the optimum conditions for biodiesel production are suggested in this paper.

Rahman et al., examined the potential of biodiesel obtained from Jatrophacurcas and Moringaoleifera oils [5]. The physiochemical properties of J. curcas and M. oleifera methyl esters were presented, and their 10% by volume blends (JB10 and MB10) were compared with diesel fuel (B0). The performance of these fuels and their emissions were assessed in a fully loaded multi-cylinder diesel engine at various engine speeds. The properties of J. curcas and M. oleifera biodiesels and their blends agreed with ASTM D6751 and EN 14214 standards. Engine performance test results indicated that the JB10 and the MB10 fuels produced slightly lower brake powers and higher brake specific fuel consumption values compared to diesel fuel over the entire range of speeds. Engine emission results indicated that the JB10 and MB10 fuels reduced the average emissions of carbon monoxide by 14 and 11%, respectively; and hydrocarbons by 16 and 12%, respectively. However, the JB10 and MB10 fuels slightly increased nitrous oxides emissions by 7 and 9%, respectively, and carbon dioxide by 7 and 5%, respectively compared to B0. In conclusion, J. curcas and M. oleifera are potential feedstock for biodiesel production, and the JB10 and MB10 blends can replace diesel fuel without modifying engines to produce cleaner exhaust emissions.

Shah et al.,analysed that Biodiesel has already been commercialized in the transport sector [6]. In the present work, a turbocharged, intercooled, DI diesel engine has been alternatively fuelled with biodiesel and its 20% blend with commercial diesel. The experimental results show that BSFC, maximum combustion pressure and start of injection angle increase; on the other hand BSEC, maximum rate of pressure rise, ignition lag and premixed combustion amount decrease; however HRR duration remains almost unaffected in the case of biodiesel as compared to commercial diesel.

Ganesan et al., it was clear that one hundred years ago, Rudolf Diesel first tested vegetable oil as fuel for his engine [7]. With the advent of cheap petroleum, appropriate crude oil fractions were refined to serve as fuel and diesel fuels and diesel engines started evolving together. Later in the 1940's, vegetable oils were used again as fuel in emergency situations, during the period of World War II. Because of the increase in crude oil prices, limited resources of fossil fuels and the environmental concern, there has been renewed focus on vegetable oils and animal fats for the production of biodiesel fuel. Bio-diesel has the potential to reduce the level of pollution and the level of global warming. In this paper they are focusing on combination of diesel, castor oil and ethanol.

Dwivedi et al., analysed that Biodiesel, derived from the transesterification of vegetable oils or animal fats, is composed of saturated and unsaturated long-chain fatty acid alkyl esters [8]. In spite of having some application problems, recently it is being considered as one of the most promising alternative fuels in internal combustion engine. The aim of the present paper is to do a comprehensive review of engine performance and emissions using biodiesel from different feed stocks and to compare that with the diesel. From the review it is found that the use of biodiesel leads to the substantial reduction in PM, HC and CO emissions accompanying with the imperceptible power loss, the increase in fuel consumption and the increase in NOx emission on conventional diesel engine with no or fewer modification. However, many further researches about modification on engine, low temperature performance of engine, new instrumentation and methodology for measurements, etc., are recommended while using biodiesel as a substitute of diesel.

Kumar et al., looked that the demand of diesel for transportation is huge, captive power generation and agricultural sector, the biodiesel is being viewed a substitute of diesel [9]. The performance of diesel engine under the engine loading conditions showed that maximum output power at full load condition is nearly same for B10 and diesel fuel. For combustion characteristics, slightly shorter ignition delay and lower peak heat release rates were observed for biodiesel while there is slight reduction in SO2 and HC emission with increase in NOX emission when biodiesel and its blends are used. The present paper covers combustion, performance, and emission characteristics of biodiesel and its blends with diesel. The performance of diesel engines using biodiesel and its blends with petro-diesel in terms of brake power, torque, brake specific fuel consumption (BSFC), thermal efficiency (BTE) and exhaust emissions is reviewed. The engine problems and their possible remedial measure are also suggested in this paper.

III. METHODOLOGY

Methodology used in this experiment is that at different load conditions and at different blend proportion emission of the CI engine is estimated. We have selected three different load conditions i.e. ideal load condition, intermediate load condition and rated load condition. The blend proportions used for this are B20, B40 and B60. Emissions are measured at this various load condition and blend. Methodology remains same as we used for normal diesel.

A. Blends of Palm oil Biodiesel and Diesel and Formation of Palm oil-

The procedure followed for conducting the experiment using blends of palm biodiesel and diesel is same except that blends (B20, B40and B60) of palm biodiesel and diesel is to replace Palm biodiesel as fuel. The blend selected for the experimental study is B20, B40, B60, B80. For example, table below gives properties of B40 Palm oil.

Table.3.1 Properties of Palm oil

Type of source	Renewable
Calorific value (MJ/kg)	41.3
Gross heat of combustion (KJ/kg)	40.135
Cetane level	65
Flash point (°C)	174.0
Pour point (°C)	16.0
Density at 40 °C (kg/L)	0.855
Viscosity at 40 °C (cST)	4.5
Sulphur content (wt. %)	0.04
Carbon residue (wt. %)	0.02

B. Measurement Principle-

The test shall be carried out with the engine mounted on a test bench and connected to a dynamometer. The gaseous emissions from the exhaust of the engine include hydrocarbons, carbon monoxide and oxides of nitrogen. During a prescribed sequence of warmed up engine operating conditions the amounts of the above gases in the exhaust shall be examined continuously. The prescribed sequence of operations consist of a number of speed and power modes which span the typical operating range of diesel engines. During each mode the concentration of each pollutant, exhaust flow and power output shall be determined and the measured values weighted and used to calculate the concentration of emission.

Fig.3.1 Methodology used

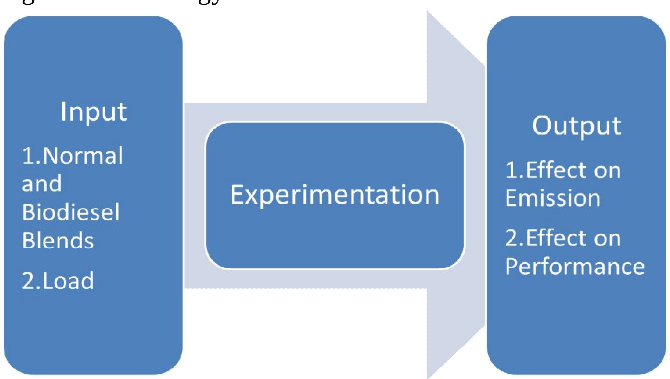

Fig.3.1 Methodology used

IV. EXPERIMENTATION

The followings experiment environment used for experimental analysis with diesel.

A. Experimental Set-up

Fig.4.1 Experiment Setup

B. Specification of Engine

1. Engine:

Table 4.1 Engine specifications

Make	Kirloskar
Model	TVI
Rated power	6kw at 1500 rpm
Bore	95.0mm
Stroke	110.0mm
Compression ratio	18.1:1
Type	Single cylinder, 4- Stroke, water cooled Diesel engine

2. Dynamometer:
Type eddy current, water cooled with loading unit.

3. Piezo Sensor:
Range 1000 PSI make PCB USA, low noise cable, water cooled adapter.

4. Crank Angle Sensor:
Resolution 10, Speed 5000 rpm with TDC maker pulse.

5. Engine indication:
For data scanning and interfacing with speed indicator.

6. Software:
For P-Q, P- V, IHP & MEP calculation, data lagging printing.

7. Air Box:
With orifice and monometer .

8. Fuel Tank:
10 L capacity, with graduated glass fuel metering column.

9. Rotameter:
For water flow measurement (2Nos).

10. Temp. Indicator:
Digital, PT-100, type temp.sensor (6point).

11. Gas analyser:

Table 4.2. Technical specification of Gas Analyzer

Gases measured	Carbon Monoxide,Hydrocarbon, Carbon dioxide and Oxygen
Principal	Discover perfection and know-how for precision in analysis without compromise
Startup Time	≤3 minutes from power ON, full accuracy in 4 minutes
Operating temperature	5-450C
Gas Flow Rate	300-500 ml per minute
Dimension	270×85×340mm
Weight	4.2 kg
Power requirement	Max. 20 VA

C. Procedure

First we selected load conditions which are 50% and 100% for normal diesel.At these conditionswe determined the parameters that will be used to predict the performance of IC Engine and then measured the emissions by Gas Analyser.

V. RESULT

The following are result found during the experimental analysis with diesel in indicating emission in term of % of volume and performance in term of efficiency.

Table.5.1. Emission Reading with Diesel

Speed \ Load		50%	100%
1000	CO_2	3.68	6.59
	CO	0.029	0.025
	NO_X	0.021	0.031
1500	CO_2	3.57	6.14
	CO	0.021	0.019
	NO_X	0.028	0.039
2000	CO_2	3.17	5.59
	CO	0.013	0.01
	NO_X	0.032	0.041

Table.5.2. Efficiency of engine with Diesel

Speed RPM	Load Kg	η_{mech} %	η_{bth} %	η_v %
1570	3	37.37	2.67	77.7
1550	6	54.4	5.34	76.57
1530	9	64.1	8.00	76.24
1500	12	70.4	10.63	76.11

V. CONCLUSION

A. Emission-

As the speed increases, the amount of CO_2, CO decreases while the amount of NO_X increases. At particular speed as percentage of load increases amount of CO_2, NO_X increases while amount of CO decreases.

B. Performance-

We can conclude that we get maximum mechanical efficiency, brake thermal efficiency at lowest speed. With decreasing speed the volumetric efficiency decreases.

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