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Engineering parameters for practical utilization of biodiesel as a green fuel

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Abstract - Bio-diesel has become one of the most versatile alternative fuel options for diesel engine applications. The recent bio-diesel researches in India receives its attention towards Jatropha curcas oil based bio-diesel. In India plants bearing seeds which are rich in oil has been found mainly Jatropha curas (Ratan jot) and Pongmia Pinnata (Karanja) which are grown in our suitable climatic conditions (Patil and Singh, 1991).

The use of bio-diesel is economically feasible and a strategic option, to meet the increasing demand of energy requirement of the nation.

Out of various non-edible oil resources, Jatropha curcas oil is considered as an alternate fuel for compression ignation engines. The present study describes the process used for blending of Jatropha oil with diesel. For finding mechanical parameters. A vertical water cooled diesel engine used under study for various measurements. Jatropha oil blended in the proportion of 20,40 and 60 percent (by volume) respectively in the diesel. The specific fuel consumptions at various loads has calculated under study. Respective performance analysis has evaluated. In has found that the minimum fuel consumption was found with B_{60} blend as 0.1966 Kg/KWh and maximum B.T.E of 43.67% obtained at 70% load conditions, shown as 32% increase as compare to diesel with full load operations. At the same time there were decrease of 3.3% and 1.6% in volumetric efficiency and mechanical efficiency respectively at full load operations with B_{60} blend of diesel oil.

Keywords: B.T.E- Break thermal efficiency Bio-diesel, B.S.F.C – Break specific fuel consumption, C.I engine – Compression ignition engine.

I. Introduction

The world wide fossil fuel demand is projected to exceed 100 million barrel/day by 2040, with diesel demanding more than 5 million barrel/day. Biodiesel is one such alternative liquid fuel which is almost similar to petro-based diesel and has some critical advantage over it: eco-friendly; suitable to normal diesel engine (either as 100% or as a blend in commercial diesel) and can be synthesized using different vegetable oils; waste frying oils; waste animal fats; algal and microbial oils.

The idea of using bio-diesel (vegetable oils) a fuel has been around as long as the diesel engine. Rudolph diesel, the inventor of the engine that bears his name, experimented with fuels ranging from powdered coal to peanut oil. In the early 20th century, however diesel engine was adapted to burn petroleum distillate rose, and by late 1970's there was renewed interest biodiesel. Research work on bio-diesel reveals

that large number of experimental studies of bio-diesel, derived from various feed stocks, as fuel for engines used for transportation and or other applications have been carried out all over the world. Application of bio-diesel, as fuel in transportation have been common in almost all oil importing nations, due to high oil import bills and uncertainties associated with the import due to political chaos.

The use of vegetable oils for engine fuel may seem insignificant today but such oils may become in coarse of time, as important as petroleum (Vasudevan, 2005). In this context many raw materials have been used by different countries depending upon the availability and economic affordability. This is reported that the rapeseed, sunflower, palm, coconut oil, waste plastic oils etc, have been found suitable and feasible for use in the diesel engine. Several researches are carried out in India; reveals that the bio-diesel derived from Jatropha, Karanja, Mahua, Polonga etc are suitable fuel for use in the diesel engine applications. The recent bio-diesel research in India includes its attention towards the use of algae bio diesel, waste cooking oil, tamarind oil, fish oil bio diesel etc. The use of Jatropha Curcas bio diesel as a fuel in diesel engine and its performance studies carried out in an single cylinder engine direct injection diesel engine is presented in this study.

II. Materials and Methods

The study has carried out at Mahamaya college of Agricultural Engineering and Technology w.e.f. 2016-17 to 2018-19. A vertical single cylinder, water cooled constant speed diesel engine (Table-1) coupled with rope brake drum to absorb the power produced. The engine crank started and the necessary dead weights and spring balance are included to apply load on the break drum. Suitable cooling water arrangement for brake drum is provided. Separate cooling waterline fitted with temperature measuring device (thermo couples) are provided for engine cooling. A measuring system for fuel consumption consisting of a fuel tank, burette and 3-way cock mounted on standard stop watch , U- tube differential manometer also designed. Temperature indicator with selector switch for temperature measurement for a digital rpm indicator for speed measurement are provided in the penal board. A governor is also provided to maintain a constant speed.

Table-1: Specification of the engine under study

S.N.	Particulars	Specifications
1.	Make	Kirloskar
2.	Rated power	08 HP
3.	Bore	80 mm
4.	Stroke length	110 mm
5.	Compression ratio	16.5: 1

For experimental investigations, pure diesel and bio diesel derived from Jatropha Curcas oil was mixed with diesel in varying proportions 20%, $0%, ^)% by volume respectively to all the blends. The properties of test fuel are provided in the table-2. The specific fuel consumption is obtained by dividing fuel consumption / unit time to brake power at different blends. Many activities like- removal of air lock, lubrication and cooling water supply was ensured. Start the engine using decompression lever ensuring that no-load to get stabilization. Note down the spring balance reading, time taken for 10 cc fuel consumption and manometer reading which represent the experiment at 10% to 100%, load and the speed of 10% increase. Following observations were carried out for specific fuel consumption w. r. t. Brake power (Kw) and D_F, B_{20}, B_{40}, B_{50} and B_{60}. Similarly brake thermal efficiency, air fuel ratio, mechanical efficiency, volumetric efficiency and brake specific fuel consumption also calculated.

Table-2: Pure diesel fuel, compared with JBDF, FOBD and TOM.

S.N.	Property	Pure diesel fuel (D_F)	Jatropha fuel (JBDF)	Fish fuel (FOBD)	Tamrind oil (TOBD)
1.	Cetane no	45-55	58.4	59	58
2.	Density (Kg/M^3)	820-850	926	880	870
3.	Kinematic viscosity at 30^{0}C	3 cst	4cst	5cst	5cst
4.	Calorific value, Kj/Kg	42000	39340	32000	36356
5.	Flash point ^{0}C	56	152	162	120
6.	Carbon residue %	0.275	-----	-----	0.875
7.	Ash content %	0.005	-----	-----	0.134

III. Result and Discussion

In the analysis it was found the maximum thermal efficiency for B_{60} was higher (43.57%) load than that of diesel engine (36.34%). This blend of 60% also gave minimum brake specific fuel consumption (0.1966 kg/kwh). Hence this blend was selected as optimum blend for further investigations and long term operations. The brake specific fuel consumption in full load in brake power due to relatively less portion of heat losses at higher loads. The conditions for diesel are 0.267 and among the entire blend B_{60} has taken minimum fuel giving the value of 0.1966. The main reason for this could be that percentage increase in fuel required to operate the engine is less than the percentage increase in the brake power due to relatively less portion of heat losses at higher loads. The BSFC for B_{60} was observed lower than diesel.

Generally brake specific fuel consumption is not used to compare different fuels because their calorific values, density, chemical and physical parameters are different. Brake specific fuel consumption of bio-diesel is slightly higher than that of neat diesel, inherent oxygen of fuel molecules improves the combustion characteristics. The air fuel rating decreases with increase in load because of load can only be done with increasing the quantity of fuel injection to develop the power requirement for loads. In the study it was concluded that the minimum fuel consumption is 0.1966 kg/kwh as that of diesel 0.267 kg/kwh. The maximum brake thermal efficiency is 43.57% which is obtained for B_{60} blend at 80% of load. In this way the brake thermal efficiency of jatropha carcas oil is increasd up to 32% as compared with diesel at full operations. The volumetric efficiency decreased by 3.3% at full load operation compare with B60 blend. It was also found that the mechanical efficiency decreased by 1.6% at full load operations compared with B_{60} blend. The BSFC was decreased by 24% at the full load operations of the engine.

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