PERFORMANCE CHARACTERISTICS OF DI DIESEL ENGINE FUELLED WITH METHYL ESTERS OF WASTE VEGETABLE OILS ON HELICAL SPRING BLUFF BODY

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ABSTRACT: With the rise in the requirement for the fossil fuels which are exhausting day by day, the need for the alternative fuels also increased accordingly. Biodiesels are one of the best examples as an alternative to be used for fossil fuels. Research has been carried out on the performance of the diesel engine, where emission control also took place and hence it is feasible to use bio diesels as an alternative source for the engines and observe the performance. In this research, the Methyl esters of waste vegetable oil are used as biodiesel for the direct injection diesel engine and analyze the performance characteristics of the engine using different volumes of the diesel blends.

The performance of the engine can also be enhanced with the modifications in design of the engine. Since the modification of the total design of the engine is complicated, modification of any single component makes it simple and the piston design modification is one of the techniques to improve the performance of IC engine. In this research, a helical spring bluff body is placed in the piston bowl; this helical spring improves swirling motion to the fuel which helps for the complete combustion of the fuel. Complete combustion of the fuel improves the thermal efficiency of the engine and performance tests are conducted by using the waste vegetable oil with diesel and the same is compared with the performance of normal D.I diesel engine. The integration of bluff body in the piston bowl improves the brake thermal efficiency by 2%, mechanical efficiency3.5% and reduces the exhaust emissions by considerable percentage with blend B (10)of waste vegetable oil.

Key words: - Direct injection (D.I) method, waste vegetable oils and helical spring bluff body.

1. INTRODUCTION

Present days most of the industries (Pharma industries and Agri industries), agricultural equipments and small machinery are working by using internal combustion engines. The major part of the engines is working by using fossil fuels. Fossil fuels are used for combustion process in the engine to produce heat energy. That heat energy later converted to mechanical energy. This mechanical energy is used to run external loads with the help of rotational crank. The main problem in using the fossil fuels is they are exhausting day-by-day. But the demand is increasing continuously. The other problem with the fossil fuels is exhausting of emissions. These emissions are produced when the fossil fuels are burning in the combustion chamber in the form of air fuel mixture. CO_2, CO, HC and NO_x are the present in the emissions. Emissions are the contaminants which pollute the atmosphere. Pollution creates hazards to the life cycle of all living beings and pollution is the major problem which is faced by the humans.

The features of the fuel flow and air fuel mixture in the combustion chamber affects with the shape of the bluff body. The geometric shapes affect the engine performance and emissions of the engine. The following are the different research papers which explain the affect of bluff body in the engine.

LONGWELL [1] the incorporation of the bluff body creates the turbulent flow in the combustion chamber. This turbulent flow creates the homogeneous mixing of the air and fuel. In turn this homogeneous mixture produces standardised flame of high intensity. The evolution of the standard flame is required to get the high output from the air-fuel mixture. The author proposed that insertion of bluff body is needed to get high performance from the engines without the modification of all the components of the engine.

VENKATESH BABU [2] the swirl motion is mandatory to acquire the uniform mixing of the air and fuel in the direct injection engines. Without uniform mixing of the air- fuel the instantaneous and non-uniform combustion will produce in the cylinder and this guides to the knocking tendency in the cylinder. It must be avoided to protect the engine as well as environment from the emissions. This situation is optimized by the incorporation of a bluff body in the combustion chamber. The irregular shape of the bluff body creates sufficient swirl in the combustion chamber for uniform combustion.

PADMA PRIYA & DR. KALYANI RADHA [3] reported on the mesh type bluff body of thickness 0.177mm and crown piston is placed on the normal piston by cutting the 13mm depth of the piston. Brass metal of round shape is fixed on the top surface of the piston. The brass material has high stability to withstand at high temperatures, high pressure and vibrations. The mesh type of bluff body is placed between the Aluminium crown and upper brass crown piston portion. The brass crown is fitted with screws of M4*20. On this work the performance is conducted with diesel and blends of the Pine oils with varying proportions. These modifications increase the performance of the engine when it is fuelled with diesel blended with Pine oils.

RAMESWAR TAGORE NAIK & DR. KALYANI RADHA [4] investigated on the threaded bluff body of 6mm diameter is inserted axially to the piston axis. The flutes of the threaded portion are placed in different places of the rod of the bluff body. The performance tests are conducted on the diesel engine by using blend of corn biodiesel and high flammable diesel. The emissions of the engine are reduced due to the uniform combustion of the air-fuel mixture and performance also increased.

M.S.FAUZI [5] rape seed oil is used as the biodiesel blend for the engines which is an alternative to the fossil fuels. The properties of the rape seed oil are closely similar to the diesel and it is one of the best options for the diesel engines.
The alternatives are needed to control the using of the fossil fuels. Improvement in the performance will also reduce the consumption rate of fossil fuels. If performance increases the unit fossil fuel will produce more power and more output. In this regard of improvement in performance is done by the modifications of the different engine components. Among all the modifications, piston modification is simple technique when compared to other techniques. A helical spring is used as a bluff body which is placed in the combustion chamber. The bluff body in the combustion chamber is used for creating the swirl motion. Swirl motion creates uniform mixing of the air fuel mixture that leads to the proper combustion in the cylinder. Due to this the performance of the engine will increase and also reduce the emissions.
Based on the above research results the present work is modified by using helical spring bluff body in the combustion chamber and the engine is tested for knowing the performance and emissions by using blends waste vegetable oils with diesel on varying proportions.

3. EXPERIMENTAL SETUP

Diesel is used as the fuel for the experimental setup. The four stroke direct injection diesel engine is used for examining the performance and emissions characteristics. An experimental setup of a 5HP single cylinder vertical engine of water cooled Kirloskar engine is used to examine the performance of the engine when it is equipped modified piston and conventional piston with diesel and blends of waste vegetable oils. The experimental setup contains a fuel tank, fuel injection pump, air filter, U tube manometer, rope brake dynamometer, fly-wheel and exhaust system.

Fig.1. Arrangement of the experimental setup.

Fig.2. Arrangement of the modified piston in experimental setup.

3.1. ENGINE SPECIFICATIONS
3.2.

Table.1.Engine specifications

ENGINE PARAMETERS	SPECIFICATIONS
ENGINE	KIRLOSKAR
ENGINE TYPE	Single cylinder four stroke, water cooled CI Engine
Bore	80 mm
Stroke	110 mm
Speed	1500 rpm
Rated Power	5 HP
Power Output	3.7 kW

3.2. ARRANGEMENT OF THE BLUFF BODY

Fig.3. Arrangement of the bluff body in piston.

Fig.4. Diagram The Bluff Body.

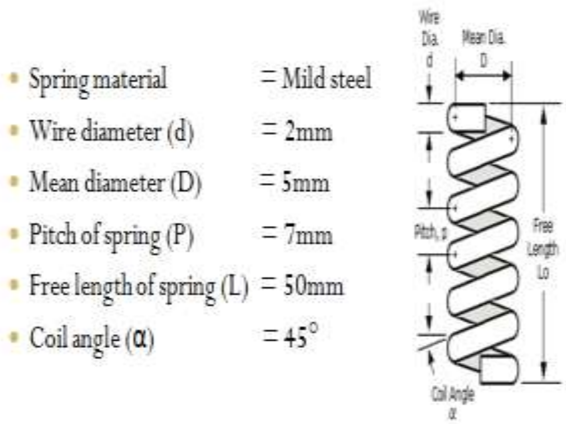

Fig.5. Specifications Of The Bluff Body.

Piston is drilled with 2mm drill bit on a universal drilling machine on the piston's combustion chamber. The spring type bluff body is placed in recess which drilled on the piston bowl. Then the two ends of the bluff body are adjusted to settle in the holes of piston bowl. The drilled holes are filled with the aluminium material to close the recess.

4. FUEL PROPERTIES

Table.2.Fuel Properties

PROPERTIES	DIESEL	WASTE VEGETABLE OIL (B100)	B10	B15	B20
DENSITY (kg/m3)	840	960	744.2	749.2	760
KINEMATIC VISCOSITY at40^{0}C(cst)	4.093	6.0	4.5	4.58	4.66
CALORIFIC VALUE kJ/kg	42000	36000	41300	41268	41230
FLASH POINT (^{0}C)	49	320	51	54	57
FIRE POINT (^{0}C)	52	345	53	56	60

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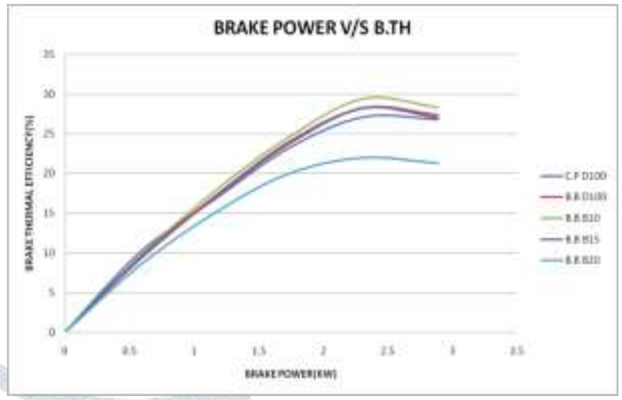
5. RESULTS AND DISCUSSIONS

The performance characteristic graphs of the direct injection diesel engine by using the normal piston and helical spring bluff body with various blends of waste vegetable oils with diesel are listed below.

5.1. BRAKE POWER V/s BRAKE THERMAL EFFICIENCY.

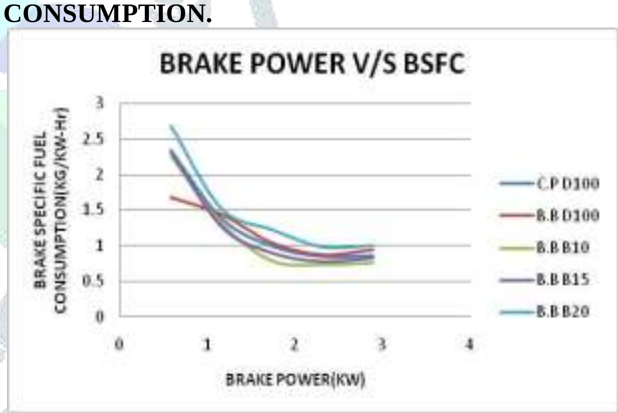
The outcomes for the variations of brake thermal efficiency with respect to different brake power of the engine and different blends diesel and methyl esters of waste vegetable oil for conventional piston and piston with fluted bluff bodies is shown in graph-1.



Graph-1: Brake Power V/S Brake Thermal Efficiency.

The graph represents that maximum brake thermal efficiency (29.5%) is obtained for blend (B10) on helical spring bluff body. The bluff body create the swirl motion of air-fuel mixture in piston and homogeneous mixture produces in the combustion chamber. This leads for the complete combustion of the air –fuel mixture. Complete combustion produces a large amount power with the limited supply of heat input to air –fuel mixture.

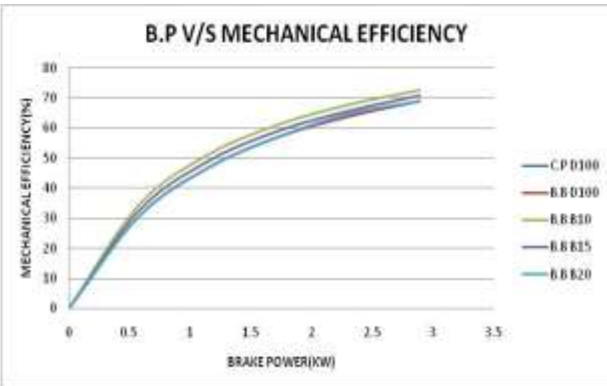
5.2 BRAKE POWER V/s BRAKE SPECIFIC FUEL CONSUMPTION.



Graph-2: brake power v/s brake specific fuel consumption.

The graph represent that brake specific fuel consumption (0.7317) is less for blend (B10) on helical spring bluff body. When load on the engine increases the specific fuel consumption rate will decrease. Total burning capacity of the fuel is increases with rise in load. This results in decrease in brake specific fuel consumption of the fuel.

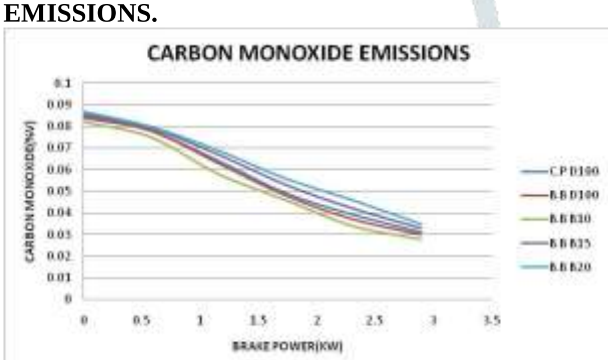
5.3 BRAKE POWER V/s MECHANICAL EFFICIENCY



Graph-3:Brake power v/s Mechanical efficiency.

The graph represents that maximum mechanical efficiency (72.5%) is obtained for blend (B10) on helical spring bluff body .Optimisation of frictional power leads to the rise in mechanical efficiency. At high loads maximum amount of torque is applied on the engine and mechanical efficiency is maximum for high loads .Applied torque on the engine is proportional to the mechanical efficiency produced from the engine.

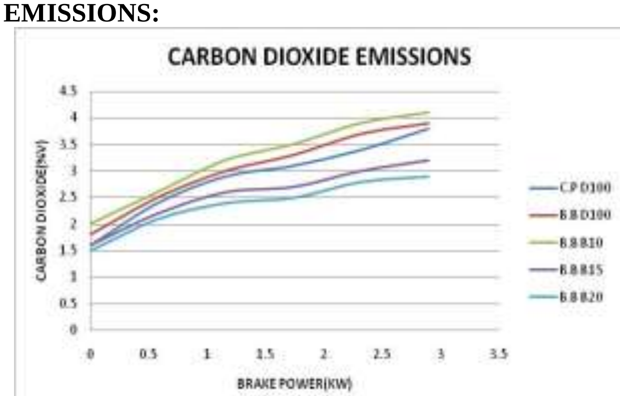
5.4 BRAKE POWER V/S CARBON MONOXIDE (CO) EMISSIONS.



Graph-4:Brake power v/s CO emissions.

The graph represent that minimum amount of emissions (0.028%V) obtained in the blend (B10) on spring bluff body. Bluff body create the uniform mixing of air-fuel mixture by providing swirl motion in cylinder piston. Due to this required proportion of oxygen is supplied to fuel for combustion and results in the reducing of CO emissions in engine exhaust .Helical

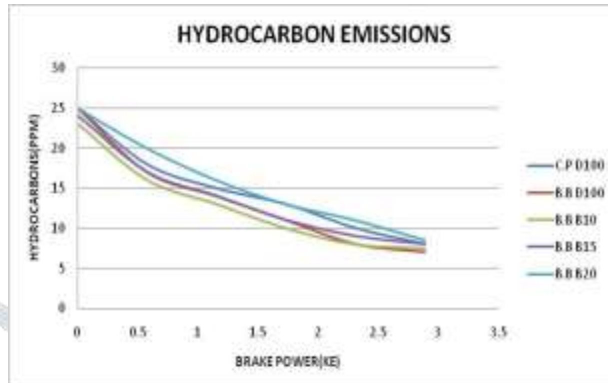
5.5 BRAKE POWER V/S CARBON DIOXIDE(CO_2) EMISSIONS:



Graph-5: Brake Power v/s CO_2 emissions.

The graph represent that maximum co_2 emissions (4.1%V) are obtained in blend (B10) on helical spring bluff body**.** Bluff body leads for the complete combustion of air-fuel mixture results in increase in co_2 emissions content in engine exhaust system.

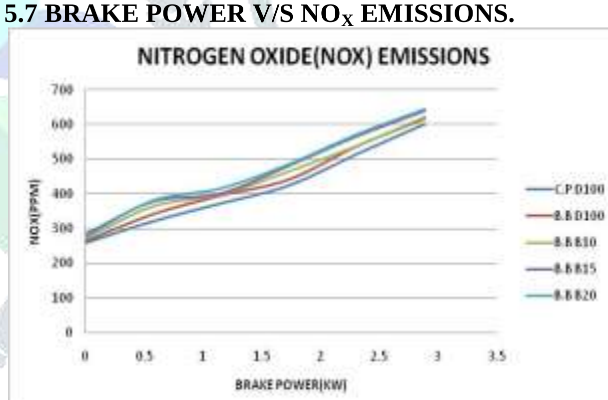
5.6 BRAKE POWER V/S HYDRO CARBON (HC) EMISSIONS.



Graph-6:Brake Power v/s HC emissions.

The graph represent that minimum of unburned hydrocarbons(7 PPM) existing in blend (B10) on helical spring bluff body. Proper combustion of air-fuel mixture leads to burn maximum hydrocarbons present in combustion chamber. Due to this HC emissions are less in (B10) than other blends like B15,B20 and with diesel.

5.7 BRAKE POWER V/S NO_X EMISSIONS.



Graph-7:Brake power v/s NO_X emissions.

The graph represent that blend(B10) has a moderate (640) of NO_X emissions in the exhaust.NO_X emissions are formed due to the high temperature present in the engine cylinder .By using waste vegetable oils for the diesel engines produces high temperatures in engine cylinder leads to formation of more NO_X in the engine exhaust. Blend (B20) has maximum of NO_x in its exhaust of the engine.

CONCLUSION:

The work presents performance characteristics of helical spring bluff body with diesel and various blends of waste vegetable oil on CI engine. The following work concludes that blend (B10) of waste vegetable oil with diesel has 2% improvement in brake thermal efficiency,3.5% improvement in mechanical efficiency,0.05%V decrease in CO emissions,0.3%V improvement in CO_2 emissions, 2%PPM decrement in Hydrocarbon emissions and 8%PPM improvement in NO_X emissions.

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