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Experimentally Investigate and ANN Validation of Performance Parameter on Application of Microalgae Methyl Ester on 4S Diesel Engine.

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ABSTRACT: Experiment were carried out by using micro algae oil blends B08,B16, B20, B24, B30 on diesel engine. Parameter of engine performance like brake thermal efficiency, brake specific fuel consumption, indicated power, brake power, vibrations, exhaust gas temperature are studied. The graphical presentation of results was done to observe rate of decrease in losses and increase in efficiency of micro algae oil with respective blends and diesel. B08 has higher brake power at maximum load and have less BSFC as compare to diesel fuel. It was found that B08 has 23.72% brake thermal efficiency than diesel which has 21.75%. B08 can be better replacement for diesel fuel in future. In future economically micro algae biodiesel can be better replacement to diesel fuel if we increase the cultivation.

KEYWORDS: micro algae oil, biodiesel, transesterification, performance characterization.

I. INTRODUCTION

Industries like mining, automobile, construction and manufacturing use petroleum based crude oil as a fuel for various engines they use. One of the most common fuels used for heavy work is diesel. Using diesel fuel comes with its own challenges. Extracting oil from underground reservoirs then its purification and transport is time consuming process and it also becomes economically unreliable when it comes to problems like leakage and fire hazards. Using diesel in engines is also relatively costly due to its poor efficiency. Average efficiency of diesel based engine is between 40 to 44% and so is the performance. Another major problem regarding conventional fuel is its impact on nature and human beings due to pollution. All diesel based engines have exhaust gases such as CO, CO₂, NO_x, HC and smoke.

Due to all these issues depending on diesel as fuel is not beneficial. So it's necessary to come up with an alternative to diesel fuel or at least we have to change properties of diesel fuel so that it will yield better performance with less emission of harmful gaseous. This is where biodiesel can be useful. Biodiesel can be made with help of many sources like vegetable oil, waste cooking oil, fish oil, cotton seed oil. Two chemical process esterification and transesterification are used. In esterification oil with accurate value of FFA content is mixed with methanol, further preheated ester oil is used for transesterification along with methanol in presence of base catalyst. Once oil becomes from free fatty acid we can convert the oil into ester which is called as the biodiesel.

These oils which are used to make biodiesel can be divided into two main groups. Edible and non-edible. Though edible oils can be used to make bio diesel but it can have negative impact on food industry. So we use non edible oils for making biodiesel. There are several sources such as jatropha tree (*Jatropha curcas*), karanja (*Pongamia pinnata*), mahua (*Madhuca indica*), castor bean seed (*Ricinus communis*), neem (*Azadirachta indica*), rubber seed tree (*Hevea siliensis*), tobacco seed (*Nicotianata bacum*). But before using these biodiesels it's important to study their properties and behavior through various experiments. This will helps us to decide the optimum amount which can be added in diesel fuel for best performance. So we have selected micro algae based biodiesel for this experiment we have observed and study its performance and emission characteristics. We have prepared 5 different blends of microalgae biodiesel. All with varying added quantity of algae oil in them. And a pure diesel for comparison.

II. EXPERIMENTATION

Experiment is done on single cylinder four stroke diesel engine at the APEX INNOVATION SANGLI. Micro algae oil is used for the test, there is no change required in the set of engine before testing. Engine is single cylinder four stroke diesel engine with compression ratio which can be varies over range of 14:1, 16:1 and 18:1, speed is 1500rpm, 5.2KW power rating and is used.

Various blends used for test are as following:

B00, B08, B16, B20, B24, B30.



Fig.1 Experimentation Set Up For micro algae Oil Biodiesel

Where,

T1 = Temperature of jacket water in

T2 = Temperature of jacket water out

T3 = Temperature of water Calorimeter in

T4 = Temperature of water Calorimeter out

T5 = Temperature of Exhaust Gas, before calorimeter.

T6 = Temperature of Exhaust Gas, after calorimeter

F1 = Flow rate of fuel

F2 = Flow rate of air

F3 = Flow rate of engine cooling water

F4 = Flow rate of calorimeter cooling water

Wt. = Load cell reading

N = Engine speed Tachometer reading.

III. METHODOLOGY

The engine was started and allowed to run for 10-20 minutes to get stabilized using pure diesel fuel and baseline data for B00 was generated. Compression ratio was set at 14:1, 16:1 and 18:1. Performance parameters were noted using I.C. engine software. The exhaust gas emission parameters like HC, NO_x, CO₂, CO were recorded by pelting the probe of NPM-MGA gas analyser in the exhaust pipe. Then the load on the engine was further increased from 0 kg, 3 kg, 6 kg, 9 kg and 12 kg. The engine was run for sufficient time duration to ensure that the diesel fuel phase is over and the engine has started running with Hybrid biodiesel as fuel. The entire process was repeated while engine running with different blends of hybrid biodiesel i.e. B00, B08, B16, B20, B24, and B30 as a fuel and various performance and emission parameters were noted.



IV. EXPERIMENTAL RESULTS

1. Brake Power

Brake power is defined as the power available at output shaft and is also known as output power. Fig. 2 shows variation of brake power (KW) with load for blends B00, B08, B16, B20, B24, B30 at CR14, 16, 18. It is observed that brake power for blends B08, B20 and B24 is nearly equal to pure diesel for CR 14, 16 and 18. At some loads brake power is slightly larger than pure diesel but it is comparable to pure diesel. It also observed that with increase in load brake power also increases.

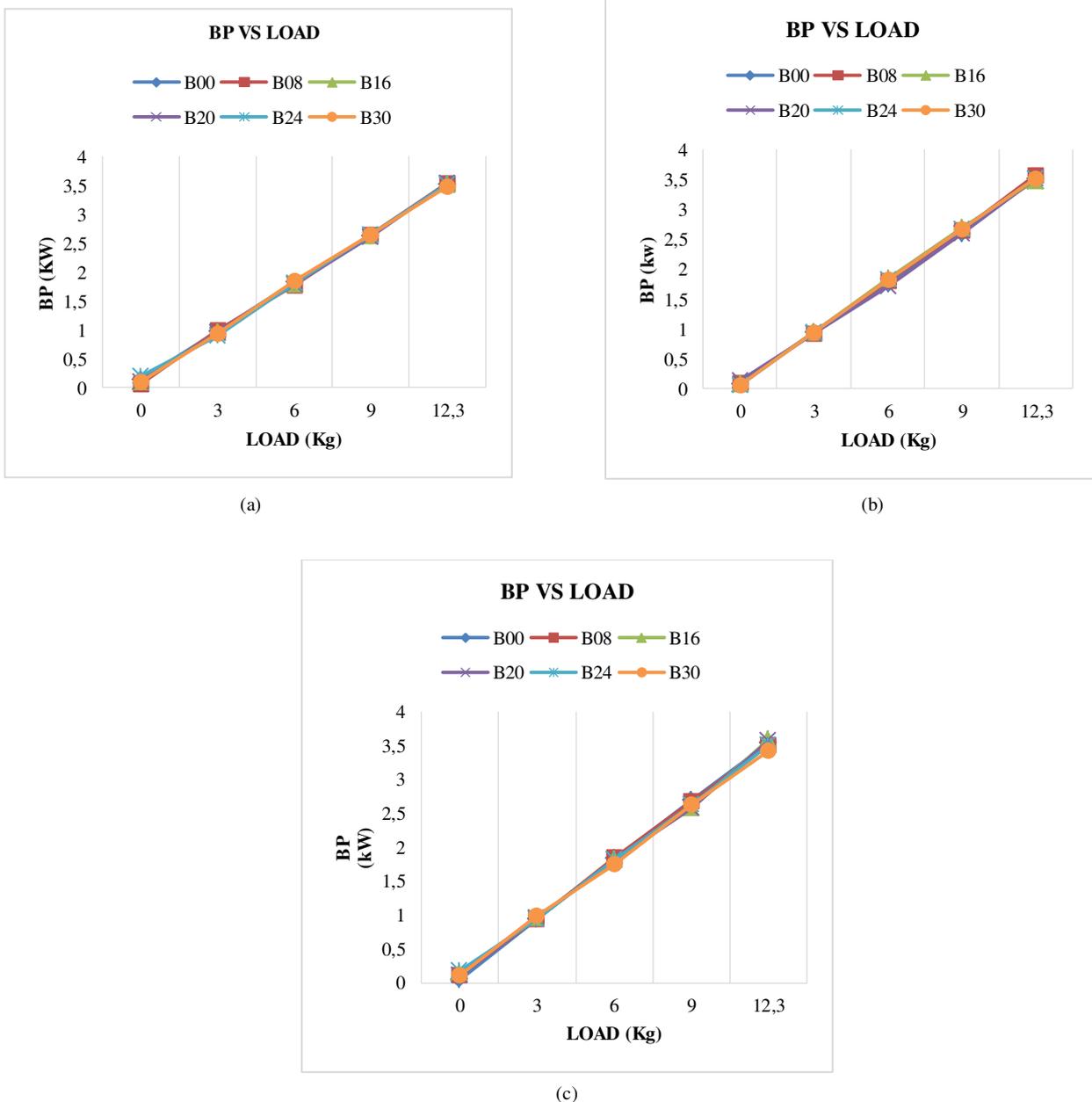
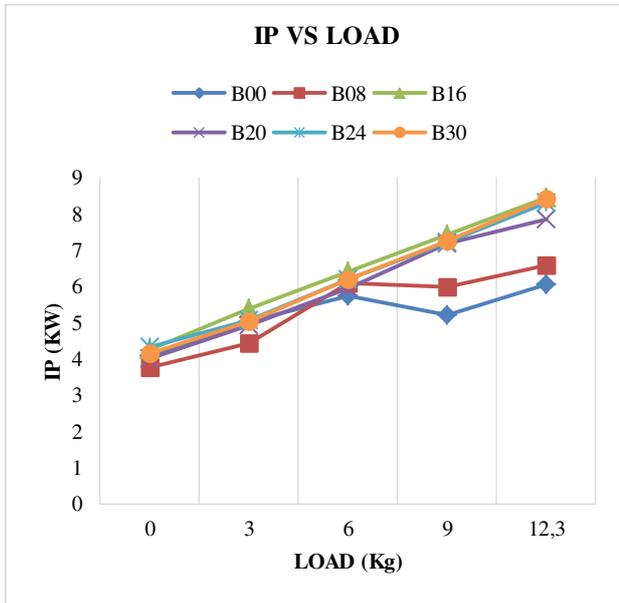


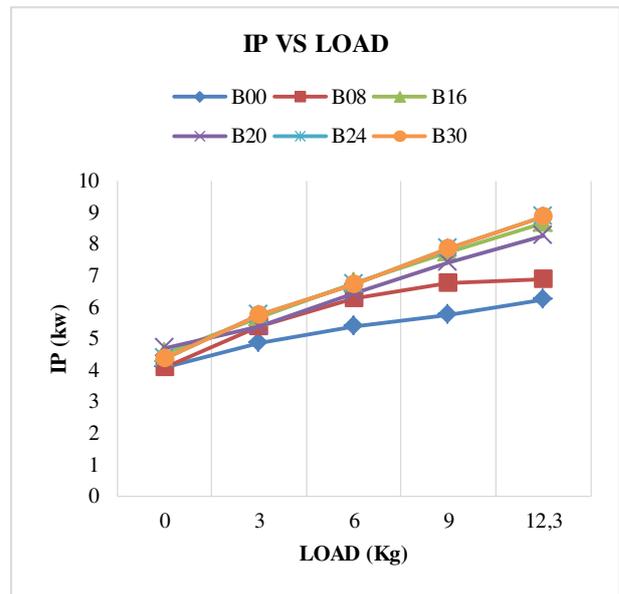
Fig. 2 Variation of BP with load (a) CR14 (b) CR16 (c) CR18

2. Indicated Power

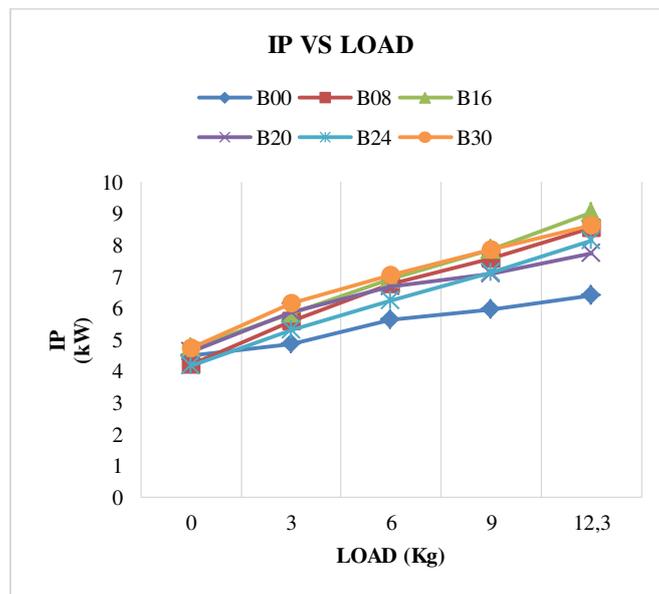
Now if we observe following graphs and the behaviour of all five blends at different compression ratios 14, 16 and 18; we can see similar results as frictional power, that all the blends provide higher indicated power than diesel. B30, B20, B24 and B16 have relatively same IP and blend B08 closer to pure diesel in fig 3.



(a)



(b)



(c)

Fig. 3 Variation of IP with load (a) CR14 (b) CR16 (c) CR18

3. Mechanical Efficiency

It is the ratio of brake power (B.P.) to the indicated power (I.P.). It can also be defined as the percentage of energy that the engine puts out after subtracting mechanical losses such as friction, compared to what the engine would put out with no power loss. Observing following graphs we can see that mechanical efficiency of all blends is same till the load of 6 Kg but as load increases beyond that we can see certain fall in mechanical efficiency of blends B20, B24, B30 whereas the efficiency of blend B08 is relatively closer to pure diesel in fig.4.

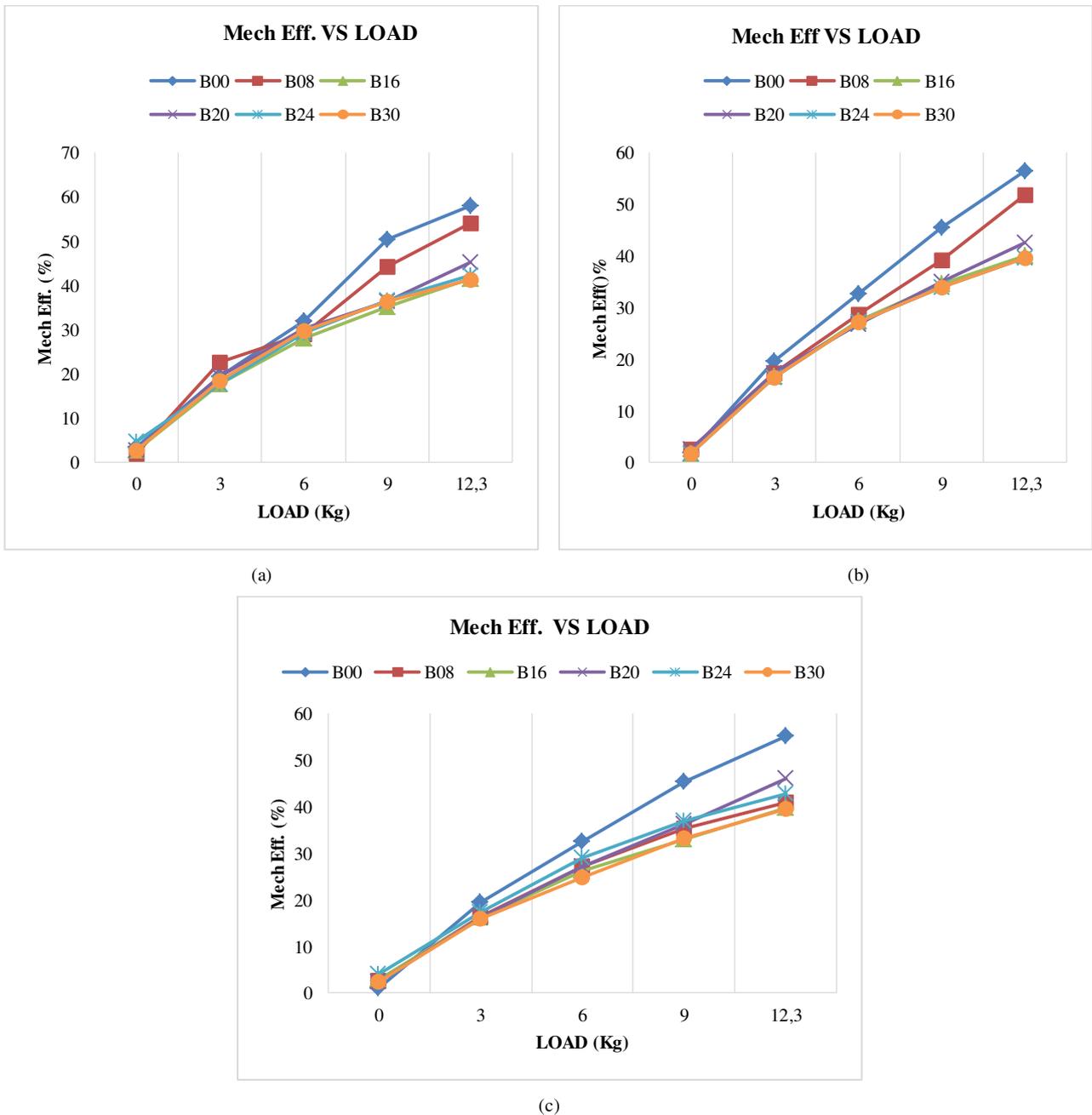


Fig. 4 Variation of Mechanical efficiency with load (a) CR14 (b) CR16 (c) CR18

4. Brake Specific Fuel Consumption

Specific fuel consumption is defined as the amount of fuel required to be supplied to engine to develop 1 KW of power per hour. Fig. 6 shows the specific fuel consumption in (kg/kWh) vs. load for B00, B08, B16, B20, B24 and B30 at CR 14. Specific fuel consumption decreases with increase in load for all blends and pure diesel.

Fig. 5 shows variation of SFC vs. Load at CR 14 here it is observed that specific fuel consumption for blends like B08, B16, B20, B30 shows more fuel consumption as compared to pure diesel. Fig.7 shows variation of SFC vs. Load at CR18, here it is observed that specific fuel consumption for blends like B08, B16, B20, B30 shows less fuel consumption as compared to pure diesel, but with increase in load specific fuel consumption for all blends is nearly equal. We can also observe that blend B24 requires less fuel than pure diesel.

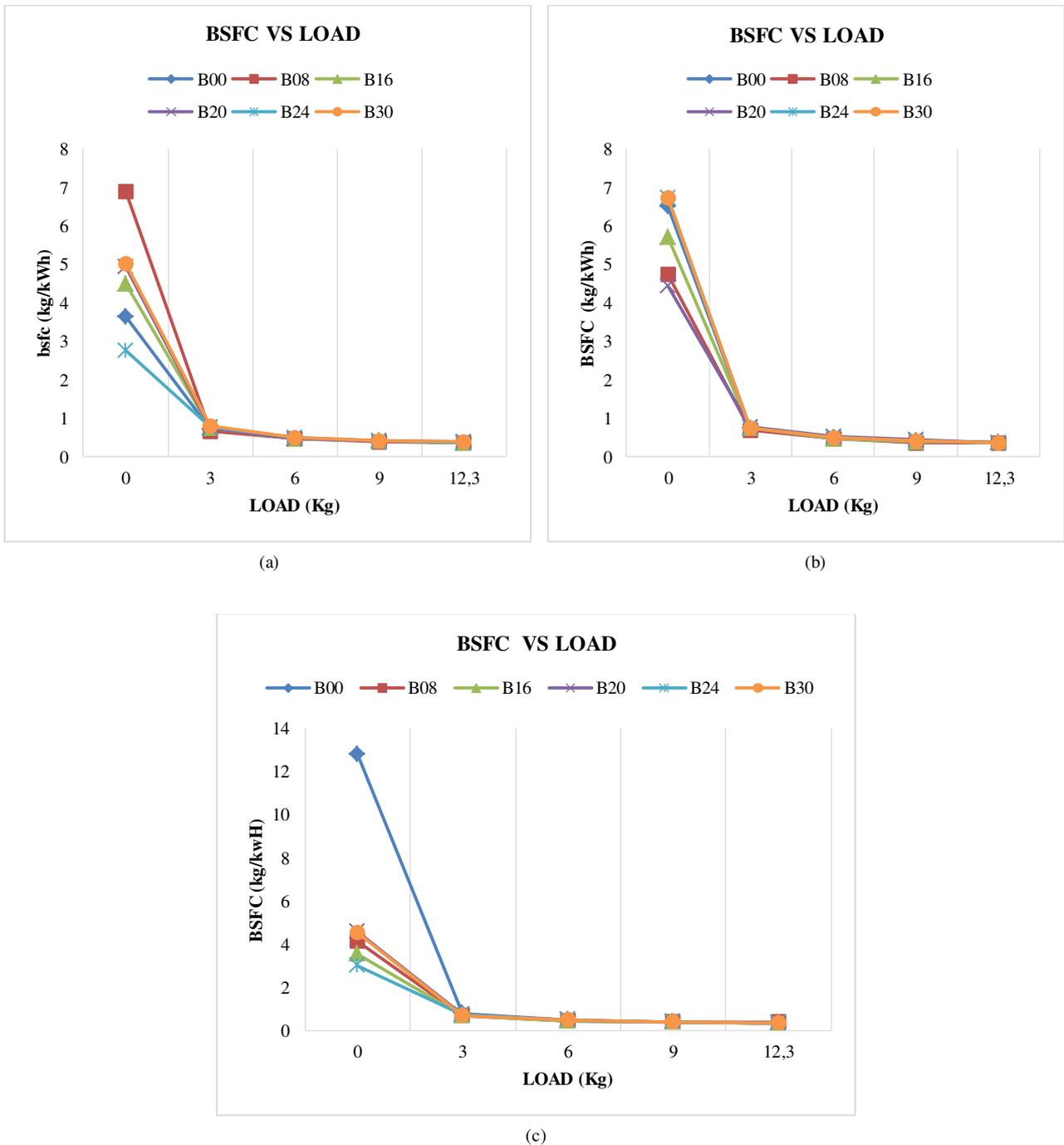
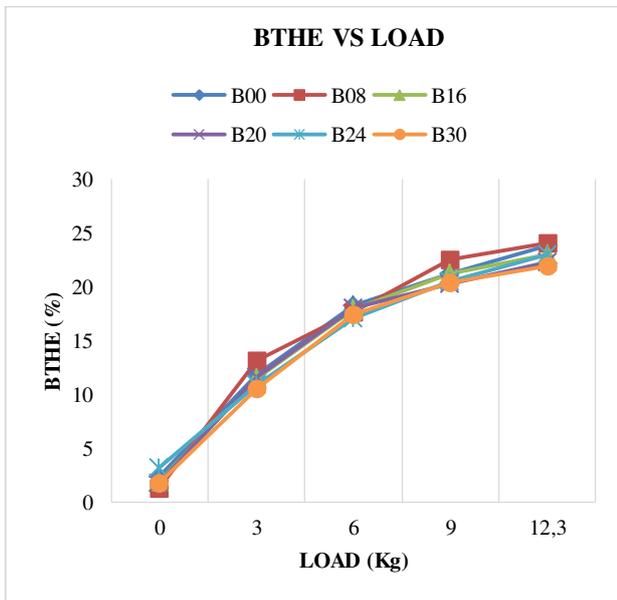


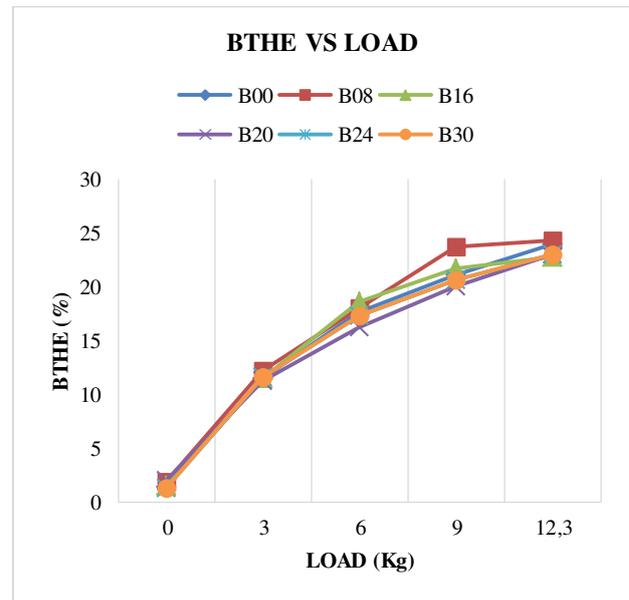
Fig. 5 Variation of specific Fuel Consumption with load (a) CR14 (b) CR16 (c) CR18

5. Brake Thermal Efficiency

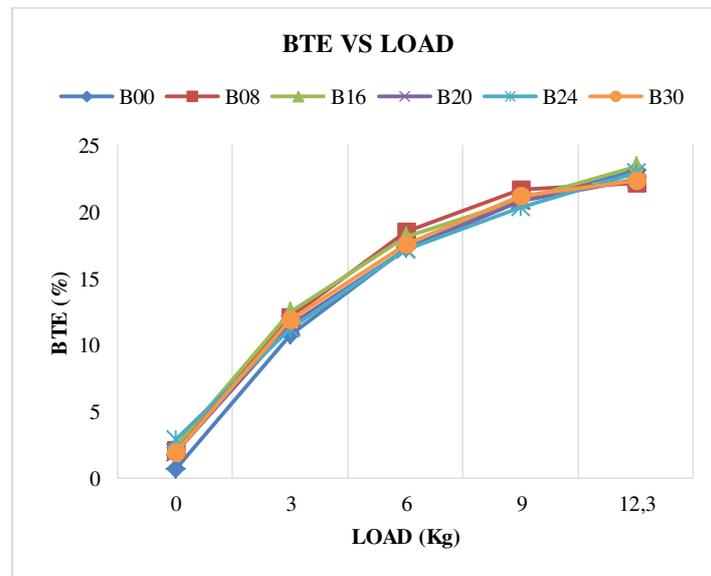
It is the ratio of output i.e. BP to that of the chemical energy of fuel supplied. Fig.6 shows the variation of brake thermal efficiency vs. load for CR14 for blends like B08, B16, B20, B24, and B30. It has been observed that for blends B016, B20, B24, B30 brake thermal efficiency is less than pure diesel. While for blend B08 it is nearly equal to pure diesel. Fig. 10 and Fig. 11 show the variation of brake thermal efficiency vs. load for CR 16 and 18. It is observed that brake thermal efficiency increases with increase in CR. For CR 16 and 18 blends B08 shows higher brake thermal efficiency than pure diesel.



(a)



(b)



(c)

Fig. 6 Variation of BTE with load (a) CR14 (b) CR16 (c) CR18

V. ANN VALIDATION

Graphical Presentation of comparison between variable parameters and output is shown. Performance of engine is validated by using ANN validation technique. Validation is carried out for checking performance parameters as Brake power, Brake thermal efficiency, Specific fuel consumption, volumetric efficiency, exhaust gas temperature and exhaust gases at compression ratio 18. ANN validation is carried out for calculation of regression coefficient (R) and Mean Square root Error (MSE). Graphs are plotted variable parameters against output of performance parameters.

1. ANN Graphs for Brake Power

From graph it can be said that regression coefficient (R) for training, testing, validation and all is 0.99971, 0.99974, 0.99831 and 0.99925 which is near to 1 respectively.

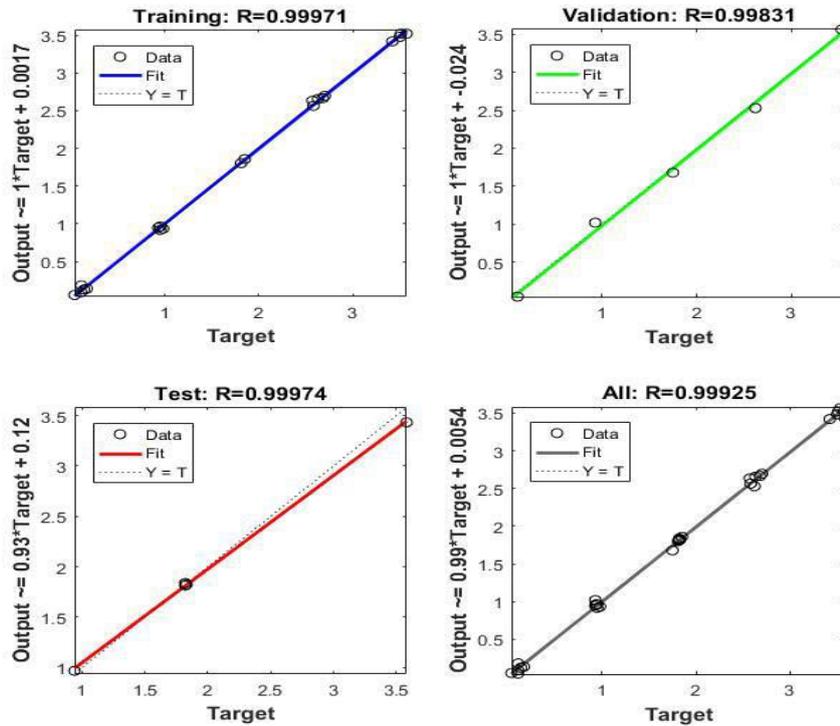


Fig 7: Graph for variable and output parameters of brake power

2. ANN Graphs for Indicated Power

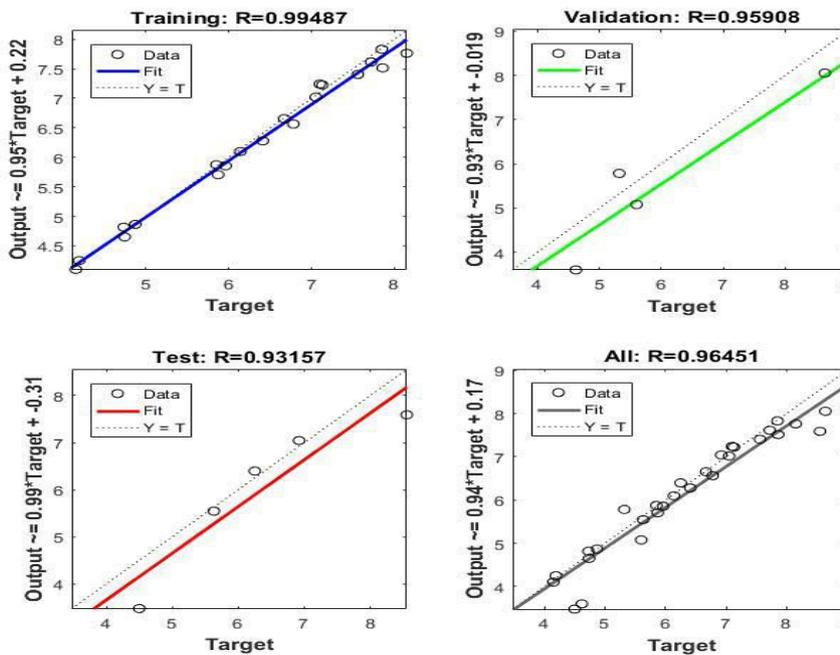


Fig. 8: Graph for variable and output parameters of indicated power

From graph it can be said that regression coefficient (R) for training, validation and testing is 0.99487, 0.93157 and 0.95908 respectively which is near to 1. From this it can be said that experimental results of indicated power are validated by ANN.



3. ANN Graphs for Brake Specific Fuel Consumption

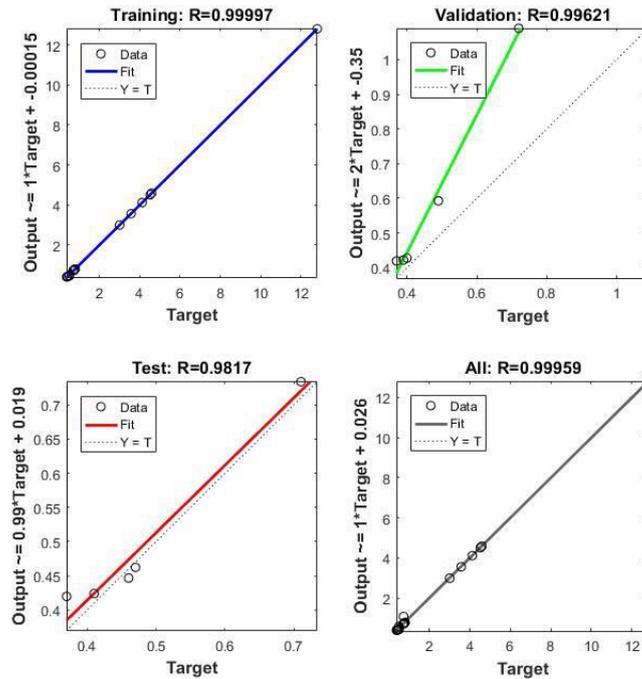
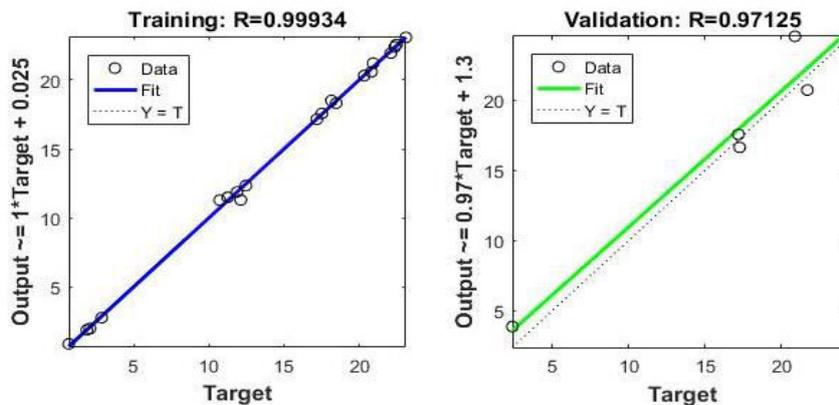


Fig. 9: Graph for variable and output parameters of Brake Specific Fuel Consumption

From graph it can be said that regression coefficient (R) for training, test, validation and all is 0.9997, 0.9817, 0.99621 and 0.99959 respectively which are closer to 1. From this it can be said that experimental results of Specific Fuel Consumption are validated by ANN.

4. ANN Graphs For Brake Thermal Efficiency

Figure 10 show the results for variable and output parameters of brake thermal efficiency. From graph it can be said that regression coefficient (R) for training, validation and testing is 0.99934, 0.99859 and 0.97125 respectively which is near to 1. From this it can be said that experimental results are validated by ANN.



(a)

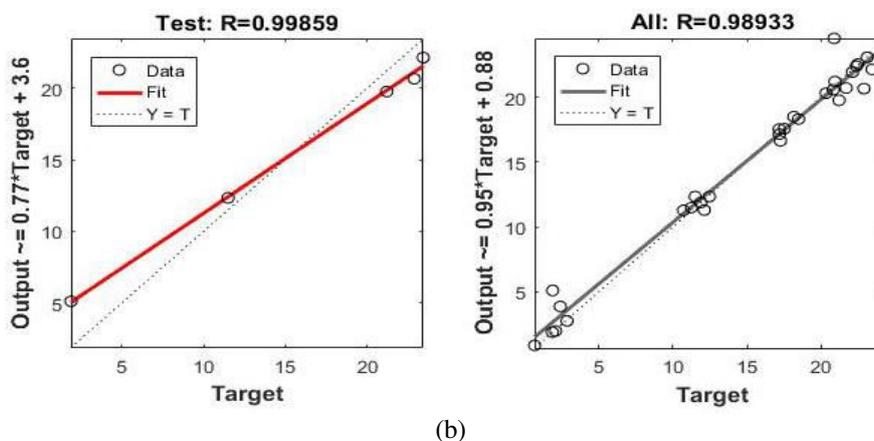


Fig. 10: Graph for variable and output parameters (a) Training and Validation (b) Test and All of Brake thermal efficiency

VI. CONCLUSION

The experimental study is carried on single cylinder, four stroke diesel engines having variable compression ratio by using algal biodiesel blends with diesel. The emission analysis and performance analysis is evaluated by running the engine at different compression ratios like 14, 16 and 18 by varying load. The emission parameters measured are CO, HC and NO and performance parameters measured are brake power, specific fuel consumption, exhaust gas temperature. Based on the experimental studies, following are the observations found.

1. Fig.2 shows variation of brake power (KW) with load for blends B00, B08, B16, B20, B24, B30 at CR14, 16, 18. It is observed that brake power for blends B08, B20 and B24 is nearly equal to pure diesel for CR 14, 16 and 18.
2. All the blends provide higher indicated power than diesel. B30, B20, B24 and B16 have relatively same IP and blend B08 closer to pure diesel.
3. It is observed that mechanical efficiency of all blends is same till the load of 6 Kg but as load increases beyond that we can see certain fall in mechanical efficiency of blends B20, B24, B30 whereas the efficiency of blend B08 is relatively closer to pure diesel.
4. It is observed that specific fuel consumption for blends like B08, B16, B20, B30 shows less fuel consumption as compared to pure diesel, but with increase in load specific fuel consumption for all blends is nearly equal. We can also observe that blend B24 requires less fuel than pure diesel.
5. Brake thermal efficiency been observed that for blends B016, B20, B24, B30 brake thermal efficiency is less than pure diesel. While for blend B08 it is nearly equal to pure diesel. For CR 16 and 18 blends B08 shows higher brake thermal efficiency than pure diesel.
6. ANN validation is carried out for calculation of regression coefficient (R) and Mean Square root Error (MSE). The data is validated using ANN as the values of regression coefficient (R) are nearly equal to 1 and Mean Square root Error (MSE) is nearly equal to zero for graph of training, test and validation for different outputs.

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