

# International Journal of Innovative Research in Science, Engineering and Technology

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## Analysis of Blended Fuel Properties, Engine Performance and Smoke with Palm Acid Oil Biodiesel and Turmeric Leaf oil as an Additive

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**ABSTRACT:** Like much other research and methodological innovation has been done to explore the study presented for the production of bio-diesel B100 since B100 cannot be used in engines directly it is used with partial replacement of diesel with biodiesel. Palm oil being on the most commercially used biodiesel feedstock many tests have been performed on it and is produced on a large scale, Palm acid oil being a byproduct produced during palm oil production is also a potential feedstock for the production of biodiesel due to its high acidity and easy availability. Therefore it is important to study the various parameters of biodiesel produced from palm acid oil, In this study we have tested the palm acid oil Biodiesel at B18 with turmeric as an additive and investigated the various parameters with diesel. The biodiesel production and fuel properties testing was performed at IBDC ( Indian Biodiesel Corporation ). The fuels were tested on the single cylinder water cooled diesel engine and the investigation so done is demonstrated here.

**KEYWORDS:** turmeric leaf oil , palm acid oil ,additive, performance, smoke, HSU

### I. INTRODUCTION

Indian biofuel policy defines biodiesel as “*a methyl or ethyl ester of fatty acid produced from vegetable oil both edible and non-edible or animal fat of diesel quality*”. As biodiesel is the renewable and alternative fuel for C.I engine, which is made from vegetable oils (soybean oil, sunflower oil, canola oil, corn oil) , animal fats (fish oil, beef tallow, etc) ,Waste oil (cooking oil, fried oil, mixed waste oil) , acid oil (palm ,soya , etc) , plant oil (Jatropha, Karanja, moha, neem, etc.). the properties of the biodiesel should be technically competitive and environmentally friendly which makes it the best alternative to conventional petroleum diesel. The biodiesel is having same cetane number as compare with diesel which makes it ignite quickly and which leads to higher engine efficiency and emission reduction. There are many other properties of biodiesel as compare to regular diesel like one of them is the flashpoint which is important for the safe handling of fuel.

#### FEED-STOCK FOR BIO-DIESEL PRODUCTION-

The main criteria by which we select a proper feedstock for the production of biodiesel is done by focusing on the development of feedstock supply and other by reducing production cost, the preferred feedstock should be non-edible in order not to affect the prices of edibles. Considering all the criteria required for the production of biodiesel the feedstock selected is palm acid oil due to its easy availability, it is a byproduct of chemical refining of palm oil

#### ADDITIVES ADDED IN BIO-DIESEL PRODUCTION-

The use of additives is to be done to increase the brake thermal efficiency with a decrease in exhaust emission. As per literatures the addition of eco-friendly additives increases the cetane number and decrease the NOx content in the emission the additive used here complimentary to palm acid oil is turmeric leaf oil which is having a huge range of

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health benefits. The turmeric leaf oil is added in less volumetric percentage with palm acid oil as B18Ty where y represents the volumetric % of turmeric leaf oil it was taken with an increase of 2% from 4% to 12%.

## II. LITERATURE REVIEW

**N. Vedaraman, 1 January 2015, 1543-5083:** In this study palm biodiesel was prepared from palm oil by transesterification and subsequently different blends (B20, B30, and B40) with diesel were prepared and tested in a standard diesel engine. From the engine test result, B20 was found to be an optimum blend ratio based on engine performance and emissions. The test result shows that the exhaust emissions such as CO and HC are reduced with B20 by 28% and 30%, respectively, compared to diesel. The NO<sub>x</sub> emissions are almost the same as diesel fuel. To reduce NO<sub>x</sub> emission, a small quantity of different additives namely methanol, ethanol, distilled water, and diethyl ether were added to B20 and evaluated in a standard diesel engine for performance and emissions characteristics. Among all the additives with B20, B20 with 2% distilled water shows the lowest NO<sub>x</sub> emission and this may be due to lower combustion temperature compared to other additives [11].

**M. Habibullah, 6 March 2014, 0196-8904:** This study investigated the production, characterization, and effect of biodiesel blends from two prominent feedstocks, namely, palm and coconut (PB30 and CB30), on diesel engines. Palm biodiesel has high ignition quality, while coconut oil has a higher oxygen content. So, to optimize the results, both these biofuels were blended simultaneously with pure diesel to create a 30% blend (PB15CB15). A 10 kW, horizontal, single-cylinder, four-stroke, and direct-injection diesel engine was utilized under full load and variable speed. The maximum torque values were obtained at 1800 rpm engine speed for the blend. Beyond this speed, the torque of the engine decreased mainly because of decreased volumetric efficiency attributed to the increase in speed, and growths in the mechanical losses. Maximum engine torque was found to be 31.67N for pure diesel. With the use of biodiesel blends, the brake torque slightly dropped. The maximum torque levels of the engine using PB30, CB30 and PB15CB15 were 30.47Nm, 30.24Nm, and 30.44 Nm respectively. Thus, the overall reductions in brake torque for PB30, CB30, and PB15CB15 compared with diesel were 3.94%, 4.74%, and, 4.11% respectively. For all the tested fuels, break power steadily increased with engine speed until 2400 rpm. The maximum break power output values obtained for diesel, PB30, CB30, and PB15CB15 were 7.70, 7.40, 7.35, and 7.38 kW respectively. Thus, the average brake power outputs were lower than that of diesel fuel by 3.92%, 4.71%, and 4.10% for PB30, CB30, and PB15CB15 respectively. The average BSFCs for diesel, PB30, CB30, and PB15CB15 over the entire engine speed range were 258.35, 280.53, 281.69, and 280.45 g/kWh respectively. Thus, the average BSFCs were 8.58%, 9.03%, and 8.55% higher than that of diesel fuel for PB30, CB30, and PB15CB15 respectively. The average NO<sub>x</sub> emissions for diesel, PB30, CB30, and PB15CB15 were 643.83, 664, 680.33, and 672.16 ppm, respectively. Thus, the average NO<sub>x</sub> emissions for PB30, CB30, and PB15CB15 were respectively 3.13%, 5.67%, and 4.40% higher than that of diesel fuel. The average CO emissions for PB30, CB30, and PB15CB15 were reduced by 13.75%, 17.97%, and 15.84%, respectively, compared with diesel fuel [10].

## III. METHODOLOGY

The Palm Acid Oil biodiesel used in the experiment was produced and tested for fuel properties at the IBDC (Indian biodiesel corporation), Baramati, Pune, India. The pure biodiesel B100 was produced by the process involving acid esterification reaction by using 0.5% H<sub>2</sub>SO<sub>4</sub> as catalyst and 10% CH<sub>3</sub>OH as solvent at a temperature of 55-60 °C for 30 min with agitation of 600-700 rpm, and base transesterification reaction by using 0.5% KOH as catalyst and CH<sub>3</sub>OH as solvent at a temperature of 55-60 °C for 60 min with agitation of 600-700 rpm. All the preprocessing such as demulsification, filtration, and postprocessing such as settling, separation (giving glycerine as a byproduct), hot water washing, etc were performed to yield B100. Since methanol was used as alcohol for reaction hence the ester so formed is Palm Acid Oil Methyl Ester (PAOME).

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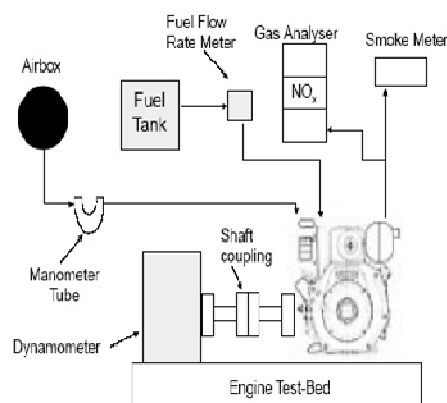
### ENGINE TEST:

The fuels tests were conducted at Heat Engine Laboratory of the Automobile Engineering Department, M. H. Saboo Siddik College of Engineering, University of Mumbai, on a naturally aspirated single-cylinder four stroke water cooled diesel engine analysis setup.

#### ENGINE SPECIFICATIONS:

Manufacturer = Rocket Engineering  
Bore = 87.5mm  
Stroke = 80.0mm  
R.P.M = 1500  
B.H.P = 5 H.P.  
Compression ratio = 16.7:1

The engine was coupled to a dynamometer which measured and controlled the effective torque and engine speed. All the blended fuels were tested on the engine on various loads varying from zero loads to full load simultaneously the engine was also connected to a Diesel Smoke Meter to determine the smoke Opacity of the blends. All the specification such as coefficient of discharge, Orifice diameter, etc were taken from the manufacturer provided manual. The engine was operated at a constant speed of 1500 rpm and a constant water (coolant) flow rate of 4 L.P.M for the testing. The test was performed to Palm acid oil biodiesel having turmeric leaf oil as additive with constant PAOB of 18% with various composition of additive (turmeric leaf oil (TLO)), ranged from B00 (pure diesel), B18T04 (PAOB of 18% and TLO of 4%), B18T06, B18T08, B18T10, B18T12. The fuel consumption rate, engine power, and smoke opacity were measured at different load conditions and various parameters such as brake power brake specific fuel consumption brake thermal efficiency were calculated and the variation of these parameters are demonstrated.



## IV. RESULTS AND DISCUSSION

### 1) ANALYSIS OF FUEL PROPERTIES:

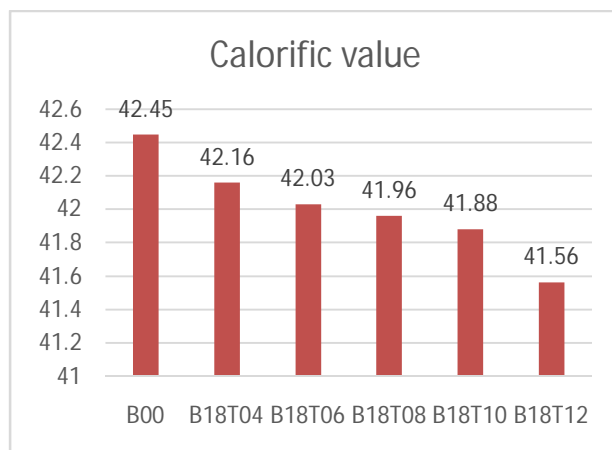
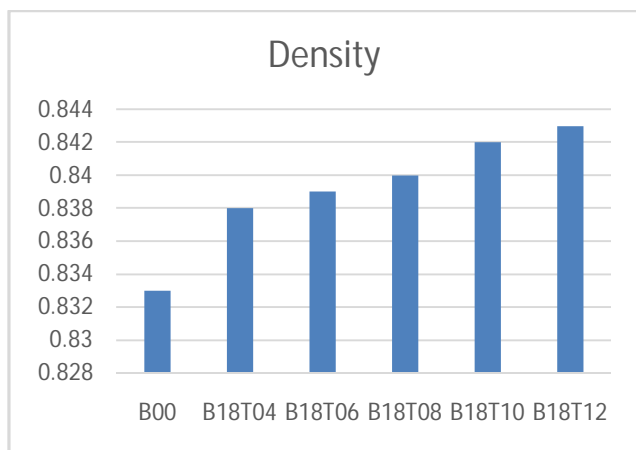
**DENSITY:** The fuel density is an important parameter for various aspects of diesel engine performance, as the high biodiesel fuel density can influence the engine power output due to the difference in fuel injected mass. Where the fuel is measured by volume in a fuel injection system. Biodiesel and mineral diesel has very similar densities, further, the comparison shows that the density of blends keeps on increasing as the volumetric % of additive increases, B18T12 has 1.2% higher density than diesel and B18T04 shows the density closer to diesel which shows on 0.6% higher than diesel.

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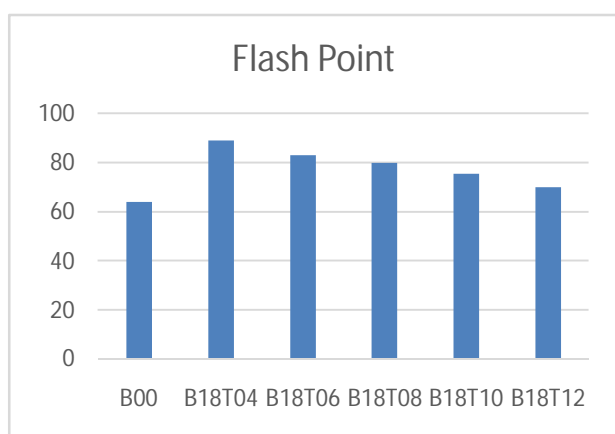
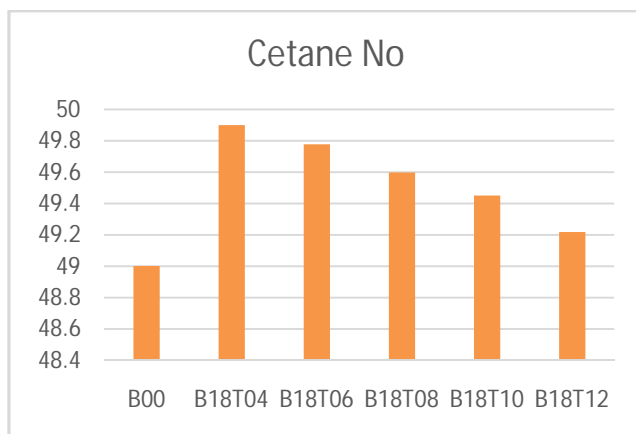
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**CALORIFIC VALUE:** It represents the energy contained in the fuel or it is a measure of heat produced by complete combustion of a specified fuel quantity. A decrease in the calorific value was observed as the volumetric % of additive increases, diesel(B00) being the highest and B18T12 being the lowest showing a decrease of 2.09% w.r.t diesel.

**CETANE NUMBER:** It is an important parameter representing the ignition value of a fuel .The cetane number of all the blends were higher than diesel, B18T04 has the highest cetane no of about 1.8% greater than diesel and keeps on decreasing as the volumetric % of additives increases the lowest cetane number among the blends was observed at B18T12 which is also 0.24% higher than diesel.



**FLASHPOINT AND FIRE POINT:** As the turmeric was introduced the flashpoint increases and highest was observed at B18T04 about 39% higher than diesel and further keeps on decreasing as we the volumetric % of additive increases at B18T12 is shows flashpoint only 9.3% higher than diesel. The fire point also shows an increase at B18T10 a 15.49% rise was observed.

**CLOUD POINT and POUR POINT:** The pour point is the lowest temperature used to characterize cold flow properties and cloud point is the highest the results show that both the parameters show an increase in their value where blend B18T10 shows an increment of 3°C in cloud point and 10.5°C in pour point.

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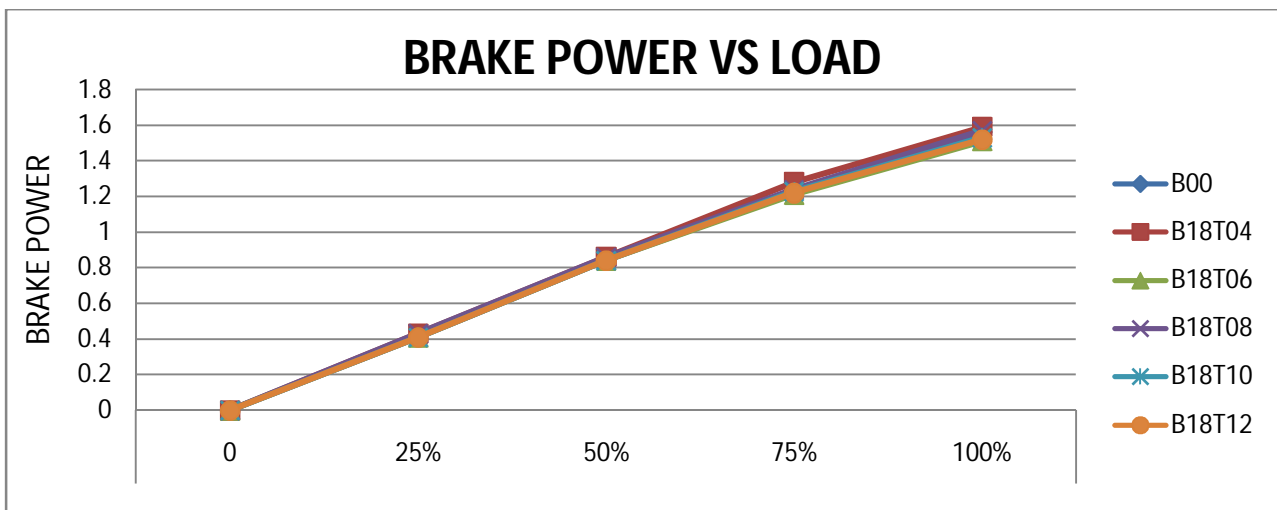
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### 2) ANALYSIS OF ENGINE PERFORMANCE:

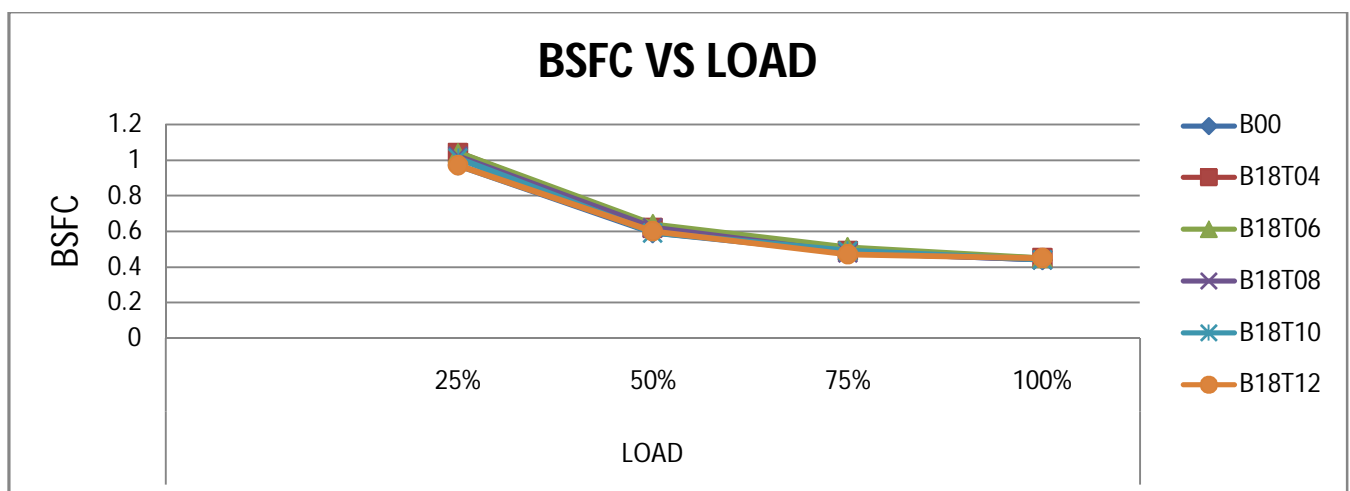
#### BRAKE POWER:

The graph shows the engine brake power at different load conditions. It was observed that at full load condition the engine brake power is found to be 1.8% higher for blend B18T04 when compared with diesel and is the highest value observed whereas the brake power for blend B18T08 is close to diesel and the other blends show a slight decrease in the brake power when compared with diesel and B18T12 having the least and showing a decrease of 2.5% when compared with diesel.



#### BRAKE SPECIFIC FUEL CONSUMPTION:

The graph shows the brake specific fuel consumption for diesel and other blends it is observed that at full load conditions the specific fuel consumption for blend B18T04, B18T06, and B18T12 has slightly increased specific fuel consumption of about 2.27% when compared to diesel whereas the blend B18T08, B18T10 shows specific fuel consumption equal to diesel. Hence we can say that there is not much change in the brake specific fuel consumption.



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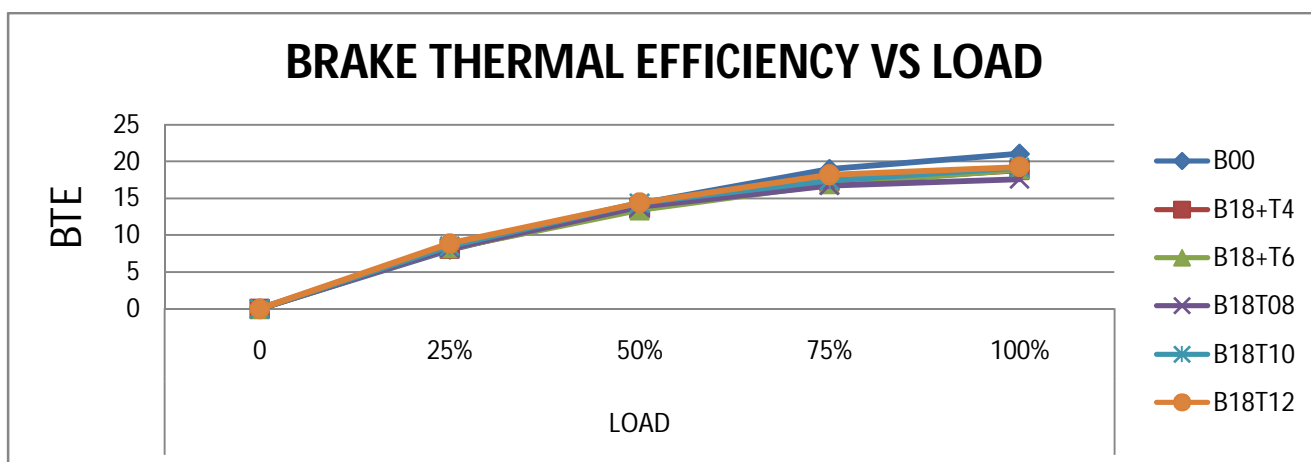
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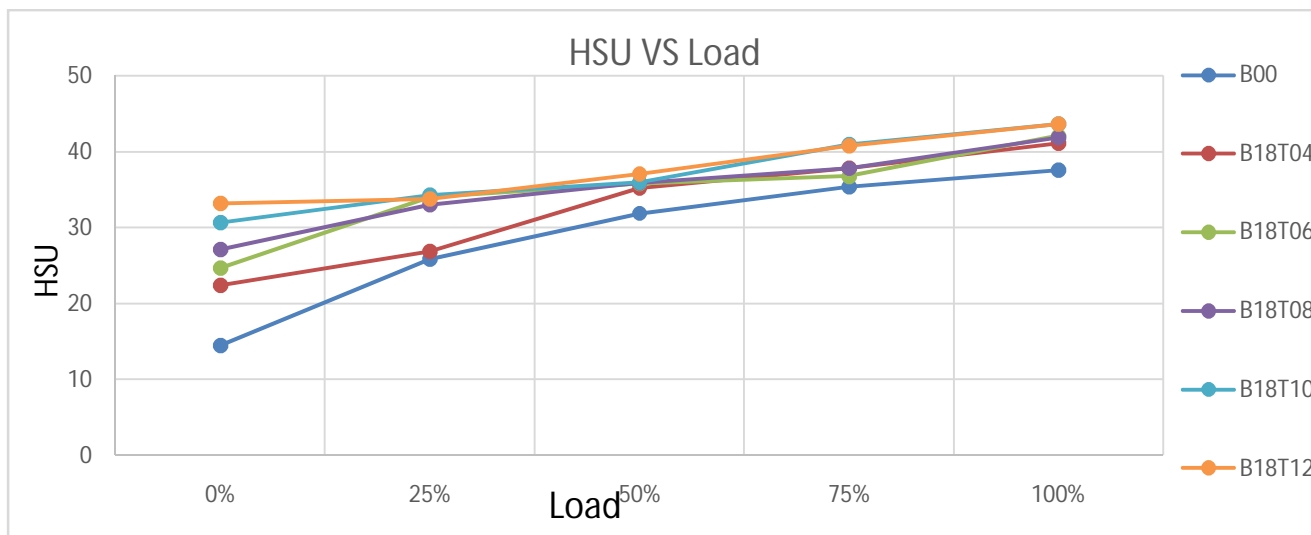
### BRAKE THERMAL EFFICIENCY:

The variation of brake thermal efficiency for the different blend is represented in the graph it is observed that in comparison with the B00 (diesel) all the blends shows a decrease in the brake thermal efficiency. B18T12 showing the least decrease of 1.78% followed by B18T10 showing a decrease of 1.9%, B18T06 showing a decrease of 2.13%, B18T04 showing a decrease of 2.22% and B18T08 showing the highest decrease of 3.45%



### PM and SMOKE:

Particulate matter constitutes of majorly three components DS (dry soot), sulfate and SOF(soluble organic fraction). The literature review shows that the oxygen contained in biodiesel, high cetane number and low level of sulfur content, results in the reduction of PM emissions. The below graph shows the variation of HSU at different load condition for diesel and various blends. A increase in the HSU was observed as the volumetric % of additive increases. The blends B18T10 and B18T12 shows an increase in the value of HSU at full load condition whereas the other blends B18T04, B18T06, B18T08 shows slight increment in the value of HSU when compared with diesel, in other words, the blends shows increased HSU as compared to diesel. The highest increment observed was 10.5 HSU higher than the diesel HSU. Since all the HSU values of blends are under BS IV limit hence the blends are acceptable.



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## V. CONCLUSION

In this study it was evidently seen that when the test engine was fuelled with palm acid oil biodiesel with turmeric as an additive an increase in the density and decrease in the calorific value was observed as the volumetric % of additive was increased whereas cetane no was max for B18T04 and shows a decrease as the volumetric % of additive increased upto B18T12 but B18T12 has a cetane no still higher than B00. Flash point also shows a similar variation as seen in cetane no. the investigation of the engine performance and smoke analysis of the fuels shows that the brake power for B18T04 was higher B18T08 having equal and others having values lower than the diesel. Whereas only slight change in BSFC was observed on the increased side. The BTE values were much lower than the diesel they all shows a decrease and the highest and lowest decrease was observed at B18T12 (1.78%) and highest decrease at B18T08 (3.45%). The smoke analysis of fuels shows an increase in HSU value for all the blends as the volumetric % of turmeric leaf oil was increased and the highest increase was observed at B18T12 of about 10.5 HSU.

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