NVEO
Natural Volatiles & Essential Oils

# Combustion Analysis of Ci Engine Fulled with Micro Alagae Biofuel Blends

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**ABSTRACT**

Micro algae based bio oil is other solution for energy disaster and temperature change of Earth because of its high yielding, large growth rate, nontoxic, decomposable, carbon-free, eco-friendly, low ignition waves. A bio fuel generates from the algae (chlorella) oil by alcoholises process. Demonstration experiment were carried out on one cylinder, four stroke, direct injection, diesel engine at stable engine rate of 1400 rpm and compression ratio of 14 at different loading state to calculate the performance, ignition lag, and ignition properties on microalgae bio-oil blending of 30%, 40%, 50%, along with 60%, besides the outcomes are compared with dieseline. The brake thermal efficiency displayed decline direction (displayed 6%) while specific fuel consumption (up to 8%) and exhaust gas temperature (up to 3%) displayed rise direction for microalgae bio oil blends differentiate with dieseline. Reduction in emission of hydrocarbon (up to 24%) and carbon monoxide (up to 22%) ignition was noted for microalgae bio-oil blended with a minimal rise in NOx (up to 11%). This paper also gives information about what are different methods used for cultivation for micro algae and what is different extraction process used for bio diesel from microalgae.

## INTRODUCTION

Researching bulk amount of renewable and not harmful energy for the lengthy spell is attached besides earth safety, financial booming and standard of life. Amongst present source about endless energies sources close in for upcoming generation is biodiesel [10]. Harness of micro algae is best replacement since micro algae is supreme biotic manufacturer of oil on this planet and set off ingenious bio diesel. Micro algae are ancient organism and quickly raise herb.

| Sr.no | Property | Unit | Dieseline | MAOME 30 | MAOME 40 | MAOME 50 | MAOME 60 |
|---|---|---|---|---|---|---|---|
| 1 | Calorific value | KJ/kg | 42400 | 42480 | 42540 | 42600 | 42640 |
| 2 | Cetane no | - | 49.6 | 48.91 | 48.81 | 48.55 | 48.21 |
| 3 | Density at 30°C | gm/cc | 0.81 | 0.848 | 0.852 | 0.883 | 0.891 |
| 4 | Fire point | °C | 71 | 73 | 75 | 78 | 79 |
| 5 | Flash point | °C | 67 | 71 | 73 | 75 | 76 |
| 6 | Viscosity | $mm^2/s$ | 2.7 | 2.72 | 2.82 | 2.89 | 3.01 |

Table.1

Micro algae consist of broad and different bunch of quickest raise oxygenic nanoscopic marine herbs stretch from one cell to multi cell with simple structure. Nearly 350000 Varity of algae diverseness which are more than shrub. Rely on the category; microalgae can create various kinds about fats, starch and oils with different ratios in huge amount in tiny period [8, 9, and 11]. A bio diesel creates from phytonutrients seaweed oil via alcoholic's procedure implemented in this experiment, although, bio-oils and dieseling blended were ratio volumetrically base of dieseline and micro algae bio fuel for net quantity (volume). The characteristic of fuels

shown in table no 1.

## MICRO ALGAE

The major benefit of biofuel, except being a renewable energy origin, is that its ignition is clean than fossil fuel; eco-friendly and it can be replacing present fossil fuels. Microalgae require low demand to extend i.e. carbon dioxide, sun light, and water. They can spread in no arable land or in waste water. Microalgae grow very fast and have lipid amount higher than that of seed plants. They grow so fast even though they can double their production in few hours and some acres. [18]


**Fig**

## Open cultivation method

Cultivation of microalgae can be completed in wide open-tradition systems such as lakes or ponds. They are made with redistribute trench provision with propeller or peddle for homogeneous blending and flowing to restrict precipitation. These trenches are made of concrete and plastic. The photoautotrophs procedure in open-pool take place in a cycle; micro algal cells catch photon energy from sun during the day and cells undergo photosynthesis, which discontinues during night time. Canal pools are easily growing microalgae for bio fuel.

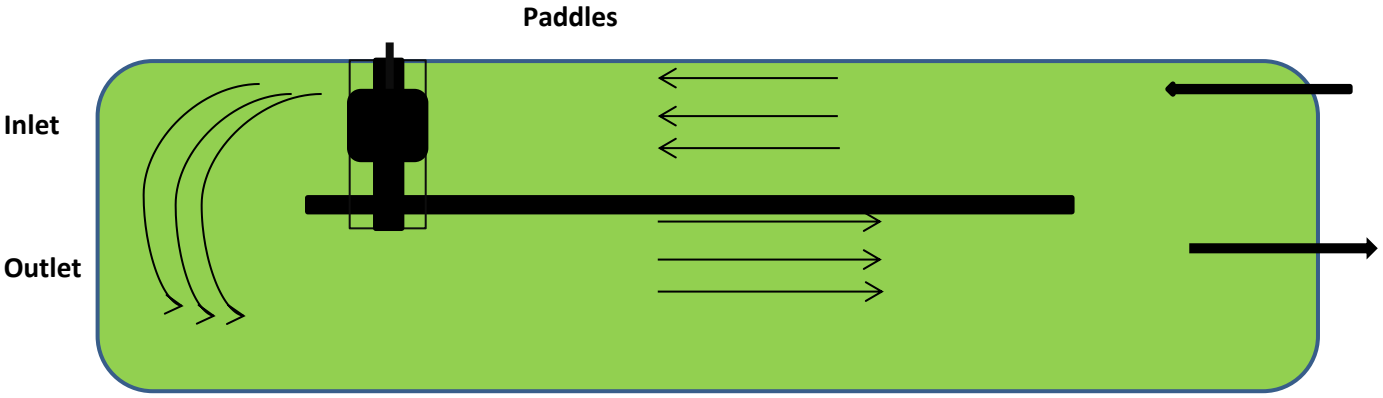
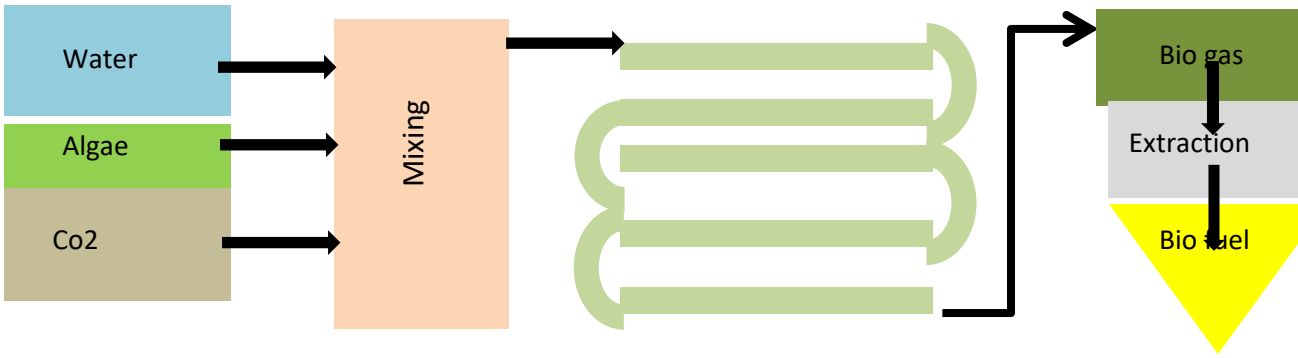



**Fig.**

## Closed cultivation method

Best Microalgae cultivation and extraction of oil is in small temperature time interval. Thus night particle emission, change in temperature and large amount of solar radiation will effect on algae growth and lipid production. Hence, microalgae cell can be cultivated in a closed photo bioreactor. Practically, any transparent vessel can be PBR. As compared to open cultivation method closed cultivation method is good. It is designed to protect microalgae from bacteria attacks, dirty air, rain and toxic gases. The productiveness of closed cultivation method is higher than open cultivation method by five times.[20]




**Fig**

## METHODOLOGY

The set up contains of a one cylinder, four stroke, water cooled face to face injection and different compression ratio diesel engine. Foucault current dynamometer pre owned for loading motive. It is provision with important devices like a cylinder pressure actuator, crank angle coder, fuel flow measurements, thermocouple and strain gauge load cell that are combined to computer via high-speed data acquire instrument. Variable area meter are used for cooling water and calorimeter water flow calculation. Engine soft is software used for engine completion observing all procedure.

### Engine setup

Performance test be conducted in diesel engine using dieseline and micro algae bio fuel (B30, B40, B50 and B60) with Indian standards. Dieseling was used to ignite the engine and for adequate heat up. The engine was charge at steady speed of 1400 rpm by changing the engine load from no load to full load in stride up 25%. Other test was conducted at fixed condition. Tests were conducted for 1 hour of time period and reading was noted down at gap of 15 minutes for certain engine load.

Throughout the test different specific terms i.e. break thermal efficiency; specific fuel consumption and exhaust gas temperature were calculated by measuring fuel consumption, engine torque, and exhaust gas temp. The pressure detectors was fixed on cylinder head at the middle to lower all miscalculations, additionally its output was magnified and recreates to mathematical(digital) signal and recorded for every crank angle. In ordering to eliminate the cycle to cycle difference, in cylinder pressure date were noted down for every ten cycles and then mean was taken for analysis. Accordingly the combustion parameters were taken at accuracy of 0.1[3, 12]. Further, emission of hydrocarbon, carbon monoxide, carbon dioxide and oxide of nitrogen were calculated with the help of exhaust gas analyser.

| | |
|---|---|
| Engine model | Kirloskar |
| Type of Engine | Diesel engine. Single cylinder, Four stroke |
| Cylinder diameter | 87.5mm |
| Stroke length | 110mm |
| Power | 3.5KW |
| Speed | 1400 RPM |
| Compression ratio | 14:1 |
| Injection point variation | 25℃ |
| Injection Pressure | 200bar |
| Engine Capacity | 0.660 lit |
| Cooling arrangement | Water cooling |

Table.2

## RESULT AND DISCUSSION

### Break thermal efficiency

Calculation of Break thermal efficiency will show how engine efficient to transform fuel in to beneficial work [13]. The change Break thermal efficiency percentage for dissimilar loading state is display in figure 3a. The BTE shows increment in drift while raising in engine drive charge. It occurs because of deflection of heat dropping and increment in engine power growth at the same time increasing in engine load. BTE was a bit less for micro algae fuel than dieseline fuel, although difference was less than 6% at all the load states. The highest BTE value acquire for dieseline B30, B40, B50, B60 are 26.76%, 26.30%, 26.84%, 26.45%, 26.24% respectively. BTE shows little bit decline with increment in percentage of micro algae fuel because of its undesirable ignition and jet dissipation properties due to its high viscidity and density besides its low heating rate. [6]

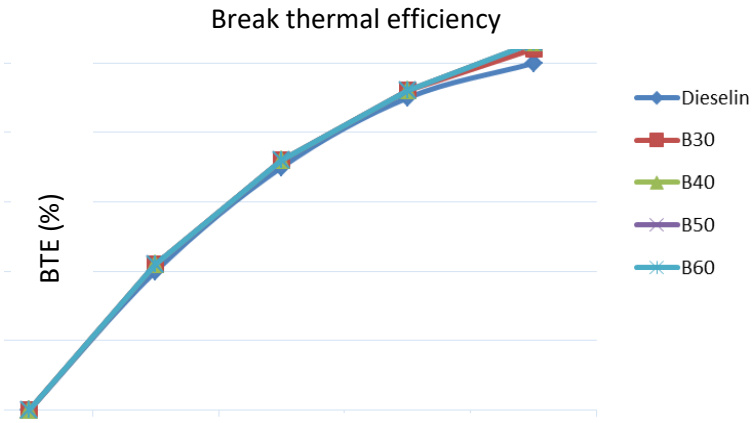



**Fig. 3a**

## SPECIFIC FUEL CONSUMPTION

Figure no.3b shows variability in specific fuel consumption for different blending for different working state. The graph shows that when load increases, SFC of all types of fuels will decreases, although decline in BSFC increased with engine load for all blending. The SFC for blends B30, B40, B50, and B60 are 0.331, 0.337, 0.341, and 0.344 respectively in kg/kWh; although for dieseline it is 0.319 kg/kWh. It was shown down SFC of micro algae fuel is higher than dieseline by 8% at all loading state. This caused by presence of volumetric oil injection rate, low CV and high density.[2]

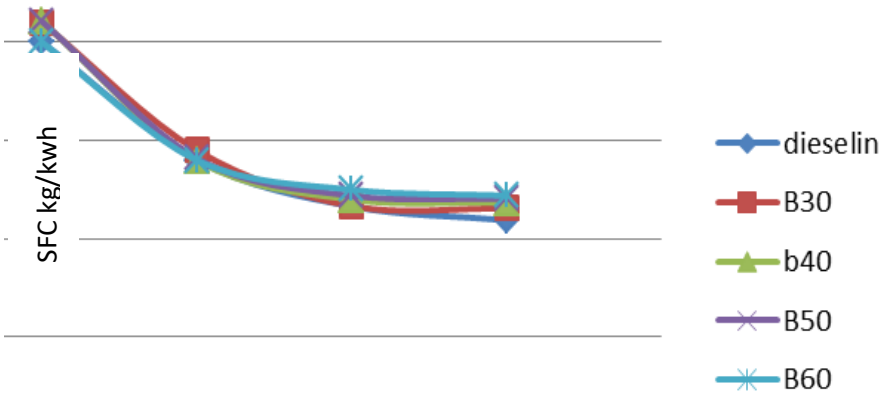



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**Fig. 3b**

## EXHAUST GAS TEMPERATURE.

The differential in exhaust gas temperature for various engine loads and for various blends shown in figure 3c. Hardly increment in EGT during increment of percentage of micro algae fuel and engine load is noted. The EGT for dieseline, B30, B40, B50, B60 are 327.20C, 328.26C, 335.24C, 336.45C, 337.45C respectively, at full load state. Because of lower value of compressibility of bio oil than dieseline instantly arise in pressure generated by pump, its high value of density and viscosity assist increment injection tube pressure. This opens injector pointer flap earlier than dieseline which outcomes the earlier start of combustion and results higher temperature of EGT for micro algae fuel.

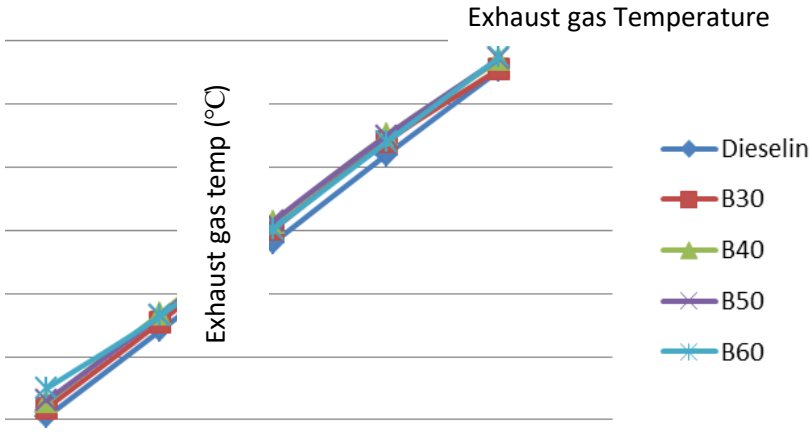


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**Fig 3c**

## IGNITION ANALYSIS

## CYLINDER PRESSURE

For computation of pressure of cylinder is most important tool utilized for analysis of combustion process as it capability of the oil to mix with air and burn [10-11]. Variability of cylinder pressure concerning with crank angle with full load state and for various blends as follows in figure 4a. It was recorded that apex pressure was high for dieseline relative to all blends at all full load states. The peak pressure has been recorded i.e. 69.63 bar, 67.21bar,67.02 bar, 66.53 bar, 66.28 bar for dieseline and micro algae bio fuel blends B30, B40, B50, B60 respectively at full load state. Little bit decrement in pressure of micro algae bio fuel were recorded as compare to dieseline with increment of percentage of microalgae fuel in dieseline due to higher amount of the viscosity in micro algae oil [5].

## IGNITION LAG

Ignition lag is one of the most important variables utilized for combustion study. At full load state, the ignition lag interval for B30, B40, B50, B60 are 5.21, 5.01, 4.88, 4.62/CA sequentially that are

less than the ignition lag period for dieseline i.e. 7.35/CA. It was noted that lag period for micro algae fuel blend shows the decrease drift as increment in load because of increment in cylindrical gas temperature. Due high amount of unsaturated fatty acid, high amount of oxygen which assist self (auto) ignition tends to short combustion lag [6].

**NET HEAT LIBERATION**

The heat liberation arc shows the probable availability of heat power through ignition, whichever transfer in to usable work and use for different ignition scale of oils [5]. The net het liberation at full load state in respect of crank angle for various micro bio fuels. The maximum heat liberated in fuel blends B30, B40, B50, B60 and dieseline was 63.88 J/CA, 64.21 J/CA, 66.21 J/CA, 67.25 J/CA and 71.21 J/CA respectively. Heat liberation rate for dieseline was more than other micro algae fuel blends because of its high value of volatility, long ignition lag time interval and easy spray formation [4].

**EMISSION STUDY**

**HYDROCARBON**

The differentiation of hydrocarbon discharge under several engine loads is shown as per graph 5a. The discharge of hydrocarbon is increase trend with increment in load for all type of fuel tested. It was shown that the discharge of hydrocarbon decreases rectilinear with adding of percentage of micro algae fuel in dieseline. The noted emissions values of HC for micro algae blend fuel were located less than dieseline by average of 24%. Because of high amount of oxygen, long chain, high saturation of micro algae fuel tend to decreases emission of hydrocarbons with respect to dieseline[16].

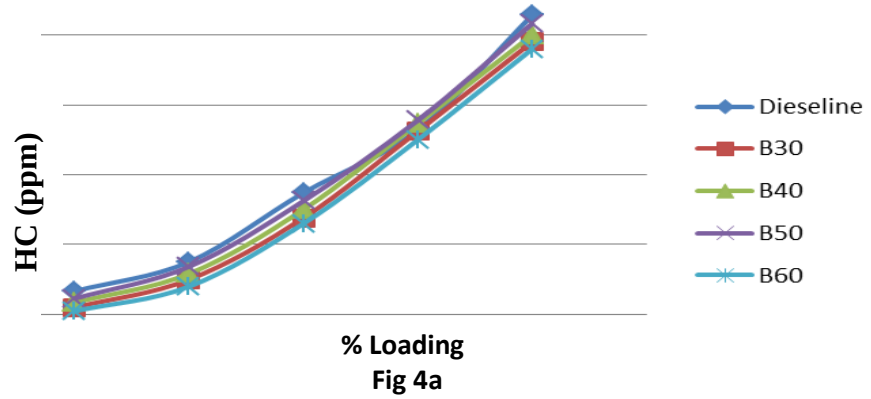


**Fig 4a**

**CARBON MONOXIDE**

Figure 5b shows the differentiation of CO discharge for various engine loads. The discharge of CO is increase trend with increment in load for all type of fuel tested. The noted discharge values of CO for micro algae fuel were found less than dieseline fuel by average of 22%. CO produces in engine due because of less amount oxygen in ignition since micro algae fuel is oxygenized fuel with less amount of carbon.

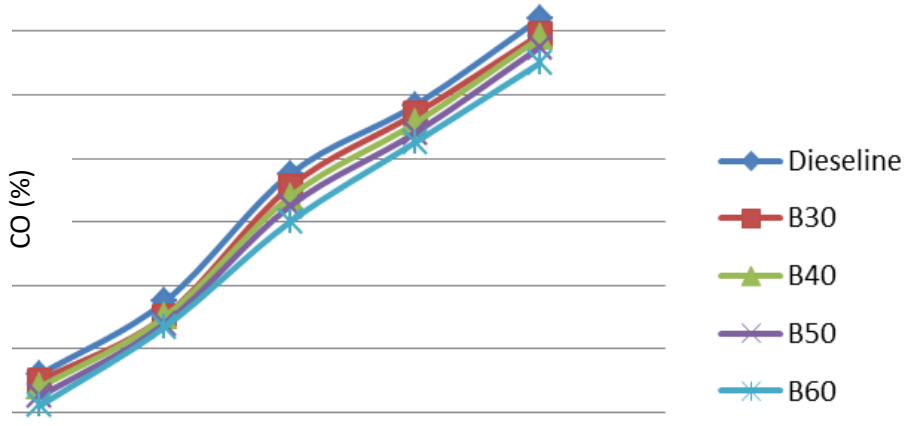


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Fig 4b

**CARBON DIOXIDE**

Figure 5c shows differentiation of carbon dioxide discharge for various engine loads for different blends. The discharge of CO2 is increase trend with increment in load for all type of fuel tested. Discharge of carbon dioxide is increase with increase in percentages of microalgae fuel in to dieseline due to high amount of oxygen; it directly converts co in to O2.

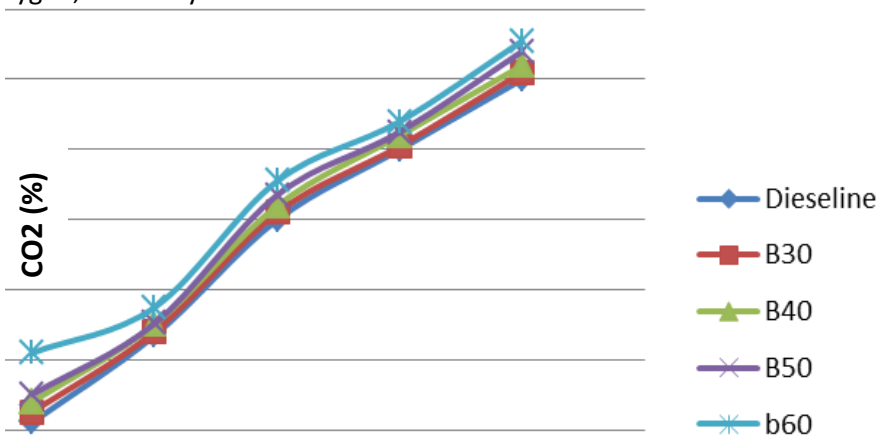


**Fig. 4c**

**NITROGEN OXIDE**

Figure 5d shows the differentiation of nitrogen oxide discharge for various loads for different blends of micro algae. The discharge of nitrogen oxide is increase with increase in loads and increase in bio fuel ratio in blends. The noted NOx value for micro algae fuel blend was more than dieseline by 11%, because of approximate cetane number and high amount of oxygen contained by micro algae fuel.

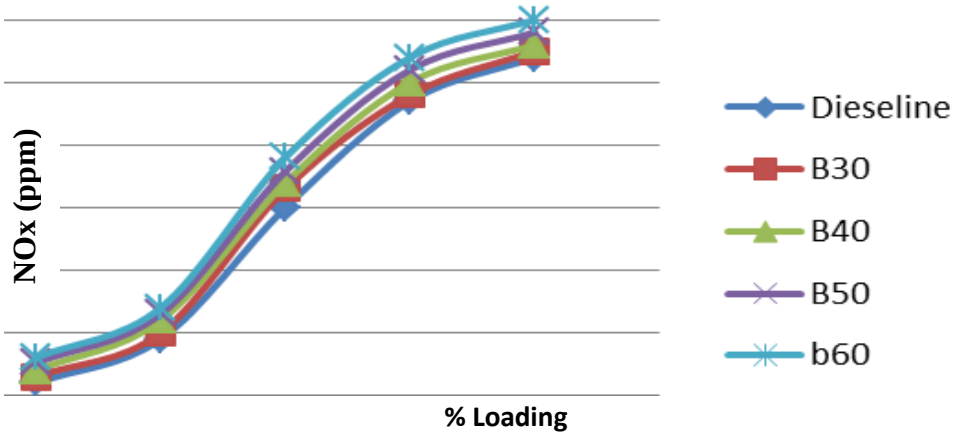


**Fig.4d**

## CONCLUSION

Performance, discharge and ignition study of CI engine charge with micro algae bio-oil blending of 30%, 40%, 50%, 60% were analytically performed. It can be concluded that with use of micro algae bio fuel in dieseline we can control air pollution.

The performance variable like Break thermal efficiency displayed in decline direction by 6% and for specific fuel consumption it is 8% exhaust gas temperature (up to 3%) displayed rise direction for microalgae bio oil blends differentiate with dieseline. Reduction in emission of hydrocarbon (up to 24%) and carbon monoxide (up to 22%) ignition was well known for microalgae bio-oil blending along with minimum rise in oxides of nitrogen NOx (up to 11%). And Ignition properties of micro algae bio fuel is almost similar to the diesel. Inclusion, it can be concluded that the net and average of heat release rate of microalgae bio-oil blends is nearly similar to dieseline because of its lower net heat value, less amount of volatility, low ignition lag and high density.

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