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EMISSION AND PERFORMANCE CHARACTERISTICS OF THIRD GENERATION MICROALGAE AZOLLA BIODIESEL AND ITS BLENDS IN A COMPRESSION IGNITION ENGINE.

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Abstract—Nowadays the shortage of fossil fuels, increasing crude oil price, energy security and accelerated global warming have led to growing worldwide interests in renewable energy sources that is increasingly being used worldwide is biodiesel . The present work focuses on the third generation biofuel on Microalgae-Azolla are becoming important as source of biofuel. This research focus on Microalgae Azolla, the small microorganisms, can grow in fresh, marine, waste and saline water. Microalgae azolla raw extract is converted into biodiesel to avoid harmful emission by transesterification process and their biodiesel properties are studied. Biodiesel was prepared from the non-edible oil of Azolla by transesterification of the crude oil with methanol in the presence of KOH as catalyst. A maximum conversion of 92% (oil to ester) was achieved at 65˚C and balance waste oil (glycerol) used produce pharmaceutical, cosmetics etc.

Performance and emission tests were carried out for 25%, 50%, 75%and 100% Azolla algae oil diesel blends. And then it is blended with the Microalgae Azolla biodiesel with conventional diesel and it's the Performance & Emission behaviour is studied. Microalgae produce 15-300 times more oil for biodiesel production than traditional crops on an area basis. The cultivation of microalgae needs less water than other energy oil crops. The Natural Resources Development Project (NARDEP) in India has been working on azolla for the last three to four years.

Keywords: Azolla oil, Biodiesel, transesterification, Performance, emission

I. INTRODUCTION

In the last few years interest & activity has grown up around the globe to find a substitute of fossil fuel. According to Indian scenario the demand of petroleum product like diesel is increasing day by day hence there is a need to find a solution. The use of edible oil to produce biodiesel in India is not feasible in view of big gap in demand and supply of such oil. Under Indian condition only non-edible oil can be used as biodiesel which are produced in appreciable quantity and can be grown in large scale on non-cropped marginal lands and waste lands. The first generation biofuels possess notable economic, environmental and political concern as the mass production of biofuel requires more arable agricultural lands resulting in reduced lands for human and animal food production. Moreover, production process of first generation biofuels is also responsible for environmental degradation. Therefore, enthusiasms about first generation biofuels have been demised.

As first generation biofuels are not viable, researchers focused on second generation biofuels. Because of the second generation biofuels production process requires expensive and sophisticated technologies, the biofuel production from the second generation is not profitable for commercial production.

Therefore, the researchers focused on third generation biofuels. The main component of third generation biofuels is microalgae. It is currently considered to be a feasible alternative renewable energy resource for biofuel production overcoming the disadvantages of first and second generation biofuels.

. Microalgae can provide several different types of renewable biofuels. This includes methane biodiesel and bio-hydrogen There are many advantages for producing biofuel from algae as microalgae can produce 15 to 300 times more biodiesel than traditional crop on area basis. The harvesting cycle of microalgae is very short and growth rate is very high. Moreover, high quality agricultural land is not required for microalgae biomass production.

A. HARVESTING METHODS OF MICROALAE AZOLLA

Producing micro algal biomass is generally more expensive than growing crops. Photosynthetic growth requires light, carbon dioxide, water and inorganic salts. Temperature must remain generally within 20 to 30 °C.

.To minimize expense, biodiesel production must rely on freely available sunlight, despite daily and seasonal variations in light levels.

Two methods are to harvest they are

1. Raceway Ponds.
2. Photo bioreactors.

A.1 Raceway Ponds

A raceway pond is made of a closed loop recirculation channel that is typically about 0.3 m deep. Mixing and circulation are produced by a paddlewheel. Flow is guided around bends by baffles placed in the flow channel. Raceway channels are built in concrete or compacted earth, and may be lined with white plastic. During daylight, the culture is fed continuously in front of the paddlewheel where the flow begins. Broth is harvested behind the paddlewheel, on completion of the circulation loop. The paddlewheel operates all the time to prevent sedimentation.

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A.2 Photo bioreactors

This tubular array, or the solar collector, is where the sunlight is captured. The solar collector tubes are generally 0.1m or less in diameter. Biomass sedimentation in tubes is prevented by maintaining highly turbulent flow. Flow is produced using either a mechanical pump.

Selecting a suitable microalgal biomass production method for making biodiesel requires a comparison of capabilities of raceways and tubular photo bioreactors

B.1 Micro Algae Azolla Oil extraction: Algae were ground with motor and pestle as much as possible. The ground algae were dried for 20 min at 80degree in a incubator for releasing water. Hexane and ether solution (20 and 20 mL) were mixed with the dried ground algae to extract oil. Then the mixture was kept for 24 h for settling.

B.2 Biomass collection: The biomass was collected after filtration and weighted.

B.3 Evaporation: The extracted oil was evaporated in vacuum to release hexane and ether solutions using rotary evaporator.

B.4 Mixing of catalyst & methanol:

0.25 g KOH was mixed with 24 mL methanol and stirred properly for 20 min.

B.5 Biodiesel production:

The mixture of catalyst and methanol was poured into the algal oil in a conical flask. The following reaction and steps were followed,

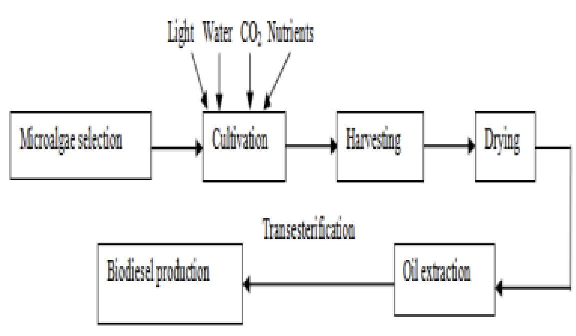
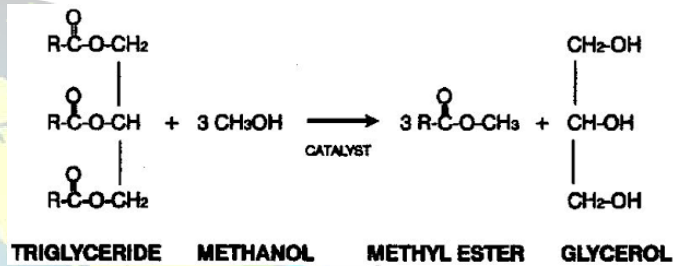


Figure 1. Different stages of production of microalgal biodiesel

B.6TRANSESTERIFICATION:

Explained the production of biodiesel using trans- esterification as follows. The catalyst used is typically potassium hydroxide (KOH) with 12% of one liter oil quantity. It is dissolved in the 200ml of distilled methanol (CH3OH) using a standard agitator at 700 rpm speed for 20 minutes. The alcohol - catalyst solution was prepared freshly in order to maintain the catalytic activity and prevent the moisture absorbance. After completion it is slowly charged into preheated esterified oil. When the methoxide was added to oil, the system was closed to prevent the loss of alcohol as well as to prevent the moisture. The temperature of reaction mix was maintained at 60 to 65oC (that is near to the boiling point of methyl alcohol) to speed up the reaction. The recommended reaction time is 70 min. The stirring speed is maintained at 560- 700rpm.

Excess alcohol is normally used to ensure total conversion of the fat or oil to its esters. The reaction mixture was taken each after 20 min. for analysis of FFA. After the confirmation of completion of methyl ester formation, the heating was stopped and the products were cooled and transferred to separating funnel. Once the reaction is complete, it is allowed for settling for 2-3 hours in separating funnel. At this stage two major products obtained that are glycerin and biodiesel. Each has a substantial amount of the excess methanol that was used in the reaction. The glycerin phase is much denser than biodiesel phase and is settled down while biodiesel floated up. The two can be gravity separated with glycerin simply drawn off the bottom of the settling vessel. Once the glycerin and biodiesel phases were been separated, the excess alcohol in each phase was removed by distillation. Once separated from the glycerin and alcohol removal, the crude biodiesel was purified by washing gently with warm water to remove residual catalyst or soaps.



B.7 Shetteling: After shaking the solution was kept for 16 h to settle the biodiesel and sediment layers clearly.

B.8 Separation of biodiesel: The biodiesel was separated from sedimentation by flask separator carefully. Quantitysedimeant (glycerine, pigments, etc.) wasmeasured.

B.9Washing: Biodiesel was washed by 5% water until it was become clean.

B.10 Drying: Biodiesel was dried by using dryer and finally kept under the running fan for 12 h.

Storage: Biodiesel production was measured by using measuring cylinder; pH was measured and stored for analysis.

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PARAMETERS	RESULT OBTAINED FOR MAA	DIESEL
Kinematic viscosity @ 40 Deg. C	6.44 cst	2.6 cst
Density @15 Deg.c	0.8670gm/cc	0.850gm/cc
Conradson carbon residues	0.50%	0.17%
Flash point by PMCC method	46 Deg.c	52 Deg.c
Fire point by PMCC method	56 Deg.c	56 Deg.c
Gross calorific value in kcal/kg	10027kcal/kg	4392kcal/Kg
Calculate cetane index	49	47.982
Sediments(insolubles in hexane)	0.53%	0.015%
Sediments(insolubles in benzene)	0.34%	0.01%

Azolla oil extraction setup

C. Micro algae Azolla properties

TABLE I

D. PERFORMANCE AND EMISSION TEST

Engine performance is an indication of the degree of success with which it does its assigned job *i.e.,* conversion of chemical energy contained in the fuel into useful work.

In evaluation of engine performance certain basic parameters are chosen and effect of various operating conditions and modifications on these parameters are studied.

Basic performance parameters

1. Power and mechanical efficiency
2. Mean effective pressure
3. Volumetric efficiency
4. Thermal efficiency
5. Specific fuel consumption

Internal combustion research engine

The performance tests were carried out in IC research engine for various proportions of Micro algae Azolla diesel blends. The specifications of the research engine are given in the table.

E. Specification of IC research engine

S.No.	Parameters	Specifications
1	Engine type	Water cooled 4 stroke single cylinder diesel engine
2	Power	5.2 kW
3	Rated speed	1500 rpm
4	Cylinder bore	87.5 mm
5	Stroke length	110 mm
6	Compression ratio	17.5

Test rig Circuit diagram

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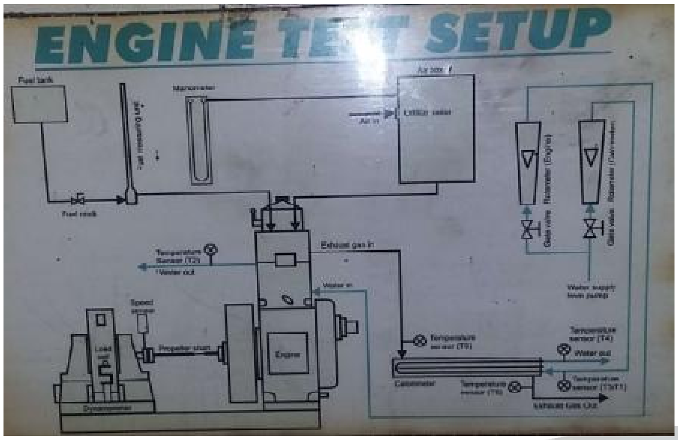

F. Data collection

There are five test fuels were used during performance test includes 100 % diesel, 25%, 50%, 75% & 100% microalgae azolla blend with diesel. The following tables shows the obtained data's from performance tests for various diesel blends such as Brake power, Indicated power, brake mean effective pressure, indicated mean effective pressure, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, volumetric efficiency, specific fuel consumption, air flow, fuel flow and air fuel ratio.

Indicated power for various Diesel blend

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	2.059	2.059	2.059	2.059	2.059
40%	3.099	3.099	3.099	3.099	3.099
60%	4.139	4.139	4.139	4.139	4.139
80%	5.179	5.179	5.179	5.179	5.179
100%	6.219	6.219	6.219	6.219	6.219

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Brake power for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	1.039	1.039	1.039	1.039	1.039
40%	2.079	2.079	2.079	2.079	2.079
60%	3.119	3.119	3.119	3.119	3.119
80%	4.159	4.159	4.159	4.159	4.159
100%	5.199	5.199	5.199	5.199	5.199

Specific fuel consumption for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	0.670	0.719	0.778	0.776	0.651
40%	0.783	0.887	0.930	1.039	0.868
60%	1.081	1.167	1.264	1.248	1.104
80%	1.197	1.310	1.352	1.402	1.256
100%	1.315	1.496	1.633	1.587	1.467

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Fuel power for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	7.812	8.384	9.0712	9.0448	8.0519
40%	9.134	10.337	10.847	12.110	10.731
60%	12.60	13.608	14.737	14.544	13.65
80%	13.95	15.275	15.762	16.346	15.52
100%	15.326	17.437	19.038	18.495	18.134

Brake thermal efficiency for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	13.311	12.403	11.464	11.49	12.196
40%	22.770	20.120	19.174	17.174	19.381
60%	24.761	22.925	21.170	21.451	22.856
80%	29.801	27.232	26.391	25.448	26.795
100%	33.92	29.82	27.312	28.114	28.67

Indicated thermal efficiency for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	26.37	24.57	22.71	22.78	25.58
40%	33.94	29.99	28.58	25.60	28.89
60%	32.86	30.42	28.09	28.46	30.33
80%	37.11	33.91	32.86	31.69	33.37
100%	40.58	35.67	32.67	33.63	34.30

Brake specific fuel consumptions for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	0.645	0.692	0.748	0.746	0.627
40%	0.377	0.426	0.448	0.500	0.418
60%	0.347	0.374	0.405	0.400	0.354
80%	0.288	0.315	0.325	0.337	0.302
100%	0.253	0.288	0.314	0.305	0.282

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Indicated specific fuel consumption for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	0.325	0.349	0.378	0.377	0.316
40%	0.253	0.286	0.300	0.335	0.280
60%	0.261	0.282	0.305	0.301	0.267
80%	0.231	0.253	0.261	0.271	0.243
100%	0.211	0.241	0.263	0.255	0.236

G. Types of Emission

1. Carbon monoxide (CO)
2. Hydrocarbons (HC)
3. Nitrogen oxide (NO_X)
4. Carbon dioxide (CO_2)
5. Oxygen (O_2)
6. Other gases (X)

Carbon monoxide (CO) for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	0.08	0.011	0.1	0.1	0.09
40%	0.07	0.08	0.09	0.09	0.09
60%	0.08	0.1	0.09	0.09	0.07
80%	0.12	0.14	0.2	0.11	0.12
100%	0.37	0.28	0.3	0.15	0.36

Hydrocarbons (HC) for various diesel blends.

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	35	41	47	47	35
40%	54	49	61	51	70
60%	61	64	72	58	83
80%	61	76	82	74	100
100%	71	106	105	94	154

Nitrogen oxide (NO_X) for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	372	341	289	246	346
40%	554	525	486	453	680
60%	884	823	742	570	845
80%	1030	973	867	750	1154
100%	1125	1089	989	886	1230

Carbon dioxide (CO_2) for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	3.6	3.9	3.9	3.5	2.4
40%	4.3	4.1	4.2	3.9	3.2
60%	4.7	5.7	5.3	4.3	3.9
80%	7	6.6	5.9	6	6.4
100%	8	7.4	7	6.8	7

Oxygen (O2) for various diesel blends

LOAD	25% BioDiesel blend	50% BioDiesel blend	75% BioDiesel blend	100% BioDiesel blend	Diesel
20%	19.62	19.14	18.93	18.43	18.26
40%	19.6	20.04	19.58	18.21	17.04
60%	18.36	19.39	19.21	18.09	15.04
80%	18.8	19.12	18.84	17.67	14.81
100%	18.48	20.07	18.4	17.6	12.1

Engine Performance and Emission Characteristics of Micro Algae Azolla Oil

The algal oil's engine performance and emission characteristics were compared with the others. Algal oil produced lower engine power than others, which is explained by the lower heating value of the former. On the other hand, algal oil demonstrated significantly higher brake specific fuel consumption (BSFC) at low loads (10%), while this difference is zeroing at higher loads. The lower energy density of algal oil compared to other oil necessitated an increase in the volume of injected fuel to retain the same power output, increasing the BSFC in algal relative to other oil. In addition, the high kinematic viscosity and density of fuels can cause decrease of the fuel atomization and vaporization, leading to high BSFC. Moreover, at 10% engine load there is a low temperature rise, which causes a lean combustion mixture, thus it can trigger even higher fuel consumption in low energy containing fuels, compared to fuels with higher heating values. In contrast, the higher oxygen content of algal oil compared to other favours the complete combustion of the fuel leading to the reduction of the BSFC at higher loads, in which there is higher temperature rise compared to low loads. In contrast, the CO2 emissions of algal oil are higher at 25, 50 and 75% loads, whereas at 10 and 100% loads CO2 emissions are almost identical. This result is a combination of the higher carbon content of oil and, on the other hand, the higher viscosity and lower heating value of algal oil which causes the increase in BSFC, thereby increasing CO2 emissions.

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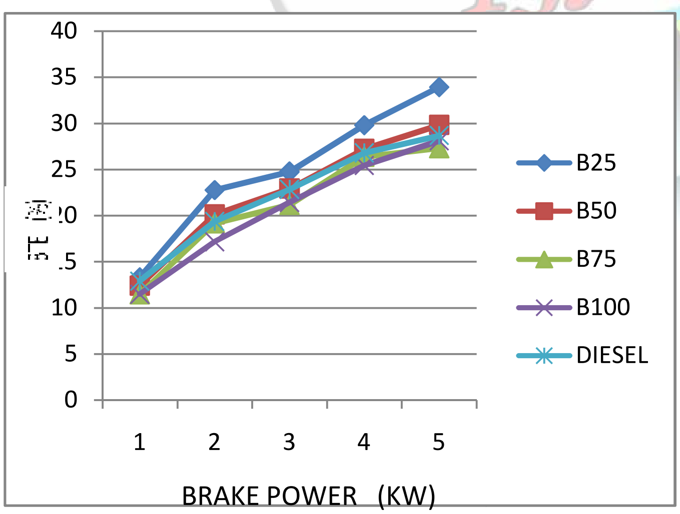
The higher cetane number of algal oil accounts for the lower NOx emissions. Fuels with a higher cetane number have lower ignition delay, hence shorter duration of premixed combustion, which suggests a slower rise of combustion pressure, and as a result lower temperatures and slower NOx formation rate. On the other hand, the higher viscosity of algal oil compare to other oil, alters the fuel atomization and increases the smoke emissions. Finally, suggests that the PM emissions of algae oil are significantly higher at 10% load, compare to other oil, whereas at higher loads the emissions are almost equal. The significant increase of PM emission at low loads (10%) is a result of the high BSFC which favours the accumulation of un-burnt emissions. The lower sulphur content and of algal oil compared to other oil, with at the same time higher oxygen content, explains the significant reduction of PM emissions of algal oil at higher and full loads. Problems caused by the high viscosity (such as poor fuel atomization and obstruction of fuel lines and filters) of algal and other oil could be resolved by increasing fuel injection temperature for the oils.

H. RESULT AND DICUSSION

The performance and emission was compared with pure diesel from the obtained performance and emission graphs. The basic performance and emission parameters were presented against brake power for all Micro algae azolla oil diesel blends

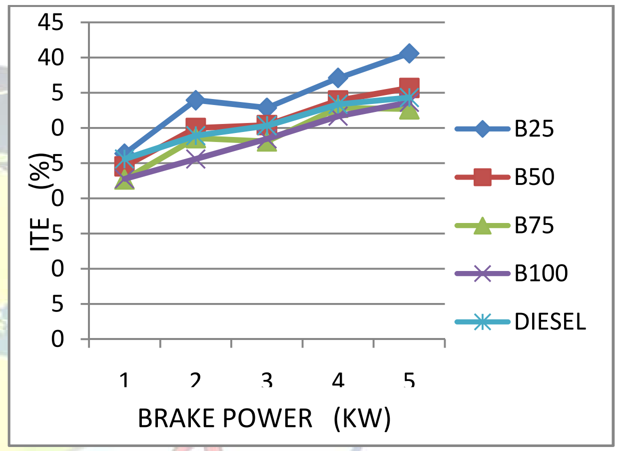
Brake thermal efficiency

The variation of brake thermal efficiency with brake power is shown in Figure7.1. It can be observed from the figure that the thermal efficiency is 28.67% at 5.19Kwbrake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the thermal efficiency of 33.92%, 29.82%, 27.31%, and 28.11%respectively at 5.19kwbrake power. It is also observed that brake thermal efficiency is higher for 25% and 50% MAA Diesel blends and it is slightly lower for 75 % and 100% MAA Diesel blend when compared to pure diesel.



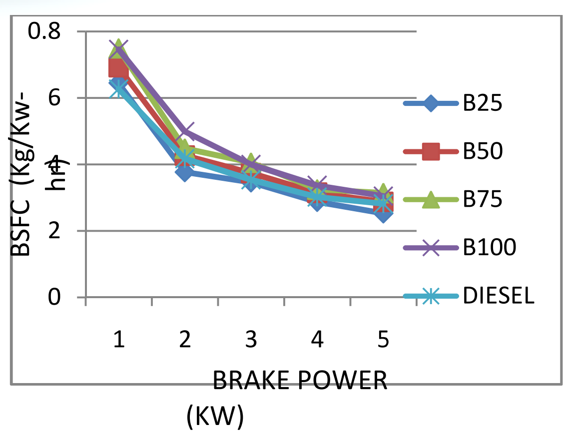
Indicated thermal efficiency

The variation of indicated thermal efficiency with load is shown in Figure 7.2. It can be observed from the figure that the indicated thermal efficiency is 34.30 % at 5.19kwbrake power for diesel. When the engine is fueled with MAA diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the thermal efficiency of 40.58%, 35.67%, 32.66%and 33.62 % respectively at 5.19kwbrake power. It is also observed that indicated thermal efficiency is also higher for 25% and 50% blends and it is slightly lower for 75% and 100% MAA Diesel blend when compared to pure diesel.



Brake specific fuel consumption

The variation of brake specific fuel consumption with load is shown in Figure7.3. It can be observed from the figure that the brake specific fuel consumption is 0.282 kg/kWh at 5.19kwbrake power for diesel. When the engine is fueled with MAA diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, its brake specific fuel consumption is 0.2529kg/kWh, 0.2877kg/kWh, 0.3141kg/kWh and 0.3052kg/kWh respectively at 5.19kwbreak power. It is also noted that the brake specific fuel consumption is decreased for 25 % and 50% MAA Diesel blends and it is slightly increase for 75% and 100% MAA Diesel blend when compared to pure diesel.



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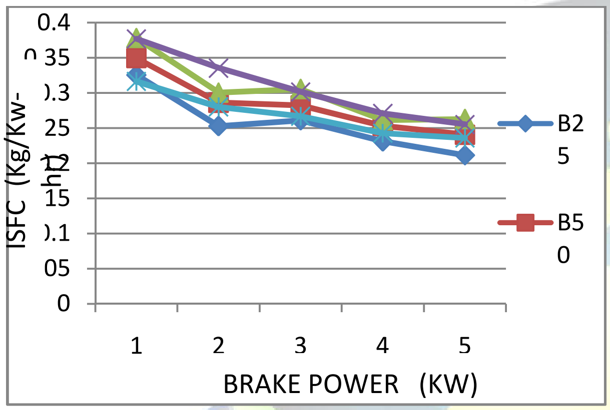
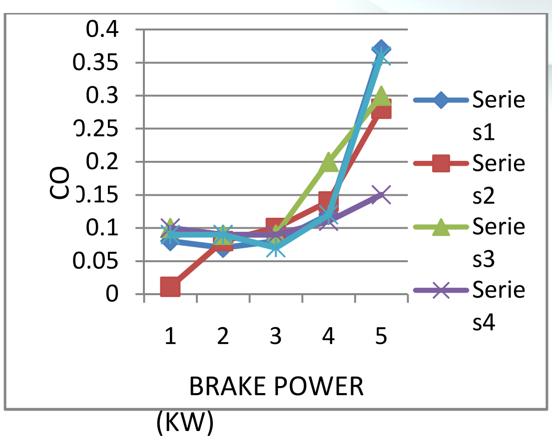
Indicated specific fuel consumption

The variation of indicated specific fuel consumption with load is shown in Figure7.4. It can be observed from the figure that the indicated specific fuel consumption is 0.236 kg/kWh at 5.19kwbrake power for diesel. When the engine is fueled with MAA diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, its indicated specific fuel consumption is 0.2113kg/kWh, 0.2405kg/kWh, 0.2626kg/kWh and 0.2551kg/kWh respectively at 5.19kwbreak power. It is also noted that the indicated specific fuel consumption is decreased for 25 % and 50% MAA Diesel blends and it is slightly increase for 75% and 100% MAA Diesel blend when compared to pure diesel.



carbon monoxide (CO)

The variation of carbon monoxide (CO) with brake power is shown in Figure7.5. It can be observed from the figure that carbon monoxide (CO) is 0.36% at 5.19kw brake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the carbon monoxide (CO) of 0.37%, 0.28%, 0.3%, and 0.15% respectively at 5.19kwbrake power. It is also observed that carbon monoxide (CO) is lower for 25%, 50%, 75% and 100% MAA Diesel blends when compared to pure diesel.



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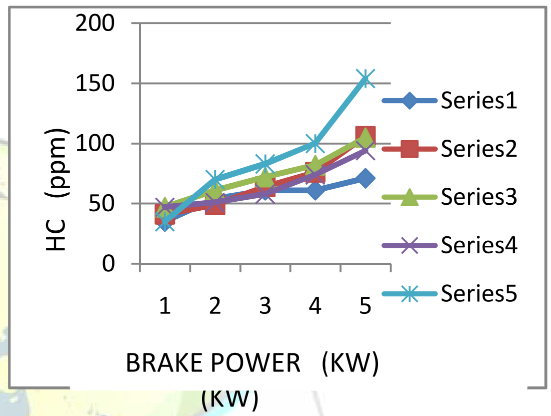
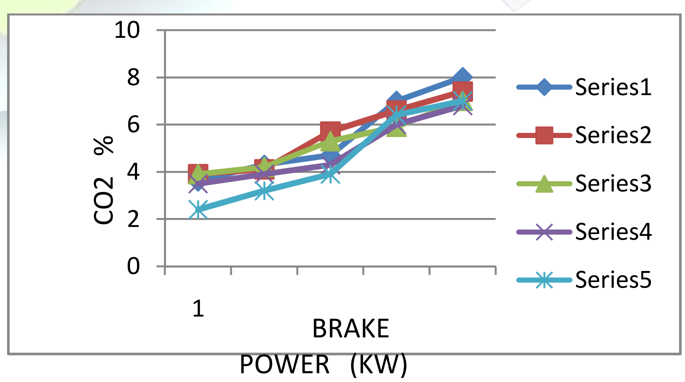
sHydrocarbons (HC)

The variation of hydrocarbons (HC) with brake power is shown in Figure7.6. It can be observed from the figure that a hydrocarbon (HC) is154ppm at 5.19kwbrake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the hydrocarbons (HC) of 71ppm 106ppm, 105ppm,and 94ppm respectively at 5.19kwbrake power. It is also observed that hydrocarbons (HC)is lower for 25% , 50%, 75% and 100% MAA Diesel blends when compared to pure diesel.



Carbon dioxide (CO_2)

The variation of Carbon dioxide (CO_2) with brake power is shown in Figure7.7. It can be observed from the figure that Carbon dioxide (CO_2) is7% at 5.19kw brake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the Carbon dioxide (CO_2) of 8%, 7.4%, 7%and 6.8% respectively at 5.19kwbrake power. It is also observed that Carbon dioxide (CO_2) is lower for 25% , 50%, 75% and 100% MAA Diesel blends when compared to pure diesel.



Oxygen (O_2)

The variation of Oxygen (O_2) with brake power is shown in Figure7.8. It can be observed from the figure that Oxygen (O_2) is 12.1% at 5.19kw brake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75%

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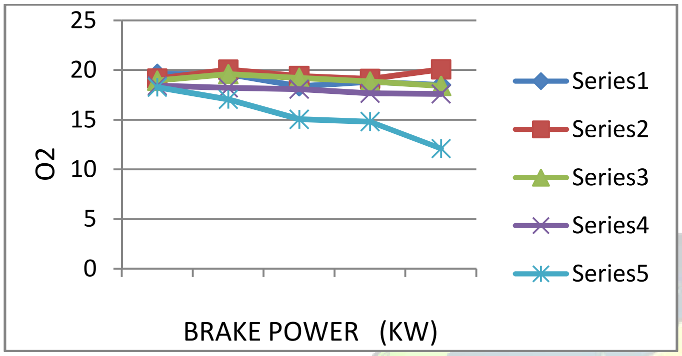
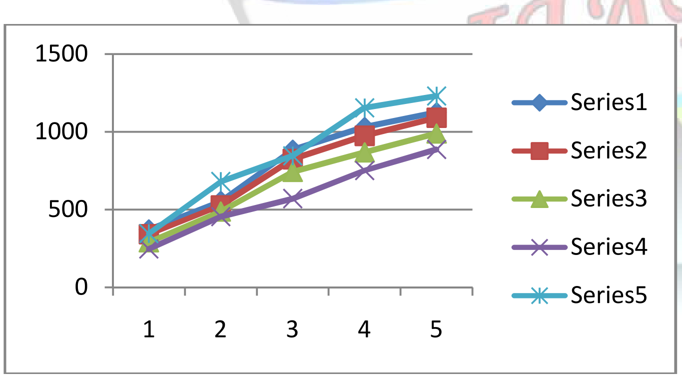
MAA, and 100% MAA, it gives the Oxygen (O_2) of 18.48%, 20.07%, 18.4%, and 17.6 % respectively at 5.19kwbrake power. It is also observed that Oxygen (O_2) is lower for 25%, 50% and 75% MAA

Diesel blends and it is slightly higher for 100% MAA Diesel blend when compared to pure diesel.



Nitrogen oxide (NO_X)

The variation of Nitrogen oxide (NO_X) with brake power is shown in Figure7.5. It can be observed from the figure that Nitrogen oxide (NO_X) is1230ppm at 5.19kw brake power for diesel. However when the engine is fuelled with MAA-diesel blends such as 25% MAA, 50% MAA, 75% MAA, and 100% MAA, it gives the Nitrogen oxide (NO_X) of 1125 ppm, 1089ppm,989ppm and 886ppm respectively at 5.19kwbrake power. It is also observed that Nitrogen oxide (NO_X) is lower for 25% , 50%, 75% and 100% MAA Diesel blends when compared to pure diesel.



I. CONCLUSION

In our work the Biodiesel was prepared from the non-edible oil of Micro algae Azolla by transesterification of the crude oil with methanol in the presence of KOH as catalyst. A maximum conversion of 92% (oil to ester) was achieved at 65˚C. the received Azolla oil is blended in differentproportion 25%,50%,75% and 100%.the blends are subjected to performance and emission test rig engine the calculation are arrived
The algal oil exhibited a negative influence on engine power, BSFC, CO2 and PM emissions, while the NOx emissions werelower with algal oil than other oil. Nevertheless,algal oil is feasible as a fuel in a diesel engine as the performance and emissions are acceptable, especially at higher loads.

- Engine was able to run with 25% & 50% waste micro algae oil-diesel blend
- Engine fuelled with 25% & 50 % waste Azolla oil-diesel blend exhibits higher brake power when compared to pure diesel.
- Mechanical efficiency is higher for 25% & 50 % Azolla oil-diesel blend when compared to pure diesel
- The results are in line with that reported in literature by different researchers using various biodiesel fuels and their blends and
- Economic analysis shows that micro algae azolla oil biodiesel can be used in an existing diesel engine without any engine modifications which will lead to employment generation and saving in vital foreign exchange.

J.REFERENCES

[1] Micro-algae cultivation for biofuels: Cost, energy balance, environmental impacts and future Prospects Raphael Slade, AusilioBauen Imperial Centre for Energy Policy and Technology, Centre for Environmental Policy, Imperial College London, South Kensington Campus, London SW7 2AZ, UK.

[2] Non-edible vegetable oils: A critical evaluation of oil extraction, fatty acid compositions, biodiesel production, characteristics, engine performance and emissions production . A.E. Atabania,n, A.S.Silitongaa,b,n, H.C.Ong a, T.M.I.Mahlia c, H.H.Masjuki a, IrfanAnjumBadruddin a, H.Fayaz.

[3] The 6th International Conference on Applied Energy – ICAE2014 Algae to energy: Engine performance using raw algal oil.PanayiotisTsaousisa, YaodongWanga, Anthony P.Roskillya, Gary S. Caldwell.Evolving Energy-IEF International Energy Congress (IEF-IEC2012).

[4] Biofuel from algae- Is it a viable alternative? FirozAlam*a, AbhijitDatea, Roesfiansjah Residing, SalehMobinb, HazimMoriaa AbdulBaquic.6th BSME International Conference on Thermal Engineering (ICTE 2014) Third generation biofuel from Algae. FirozAlam, SalehMobin and HarunChowdhury.

[5] The dark side of algae cultivation: Characterizing night biomass loss in three photosynthetic algae, Chlorella sorokiniana, Nannochloropsissalina and Picochlorum sp. Scott. J. Edmundson, Michael H. Huesemann.

[6] Biodiesel: Algae as a Renewable Source for Liquid Fuel Matthew N Campbell Guelph University, Guelph, Ontario, N1G 2W1, Canada.Status of biofuel production from microalgae in India Mukesh Kumar, MP Sharma Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee, Uttrakhand, 247667, India.

[7] International Journal of Advanced Engineering Technology E-ISSN 0976-3945 IJAET/Vol.II/ Issue III/July-September,

2011/320-323.Research Article BIOFUEL FROM ALGAE K.Sumithrabai, Dr.M.Thirumarimurugan, Prof.S. Gopalakrishnan.

[8] Research Article Investigations on Performance and Emission Characteristics ofDiesel Engine with Biodiesel and Its Blends. Amar Pandhare1 and AtulPadalkarDepartment of Mechanical Engineering, Smt. KashibaiNavale College of Engineering, Pune, Maharashtra 411041, India. Flora Institute of Technology, Pune, Maharashtra 411041, India