EXPERIMENTAL INVESTIGATION ON DIESEL ENGINE FUELLED WITH PONGAMIA BIODIESEL AND HYDROGEN BASED LIQUID ADDITIVE

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Abstract: ***Fossil fuels are depleting day by day, as energy demand is increasing due to increased number of vehicles and industrialization. Even though Biodiesel can be the immediate replacement to the pure diesel in CI engine, the effective replacement and utilization of Biodiesel is a topic of research since many years. An attempt has been made to improve the Performance and Emission characteristic of 4 Stroke, Single cylinder, Water Cooled Direct Injection CI Engine fuelled with Diesel-Pongamia Biodiesel-Distilled Water blends. Distilled water is used as an additive at 1%, 2%, 3% proportions. And improvement in Performance characteristics and Emission characteristics of the engine has been found from the experimentation***

Index Terms - Biodiesel, Hydrogen based liquid additive, Distilled water, DI Diesel engine;

I. INTRODUCTION

Diesel is a successful fuel for internal combustion engines since long. But now the problem associated with using diesel are depletion of fossil fuel as energy demand is increasing day by day due to increased number of industries and vehicles. And another problem which is questioning Diesel is its pollutant emissions to environments.

Above discussed problems made us to look for alternative fuel which has the potential to replace diesel in CI engine completely or partially. In the present scenario the immediate replacement to the petro-diesel is Biodiesel because it can be used in the already existing engines with almost no modifications to the engine.

Improvement is a never ending process and there is always a provision for improvement in engineering. So many researchers have been going on to use Biodiesel as an effective alternative fuel in the diesel engine. All the research works that have been undergone about bio fuels insist us to improve the certain properties of the Biodiesel. If it comes to improvements in properties of biodiesel, additives are playing vital a role now a days. Additives are the substances added to temperature. This is because, the water particles absorbs biodiesel to improve the desired properties of fuel. Using distilled water as an additive with biodiesel is the main idea of this project work. Adding the distilled water to the Blends of Diesel and biodiesel improvises the atomization of the fuel blend by the rapid explosion of water droplets inside the combustion chamber. When water particles enter the engine cylinder with the fuel it undergoes rapid micro explosion due to the high temperature in the engine cylinder. This rapid explosion of water particles enhances the fuel atomization. Enhanced atomization of fuel blend increases the expansion work during the expansion stroke which in turn increases the thermal efficiency. And also addition of water reduces the NOx emissions considerably because the water content will quench the adiabatic flame the certain amount of heat inside the cylinder thereby reducing the engine peak temperature. This reduction in peak engine temperature is undesirable for NO_x formation, as decrement in the peak temperature can reduce the rate of conversion of diatomic nitrogen to mono atomic nitrogen.

II. LITERATURE REVIEW

[1] Rachan D Shekar and H R Purushothama had carried out a study on different methods of hydrogen induction to CI engine working on biodiesel. Different methods of hydrogen induction to diesel engine are;

- Mixing of hydrogen based chemicals like hydrogen peroxide and water to the diesel as an additive.
- Separation of hydrogen from electrolysis method and then injecting mixture of H_2-O_2 into the engine cylinder with the atmospheric air.
- And injecting gaseous hydrogen into the engine cylinder with atmospheric air.

Among above discussed methods; adding of hydrogen based liquid additive to the fuel is a smart and easy way because it does not need any modification to the existing engine. And it is concluded that performance of the engine cal be improved by adding hydrogen based liquid additive to the fuel.

[2] Nagaprasad K.S and D. Madhu carried out an experimental study on effect of hydrogen peroxide injection to CI engine. An experimented was conducted on 4-stroke, multi cylinder, water cooled, direct injection CI engine fuelled with pure diesel and blends of diesel and hydrogen peroxide. Addition of hydrogen peroxide was in 2%, 5%, 10% proportions with the pure diesel. Constant speed o 1500 rpm, compression ratio of 23:1 and IOP is of 150 bar is maintained with an injection timing 10° BTDC and 15° BTDC.

All readings were taken at no load, 10%, 20%, 30%, 40% and 50% load conditions. Experimental results conclude that, brake thermal efficiency increase as concentration of hydrogen peroxide increases in the fuel blend. This is because, the hydrogen peroxide release additional oxygen molecule during combustion. And decrease in exhaust gas temperature (EGT) has been found as concentration of hydrogen peroxide increases.

III. EXPERIMENTATION

The main fuel used for the running of engine is blends of Diesel and Pongamia biodiesel. Distilled water is used as an additive with Diesel-Pongamia biodiesel blend at 1%, 2%, 3% proportions. The chemical formula of Distilled water is H_2O. Table 1 shows the properties of fuel blends used for the experimentation.

Experiments were conducted on a four stroke single-cylinder, water cooled compression ignition engine. The specifications of the engine are tabulated in the table 2. The engine had eddy current dynamometer. All tests were conducted at 15%, 30%, 50%, 70% load conditions. The engine was maintained constant speed at 1500 rpm. The injection pressure is kept constant at 180 bar with an injection timing of 23° BTDC and Compression ratio 16.5:1.

Table 1. Engine Specifications

SL.NO	ENGINE PARAMETERS	SPECIFICATIONS
1	Engine Type	AV1, Kirloskar
2	Number of cylinders	Single
3	Rated Power	3.7 kW
5	Bore	80 mm
6	Stroke	110 mm
7	Type Cooling	Water Cooling
8	Type of Loading	Eddy Current Dynamometer
9	Compression ration	16.5:1
10	Injection Timing	23° BTDC

Table 2. Fuel Properties

Properties	Units	Diesel	D70B30	D70B29A1	D70B28A2	D70B27A3
Density	kg/m^3	835	854	857	860	863
Viscosity	cSt	3.1	3.408	3.4	3.390	3.35
Flash point	°C	52	80	82	83	85
Fire Point	°C	57	88	89	90	90
Calorific Value	kJ/kg	44800	43456	3152	43264	43390

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IV. RESULTS AND DISCUSSIONS

Brake Thermal Efficiency

From the Fig.7.1 it can be said that, the increment in the Brake Thermal Efficiency is observed as load increases for all fuel blends. And also Brake Thermal efficiency increased as concentration of the distilled water increases in the fuel blend. The maximum efficiency is found for blend having 3% distilled water concentration, which is near to the diesel fuel efficiency but slightly less than that. This is may be due to the rapid micro explosion of water particles inside engine cylinder. The rapid micro explosion of water particles inside engine cylinder promotes further atomization of the fuel, which in turn increases the expansion work during the expansion stroke.

Brake Specific Fuel Consumption

From the observation of above Fig.1 it could be stated that, decrement in the BSFC is observed with the increment in the load for all fuel blends. And also, decrement in the BSFC is noted as the concentration of distilled water increases in the fuel blend. The minimum BSFC is found for blend having 3% distilled water concentration, which is very nearer but slightly more than the diesel fuel BSFC.

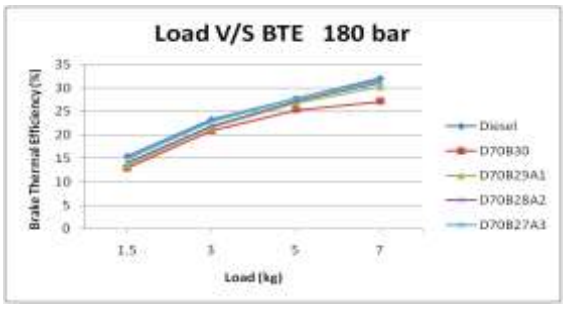

Fig.1: Load V/S Brake Thermal Efficiency.

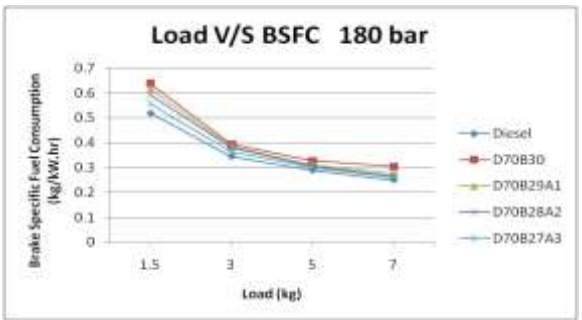

Fig.2: Load V/S Brake Specific Fuel Consumption.

NO_x

From the Fig.3, it can be observed that, NOx content increased as load on the engine increases. And the NOx content in the emission gas decreased; as the distilled water concentration increase in the fuel blend. This is due to the decrement in the peak temperature inside engine cylinder caused by the quenching effect of distilled water, which is used as an additive. The minimum NOx content is found for blend having 3% distilled water concentration, which is near to the diesel fuel NOx emission.

CO

From the observation of Fig.4, it is clear that, CO content decreased as load on the engine increases. And CO content in the emission of the engine decreases as the concentration of the distilled water increases at all load conditions. This is due to the complete combustion occurred by the increased atomization, which is a result of micro explosion of water particles inside the engine cylinder. The minimum CO content is found for blend with 3% distilled water concentration.

Fig.3: Load V/S NOx Emission.

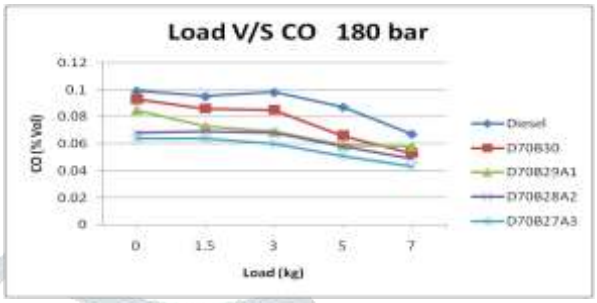

Fig.4: Load V/S CO Emission.

CO_2

From the Fig.5, it can be stated that, CO_2 emission increases as load on the engine increases for all fuel blends. And the increment in the CO_2 content is observed as the concentration of distilled water increases in the fuel blend. This shows the complete combustion occurred due to improved fuel atomization inside the engine cylinder, which is the result of rapid micro explosion of water particles.

HC

From the Fig.6, it can be said that, HC emission increases as load on the engine increases for all fuel blends. And decrement in the HC emission is noted as concentration of distilled water increases. This is due to the complete combustion caused by the improved atomization due to the micro explosion of water particles inside the engine cylinder. The minimum HC content found for blend having 3% distilled water concentration.

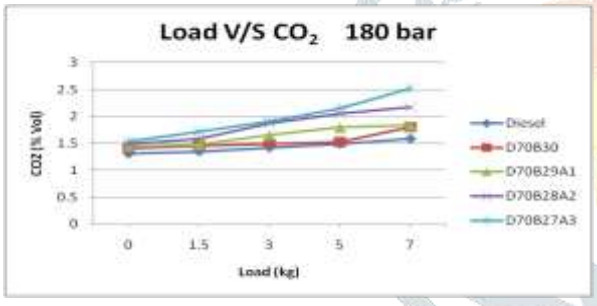

Fig.5: Load V/S CO_2 Emission.

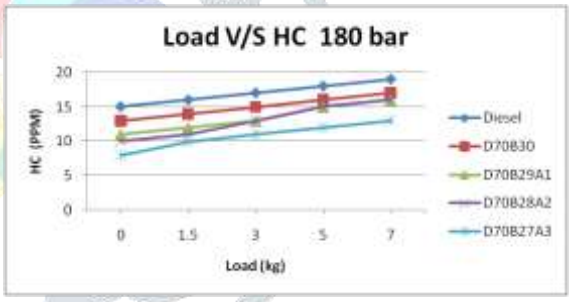

Fig.6: Load V/S HC Emission.

V. CONCLUSIONS

- BTE increases as concentration of Distilled water increases in the fuel blend. Maximum BTE is found for blend having 3% distilled water concentration, which is very nearer to diesel fuel BTE but slightly less than that.
- BSFC decreases as concentration of Distilled water increases in the fuel blend. Minimum BSFC is found for blend having 3% distilled water concentration, which is very nearer to diesel fuel BSFC but slightly more than that.
- Decrement in emission of CO, HC, NOx has been found as concentration of distilled water increases. Minimum amount of CO, HC, NOx found for blend having 3% distilled water concentration.
- Fuel blend D70B27A3 is found to be optimum blend both for performance and emission characteristics.

REFERENCES

1. Rachan D Shekar, Dr H R Purushothama, "*Hydrogen Induction to Diesel Engine Working On Bio Diesel*". Global Challenges, Policy Framework & Sustainable Development for Mining of Mineral and Fossil Energy Resources (GCPF2015). Procedia Earth and Planetary Science 11 (2015) 385-392.
2. Nagaprasad K. S, D. Madhu, *"Effect of Injecting Hydrogen Peroxide into Diesel Engine"*. International Journal of Engineering Sciences &Emerging Technologies, April 2012. Volume 2, Issue 1, pp: 24-28.
3. Pradeep s. kumar, Venkatesh B, Rajeshwari B, Veeranjaneya L. Reddy, and ShaValli P.S. khan, *"Emission Control by Using Water Emulsified Diesel in Single Cylinder Diesel Engine"*- International Journal of Advances in Engineering & Technology, Jan.2013. Volume5, Issue 2. Pp: 263-273.
4. Muhammad Saad Khan, Iwbal Ahmed, M I Abdul Mutalib and M A Bustam , *"Characterization of Diesel-Hydrogen Peroxide Fuel Blend"*. Journal of Energy Technology and Policy Volume 3, No.11, 2013.

5. M.Prabhahar, R.Murali Manohar, S.Sendilvelan. *"Performance and Emission Studies of a Diesel Engine with Pongamia Methyl Ester at Different Load Conditions"*. International Lournal of Engineering Research and Applications (IJERA), Vol.2, Issue 3, May-Jun 2012, pp.2707-2713.
6. C.V.Mahesh, E.T.Puttaiah., *"Studies on Performance and Emission Characteristics of Non-Edible oil (Honge oil) as alternative Fuel in CI Engine"*. International Journal of Engineering Research and Applications (IJERA) Vol.2, Issue 3, May-Jun 2012, pp.2288-2293.
7. A. Haiter Lenin, K.Thyagarajan., *"Performance evaluation of a diesel engine fuelled with Methyl Ester of Pongamia oil"*. International journal of Energy and Environment. Vol.3, Issue 6, 2012 pp.939-948.
8. Gaurav Dwivedi, M.P.Sharma., *"Performance Evaluation of Diesel Engine Using Biodiesel from Pongamia Oil"*. Intarnational Journal of Renewable Energy Research, Vol. 3, No.2, 2013.
9. Arulurasu.s, Appu Raja.S, Thyagaraj.M, Annamalai.K., *"Areview on Effect of Biodiesel-diesel-Water emulsion in DI Diesel Engine"*. National Conference on Green Engineering and Technologies for Suatainable Future-2014. Journal of Chemical and Pharmaceutical Scinces. Issue 4, December 2014, pp.131-132.
10. V Ganesan. *"Internal Combustion Engines"*. Tata McGraw Hill Publication, Third Edition.
11. Gaurav Dwivedi, Siddharth Jain, Mahendra Pal Sharma., *"Pongamia as a Source of Biodiesel in India"*. Smart Grid and Renewable Energy, 2011, 2, 184-189.