Investigations on the Performane and Emission Characteristics of Diesel Engine Blende with Turpentine Oil and Dimethyl Ether

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ABSTRACT

Now a days population intensity of vehicle rapidly increase so cost of the fuel like petrol diesel, etc. are increase highly and emission of the vehicle create many problems like affecting human health, cause the depletion in ozone layer, affecting the photosynthesis of plants, etc. so reducing the pollution diesel is blended with the n-butanol at various different proportion. In previous research using turpentine oil as a additive for diesel fuel the performance of the compressed ignition engine reduced due to the poor atomization of turpentine fuel due to high density and viscosity. But emission characteristic like HC, CO and NOx emission are reduced due to compete combustion of fuel and low heat release rate of the fuel. The turpentine blende fuel reduce the smoke up to 40 to 45% compare to diesel. Another research adding dimethyl ether (DME) blended with ordinary fuel for reduce to SOx and NOx emission due to low destiny quickly atomization take place ignition delay period is reduced. Another main advantages of DME is low carbon content fuel so reduced CO and CO_2 formation compare to diesel. In these research the adding both turpentine and DME as a blend for the ordinary fuel for getting nearly performance level of diesel and reduced the emission characteristic of the compressed ignition engine. In this research performance and emission effect of different levels like 5%, 10% and 15% volume by fuel blend with non-edible oil turpentine prepared by transesterification process and DME 5% volume of fuel as constant for all the blends. The 10% of turpentine and 5% of DME blend at high load get the optimum blend for the compressed ignition engine.

KEY WORDS: Turpentine, DME, Emission, compressed ignition Engine, Alternative fuel, calorific value.

1. INTRODUCTION

Recently world moving to the fossil fuel to renewable energy due to the constant increase in demand of the fossil fuel like petrol, diesel, LPG, etc. in two to three decades the fully depletion of fossil fuel occur at the time world need alternate fuel for run the vehicle without having any major modification in the current design. The simple modifying in the internal combustion engine received considerable amount of attention among the compressed ignition engine researchers in order to improve the combustion and emission characteristics, and reducing the engine emission from the diesel as a fuel engine. Another major problem is emission of the vehicle due to that some of the environmental issue are rising like human health hazards, greenhouse gas increase, reduction of cultivation of food products, acid rain forming, etc. due to these major problem world need to reduce the usage of fossil fuel adapt the new fuel like biodiesel, alcohol, etc. for diesel direct fuel injection system best alternative was biodiesel and for petrol ignition system alcohol is best alternative. But biodiesel have low calorific value and high auto ignition temperature due to that biodiesel performance is low compare to diesel. So most of the research do their project in bio diesel to attain nearly the diesel performance by changing the injection timing, increasing the compression ratio of the engine, varying the different blend ratio, increasing the intel charge temperature, etc.

In first generation they convert the edible oil like sunflower oil, ground nut oil, coconut oil, etc. to biodiesel to run the direct fuel injection engine due to the scarcity of the food product researcher move to non-edible oil for producing the bio diesel like jatropha, cotton seed oil, neem oil, turpentine oil, etc. due to the auto ignition temperature of biodiesel is high compare to diesel due to that biodiesel is not directly used as a fuel for direct fuel injection system so biodiesel is blend with diesel to overcome the ignition problem. Mostly biodiesel blend represent like B20 means contain 20% biodiesel and remaining 80% diesel.

In Some experimental researcher like Prem Anand and Saravanan (2010), present using of turpentine oil as fuel for the compressed ignition engine the performance of the engine reduced 30 to 40% due to the low calorific value of the turpentine oil so it also increase the specific fuel conceptions of the compressed ignition engine. The turpentine oil also need more time for the atomization of the fuel to this rectify problem advanced the injection time of the engine to give more time for atomization of the fuel. Due to the clean combustion the carbon monoxide, unburned hydrocarbon and oxides of nitrogen are reduced. From Karthikeyan and Mahalakshmi (2007), present using turpentine blend with the diesel which reduce the smoke level up to 40-45% compare to diesel.

Another researcher Myung Yoon Kim and Seung Hyum Yoon (2008), present using the DME as a additives for diesel compression ignition engine the IMEP reduction of ignition delay period so peak cylinder pressure of engine reaches same compare to diesel fuel and also reduce the knocking factor. By adding the DME with Turpentine oil fuel it ratify the atomization problem in turpentine oil so performance of the engine increases and also reduce HC emission further.

The introduction of EGR (exhaust gas recirculation) technique reduces the nitro oxide emission considerably. The various researcher reported that by increasing the injection fuel pressure and advancing the fuel injection timing concluded that there is a noticeable increase in brake thermal efficiency of the engine and decrease in engine emission like CO, HC and smoke intensity of the emissions. The dual fuel or blending of fuel concept was also applied to improve the performance of the engine and to reduce the varying different load condition.

2. METHODLOGY

First taking the acid test for turpentine oil for choosing which process either esterification or transesterification process to converting the non-edible oil into biodiesel. From acid test proof that transesterification is the best process for converting the turpentine oil to biodiesel.

Choosing the bend ratio by considering the previous research 15% of turpentine is optimum blend so make it constant for all blend and vary DME 5% for each blend.

Fuel composition are DF 100% diesel, B15D5 is 15 % turpentine oil fuel and 5% DME, B15D10 is 15% turpentine oil fuel and 10% of DME and B15D15 is 15% turpentine oil fuel and 15% DME Emission test of all four fuel composition was studied in AVL DIGAS 444 for calculating the HC, CO and NOx. Smoke opacity of all four fuel composition are calculated in AVL 437C smoke meter. For present study the test fuels are taken as turpentine oil and Di Methyl Ether. The turpentine oil contain sulfur content up to 0.10 to 0.87PPM. Due to the sulfur content it will corroded the combustion chamber so before using the turpentine oil as a fuel for direct injection compression ignition engine reduce the sulfur content. In this research the sulfur content of the turpentine oil reduce up to 0.004PPM.

3. RESULTS AND DISCUSSION

Performance Analysis: Increasing the Dimethyl ether blending level specific fuel consumption gradually increase shown in the graph (figure.1) due to the low calorific value and low energy content of Dimethyl ether. Calorific value of diesel is nearly two time of Dimethyl ether but calorific value of the turpentine oils is nearly same to diesel so specific fuel consumption increase slightly by adding Dimethyl Ether.

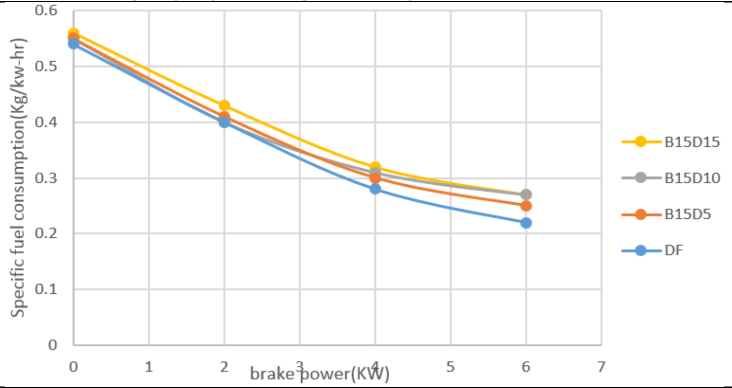

Fig.1. Brake power Vs Specific fuel consumption

Input energy required of the compressed ignition engine to develop the one kilo watt is measured by the specific energy consumption (SEC). SEC is affected by mass flow rate of the fuel and heating value of the combustion fuel. SEC is also gradually increase due to low calorific value of DME it increase the mass flow rate of the flow and low heating value of the turpentine oil fuel as show in graph (figure.2).

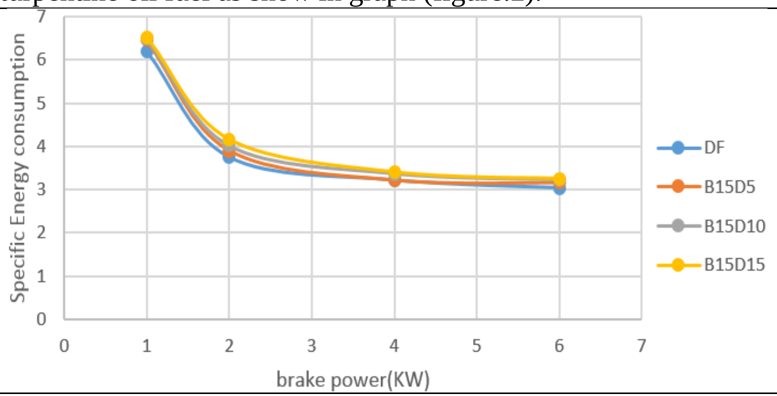

Fig.2. Brake power Vs Specific Energy consumption

Mostly brake thermal efficiency is depend on two factor one is specific gravity value in blending fuel value is higher than diesel and second is heating value in blending fuel value is lower that diesel. So only Brake thermal efficacy of the blending fuel is increased at lower load condition but the load increase the brake thermal efficiency decreased compare to the diesel because reduction of head loss during the low load condition further load increase the energy need to run engine gradually increase due to the low calorific value and energy content mass flow rate of the fuel increase so the break thermal efficiency gradually decrease in higher load condition as show in the graph (figure.3).

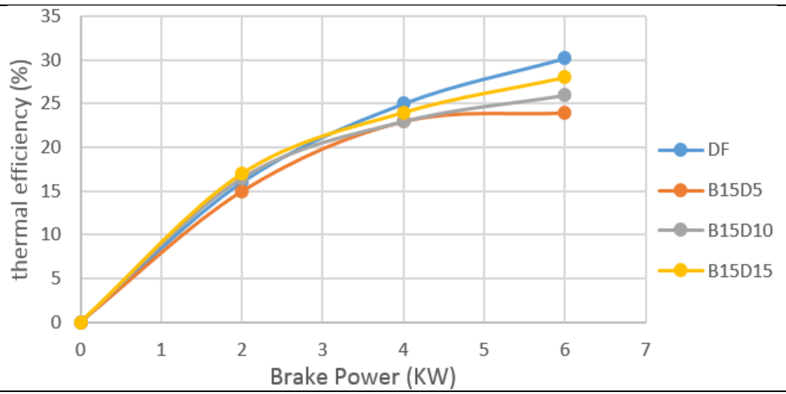

Fig.3. Brake Power Vs Thermal efficiency

From net heat release and crank angle show in the graph (figure.3) the ignition delay period of the diesel fuel taking longer time than the blending fuel so occurrence of knocking is deduced in the blending fuel but peek temperature lower than the diesel due to lower calorific vale of the blending fuel and energy content. Further performance of the engine can be increased by increasing the compression ratio of the engine without affecting the formation knock in the engine.

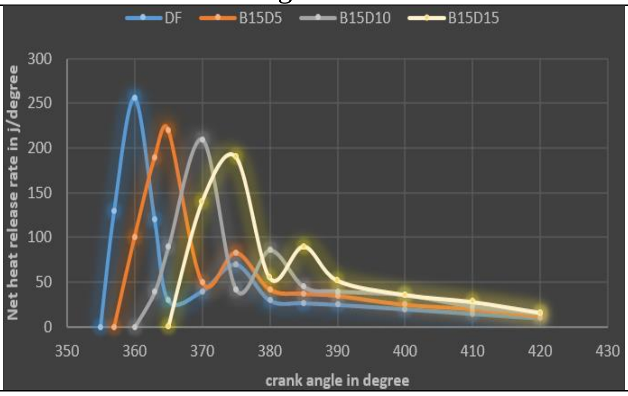

Fig.4. Crank angle Vs Net heat release rate

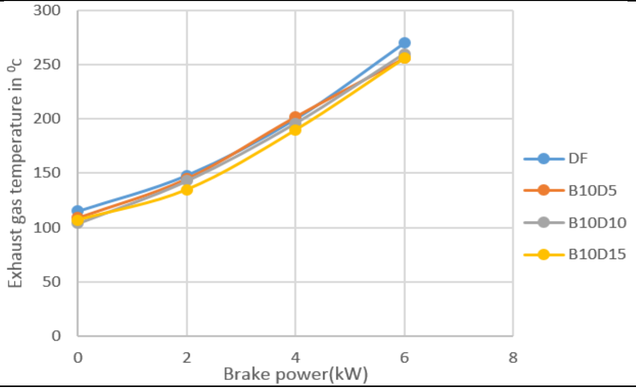

Fig.5. Brake Power Vs Exhaust gas temperature

Unburned hydro carbon is produced due to the incomplete combustion of the fuel. From graph (figure.5) hydrocarbon emission for blending fuels is lower than diesel because the density of the blending fuel is low compare to diesel due to that air and fuel atomized easily so it came more time for combustion to complete. For this reason only hydrocarbon emission decreased with Dimethyl ether proposition in blending fuels.

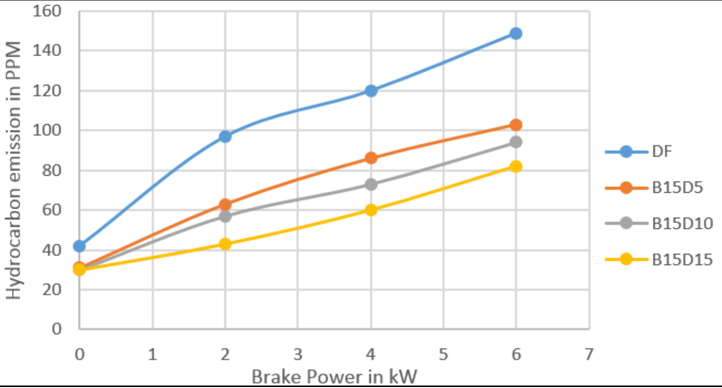

Fig.6. Brake Power Vs Hydrocarbon emission

Carbon monoxide emission formed due to the high carbon content in the fuel and insufficient oxygen supply for the combustion. From the graph (figure.6, 7) show that carbon monoxide for blending fuel is lower compare to the diesel fuel. Both turpentine oil fuel and Dimethyl Ether containing less carbon content compare to diesel and due to the increase in atomization air and fuel are equally distributed to the combustion chamber therefore sufficient amount of oxygen is available for combustion. So it reduce the carbon monoxide emission in blending fuels.

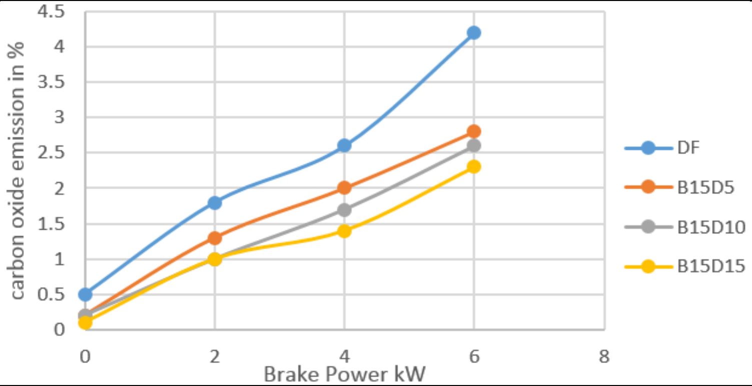

Fig.7. Brake Power Vs carbon oxide emission

Nitrogen Oxide (NOx) is formed due to high combustion chamber nitrogen is combined with oxygen presence in the combustion chamber. If complete combustion take place it increase the nitrogen oxide emission due to high heat energy release so if hydrocarbon and carbon monoxide emission reduces it automatically increase the Nitrogen oxide emission but from the nitrogen oxide emission and brake power as shown in the graph (figure.8) that nitrogen oxide emission for blending fuel is lower compare to the diesel because low calorific value of the blending fuel and also some time turpentine oil fuel as act as a lubrication oil so it reduce the combustion chamber temperature.

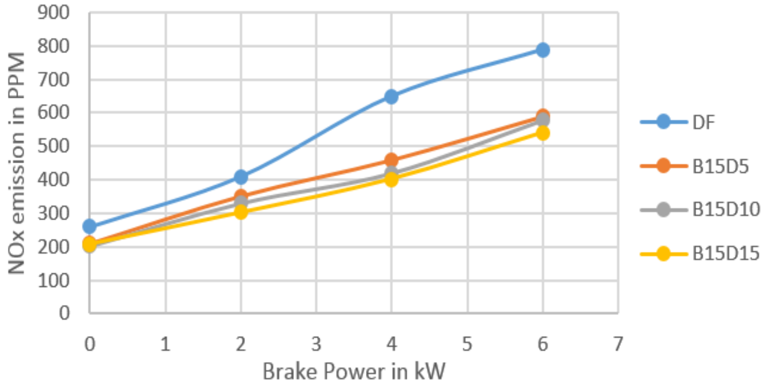

Fig.8. Brake Power Vs NOx emission

Due to the low carbon content and low heating value of the blending fuel smoke density emitted from the engine also reduced compare to diesel fuel. The proposition of the Dimethyl ether blend increase the smoke decrease as shown in the graph (figure.9).

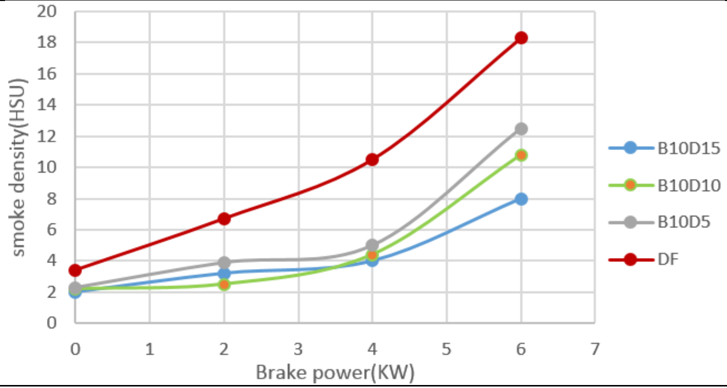

Fig.9. Brake power Vs smoke density

4. CONCLUSION

Blending fuels having the low calorific value especially Dimethyl ether due to that specific fuel consumption increase compare to diesel so it decrease the brake thermal efficiency of the engine.

Specific energy consumption increase due to mass flow rate of the fuel increase and low heading value of the blending fuel Ignition delay period reduced for blending fuel compare to diesel due to atomization of fuel with air timing reduced so knocking factor are eliminated. Hydrocarbon, carbon monoxide, Nitrogen oxide and smoke emission are reduced due the complete combustion of fuel and low calorific value of the blending fuels

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