*International Journal of Research in Advent Technology (IJRAT) Special Issue "*ICADMMES 2018*"*
E-ISSN: 2321-9637
Available online at www.ijrat.org

Effect of Additives To Thurayi Seed Oil On Combustion And Emission In CI Engine With Toroidal Combustion Chamber

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Abstract: In this paper, to achieve better combustion performance and lower engine emissions, different additives are introduced along with the Thurayi biodiesel (DR25) blends with Toroidal combustion chamber configuration. The Direct Injection diesel engine achieved the significant improvement with some of the additives. The experimental investigations show that when the diesel engine is operated with DR25 biodiesel using isopropyl nitrate as additive, there is slight improvement of 1.5% in Brake thermal efficiency and also with further decline in exhaust emissions. Finally, it is concluded that the biodiesel blend DR25 with isopropyl nitrate is regarded as the ideal choice for the operation of Direct Injection diesel engine.

Keywords: Thurayi;Toroidal piston; Additives; Isopropyl; Emissions

1. INTRODUCTION

Fuel additives which are dissolvable in fuel are natural substances. By adding fuel additives in slight amount of specific chemicals, around 25 new beneficial properties of fuels can be improved. These fuel additives are comprised to few 1000 ppm at a level from a few ppm. It is imperious that it improves few properties which do not ruin altered other fuel quality and other properties. Most of these additives can helpful to sustain fuel quality as stabilizers, biocides antioxidants, inhibitors and corrosion [1][2].

The improvement of fuel dispersion into the vehicle tank may cause by others. For example antifoams, pipeline drag reduces, flow improves and demulsifiers. It may be involved for lawful reasons like markers and colors, or engine manufactures may discoursed particular concerns like lubricity improves and deposit control additives. 103 fuel additives are used in diesel, biodiesel and their blends to develop the fuel characteristics [3][4].

The benefits of additives are:

- Removal of catastrophic wear in the CI engine.
- Development of icy flow in central distillates, improving consumption of biofuel [5].
- Stability changes are placed to increase long time storage of fuels.
- Upgraded vehicle recital and budget.
- Lower pumping costs and less power usage in lengthy fuel pipelines [6].
- Removal of corrosion of channel lines and fuel tanks.
- Development in CI octane and cetane parameters.
- Fluid constancy will improve above more kind of circumstances [7].
- Expansion of viscosity number and lessening of the amount of change of viscosity with temperature.
- Noxious emissions will decreases [8].
- Superior ignition by decreasing flash point and delay time etc.

2. LITERATURE SURVEY

In 2015, H. K. Imdadul et al. presented a broad review on the effect of additives on the performance as well as emission characteristics of CI engine [9]. The review on a contrary of that time when the purpose of additives are questioned. A large group of biodiesel manufacturers criticized the effect of additives. This review has touched many aspects of the effect of additives on both performance and emissions was presented. The effect of additives was investigated by applying the additive to pure diesel, biodiesels and more importantly the blends of biodiesel. It was concluded that the performance of CI engine will be improved by the use of additives and also the emission can be controlled.

In 2016, K. Prasada Rao et al. performed experimentation with Mahua biodiesel with Di-Ethyl Ether (DEE) additive [1]. In addition to pure Mahua biodiesel, few blends are prepared. To these blends, the

DI-Ethyl Ether was added at 3%, 5% and 10%. The blend M15 where the 15% of the biodiesel is that of Mahua biodiesel, has produced lower emissions [10].

In 2016, Gangadhara Rao et al. described about the use of additives for improving fuel properties, combustion characteristics, engine performance and emission characteristics [11]. It is found that use of additives improved the biodiesel/diesel properties like viscosity, flash and fire points and pour points etc.

In 2017, Chiranjeeva Rao Seela et al. investigated the effect of zinc oxide (ZnO) nanoparticles suspensions in diesel and Mahua biodiesel blended fuel on single cylinder diesel engine performance characteristics [12]. Experimental tests are performed with neat diesel fuel, biodiesel blends and ZnO added biodiesel blends. The results indicate that ZnO particulate addition yields favorable performance and emission control of the engine. A generalized regression neural network (GRNN) is implemented for foreseeing the concert and emissions of the engine at various working circumstances using the experimental results.

3. EXTRACTION OF THURAYI AND CUBAN ROYAL PALM SEED OILS

The ornamental trees seed such as Thurayi (DelonixRegia) and Cuban Royal Palm oil (RoystoneaRegia) were collected from their fruits. The both seed of raw oil was extracted from their seed through cold press processes. Cold press oil which is used to prepare biodiesel for IC engine is extracted from high fat oil seeds. Due to rising in ecological damage and limited mineral oil resources, these seed oils are using in the technology field. The market is growing in the field of hydraulic oils, lubricants such as chainsaw oil, gear oil and motor oil. Using fossil fuels are replacing with the pure plant oil in the motors. Nowadays most of the people are using this technique because it is tested and recommended. Pure plant oil contains low content of Sulphur and harmless. The production of Carbon monoxide gas is reducing by using cold press plant oil in the place of fossil fuels.

Figure 1 shows the overview of cold pressing process for the production of raw oil. The well dried 100 kg of Thurayi and Cuban Royal Palm seeds separately were taken into the oil expeller. The seeds were crushed by the expeller and separated into raw oil and oil cake. The oil yield for both Thurayi and Cuban Royal Palm is same. The yield of oil is 30 to 35% and remaining is converted into oil cake. The process of change of the triglyceride in the vicinity of catalyst along with some kind of alcohol to form esters of oil and glycerol is known as Transesterification.

In the presence of catalyst vegetable oil is an exposed to chemical reaction with ethanol or methanol then it is reversible and additional methanol is required to minimize the initiation energy. In this chemical reaction the triglyceride which is present in the vegetable oil is converted into biodiesel (alkyl esters). Among the alcohol for the transesterification process butanol, propanol, ethanol and methanol are used. In this way methyl esters are produced from methanol and ethyl esters formed from ethanol.

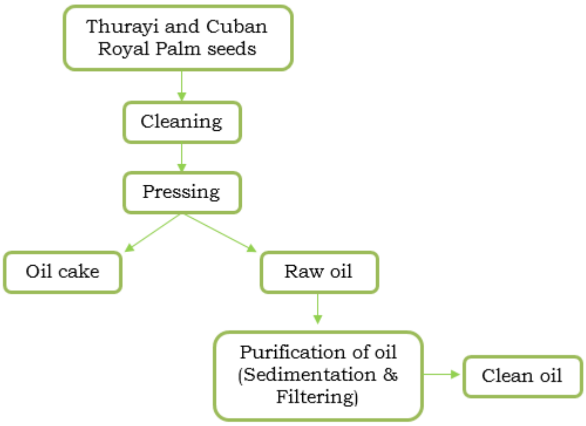

Fig.1 Overview of cold press process

4. EXPERIMENTAL RESULTS

The Figure 2 displays the Brake thermal efficiency variations of DR25 and with its mixtures of various additives throughout the series of the engine. Generallywith increase in load the Brake thermal efficiency is also increases for all the samples. Since the air motion is increased with the piston modification gives rises to well mixing air with fuel and hence greater combustion. As a result it is evident that the brake thermal efficiency has slightly improved by 1.2 % overall and In case of Isopropyl nitrate when compared to DR25 alone nearly 6.5% improvement in Brake Thermal efficiency is attained. It is so because the ignition quality has improved with this additive. At maximum load Brake thermal efficiency for DR25 blend with 2-EHN, Di-Tert-Butyl Peroxide and Isopropyl Nitrate are 28.52, 29, 29.6 and 30.2% respectively.

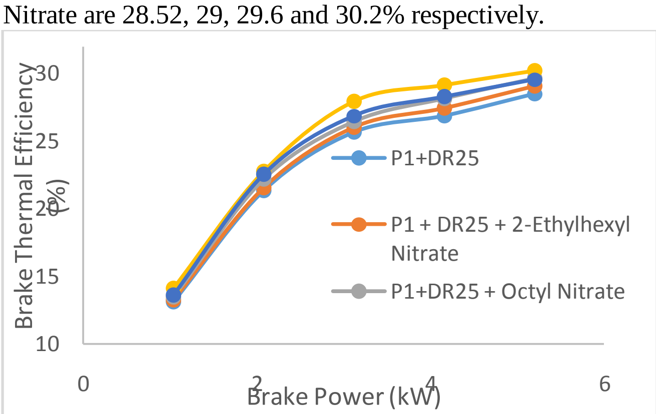

Fig. 2 Brake thermal efficiency

The Figure 3 illustrates the brake specific fuel consumption variation for all the working samples for various loads. Specific Fuel Consumption in general is found to decrease with the incising loads. When compared to the values of Specific Fuel Consumption in Standard Piston with that of the P1 (Toroidal Combustion chamber) we noticed that there is a slight decrease among all the additives. Though the heating value for the biodiesel is less the SFC is decreased because of better combustion.

From the experimented data it is understood that with the additives around 6 % decrease in SFC is attainable.

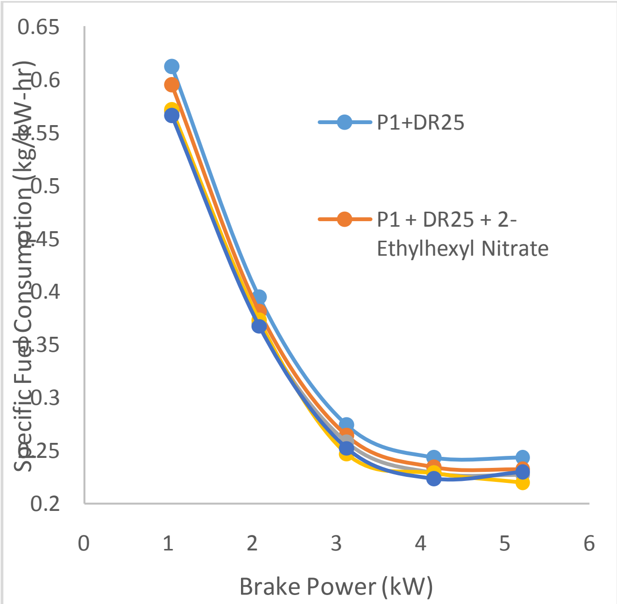

Fig.3 Specific fuel consumption

Fig.4 shows that the Smoke Density with low loads is more and as the load increases smoke levels are decreased however at higher loads for all the test samples again there is a noticeable rise. It is interesting to notice that for certain additives smoke density levels are decreasing compared with that of the same loads for DR25 especially with the Toroidal Piston (P1). At maximum load the values ofsmoke densities for 2-EHN, Di-Tert-Butyl Peroxide and Isopropyl Nitrate are 34.5, 34.85, 31.53 and 28.35 HSU respectively.

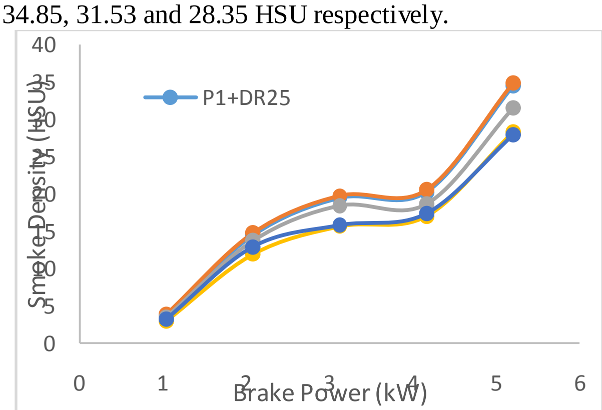

Fig.4 Smoke density

From FIGURE5 it is clear that with increasing load oxides of nitrogen increases. NO_x emissions depends on temperature, local concentration of oxygen and duration of combustion. As we discussed earlier because of sufficient air motion in the cylinder is achieved by the Toroidal Piston mixing is achieved effectively. In addition with additives which provide low ignition temperatures the NO_x emissions are very much reduced. Addition of 2-EHN, Di-Tert-Butyl Peroxide and Isopropyl Nitrate to DR25 in P1 the NO_x levels at maximum loads are 564.3, 576.9, 554.9 and 509.5 PPM respectively which are much lower than that of DR25 without any additive for which its value is 663 PPM.

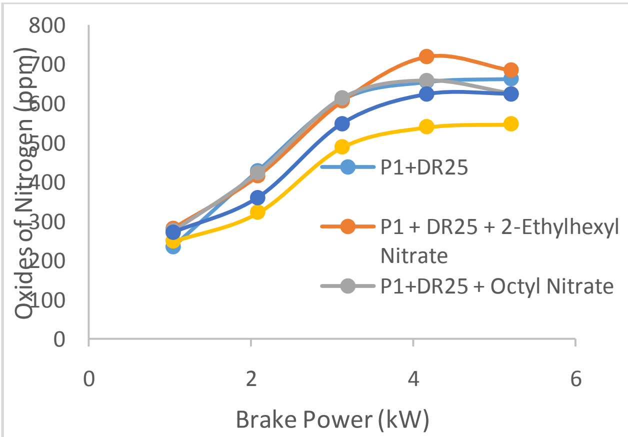

Fig.5 Oxides of Nitrogen emissions

The Figure6 demonstrates the Carbon monoxide emissions variation with increase in load for pure DR25 and all the blends of additives with biodiesel DR25 in P1. For the same air fuel ratio with toroidal piston because of high air motion there is significant reduction in CO emissions with the addition of additives. The experimental values for CO emissions at maximum loads for P1 configuration fuelled by DR25 with additives 2-EHN, Di-Tert-Butyl Peroxide and Isopropyl Nitrate are 0.287, 0.281, 0.261 and 0.271 respectively.

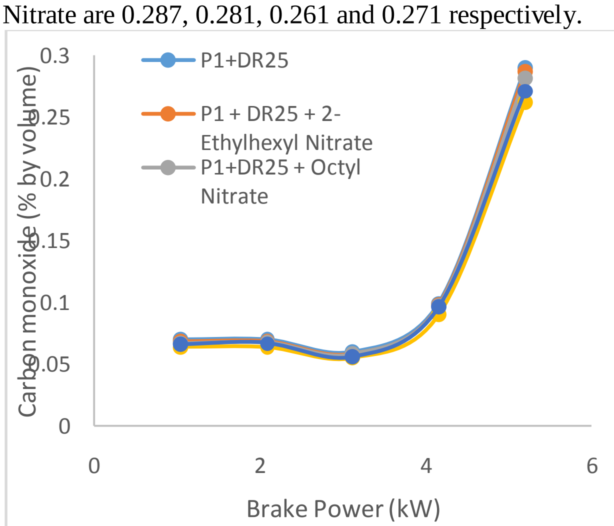

Fig.6 Carbon monoxide emissions

Figure 7 shows Hydrocarbon emissions for P1 configuration fuelled with DR25 and its mixture with different additives. From the graph we can see that HC emissions increases with rise in loads obviously with for all the additives showed significant reduction compared with DR25 alone. At peak loads with Di-Tert-Butyl Peroxide, 2-EHN and Isopropyl Nitrate the HC emissions are 12.89, 12.95, 11.37 and 11.73 PPM. Among all the additives Isopropyl Nitrate shows better HC control compared to DR25 in P1.

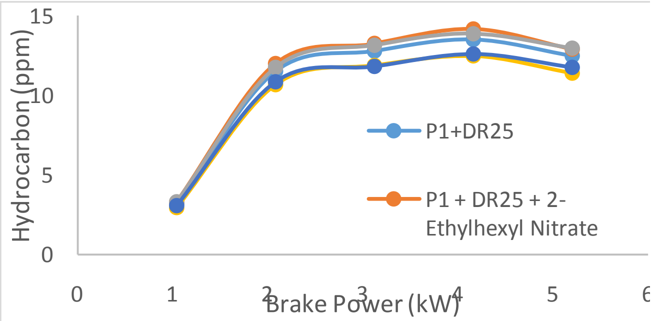

Fig.7 Hydrocarbon emissions

The in-cylinder pressure variation with the four different additives in Thurayi biodiesel blend (DR25) is shown in the Figure 8. For all the additives the pressure variation curve along with the crank angle follows the same trend at the full load condition. It is understood that due to reduction in delay period while Thurayi biodiesel blend with all additives produces lower peak pressures compared to biodiesel alone at full load conditions

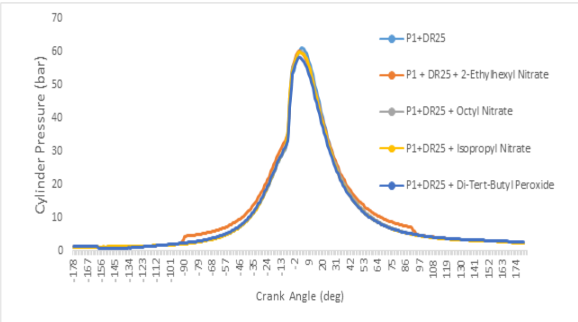

Fig.8 Cylinder pressure

From the FIGURE9 the heat release rate at full load with and without the additives in the Thurayi biodiesel blend injected in to P1 configuration the heat release rate is maximum but shorter duration which is closer to TDC because of the Premixed uncontrolled combustion phase and second peak may also be observed which sustains for quit longer crank angle degrees in the Mixing controlled combustion phase.

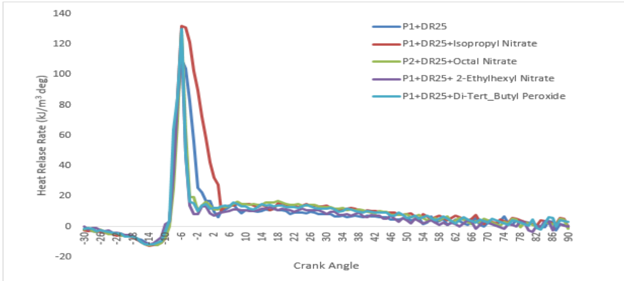

Fig.9 Heat release rate

5. CONCLUSIONS

The effect of additives to Thurayi biodiesel oil in a CI engine with toroidal combustion chamber was considered in this paper. The experimental values of exhaust emissions for the blends of Thurayi with additives showed better quality when compared with no additive case. Thurayi biodiesel bland (DR25) with isopropyl nitrate produced lower values of smoke density, Hydrocarbons, Carbon monoxide and NO_x emissions which were declined by 15.4%, 8.7%, 8.4% and 6.1% respectively when compared with that of the DR25 alone in the same P1 configuration and further there was 1.4% rise in break thermal efficiency for the same at maximum load condition of the DI diesel engine.

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