biodiesel (WPCO) blends on the engine with buttress internal threads. Lower BSFC is desirable because it is the measure of the engine's efficiency indirectly. BSFC and engine efficiency are inversely proportional. In general, BSFC is used rather than the thermal efficiency because more or less perfect definition of thermal efficiency does not exist. It is observed from the graph the brake specific fuel is decreasing for all the blends with increasing the load on the engine. For the blend B20 the decrease in BSFC is very precise at loads of 2 kW and 2.5kW with buttress threads, compared to the normal aspirated engine i.e. with normal inlet manifold as well as with buttress threads. The decrease is about 6.8 % at 2Kw load. This may be due to high swirl generation in the inlet manifold with buttress threads; possibly due to increased temperature and efficiency. And for the blend B10 also has significant decrease compared to the diesel.

5.2 Brake Thermal Efficiency

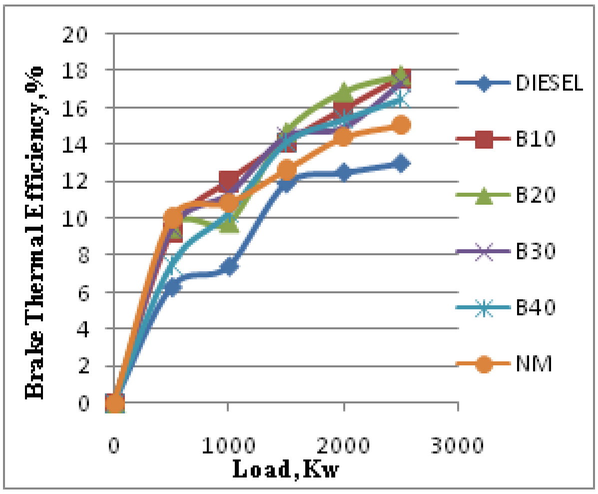

Figure 6: load vs. brake thermal efficiency

Figure 6 shows variation of brake thermal efficiency with different blends of Waste palm Cooking Oil (WPCO) and diesel. The brake thermal efficiency of all the blends is more compared to the diesel with buttress internal threads and normal inlet manifold. Blend B20 gives better performance results at the rated loads of 2 kW and 2.5 kW compared to all the blends. In-cylinder flow field structure is greatly influenced by providing threads in the intake manifold design. Air motion in Compression Ignition engine influences the distribution and atomization of fuel injected into the combustion chamber. With optimal turbulence, better mixing of air and fuel is possible which leads to complete and effective combustion so that thermal efficiency increases. Brake thermal efficiency increases with the load for the reason that as the load increases relatively less portion of power is lost.

5.3 Exhaust Gas Emissions of Carbon Monoxide

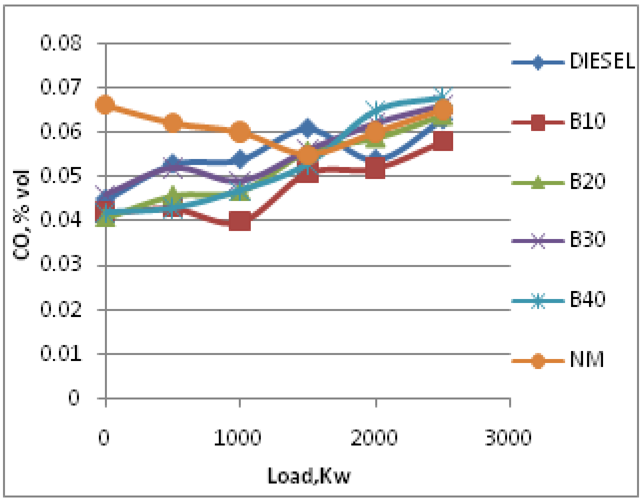

Figure 7: load vs. carbon monoxide

Figure 7 shows the variation of CO emission with engine loading. Carbon monoxide forms during the combustion process. It was observed from the graph that CO emissions are increased with increase in engine load. CO emission of biodiesel is less compared to diesel it is likely due to oxygen content present in the biodiesel is more which helps in more complete and rapid oxidation of fuel. Generally, Compression Ignition engines operate with lean mixtures and hence the CO emission would be low. With the higher swirl of air in the inlet manifolds with internal threads, the oxidation of carbon monoxide in the engine is improved and subsequently reduces the CO emissions. With rich fuel-air mixtures, there is insufficient oxygen to burn fully all the carbon in the fuel to CO_2; also, in high temperature products, even with lean mixtures, dissociation ensures there is a significant CO level. CO emission of all the blends less compare to diesel with normal inlet manifold and buttress threaded inlet manifold. Significantly, blend B10 gives less CO emission compare to all the blends and diesel.

5.4 Exhaust Emissions of Hydro Carbons

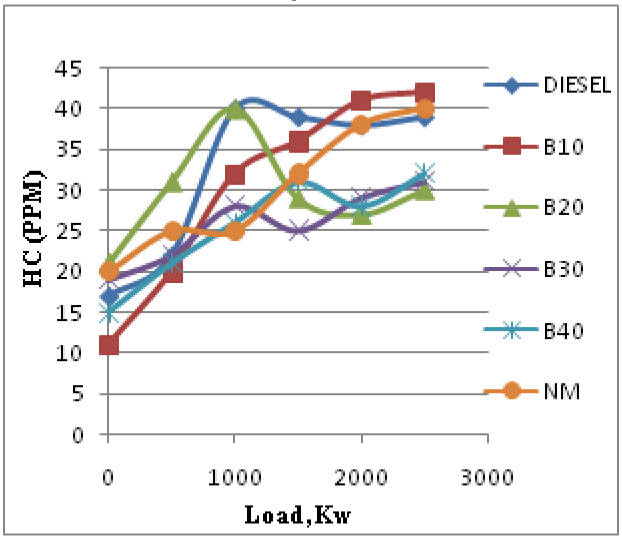

Figure 8: load vs. hydro carbons

Figure 8 variation of HC emission with various loads on normal inlet manifold engine and buttress threaded inlet manifold engine with biodiesel blends. The possible sources of HC emission in an I.C engine is during compression and combustion, the increasing cylinder pressure forces some of the gas in the cylinder into crevices, or narrow volumes connected to the combustion chamber. Most of this gas is unburned fuel-air mixture. As the engine is fitted with manifold of buttress threads, the increasing turbulence causes better mixing of fuel and air so that hydro carbon emission is decreasing. It is apparent that B20 blend gives less hydrocarbon emission at rated load of 2kW and 2.5kW compare to all blends and diesel chamber. Most of this gas is unburned fuel-air mixture. As the engine is fitted with manifold of buttress threads, the increasing turbulence causes better mixing of fuel and air so that hydro carbon emission is decreasing. It is apparent that B20 blend gives less hydrocarbon emission at rated load of 2kW and 2.5kW compare to all blends and diesel.

5.5 Exhaust Emissions of Nitrogen Oxides

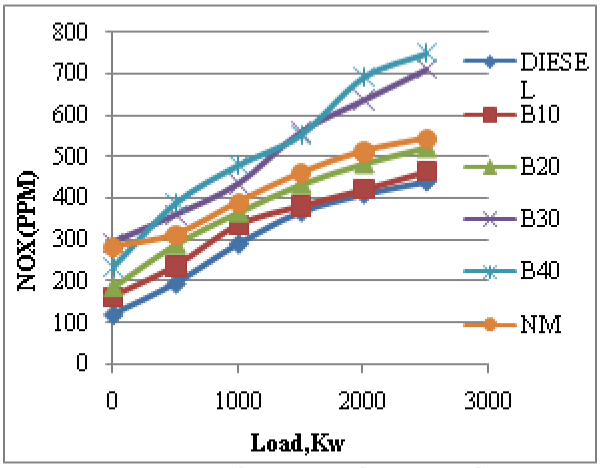

Figure 9: load vs. nitrogen oxides

Fig shows 9 variation of NO_X emission with various loads on normal inlet manifold engine and buttress threaded inlet manifold engine with various biodiesel blends. It is observed that blends B10 and B20 gives less NO_X emission with normal inlet manifold but more for buttress threaded manifold. The NO_X for diesel engine with buttress internal threads is 440ppm and for blends B10 and B20 is 465ppm, 524ppm respectively at 2.5Kw rated load. The increase in NO_X is may be due to higher oxygen content present in the waste palm cooking oil and my be due to less operating temperature in the cylinder by creating more swirl which leads to less NO_X emission at lower blends.

6. Conclusion

Performance and emission characteristics of diesel (C.I) engine with blends of biodiesel of waste palm cooking oil with diesel and buttress threads inside the inlet manifold are compared with the normal inlet manifold in this experimental investigation. From this investigation, it can be concluded that blend B20 gives better performance and emission results compared to the all blends and diesel. The results of this study may be summarized as follows.

- It is observed that reduction of BSFC for engine with buttress internal threads using waste palm cooking oil blends as compared to the engine of buttress internal threads with diesel at all load conditions. It is significant to note that a 6.8% of reduction BSFC for blend B20 with buttress threads against normal inlet manifold at 2Kw load.
- Thermal efficiency is more for all the blends compared to the diesel at all the loads because a better mixing of fuel and air due to the creation of turbulence by inlet manifold.
- The emissions of un-burnt hydrocarbon (HC) for biodiesel with buttress internal threads are less this is because of increased turbulence by creating the swirl. Blends B10 and B20 give lesser emissions at rated loads of 2Kw and 2.5Kw.
- CO emission of biodiesel is less compared to diesel it is likely due to oxygen content present in the biodiesel. Blend B10 gives less CO emission compare to all the blends and diesel.
- It is observed that blends B10 and B20 gives less NO_X emission with normal inlet manifold but more for buttress threaded manifold.

7. Scope of Future Work

The present work can be extended by varying the pitch, width and depth of the buttress threads in the inlet manifold. The engine can be tested for better performance with the buttress threaded manifold for various alternative fuels also.

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