

## APPLICATION OF BIODIESEL ON A CONVENTIONAL DIESEL ENGINE; EXPERIMENTAL INVESTIGATION OF OPERATING CHARACTERISTICS

R.P.Y.M. Rajapaksha, J.D.R. Chandrarathne, U.P.S. Sirisena and N.K.B.M.P. Nanayakkara

*Department of Production Engineering, Faculty of Engineering, University of Peradeniya*

### Introduction

Biodiesel, by the name, is a clean burning alternative for diesel which is distilled from renewable sources such as vegetable oils, animal fats and waste bio products. However, pure biodiesel is not recommended for conventional engines due to number of operational deficiencies. Therefore, biodiesels are generally mixed with petroleum diesel at predetermined percentages (B factor) to create a "biodiesel blend".

In previous studies [Schumacher *et al*, 1996; Schumacher and VanGerpen, 1998] standard performance characteristics with various B factors were obtained. In another study, a significant emphasis was given to investigate the emission levels [Schumacher and Tabitha, 1996].

In our research waste cooking oil was used in manufacturing bio diesel. It was decided to explore the possibilities to introduce biodiesel in a hand tractor to compare the performance as well as the emission levels with pure diesel.

### Materials and Methods

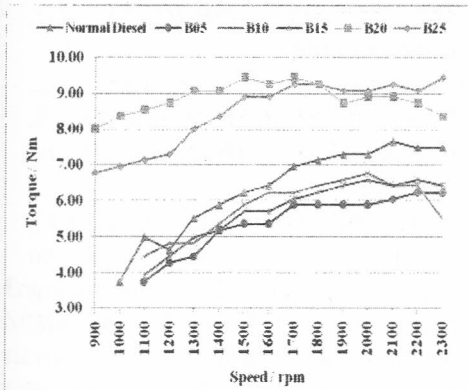
Different blends of biodiesel and petro diesel were tested in a conventional 2 cylinder Kubota tractor engine (Model TD 1700, 375CC). Biodiesel for this

research was manufactured at the Institute of Chemistry Ceylon and chemically proven that it is with reasonable substitute for petro diesel.

This research was mainly concentrated on investigating engine performance to determine the optimum blend ratios for overall engine operation. Observed performances indices include the variations of speed versus torque, speed versus power and the environmental factors through emission levels of NO<sub>x</sub>, CO<sub>2</sub>, CO and SO<sub>2</sub>. The speed-torque, speed-power characteristics were recorded using a dynamometer (FROUDE hydraulic dynamometer) for different blends. Flue gas analyzer (KM 9106, Kane May QUINTOX) was used to measure emission levels.

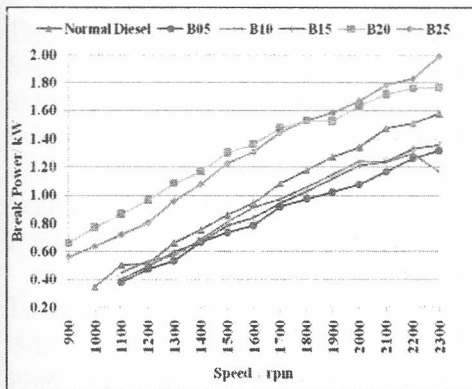
### Results

As shown in the Fig. 1, it was observed that the variation of torque increases gradually with the speed up to around 2000 rpm and then decrease with the further increase in speed. With all the speeds, the torque for B20 and B25 was greater than the normal diesel and for lower B ratios the torque speed performance was generally lower than the normal diesel. The maximum torque has been achieved around 2300 rpm.



**Fig. 1. Torque-Speed Characteristics for Biodiesel Blends**

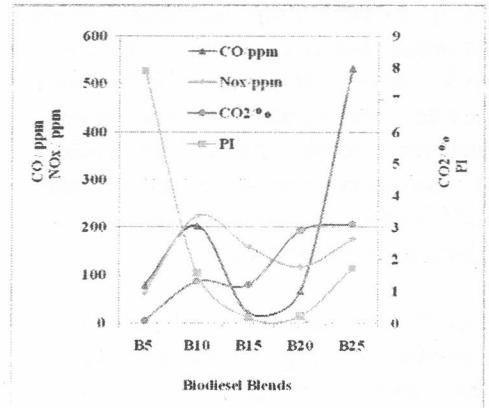
Power-speed characteristics for different blend ratios (Fig. 2) were analyzed and Break Horse Power of the B20 and B25 combinations was greater than normal diesel and B05, B10, B15 combinations showed inferior performance compared with normal diesel.



**Fig. 2. Power-Speed Characteristics for Biodiesel Blends**

The critical emissions were analyzed (Fig. 3) and it was seen that PI (Position Index, CO/CO<sub>2</sub> ratio x 100) goes down gradually until B20 and it started to increase beyond B20. It was evident that B20 has considerably lower PI and NOx. However, B15 is

also at reasonable levels comparable with B20 with these emissions.



**Fig. 3. Emission Test Results for Biodiesel Blends**

### Discussion

It was shown that B20 and B25 displayed better performance to petro diesel in terms of power and torque characteristics. B25 even better than B20 in high engine speeds beyond 1800 rpm. When the results were related with the emission levels, it was clearly seen that B20 gives considerably lower emissions than B25 especially, CO<sub>2</sub> levels.

In a previous study [Li *et al*, 2006] which was carried out with three biodiesel blends (B20, B50 and B100) derived from soya beans, it has found that B20 performed better in terms of fuel efficiency and NOx emissions. In our study, the B ratios tested were much closer to each other and consistent and finally, our overall recommendation on B ratio is in line with the above literature [Li *et al*, 2006]. Results in another research on engine testing [Mikkelsen *et al*, 2005] which was very similar to ours in terms of the testing material and the engine type, but experimented only

B20 and B100, in which it was found that B20 is better than B100. In that particular work [Mikkelsen *et al*, 2005], exhaust emission levels were not tested, but can be coupled with our work where B15 and B20 both showed reasonable emission levels. Therefore, combining with the results on emission levels in our work, justifies the fact that B20 is a better substitution for petro diesel.

In another research on biodiesel which is produced using rice bran oil [Ryu, 2004] and tested for B20, B30, B50 and B100 have found that the torque and power characteristics slightly increased when B20 was used when compared to other B ratios they have tested and confirmed our findings in current study.

### Conclusion

It was proven that a normal diesel engine can be run with comparatively better performance using biodiesel produced from waste cooking oil. The overall suitability considering the performance analysis with torque and the power with vary, blend B20 was proven to have better performance. This was further supported with emission levels, especially with PI and NOx levels. Finally, the results were proven inline with previous researches on different bio diesel products in a more justifiable manner.

### References

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