ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 4, July 2013

Review on Effect of Varying Compression Ratio on Performance & Emissions of Diesel Engine fueled with Bio-diesel

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Abstract*— Biodiesel have proven to be most promising of various alternate fuels used in diesel engine to reduced exhaust emissions maintaining the performance characteristics. The emission & performance characteristics are also affected by various working parameters like compression ratio, injection pressure and injection timing. Present paper deals with effect of variation in compression ratio on engine performance and emission. Paper deals with effects on engine fueled with diesel, blend of diesel with biodiesel and purely on biodiesel with a view to provide a platform for comparison of the parameter on various fuels. Effect on Brake Specific Fuel Consumption, Brake Thermal Efficiency, Smoke opacity, CO emissions and Exhaust Temperature have been studied and presented.

***Index Terms*—B20, B100, brake specific fuel consumption, Brake thermal efficiency, CO emissions, Exhaust gas temperature, smoke opacity .**

I. INTRODUCTION

Increasing concern for environmental pollution along with maintaining performance of diesel engines has led to extensive research in domain of fuel. Among various options investigated for diesel fuel, biodiesels have proven to be most suitable for diesel engines. Various research works have proved that performance of biodiesel is nearly similar to diesel engines with fewer emissions. Further, engine parameters such as Compression Ratio, Injection Timing & Injection Pressure are also found to be significant factors contributing on performance and exhaust emissions of diesel engine, fueled with biodiesel. Present paper focuses on effect of one parameter viz. Compression Ratio. Study of effect of CR on engine performance and emissions have been carried out number of researchers. The paper provides a platform for comparison of effect of varying CR on performance of engine fueled by (a) 100% diesel [2] (b) Blend of diesel & Biodiesel [3] (c) 100% Biodiesel [4]. The paper deals with results of varying CR on Brake Specific Fuel Consumption (BSFC), Brake Thermal Efficiency (BTE), Smoke Opacity and Carbon Monoxide Emissions, obtained after vigorous study of various research papers.

II. TEST CONDITIONS

Test conditions for the specified three fuels are as follows:

A. 100% Diesel [2]

Injection pressure 203 bars, injection 23^0 BTDC, Speed constant 1500 rpm, CR varied from 15 to 19

B. Blend of Diesel and Biodiesel [3]

Blend of 80% diesel and 20% Methyl Ester of Thevetia Peruviana Seed Oil (Referred further as B20), Injection Pressure 210 bar, Injection 37.5^0 BTDC, speed 1500 rpm, CR range 20.6, 19.2, 18.1, 17, 16, 15.3, 14.5. (Referred further in paper as B20)

C. 100% Biodiesel [4]

Biodiesel-Methyl Ester of Jatropha oil, Injection pressure 200 bar, Injection timing 23^0 BTDC, speed 1500 rpm, Compression ratio varied from 16-18. (Referred further in paper as B100)

III. EFFECT ON BRAKE SPECIFIC FUEL CONSUMPTION (BSFC)

The result of effect on BSFC for all three cases is represented in following graphs: For 100% diesel, fuel consumption was minimum at CR 17. At higher values and lower values, consumption increased. The reason

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attributed is charge dilution at higher values and incomplete combustion at lower values. (Shown in Figure 1)
For B20 blend, increase in CR decreased BSFC, lowest observed at CR 20.6. However it was higher than 100% diesel, reason being lower calorific value of biodiesel. (Shown in Figure 2)
For B100, lowest BSFC was observed at CR-18. However, similar to B20 it was higher than diesel owing to lower calorific value of biodiesel. (Shown in Figure 3)

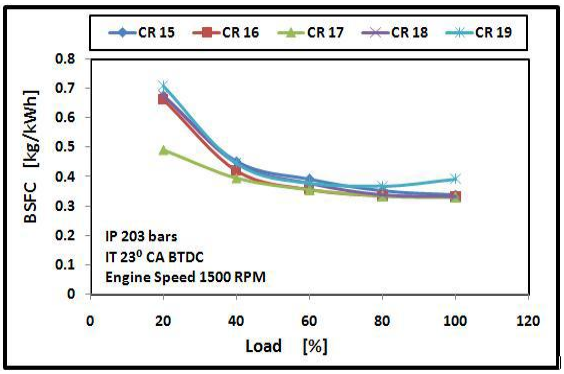

Fig 1: Effect on BSFC for 100% diesel [2]

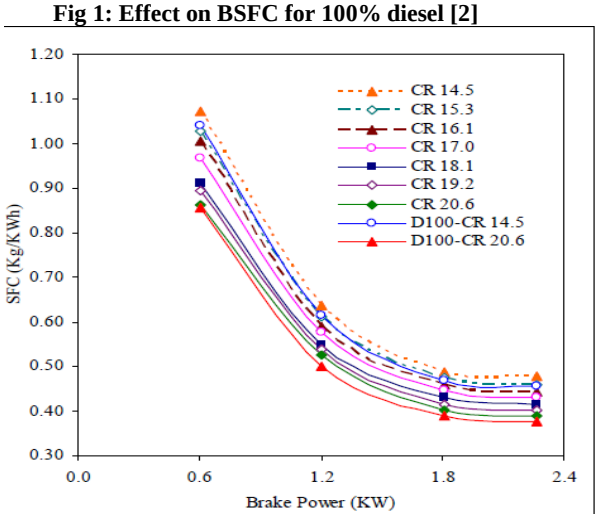

Fig 2: Effect on BSFC for B20 [3]

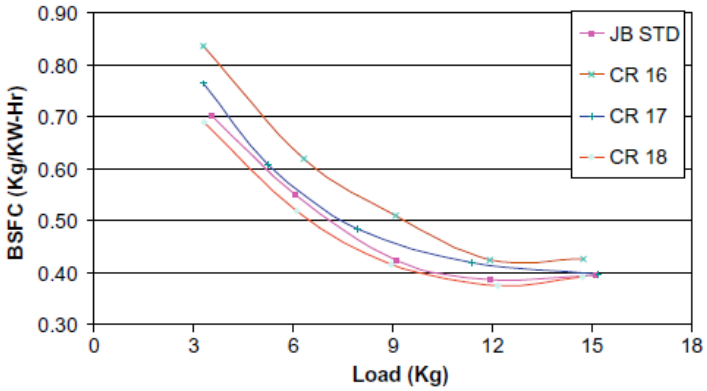

Fig 3: Effect on BSFC for B100 [4]

IV. Effect on Brake Thermal Efficiency

Lower the BSFC, higher is BTE. The same can be observed in following graphs. For 100% diesel highest BTE was observed for CR 17(Figure 4), in case on B20 highest was at CR 20.6 (Figure 5) and for B100, CR 18 gave highest BTE (Figure 6). BTE increases as load increases for all cases due to less losses and better combustion.

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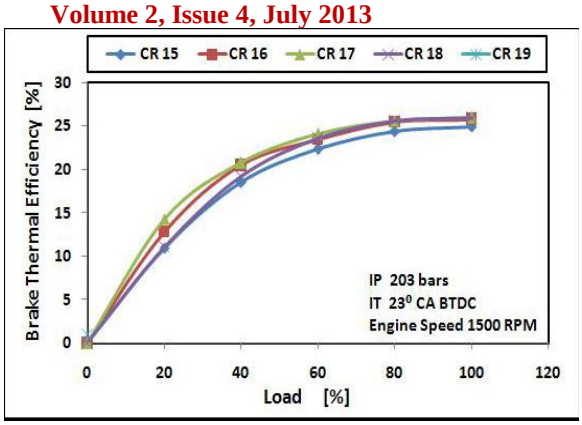

Fig 4: Effect on BTE for 100% diesel [2]

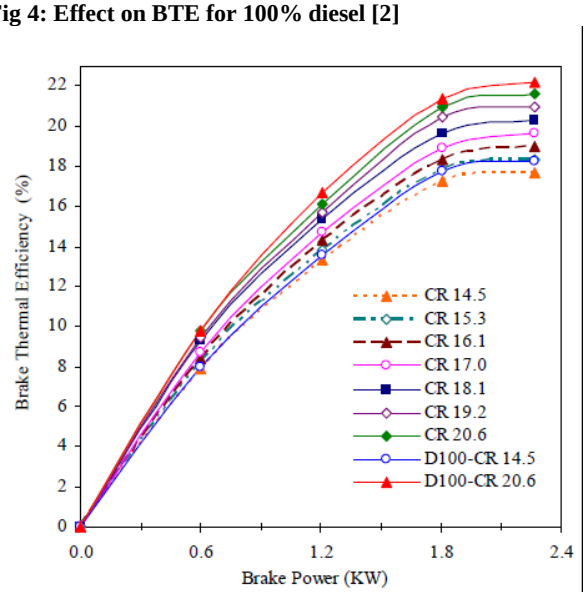

Fig 5: Effect on BTE for B20 [3]

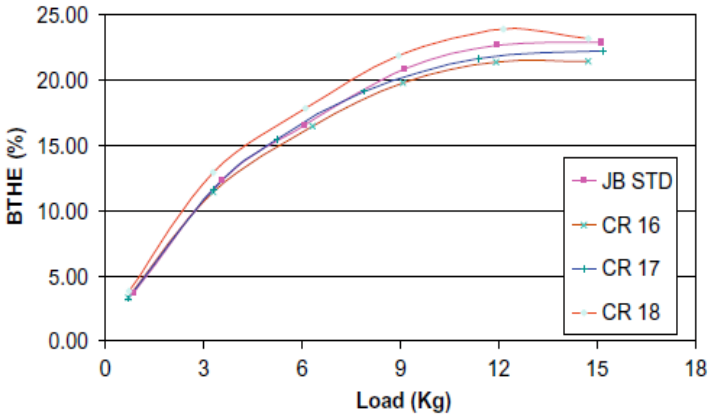

Fig 6: Effect on BTE for B100 [4]

V. SPOKE OPACITY AND CO EMISSIONS

Following graphs represent effect of change in CR on smoke emitted and carbon monoxide emission. Both emissions are result of incomplete combustion of fuel. Hence the results also show same behavioral pattern.When running on 100% diesel, both emissions were least at CR 17. At lower values and higher values, smoke increased. The reason being incomplete combustion at lower values due to less temperature of air and at higher values, more fuel consumption and hence incomplete combustion. (Figure 7 & figure 8)

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For B20 and B100 emissions decreased as CR was increased. The reason attributed is better oxidation environment and higher pressure and temperature at higher compression ratio. (Figure 9 to Figure 12)

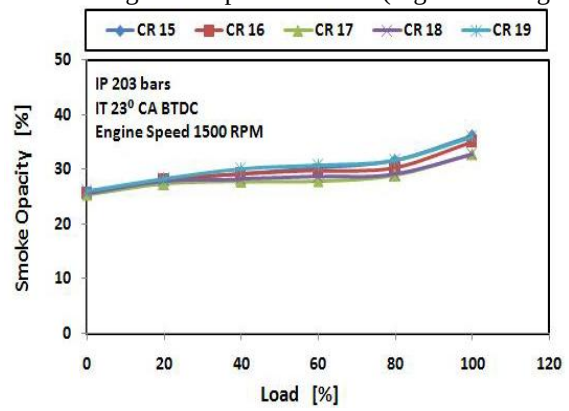

Fig 7: Effect on Smoke opacity for 100% diesel [2]

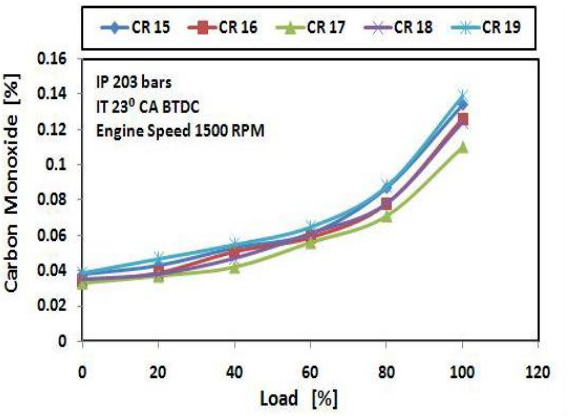

Fig 8: Effect on CO emissions for 100% diesel [2]

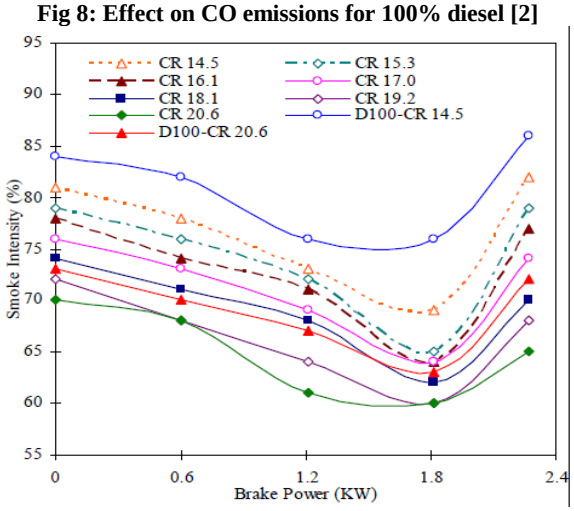

Fig 9: Effect on Smoke opacity for B20 [3]

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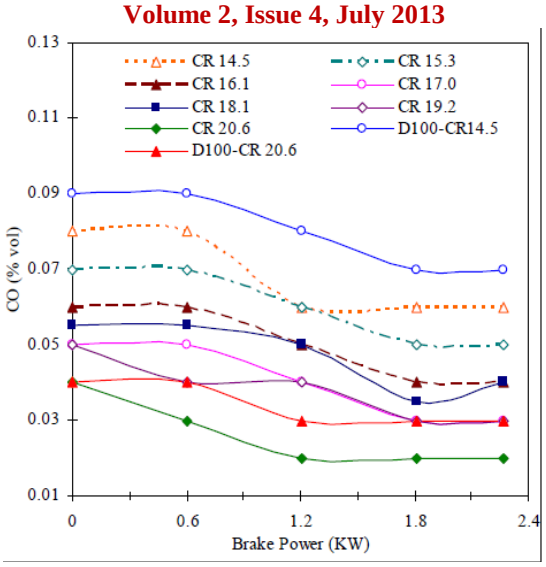

Fig 10: Effect on CO emissions for B20 [3]

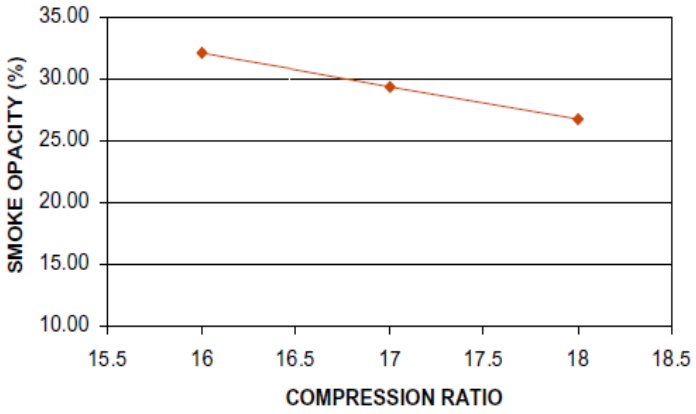

Fig 11: Effect on Smoke opacity for 100% Biodiesel [4]

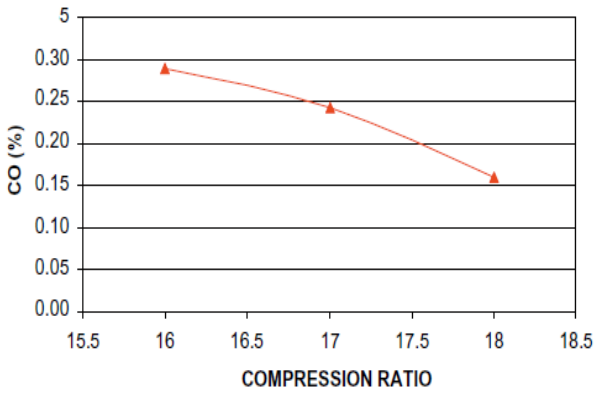

Fig 12: Effect on CO emissions for 100% Biodiesel [4]

VI. EXHAUST GAS TEMPERATURE

Exhaust Gas Temperature is an indication of effectiveness of utilization of heat energy produced by combustion of fuel. However, with increase in compression ratio, exhaust gas temperature was observed to increase for diesel (Figure 13) and B100 (Figure 14). The temperature was seen to decrease for B20 blend (Figure 15). The reason for

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this may be that with increase in compression ratio, combustion process shifts towards earlier stroke of cycle and hence more effective utilization of heat is obtained. The results are represented in following graphs:

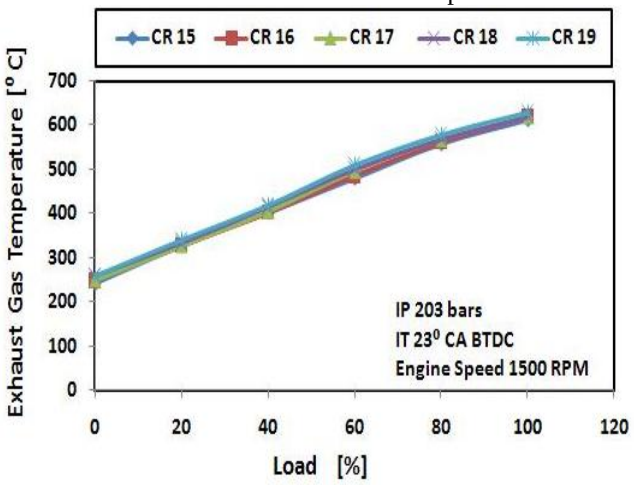

Fig 13: Effect on Exhaust Gas Temperature on 100% Diesel [2]

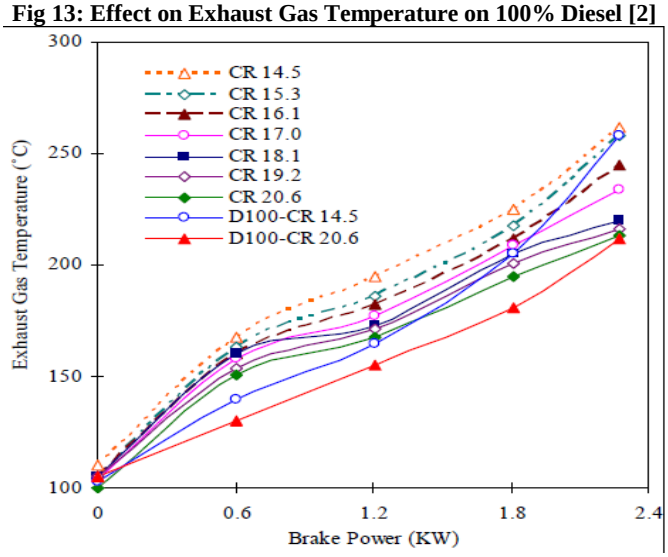

Fig 14: Effect on Exhaust Gas Temperature on B20 [3]

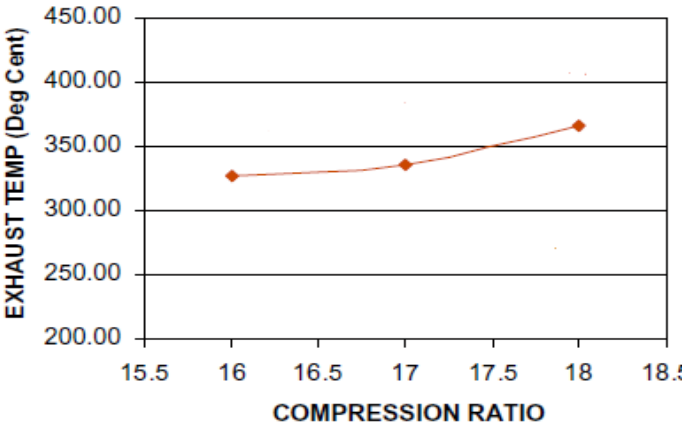

Fig 15: Effect on Exhaust Gas Temperature on B100 [4]

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VII. CONCLUSION

Varying compression ratio follows almost similar results on engine running with diesel, blend of diesel and biodiesel & biodiesel. Increasing compression ratio until certain limits increases brake thermal efficiency decreasing brake specific fuel consumption & smoke-CO emissions. However, the results can vary with change in other parameters like injection pressure and injection timings also. Exhaust gas temperature increases with increase in compression ratio.

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