COMPARATIVE AND PARAMETRIC STUDY OF EFFECT OF EXHAUST GAS RECIRCULATION ON DIESEL AND BIODIESEL

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Abstract

With the enormous increase in number of automobiles, there has been a major demand of alternative sources of fuel and reduction in exhaust emission. One of the novel solution for both is use of biodiesel. Also one of the methods that attracted the researchers to lower down emissions is use of exhaust gas recirculation method. This method is used in many commercial vehicles also.

In the present work a Jatropha Biodiesel (20% v/v) has been used to study the effect of hot exhaust gas recirculation (EGR) method on bsfc and exhaust gas temperature. Various percentages of EGR has been used and optimum EGR percentage was determined that results in least bsfc and exhaust gas temperature. Also a comparative study of effect of EGR has been made on diesel and biodiesel. For the present study an appropriate Test setup with single cylinder diesel engine and hot EGR equipment was made.

I. INTRODUCTION

With the increase in dependence on automobiles around the world, problems like scarcity of petroleum fuels and exhaust emissions are getting more severe. To overcome these problems it is required to enhance fuel properties or use equipment along with the diesel engine to reduce emissions.[1]

Biodiesel is one such solution that reduces the dependence on petroleum fuel on to some extent. Also the motivation by the government policies to use biodiesel has led to researches and manufacturers getting inclined towards making newer and better biodiesels. But at the same time it is necessary to know that how does these biodiesels react with the methods of reducing exhaust emissions. [2]

Exhaust Gas Recirculation (EGR) is an effective method for emission control. The exhaust gases mainly consist of inert carbon dioxide, nitrogen and possess high specific heat. When recirculated to engine inlet, it can reduce oxygen concentration and act as a heat sink. This process reduces oxygen concentration and peak combustion temperature, which results in reduced NOx, Sox and other gases.[3]

Saleh H E [2] used Jojoba methyl ester (JME) as a renewable fuel in numerous studies evaluating its potential use in diesel engines. These studies showed that this fuel is good gas oil substitute but an increase in the nitrogenous oxides emissions was observed at all operating conditions. The comparison of diesel and JME biodesel was made on exhaust emission when EGR technique is used to reduce down emissions. Pradeep and Sharma [3] carried out an experimental work in this field. They have concluded that diesel engines running on JBD are found to emit higher oxides of nitrogen, NOx. HOT EGR, a low cost technique of Exhaust Gas Recirculation, is effectively used in this work to overcome this environmental penalty. NO emissions were reduced when the engine was operated under HOT EGR levels of 5-25 %. However, EGR level was optimized as 15% based on adequate reduction in no missions, minimum possible smoke, CO, HC emissions and reasonable brake thermal efficiency. Abd-Alla [4] G H, reviewed the potential of Exhaust Gas Recirculation (EGR) to reduce the exhaust emissions, particularly NOx emissions, and to delimit the application range of this technique. A detailed analysis of previous and current results of EGR e_ects on the

emissions and performance of Diesel engines, spark ignition engines and duel fuel engines is introduced. From the deep analysis, it was found that adding EGR to the air ow rate to the Diesel engine, rather than displacing some of the inlet air, appears to be a more bene_cial way of utilizing EGR in Diesel
engines. Zheng et al.[5] worked on this topic. According to their work, Exhaust Gas Recirculation (EGR) is effective to reduce nitrogen oxides (NOx) from Diesel engines because it lowers the flame temperature and the oxygen concentration of the working fluid in the combustion chamber. However, as NOx reduces, particulate matter (PM) increases, resulting from the lowered oxygen concentration. Hebbar and Bhat[6] give insight into the effect of EGR level on the development of gaseous emissions as well as mechanisms of its formation. Reductions in NOx amount are found to be remarkable with EGR but combustion quality deteriorates at higher loads and higher percentages of EGR due to a significant decrease of A/F ratio.

II. EXPERIMENTAL SETUP AND METHODOLOGY

The primary point of the experimentation is to figure out practicality of Exhaust Gas Recirculation (EGR) utilizing biodiesel as a halfway substitute of diesel oil in C.I motor to minimize NOx development. The test work under this task comprises of two sections, first to test normal diesel on various parameters by using different loads on various EGR percentages. And secondly the same paramenters to be tested with Jatropha biodesel.

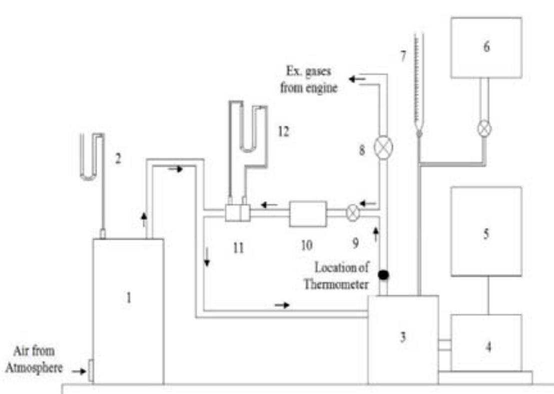

Figure 1 Schematic Line diagram Experimental Setup

(1) Air box with orifice, (2) Manometer for air flow measurement, (3) Engine, (4) A.C. Alternator, (5) Load bank, (6) Fuel tank, (7) Burette, (8) Flow control valve, (9) EGR valve, (10) Filter, (11) Orifice, (12) Manometer for measurement of recirculated gas flow

A solitary chamber 4 - stroke air-cooled diesel motor (4) creating 5.5 kW at 1500 rpm was utilized for test work. The schematic outline of the test set up is appeared in Figure 1. An electrical dynamometer (4) was utilized for stacking the motor. A manometer (2) with water as manometric liquid, associated with a vast tank (1) of 0.2 m^3 which is 275 times the cleared volume of the motor, was connected to the motor to make wind current estimation. Wind current was measured with the assistance of weight contrast created by a round, sharp edge hole of 32 mm width. The fuel stream was measured on a volumetric premise utilizing a 50 ml limit burette (7) and stopwatch. Thermometer with dial marker (reach 0^oC to 600^oC) was utilized for measuring the fumes gas temperature. An electrical burden bank (5) is readied utilizing globules of 200 watts and 100 watts limit. Electrical associations product made in a manner that 20% burden interim can be accomplished for whole load range. For distribution of fumes gasses, fumes control valve (8) and EGR valve (9) are utilized. Recycled gasses go through a channel (10). Stream of recycled gasses measured with the assistance of opening (11) associated with a manometer (12) with water as manometric liquid.

Figure 2 Actual Experimental Setup

For the experimentation, the load is varied from 0 to 80% at an interval of 20%. The EGR volume percentages are taken as 0, 5, 10 and 15. The biodiesel used is Jatropha Biodiesel with a 20%

blend. For each experiment the value of break specific fuel consumption (bsfc) and the exhaust gas temperature is measured. The valves are calibrated and marked to ensure that the required amount of exhaust gas is recirculated inside the engine. For a cross check the orifice meter readings are taken which were inline with the required percentage of exhaust gas recirculated. To insure the repeatability of the experiments, testing of the engine was done as per the Indian standard (IS: 10000 Part IV), which lays down the guidelines for declaring power, efficiency and fuel consumption and specifies relevant correction factors which are required for adjusting the observed readings to the standard reference conditions, as specified in IS: 10000 (Part II).[7] The experiments were conducted three times to increase the confidence level.

III. RESULTS AND DISCUSSIONS

Figure 3 represents the results of variation in temperature of exhaust for various EGR levels with respect to different load conditions when normal diesel is used. It can be inferred from the figure that all EGR levels the temperature of exhaust has reduced. Also among various EGR levels 5% EGR gives minimum exhaust temperature over almost all load conditions. However at 80% load condition 10 % EGR is more effective in reducing exhaust temperature. In general a reduction in 20-30 degrees is seen at all loads when 5% EGR is compared with 0% EGR. At 80% load 13 percent reduction in temperature is observed with 10 percent EGR as compared to no EGR.

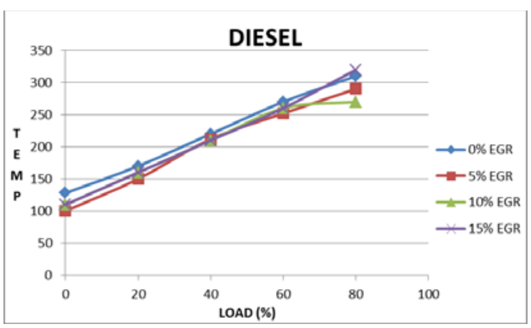

Figure 3 : Variation of temperature for normal Diesel at different EGR levels.

Figure 4 represents the results of variation of bsfc for various EGR levels with respect to different load conditions when normal diesel is used. The result shows that bsfc has increased nominally in all EGR levels with respect to 0% EGR, except for 5% EGR level. The maximum reduction in bsfc is 7.19 percent with use of 5 % EGR as compared with no EGR. Rest for all the EGR there is an increment in bsfc with 15% EGR being the maximum.

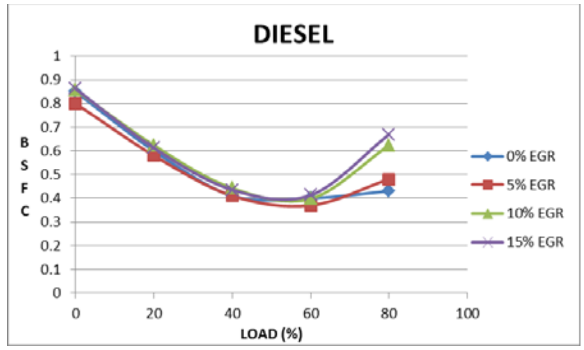

Figure 4 : Variation of bsfc for normal Diesel at different EGR levels.

So from the above graphs use of 5% EGR with normal diesel proves to be the best option in the current diesel engine.

For the biodiesel, there is a shift in trend of results. Here in figure 5, it can be seen that the temperature of the exhaust is minimum in case of 10% EGR. The maximum drop in temperature is observed to be 40 degrees with 10% EGR at 80 % loading of engine when compared with no EGR condition. The variation in temperature between 5% and 10 % EGR is not much. It can be seen that as in figure 3, here also at all the EGR's the temperature of exhaust is less than the temperature when no EGR is used.

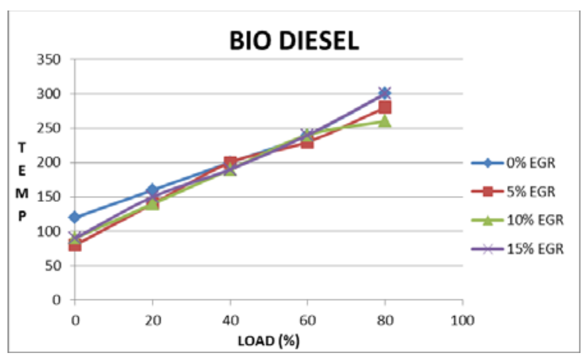

Figure 5 : Variation of temperature for bio-Diesel at different EGR levels.

It can be observed in figure 6 that bsfc has increased in all the EGR levels as compared to no EGR. But the bsfc for 5% and 10% EGR levels is almost same. There is a maximum increase of 13.5 % in bsfc for 5 % and 10 % EGR increase of as compared with no EGR. And an average increase of 7.53% as compared with no EGR.

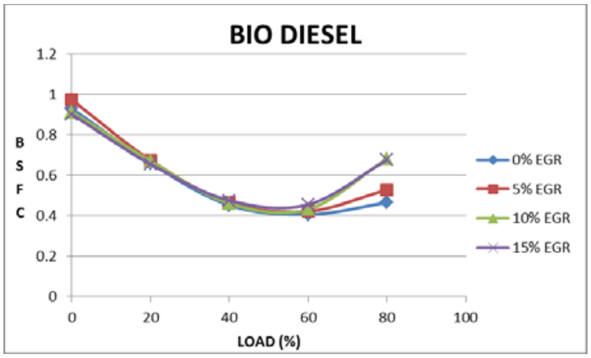

Figure 6 : Variation of bsfc for bio-Diesel at different EGR levels.

The probable reason for reduction in temperature with EGR is due to reduction in oxygen content at the time of combustion of fuel. And the probable reason for increase in bsfc can be improper combustion of fuel inside the engine.

IV. Conclusion

It is observed that there is a significant temperature drop in the exhaust temperature with EGR. A further 10 % temperature drop is observed in case of biodiesel and 5% EGR when compared with normal diesel. And the use of biodiesel doesn't have a significant impact of increase in bsfc. So it can be concluded that Jatropha Biodiesel are beneficial in reducing the exhaust temperature which in-turn will reduce NOx and SOx emissions, without much increase in bsfc.

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