EXPERIMENTAL RESEARCH INTO THE EXHAUST GAS RECIRCULATION ON COMBUSTION CHARACTERISTICS OF DI DIESEL ENGINE ADOPTING DIFFERENT AIR FILTERS

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ABSTRACT: The exhaust gas recirculation technique has proven a better solution to reduce NOx emission in diesel engines. EGR method is taken for the study to investigate the engine behavior on its combustion. In this paper the combustion characteristics such as heat release rate (HRR), cylinder pressures are presented and discussed. The discussion is presented and supported by experimental results. In the experimentation variation in EGR percentage for different air filters is selected for the study. The engine is run by adopting one type of filter at once at different loads for different percentages of EGR such as 5%, 10% and 15%.

***Key words**: Diesel engine, Air filters, Combustion Characteristics, EGR.*

1. INTRODUCTION

The air filter separation efficiency was studied for particle size of 50 and 100µm, it was found to be 94.4%. The study was made with both experimental and simulation methods. Pressure drop in the analysis was well matched with experimental results [1]. The air filters are used in automotive cabin and engine are investigated for their standards and filtration behaviors. The actual air filter performance and their definitions are related to the real time conditions. In the investigation relation between primary function of the air filter and defined one are analyze and the changes for the recommended [2]. The air filter design is critical because of the factors like limited space availability in the induction system for higher velocity of aerosol passing in the primary air filter but this increased velocity causes re-trapping of dust particles and increased dust penetration through the filter [3]. The frequency of replacing the air filter depends on its optimum usage which can reduce its cost and extended its life. The experiments conducted in optimizing geometrical configuration of intake system to keep reduced pressure drop and improved utilization of filter area. CFD analysis was made to improve air flow characteristics through the filters. An eccentricity was suggested in the filter element The eccentricity place a role of maintaining air velocity at constant in annular portion. This constant value of velocity resulted in lowering pressure drop was found to be higher for an eccentricity placed at 15mm distanced from the inlet [4]. When Exhaust Gas in which the Recirculation (EGR) on the performance and emissions of a single cylinder naturally aspirated constant speed diesel engine is studied. The results showed that EGR would be one option to reduce the nitrous oxide emissions, but with a rise in EGR rate the CO, UHC concentrations in the engine exhaust are increased [5 & 6]. When the effects of hot and cold EGR methods on emissions and efficiency of the engine is provided for obtaining different EGR methods in which the performance parameters were studied with and without exhaust gas recirculation of different methods with

10%, 15% and 20% of EGR[7& 8]. The technology adopted for the reticulated foam multilayer filters calls for no servicing and maintenance throughout the life of the vehicle i.e, 150000 miles. The technology adopted for these type of filters facilitates sum unique advantages compare to traditional air filters [9]. The restriction for air flow will be naturally higher in old filter than that of new [10]. When investigation made on air filters and their traps in different locations with different vegetation zones to study the efficiency of air filters used in motor cars. It was revealed that on efficiency filter traps will capture only the airborne particles. The contamination due to vegetation is also consider along with animal derived debris [11]. In this paper the performance characteristics and the exhaust gas emissions of stationary diesel engine are presented and discussed which is supported by experimental results. In the experimentation variation in EGR percentage for different air filters is selected for the study. The engine is run by adopting one type of filter at once at different loads for different percentages of EGR such as 5%, 10% and 15%.

2. EXPERIMENTAL SETUP

The experimentation is carried out on a single cylinder, four stroke, water cooled, DI engine. The test set up is developed to carry out set experimentation procedures. The layout of the experimental set up is shown in the Fig. 2.1. and Fig. 2.2 shows Photographic View of Computerized Experimental Diesel Engine Setup.

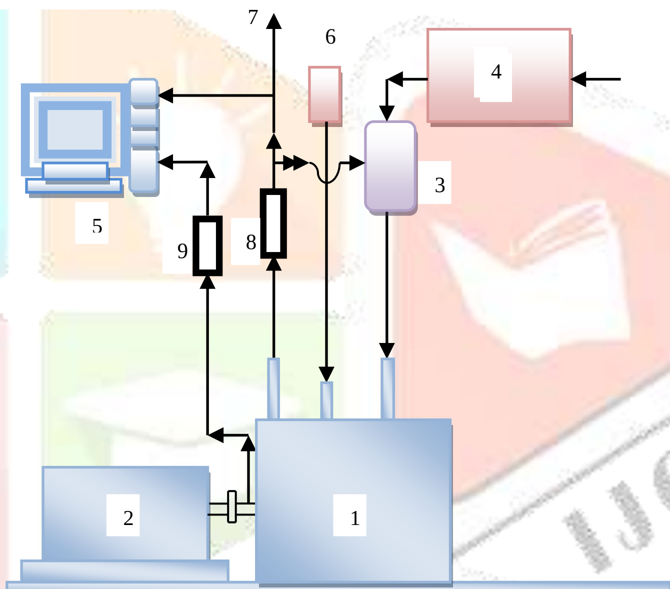

Fig: 2.1 Layout of Experimental Set up

1) Engine, 2) Dynamometer, 3) Air Filter Housing, 4) Air surge tank, 5) Computerized data acquisition, 6) Diesel fuel tank, 7) Exhaust Manifold, 8) Exhaust gas recirculation unit, 9) Crank angle encoder.

Make	Kirloskar AV-1
Engine type	4- stroke single cylinder diesel engine(water cooled)
Rated Power	3.7KW, 1500rpm
Bore & stroke	80mmx110mm
Compression rate	16.5:1 (Variable From 14.3to20)
Cylinder Capacity	553cc
Dynamometer	Electrical-AC alternator

Table.1 Engine specification

Fig: 2.2 Photographic View of Computerized Diesel Engine Setup with Air Filter Housing Arrangements and EGR Facility

2.2 Experimentation Procedure

The experiments are conducted on test engine in different stages. The engine is experimented without air filter considering as baseline operation to make the comparison study. In second stage the engine is run by adopting the air filter of type 1 (AFM1) - Model No. NF 1004 both with new and clogged filters one after the other. In third stage the engine is run by adopting the air filter of type 2 (AFM2) - Model No. NF615 both with new and clogged filters one after the other. In fourth stage the engine is run by adopting the air filter of type 3 (AFM3) - Model No. NF560 both with new and clogged filters one after the other. In fifth stage the engine is run by adopting the air filter of type 4 (AFM4) - Model No. 0313AC2261N both with new and clogged filters one after the other.

Fig: 2.4(a) AFM1 (OLD& NEW)

Fig: 2.4 (b) AFM2 (OLD& NEW)

Fig: 2.4 (c) AFM3 (OLD& NEW)

Fig: 2.4 (d) AFM4 (OLD& NEW)

3. RESULTS AND DISCUSSION

3.1 Combustion Characteristics

3.1.1 Cylinder pressure

The variation of cylinder pressure against crank angle of the engine for different filters, AFM1, AFM2, AFM3 and AFM4 with varying percentages of exhaust gas recirculation is presented and discussed below. The exhaust gas percentage is varied by 5, 10 and 15 percentages in the inlet.

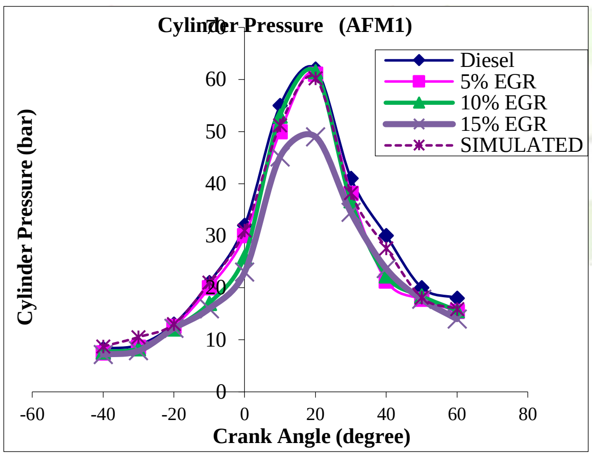

Fig: 3.1.1(a)

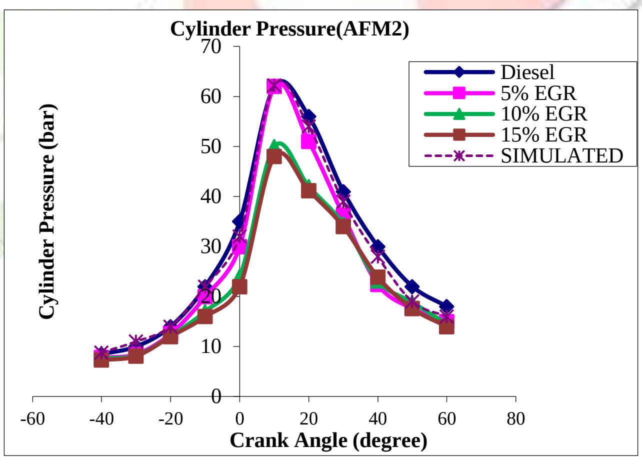

Fig: 3.1.1(b)

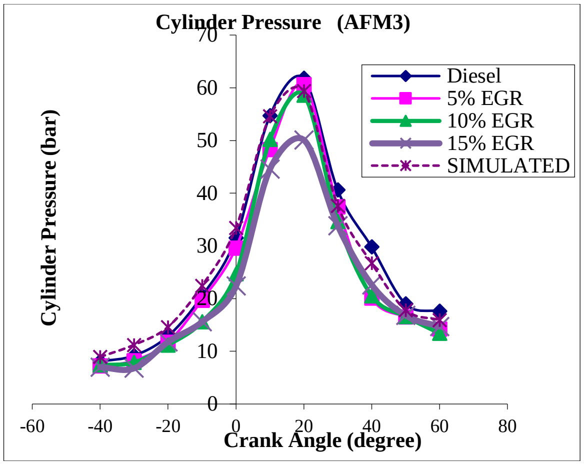

Fig: 3.1.1(c)

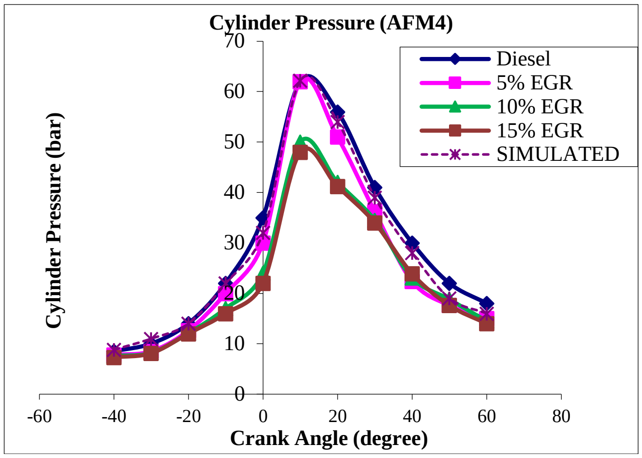

Fig: 3.1.1(d)

Fig: 3.1.1(a) to Fig: 3.1.1(d) Effect of EGR percentage on cylinder pressure adopting AFM1, AFM2, AFM3 & AFM4.

The cylinder pressure as a function of crank angle is presented in figure 3.1.1(a) to 3.1.1(d). In the figure 3.1.1(a) the effect of percentage of exhaust gas recirculation on cylinder pressure for the filter AFM1is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the cylinder pressure found to be decreasing marginally for 5, 10 & 15% percent of EGR when compared to diesel fuel operation without EGR. The decrease in cylinder pressure was recorded in the range of 2 to 5%. The values at crank angle 18 ATDC for 5, 10 & 15% percent of EGR were 62, 65 and 53 bar when compared to 65 of diesel operation without EGR. The values are well matched with simulated results.

In the figure 3.1.1(b) the effect of percentage of exhaust gas recirculation on cylinder pressure for the filter AFM2 is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the cylinder pressure found to be decreasing for 5, 10 & 15% percent of EGR when compared to diesel fuel operation without EGR. The decrease in cylinder pressure was recorded in the range of 4 to 9%. The values at crank angle 18 ATDC for 5, 10 & 15% percent of EGR were 60, 50 and 49 bar when compared to 62 of diesel operation without EGR. The values are well matched with simulated results.

In the figure 3.1.1(c) the effect of percentage of exhaust gas recirculation on cylinder pressure for the filter AFM3 is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the cylinder pressure found to be decreasing marginally for 5, 10 & 15% percent of EGR when compared to diesel fuel operation without EGR. The decrease in cylinder pressure was recorded in the range of 2 to 6%. The values at crank angle 18 ATDC for 5, 10 & 15% percent of EGR were 60, 58 and 50 bar when compared to 62 of diesel operation without EGR. The values are well matched with simulated results.

In the figure 3.1.1(d) the effect of percentage of exhaust gas recirculation on cylinder pressure for the filter AFM4 is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the cylinder pressure found to be decreasing for 5, 10 & 15% percent of EGR when compared to diesel fuel operation without EGR. The decrease in cylinder pressure was recorded in the range of 4 to 10%. The values at crank angle 18 ATDC for 5, 10 & 15% percent of EGR were 50, 45 and 51 bar when compared to 56 of diesel operation without EGR. The values are well matched with simulated results.

3.1.2 Heat release rate

The variation of heat release rate against crank angle of the engine for different filters, AFM1, AFM2, AFM3 and AFM4 with varying percentages of exhaust gas recirculation is presented and discussed below. The exhaust gas percentage is varied like 5, 10 and 15 percentages in the inlet.

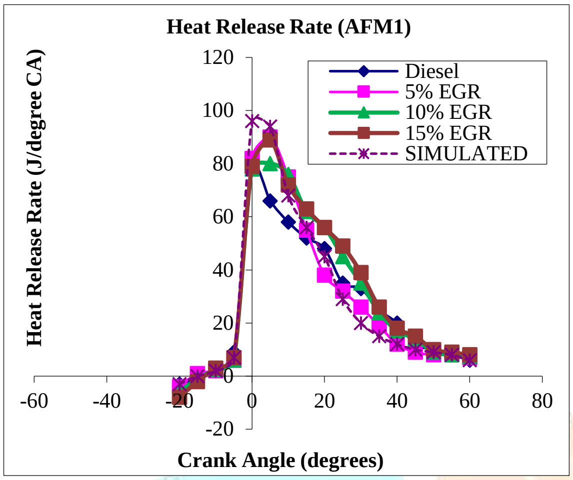

Fig: 3.1.2(a)

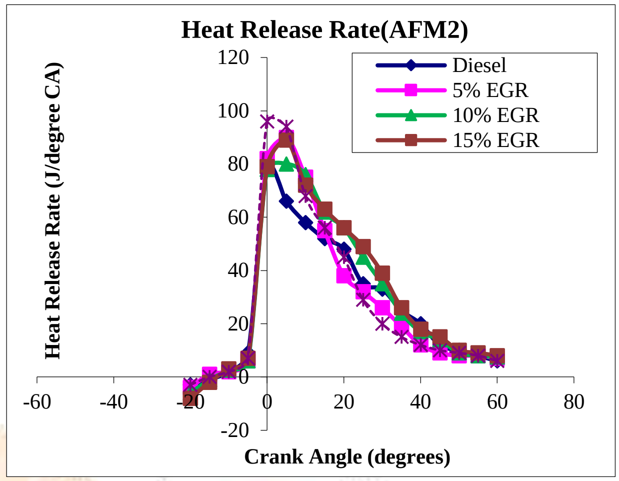

Fig: 3.1.2(b)

In the figure 3.1.2(a) the effect of percentage of exhaust gas recirculation on heat release rate for the filter AFM1is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the heat release rate found to be increasing when compared to diesel fuel operation without EGR for 5, 10 & 15% percent of EGR. The increase in heat release rate was recorded in the range of 10 to 30%. The values at crank angle 8 ATDC for 5, 10 & 15% percent of EGR were 75, 76 and 78 J/degree CA when compared to 58 of diesel operation without EGR. The values are well matched with simulated results.

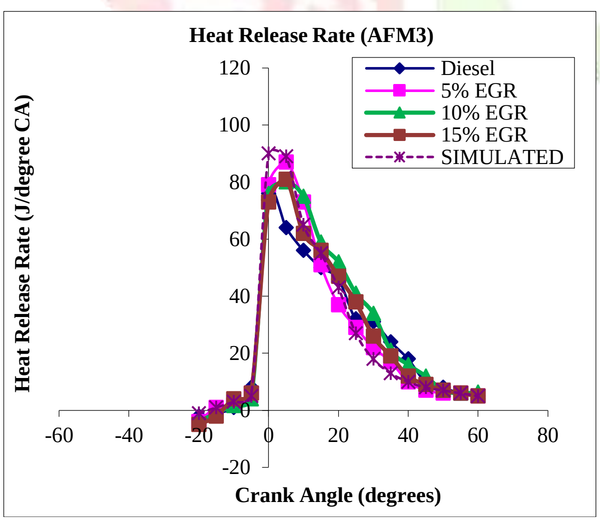

Fig: 3.1.2(c)

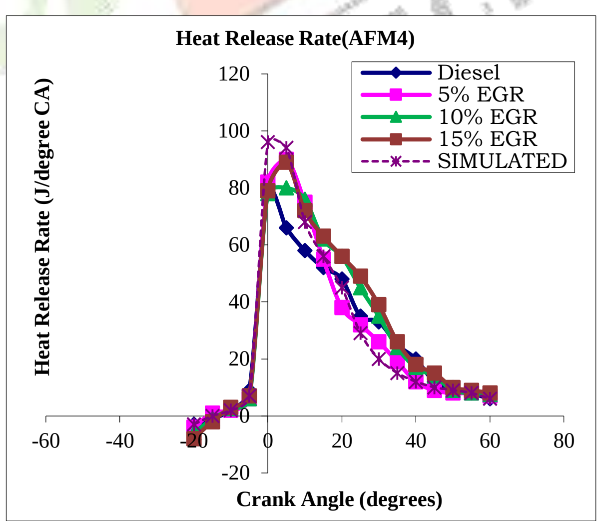

Fig: 3.1.2(d)

Fig: 3.1.2(a) to Fig: 3.1.2(d) Effect of EGR percentage on Heat release rate adopting AFM1, AFM2, AFM3 & AFM4

In the figure 3.1.2(b) the effect of percentage of exhaust gas recirculation on heat release rate for the filter AFM2 is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the heat release rate found to be increasing when compared to diesel fuel operation without EGR for 5, 10 & 15% percent of EGR. The increase in heat release rate was recorded in the range of 10 to 25%. The values at crank angle 8 ATDC for 5, 10 & 15% percent of EGR were 75, 76 and 78 J/degree CA when compared to 58 of diesel operation without EGR. The values are well matched with simulated results.

In the figure 3.1.2(c) the effect of percentage of exhaust gas recirculation on heat release rate for the filter AFM1is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the heat release rate found to be increasing when compared to diesel fuel operation without EGR for 5, 10 & 15% percent of EGR. The increase in heat release rate was recorded in the range of 15 to 30%. The values at crank angle 8 ATDC for 5, 10 & 15% percent of EGR were 73, 75 and 70 J/degree CA when compared to 56 of diesel operation without EGR. The values are well matched with simulated results.

In the figure 3.1.2(d) the effect of percentage of exhaust gas recirculation on heat release rate for the filter AFM1is presented. For each percentage of EGR the graphs are plotted against crank angle the simulated values are also compared. As the percentage of EGR increases the heat release rate found to be increasing when compared to diesel fuel operation without EGR for 5, 10 & 15% percent of EGR. The increase in heat release rate was recorded in the range of 5 to 25%. The values at crank angle 8 ATDC for 5, 10 & 15% percent of EGR were 75, 76 and 72 J/degree CA when compared to 58 of diesel operation without EGR. The values are well matched with simulated results.

4. CONCLUSIONS:

- As the percentage of EGR increases the cylinder pressure for all filters found to be decreasing marginally for 5, 10 & 15% percent of EGR when compared to diesel fuel operation without EGR.
- At 5% of EGR all the filters AFM1, AFM2, AFM3 & AFM4 have given more cylinder pressure by 10 to 15%.
- As percentage of EGR increases the heat release rate for all filters found to be increasing when compared to diesel fuel operation without EGR for 5, 10 & 15% percent of EGR.
- The filter AFM2 has produced uniform cylinder pressure and it is near TDC when compared to other filters.

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