

ANALYSIS OF FUEL CONSUMPTION AND OXIDES OF NITROGEN USING OXYGEN ENRICHED AIR IN COMPRESSION IGNITION ENGINE

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Abstract

Pollution is one major factor which affects the environment nowadays, resulting in green house effect and global warming. Suitable methods are introduced to increase the engine fuel economy and bring down the emissions within the tolerable limit. One way of doing it is by inducting oxygen into the combustion chamber since oxygen is a combustion enhancer the amount of oxygen entering into the combustion chamber if increased it would result in better engine performance and lower emissions. Oxygen can be inducted in the intake stroke by the help of an external source and mixing chamber is provided so that it helps in better mixing of air and supplementary oxygen. This additional increase of air will affects all parameters of the engine like operating temperature, fuel consumption, Brake power, emissions, and heat release but only fuel consumption and Oxides of Nitrogen (NO_x) alone is analyzed. Load test was conducted on a compression Ignition engine for various concentration of oxygen from (21% to 27%) with an interval of 2%. This experimental study shows better fuel economy and better brake specific fuel consumption but led to a very high percentage of Oxides of Nitrogen (NO_x) emission and lower carbon monoxide (CO), hydro carbon (HC) emission.

Keywords: NO_x emission, Fuel economy, Diesel engine, Oxygen enriched air.

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1. INTRODUCTION

A Diesel engine is an internal combustion engine which uses the heat of compression to initiate ignition in the combustion chamber [11]. Diesel engine has the highest thermal efficiency of all standard internal combustion engine because of the nature of the fuel used pollutants such as soot particles, carbon monoxide, oxides of nitrogen has become a major environmental issue.

Diesel engine always operated in excess air conditions hence air entering has about 78% Nitrogen improving engine performance and reducing pollution has always been a problem because higher operating temperature would result in better engine performance but will lead to NO_x emission[11]. To improve the performance and fuel economy of the engine nitrogen getting into the engine has to be eliminated.

To overcome the said problem 100% oxygen in the intake can be given which would result in zero NO_x emission. But this method has a lot of limitation. Secondly the nitrogen entering into the engine can be replaced by different kind of gas (e.g.: Inert gas) in the intake system so that it doesn't interact with the combustion process and should not be a pollutant to the performing system or to the environment.

These both methods have serious limitations. Another way of doing this is by increasing the percentage of oxygen in the intake air which will effectively replace the nitrogen from getting into the engine. This will serve as a suitable alternative.

In this study the effect of various percentage of oxygen in the intake air is studied with respect to fuel consumption and emission parameters.

2. EXPERIMENTAL SETUP

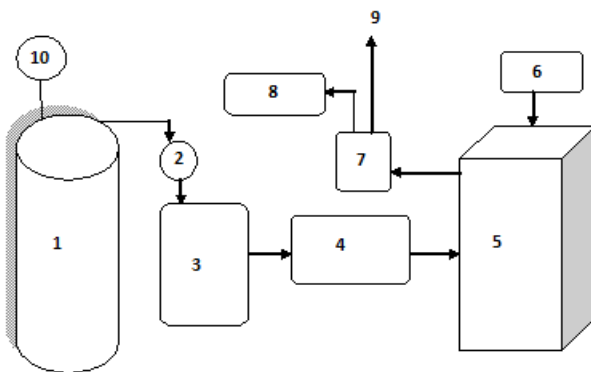
Test was conducted on a single cylinder, naturally aspirated, air cooled, and constant speed greaves engine. An eddy current Dynamometer was used as the Loading device and a Krypton gas analyzer was used for the study of the exhaust gases. The specifications of the engine are given in the Table 1.

Table -1: Engine specifications

Engine type	Naturally aspirated, air cooled, constant speed, greaves engine
No of cylinders	1
Compression ratio	18:1
Bore	68mm

Stroke	78mm
B.H.P	5
Fuel	Diesel
Specific gravity	0.8275
Loading device	Eddy current dynamometer

The source of oxygen is a commercial used oxygen cylinder which is attached to a flow meter which is fitted to a flame trap and then goes to a mixing chamber which helps in mixing of air and the supplement oxygen. Then it is feed into the engine.



(1) Oxygen cylinder; (2) Flow meter; (3) Flame trap; (4) Engine; (5) Engine; (6) Loading Device; (7) Exhaust gas; (8) Krypton gas analyzer; (9) To Atmosphere

Fig -1: Experimental setup

Test was taken for all the different percentage of Oxygen in the intake air. The amount of oxygen entering is monitored in such a way that it doesn't exceed 28% because higher percentage of oxygen would result in very high heat release and may result in explosion.

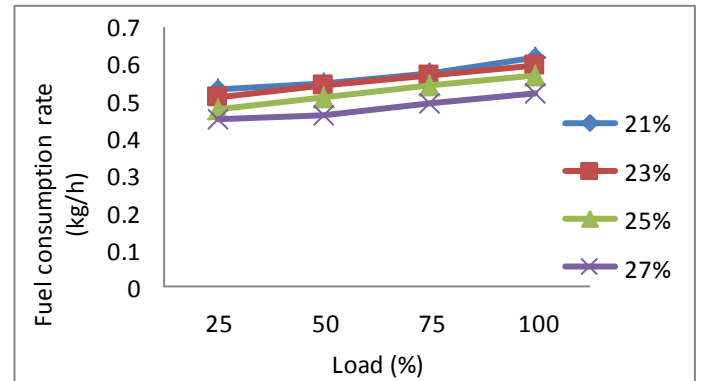
The quantity of oxygen sent additionally into the engine is given in the table 2.

Table -2: Quantity of oxygen supplemented

Percentage	Liters per minute	O ₂ % in CC	Total O ₂ in CC
21%	No additional O ₂	918	918
23%	2.5	918+42	959
25%	5	918+83	1001
27%	7.5	918+125	1043

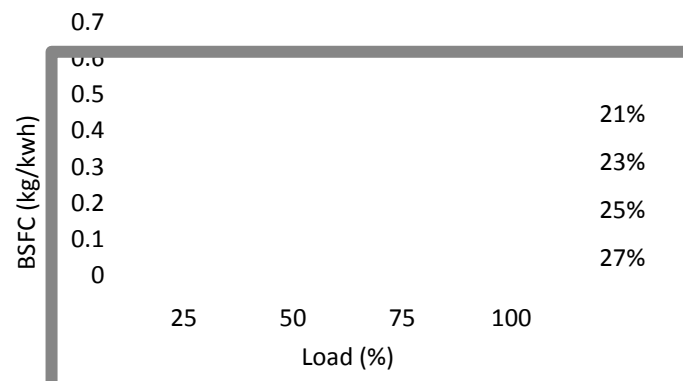
3. RESULTS AND DISCUSSION

The enrichment of oxygen in the intake air would help in better combustion and result in higher heat release for the same quantity of fuel.



Graph -1: Load vs fuel consumption rate

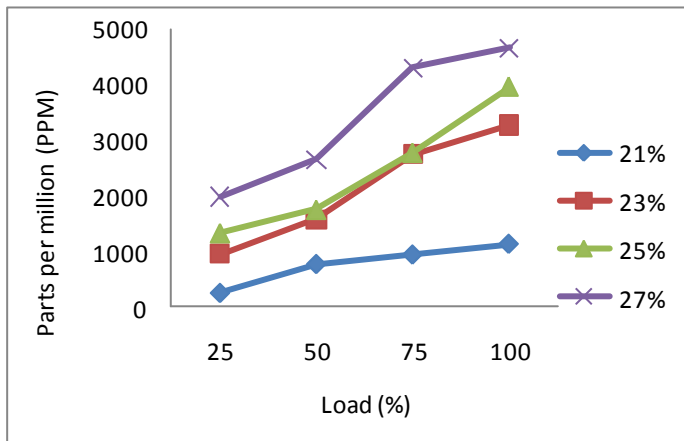
By increasing the percentage of oxygen in the intake air from (21% to 27%) the variation can be found. It is observed that for normal 21% oxygen level the engine had a maximum value of 0.6206 kg/h at 100% load when taken for 23% of oxygen enrichment there was very significant change when compared with 25% and 27% of oxygen there was a distinct change of 9% and 14% decrease was found. This shows that the same work can be done by the engine at less fuel consumption rate.



Graph -2: Load vs Brake specific Fuel consumption

The Brake specific fuel consumption(BSFC) also showed a distinct variation at higher percentage of oxygen levels in the intake air for 21% and 23% of oxygen levels the specific brake power was high as 0.645 kg/wh at minimum load and at high load conditions the amount of fuel consumed for unit brake power reduced by about 35% for oxygen enrichment of 25% and 27% the variation was distinct there was a reduction of 11% and 18% less fuel consumption at all loads which shows

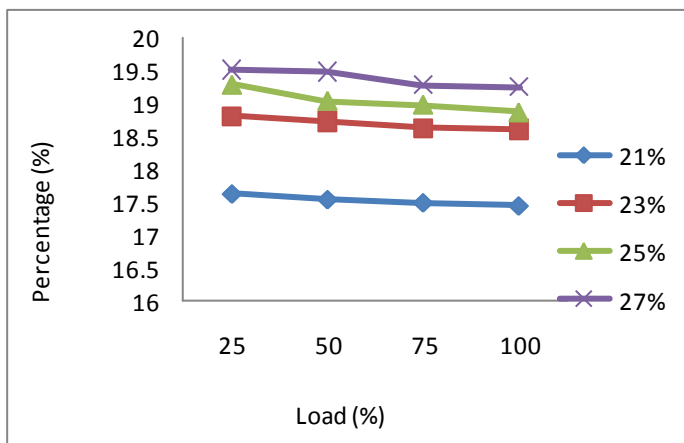
that higher oxygen percentage in the intake air results in better economy.



Graph -3: Load vs. NO_x

NO_x parameter for different percentage of oxygen shows wide variations because oxygen which is inducted inside the chamber increases the operating temperature which makes the atmospheric nitrogen into atomic nitrogen which has more affinity towards oxygen which results in the formation of NO_x in the engine.

When compared the NO_x curve for all 23%, 25%, and 27% of oxygen there is nearly 400%, 540% and 800% of NO_x increase when compared with normal 21% Oxygen level operating condition



Graph -4: Load vs Oxygen percentage in exhaust

The percentage of oxygen in the exhaust also increased considerably when more oxygen is sent into the engine CO level reduced by 33%, 39%, and 53% for the respective oxygen percentage of 23%, 25%, and 27% in the intake air.

Table -3: Comparison of all four graphs at Peak load

Percentage	Fuel consumption	BSFC	NO _x	O ₂ % in exhaust
21%	0.62	0.4106	1134	17.44
23%	0.595	0.4014	3278	18.61
25%	0.572	0.3845	3956	18.87
27%	0.523	0.3456	4656	19.26

The comparison of all four values show that increasing the oxygen percentage in the intake reduces the fuel consumption and it has the highest percentage of oxygen usage of about 23% and the only limitation is that it has more NO_x.

4. CONCLUSIONS

The use of oxygen enrichment on diesel engine under different load condition was studied and the main observations are as follows:

1. Fuel consumption rate decreases for higher O₂ percentage in the intake air.
2. The amount of fuel consumed for unit brake power is high at minimum load, and reduces when the load increases and this happens for all oxygen percentages in the intake air.
3. Oxygen which is coming out of the exhaust also increases with respect to the percentage of oxygen in the intake air.
4. CO drops a very high percentage with respect to oxygen induction in the intake as oxygen helps in better combustion.
5. NO_x which has increased exponentially can be reduced by using suitable after treatment methods or optimum level of NO_x to the percentage of oxygen in the intake air have to be found so that the NO_x is kept under tolerable limit.

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BIOGRAPHIES



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