

A Review on Performance of Variable Compression Ratio Diesel Engine by Enrichment of Oxygen in air Intake

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Abstract- Enrichment of oxygen in variable compression ratio (V.C.R.) diesel engine leads to faster burn rate and ability to burn more fuel at same stoichiometry. Added oxygen in combustion air leads to shorter ignition delay due to which poor quality fuel can be easily burn in the engine. During study, it is observed that oxygenated air is an effective method for reducing PM, CO, HC without significant increase in NOx emission. Higher compression ratio in variable compression ratio diesel engine causes increase in brake thermal efficiency and reduction in brake specific fuel consumption (B.S.F.C.), also at higher compression ratio, exhaust gas temperature increases. Thus, by enrichment of oxygen at higher compression ratio in diesel engine will improve the performance and overall efficiency of VCR diesel engine.

Keywords- VCR diesel engine; stoichiometry; ignition delay; BSFC

I. INTRODUCTION

Increasing the oxygen content of a reacting fuel-oxidizer mixture leads to complete combustion of fuel and the ability to burn more fuel at same stoichiometry. This causes increase in thermal efficiency and specific power output of diesel engine. In addition, oxygen enrichment can also be considered as a way to reduce the sudden loss in power output when vehicle operate in underground tunnels and at high altitudes.

From last two decades, the demand of conventional fossil fuels, especially gasoline and diesel has tremendously increased for I.C. Engine due to which, increase in the cost as well as the consequences of global warming. The current scenario is demanding the use of alternate fuel either completely or partially blended with the conventional fuel in order to reduce fuel consumption also reduce the exhaust gas emissions and increase thermal as well as overall efficiency of engine

Now a days, sports car use NOx cylinder to boost the speed of the vehicle but problem of using NOx cylinder is increasing in engine temperature and exhaust emissions. Rather than this, when oxygen cylinder is use to boost the vehicle speed and ultimately thermal efficiency of engine get increase.

When oxygen is added in the combustion chamber, emissions of visible smoke, particulates, unburned hydrocarbons and NO₂ decreases significantly due to complete combustion of fuel. Because of enrichment of oxygen, the ignition delay becomes shorter which offers potential for burning of lower grade and nonpetroleum fuels.

II. LITERATURE REVIEW

To study the effect of oxygen enrichment on the characteristics of variable compression ratio (VCR) diesel engine, we referred following papers.

Mohammed Fahed [1], had used oxygen enriched combustion (OEC) technology. He conclude that oxygen enriched intake air should be used to reduce the amount of stack gas CO emissions. Kuppusamy and Palanisamy [2] made the conclusion that increasing the oxygen content in air leads to further burning rate of fuel and the ability to control exhaust emissions. Oxy-fuel combustion decreases the volume of the flue gases and reduces green house effect.

K. Rajkumar [3], had studied oxygen enrichment in combustion chamber causes shorter ignition delays which offers more potential for burning of diesel. Azmi Osman [4], studied that when air is replaced by pure oxygen then combustion efficiency of that engine will get enhanced. Due to which brooder range of fuels can be used. M. Amirshakari [5] conclude that fuel consumption and brake specific fuel consumption is get decreases by enrichment of oxygen. Brake thermal efficiency increases at all loads till oxygen concentration level is of 25%. Higher the concentration of oxygen, higher the reduction of CO in exhaust gas and smoke density. NOx emissions are got increases by using pure oxygen in combustion air.

K. Kamalakkannan and P. Bharat [6] analyzed that for all oxygen percentages in intake air, the amount of fuel consumed for unit brake power is high at minimum load and reduced when load increases. Also the percentage of oxygen in exhaust gas will increase. R. J. Donahue and D. E. Foster [7] improve the performance of DI diesel engine by manipulation of combustion chamber by enrichment of oxygen. D. N. Assians [8] studied the effect of enrichment of oxygen on locomotive diesel engine and conclude that engine works efficiently at higher altitudes and long tunnels. J. Song, V. Zollo and A. L.

Boehman [9] compare the impact of oxygen enrichment and fuel oxygenation on diesel particulate emissions.

Marriner Tolman and Alan Taylor [10] invented oxygen gel. This gel is placed in porous container and when it comes in contact with atmospheric air, it get evaporates and liberate oxygen gas. This oxygen gas is then use in combustion chamber to improve the performance of engine. Sir Eugen D. Lepera [11] invented the apparatus for injection of excess oxygen in internal combustion engine. This method will increase the thermal efficiency of engine and reduce exhaust emissions. Giffard [12] improve the performance of S. I. engine by injecting pure oxygen in the engine's carburetor. Waleed Momani [13] published the article which deducted that by using excess oxygen, the engine emission got reduce efficiently.

III. ENRICHMENT OF OXYGEN

There are many methods of oxygen supply to the diesel engine out of which some are discussed here,

Oxygen gel, chemically known as poly-acrylamide is non toxic compound which liberates oxygen when it comes in contact with atmospheric air. This gel is provided in a porous container formed from a gas permeable membrane which is sufficiently porous so as to enable the gel to gradually evaporate. The evaporating gel release the oxygen, which is then drawn into air intake. Engine modifications are not required [10].

Another method is direct supply of oxygen through oxygen cylinder. Out of all the oxygen enrichment techniques, this method is most effective and efficient one. This oxygen is provided in the air intake chamber of engine. But this enrichment of oxygen will not increase more than 25%. Engine modifications are not required.

IV. FUTURE SCOPE

In recent condition, racing cars and bikes use NOx cylinder to boost the speed. This NOx cylinder can completely eliminated by using oxygen cylinders. Other than automotive industry, oxygen cylinders can be incorporated in locomotive engines. Locomotive engines would not work properly in long tunnels and at high altitude because less density of air. This can be eliminated by the use of oxygen cylinder.

Also, enrichment of oxygen can be done at proper percentage by the use some mass flow rate regulator by which engine performance enhance without much exhaust emissions.

CONCLUSION

From the referred papers, there are many techniques of oxygen enrichment such as air separation membrane, using pressure adsorption theory (PSA) by using zeolite, by using oxygen gel. But among all these techniques, oxygen enrichment by using oxygen cylinder is most effective and efficient technique to improve the performance of engine. Also, by this technique, we get maximum level of oxygen enrichment in intake air i.e. 25%.

By enrichment of oxygen, brake thermal efficiency get increase. Also exhaust emissions like CO, CO₂, HC, Particulated matter get reduce. But NO_x percentage will get increase. This percentage increase in NO_x can be reduced by supplementary treatment. Higher the concentration of oxygen causes reduction in CO exhaust gas and smoke density.

In case of variable compression ratio diesel engine, by increasing compression ratio until certain limit causes reduction in brake specific fuel consumption (BSFC) and increase in brake thermal efficiency. Also emissions get reduced by increasing the compression ratio.

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