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Research Paper

Current trends in Oxygen enriched combustion : Application and scrutiny

Abdul Raguman. A[1*], Madhankumar. D[2], Ajith. B[2], Mohanasundaram. V[2], Nandhakumar. V[2]

[1]Assistant Professor, Department of Mechanical Engineering, Karpagam College of Engineering, Coimbatore- 32, India.
[2]Department of Mechanical Engineering, Karpagam College of Engineering, Coimbatore-32, India.
**Corresponding author E-mail: ragunana@hotmail.com*

Abstract

The populace in the global scenario has drastically increased in the past decades. Due to this situation, the necessity of transportation also escalated which simultaneously raised the pollution levels. Nowadays the populace commonly prefers their individual vehicles rather than public transport system. This made the automotive manufacturers to come up with new technologies and to compensate the stringent norms introduced by several countries. Internal Combustion engine has been serving the world more than a century and plays a vital role in the means of transportation. Many types of research were made to enhance the efficiency of IC engines by the use of alternative fuels, alteration of the intake parameters, stroke variation, usage of alternative materials etc., At present scenario of IC engine, the efficiency ranges between 35 – 50 % based on the technology used. If more efficient IC engines are used it would meet the demand of depleting fossil fuels. Such engines may prevent the demise of fossil fuels. Thus our project deals with the prospect to discuss the phenomenal changes and effects occurring on IC engine when the working fluid is enriched oxygen.

keywords: *Oxygen-Enriched Combustion, Intake Parameters, Stroke Variation, Working Fluid, Fossil Fuel.*

1. Introduction

India has emerged as a fastest growing major economy in the globe; this plays a vital role in the development of the nation in several sectors, one of the significant sectors is transportation. Being a second most populated country in the world, it has created a big demand for transportation which causes the increase in the populace of vehicles that is fulfilled by many automotive industries around the world. Owing to this issue India faces a worse traffic condition in every nook and corner of cities. Another major issue is the adulteration in the ambient air due to the pollutants emitted from the vehicles. So there is an urgency to save and protect the environment from pollution for the betterment of the future generation. Many countries around the world had introduced stringent norms that differ by names according to the respective countries. Likely India is following Bharath Stage (BS), Europe is following Euro norms. This revised emission norms forced the automotive manufacturers to come up with vehicles that satisfy those norms. Also to reduce the pollution and traffic level Delhi government introduced an odd-even system in which the odd-numbered vehicles have to be driven on a particular day and even numbered vehicles on the other day. Also, several researchers focused to improve the efficiency of IC engine [11, 13], some tried with alternative fuels [7-9], some with combustion chamber [10, 12] and many with an intake system of IC engine [5, 6]. A country like India cannot immediately implement the future technologies like Electric Vehicles (EV) and Hydrogen Fuel Cell. So it is necessary to enhance the betterment of IC engines to cope up with the norms.

This paper details the oxygen-enriched combustion on the performance parameters and its impact on the emission of exhaust gases at the macroscopic level.

K. Rajkumar and P. Govindarajan [1] examined the combustion of oxygen enriched air and its performance in a single cylinder water cooled diesel engine loaded with an eddy current dynamometer. In this experiment, oxygen-enriched combustion technology was incorporated in a computerized single cylinder diesel engine using data acquisition system. In the mixing chamber, the ambient air was fed and the oxygen from the O_2 cylinder was limited to 4 L/min which was measured using a gas flow analyzer. After inscribing all the necessary parametrical values in the data acquisition system, the performance page illustrates various performance parameters such as BP, fuel consumption, load, speed and flue gas temperature. The combustion page describes miscellaneous performance characteristics likely mechanical efficiency, IP, FP and mean effective pressure. An increase of 15 % in SFC, 25 % in mean effective pressure and 5 to 20 % in η_{mech} was achieved when the oxygen concentration of 4 L/ min was maintained. The BP was increased to nearly 70 % when the O_2 concentration was maintained between 1 to 4 L/min. The combustion efficiency was increased when the exhaust gas temperature was raised to 30 °C.

Dinesha P et al. [2] incorporated enriched oxygen in a computerized single cylinder water cooled DI diesel engine coupled to an eddy current dynamometer. Cashew Nut Shell Liquid (CNSL) was the biodiesel used in this experimental setup. 20 % of cardanol, 10 % of methanol and 70 % of biofuel blends were used to test the performance, combustion and emission characteristics of oxygen enriched air supply in the concentration of 23 % (ambient air) and extra concentration of O_2 at 3, 5 and 10% at injection pressure of 180 bar and injection timing of 27 ˚ bTDC. The results were compared with the standard diesel fuel. The level of O_2 was adjusted by means of mass flow meter which was supplied from the O_2 cylinder. AVL Digas 444 analyzer and AVL 437 C smoke meter were used to measure the exhaust

emissions. A higher HRR was observed when the O_2 concentration was 7 % with B20M10 fuel. With B20M10 fuel at full load condition with 7 % O_2 enrichment a 28 % NO_x emission, 36 % increase in CO, 1 % lower smoke and 13.3 % lower HC was observed.

A. M. Falahat et al. [3] investigated the engine performance with the hydrogen-oxygen mixture as a supplement combustor in single cylinder air cooled SI engine. In this experiment, H_2 was produced on-board through water electrolysis where the H_2O molecule was split into H_2 and O_2 gases known as HHO gas or brown gas. A gas flow meter was used to measure the rate of HHO gas flow in the engine. Kane automotive gas analyzer was used to measure the exhaust emissions and the speed by the digital tachometer. The engine experimented at variable speeds ranging from 1350 to 2250 rpm with miscellaneous flow rates of 1, 1.5 and 2 LPM of HHO gas. Then the experimental parameters were kept constant and a little quantity of HHO gas was inducted and engine performance parameters were measured. Finally, the volume of HHO gas was increased until the fuel savings tend to be optimum. A peak percent of 23 % of BTE was achieved after enrichment of H_2. When the flow rate of HHO gas increases, brake power and torque increases.

Mohamed Brayek et al. [4] analyzed the performance and emission of a single cylinder air cooled SI engine when a mixture of hydrogen and oxygen was added and compared with gasoline fuel. Hydrogen and oxygen were generated by employing the fuel cell. Flame arrestor and flame trap were the safety devices that prevent the flame from reaching the electrolyser. The experiment was executed under variable load conditions. Several measuring equipment was employed to measure ambient and flue gas temperature, output voltage and current, fuel consumption and concentration of the exhaust gases. The engine was tested under steady state condition and the loads of 0, 0.3, 0.75, 1.2 and 1.5 kW with the supplement of 5 l/min of H_2/ O_2 mixture to the fuel. BSFC decreased by 7.8 % when enrichment of H_2/ O_2 increases at more than 0.3 kW loads. The flue gas temperature was reduced when the enrichment of H_2/ O_2 increases.

Abbreviations and Acronyms:

BP	Brake Power
BS	Bharath Stage
BSFC	Brake Specific Fuel Consumption
CNSL	Cashew Nut Shell Liquid
CO	Carbon Monoxide
EV	Electric Vehicle
FP	Friction Power
HC	Hydrocarbon
HHO	Hydrogen-Oxygen mixture
IP	Indicated Power
LPM	Liter Per Minute
NO_x	Oxides of Nitrogen
SFC	Specific Fuel Consumption
SI	Spark Ignition

2. Conclusion

- While employing oxygen-enriched combustion, An increase of 15 % in SFC, 25 % in mean effective pressure and 5 to 20 % in η_{mech} was achieved when the oxygen concentration of 4 L/ min was maintained.
- While using B20M10 fuel blend with enriched oxygen, with B20M10 7 % O_2 concentration was to the standard diesel fuel and suggested for better engine operation.
- When HHO gas was used as a supplement in SI engine, When the H_2 flow rate was 2 LPM, SFC decreases by 16.9 %. CO and NO_x lower when the flow rate of HHO gas increases.
- When H_2/ O_2 was employed as a supplement in SI engine, A blunt drop of HC was observed when the enrichment of H_2/ O_2 increases at all engine loads. 31. 8 % of CO was reduced when the enrichment of H_2/ O_2 increases.
- As a wholesome the oxygen enriched combustion proves well in many of the cases eliminating the harmful pollutants and increasing the performance parameters. This paper paves the way forward for the feasibility of the research incorporating the various techniques involved for the supply of enriched oxygen into the combustion chamber.

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