International Engineering Research Journal
Enhancing performance Of Internal Combustion Diesel Engine by Oxygen Enriched Air combustion by Membrane technology.

GadkarSagar[1], Deshmukh Manish[2]

[1]Student, ME(HPE)Mechanical Engineering Department,Savitribai Phule Pune University,GHRCOEAhmednagar , Maharashtra , India
[2] Professor,Mechanical Engineering Department, Savitribai Phule Pune University,JSPM, Tathwade, Pune , Maharashtra , India

Abstract

IC engine is the device which is used to produce mechanical energy from fossilfuel like petrol, Dieseletc. Those are different than external combustion engines because of burning of fuel inside the engine & heat release of the same. The air charge before combustion and the burned gases after combustion are actual working fluids. Heat release gives mechanical work as output. In recent years, that the IC engine is responsible for too much pollution, which is dangerous to human health and environment. Thus it is important to take some decision in the path of reducing pollutants without losing power and fuel consumption. The main challenge to control emission to conform the legal law & orders to protect the environment. The concept of oxygen enrichment by using Membrane technology associated at limited increase in the Oxygen in air by membrane to achieve high performance & low emission levels as well. Because of the increased oxygen content, additional fuel is burned. The resulting increase in power output is a beneficial offshoot, though it is not attempted for its own sake. Oxygen-enrichment of combustion air provides an opportunity to achieve ignition with minimum amounts of mixed fuel.

Keywords:*Oxygen Enrichment, Membrane Technology, Oxygen Enriched Combustion.*

1. Introduction

Today's conventional internal combustion engine uses only air as it is necessary for combustion process. Air is mixture of various gases which results in loss of heat energy produced by combustion due to undesired combustion of gases. This results in loss of efficiency of that particular internal combustion engine. Due to low cost of diesel fuel diesel engine are more economical as compared tothe gasoline engines. Diesel engines are widely use in field where both high power and high torque is required. But diesel engines are suffers from inherent higher particulate matter and nitride oxide emissions. Oxygen enriched combustion is one of the attractive combustion technologies to control pollution and improve combustion in diesel engines (P.Baskar et al,2016). Diesel engines are measure contributors of air polluting exhaust gasses such as particulate matter, carbon monoxide, oxides of nitrogen and other harmful compounds. by controlling the flow rate of oxygen and carbon dioxide, the intake air components of the engine are adjusted to optimize the engine performance, save energy and reduce emissions(Bingyuan Han et al,2011).All polluting exhaust gases form due to incomplete combustion of diesel fuel. To avoid pollution and heat loss it is necessary to have complete combustion of fuel which can be accomplished by availing extra oxygen for combustion. Diesel engine manufacturers face major challenges to improve performance characteristics of diesel engine by achieving proper combustion of diesel fuel. To improve performance and lower exhaust emission further one of the least exploited variables has been oxygen concentration in combustion air. Use of oxygen enriched air was compared with different level of oxygen enrichment to evaluate combustion parameters.The oxygen-enriched air improves combustion, promotes the stability and reduces CO and HC obviously, and also results in a little higher NOx. Nevertheless the rise of NOx keeps the lower level in the start process(K.rajkumar et al,2010).Among all the methods, the oxygen enrichment and diesel particulate trap without modifying engine design play a vital role in improvement of Combustion parameters in diesel engine. Use of oxygen enriched air was compared with different level of oxygen enrichment to evaluate combustion parameters.The use of oxygen enriched combustion air will have a direct affect on the combustion process and on the overall engine thermodynamics(Li Shengqin et al,2010). A number of experimental studies have demonstrated benefits of applying Oxygen Enriched Combustion in diesel engine.there is considerable improvement in power output and thermal efficiency of the engine with increased oxygen concentration and injection pressure while NOx emission increased pro rata with the oxygen added(P.Baskar et al,2013). There are different methods for the enrichment of the oxygen such as use of the zeolite, use of the different additives etc. Though many researches are being conducted on diesel engine oxygen enriched air most of them simulated oxygen enrichment by mixing air stream with pure oxygen stored in cylinder. In the present work separate oxygen cylinder was use to enrich oxygen level in intake air the small mixing chamber was provided before inlet manifold. But providing oxygen which is stored in tank is not economical and efficient way so other approach is by enriching oxygen, so for this polysulfone hollow fiber membranes tested on oxygen/nitrogen mixtures, where the effect of the feed pressure and feed flow rate on the oxygen enrichment by the air separation membrane technology.(M.I.suhaina et al,2014).

2.Experimental Methods

2.1 Experimental Process Flow

This Experimental setup is used to find out this research perspective as shown in figure. Oxygen is added during the intake by membrane technology in the air box for correct mixing measured by O2 analyzer. Flow control valve is used to control the flow of oxygen from membrane at volume fraction from 21% base value to 27 % high value.

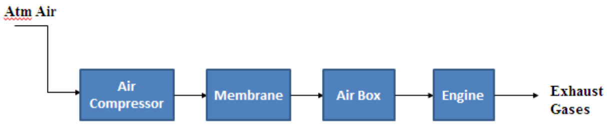

Fig 1 Process flow for experimentation

2.2 Engine Specification

A single Cylinder,four stroke, compression Ignition, Direction injection, vertical diesel engine having following specification as follows in table 1 was used to conduct the experiment.

Table 1 : Engine Specification as follows

Product	Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Product code	224
Engine	Make Kirloskar, Model TV1, Type 1 cylinder, 4 stroke Diesel, water cooled, power 5.2 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller shaft	With universal joints
Air box	M S fabricated with orifice meter and manometer
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
Piezo sensor	Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezo powering unit	Make-Cuadra, Model AX-409.

The oxygen concentration is measured with an Oxygen analyzer fitted between air box and inlet manifold of the engine. The test engine is coupled to Saj Test Plant Pvt. Ltd. (model-AG10) eddy current dynamometer. The main measuring instruments used were; a mass balance with an accuracy of 0.01 g to measure the fuel flow rate, theoretical constant is taken for the calorific value of fuel, a thermocouple to measure the temperature of exhaust gas, inlet air, a TDC marker (a magnetic pickup) and an rpm indicator. A PCB Piezotronics, INC.HSM111A22 and M108A02 electric transducer measures the combu09stion chamber pressure (it is a mean value of 50 consecutive cycles) with an increment of 1° crank angle using an data acquisition system.(NI USB-6210 Bus Powered M Series).

2.3 Experimental procedure

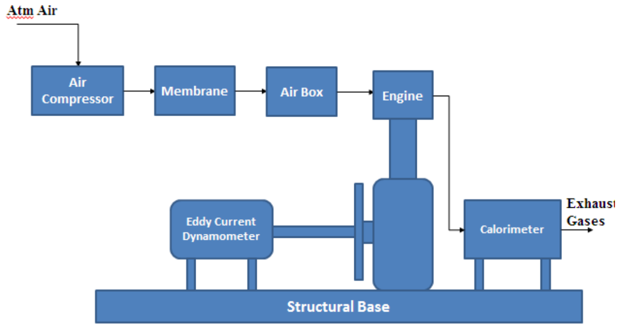

Fig 2 Experimental Setup

The engine parameters, air flow rate, fuel flow rate are measured using the above instruments. Test conditions were designed to investigate the effect of oxygen concentration on engine performance and combustion characteristics. Tests were carried out at different loadings starting from no load to the rated capacity of the engine with an incremental loading of 20%, at a constant speed of 1500 RPM. Consistency and repeatability of the engine operating conditions were ensured by first running it for approximately 10 minut.es at 1500 rpm at 50% load until exhaust gas temperature reached 250 °C. Once these conditions are achieved, the test engine was brought to the required test condition and then allowed for at least two minutes before collecting the data. Four different levels of oxygen concentration, 21% (ambient air), 23%, 25% and 27% by volume, were used for the inlet air. The fuel injection timing and injection pressure were maintained at original setting while adding oxygen to the intake air.

Results & Discussion

The prime objective of this research is to investigate the engine performance parameters affected by the use of oxygen enrichment. The performance values are reported at four operating performance points.

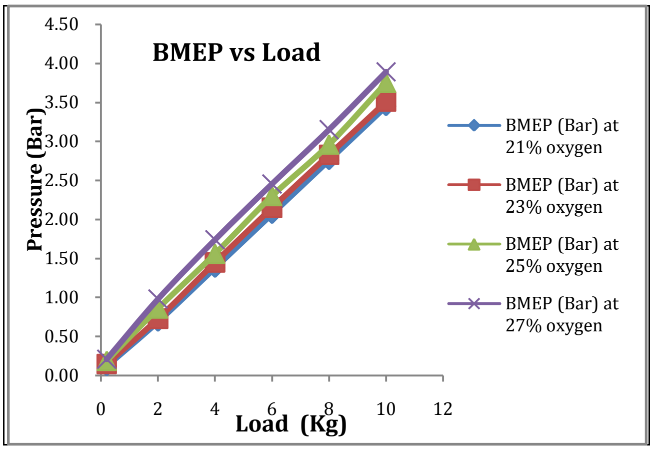

Fig 3 BMEP VS Load

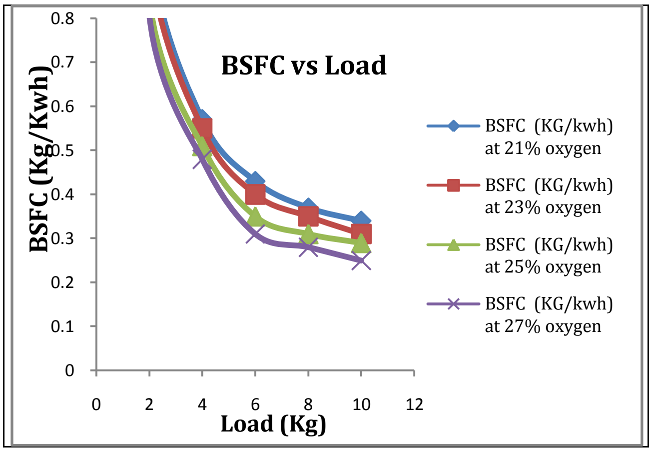

Fig 4 BSFC VS Load

Fig. illustrates Brake the mean effective pressure developed after combustion in the cylinder the maximum of 1 to 4 percent increase in peak cylinder pressures will be achieved in 23 to 27 percent oxygen enriched air than ambient air at part load conditions. These indicate a feasibility of increasing the net engine power by reasonable level. There is formation of local stoichiometric mixtures rather than rich premixed mixtures, which leads to rising in cylinder temperature and pressure.

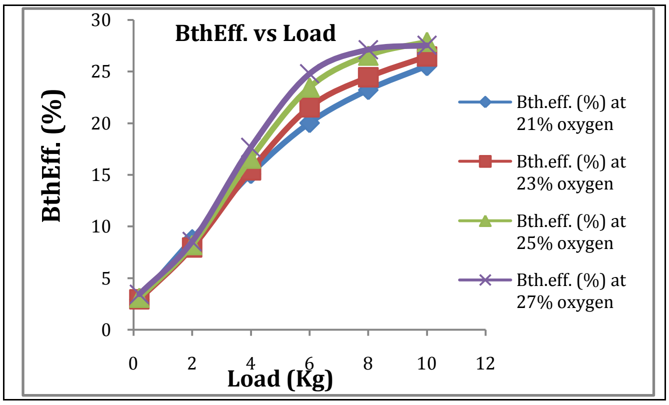

Fig 4 Bth.Eff. VS Load

The brake thermal efficiency, which is the ratio between the measured brake power to the product of the fuel flowrate and its calorific value, were calculated and plotted against different loads as shown in Fig. 3. From an ideal perspective, the brake thermal efficiency is affected by compression ratio and the thermodynamic properties of the working mixture. Compression ratio is fixed in this study; thermodynamic properties of the mixture however changed due to the addition of oxygen. An increase in oxygen concentration increases the mixture ratio of specific heats, which in essence increases the potential to convert the mixtures thermal energy to work energy.Brake thermal Efficiencies at the normal air composition that is on 21% of oxygen content, There is about 4 to 8 percent increased in brake thermal efficiency throughout all levels of oxygen enrichment as per the research is concern.

The brake specific fuel consumption is the ratio of rate of fuel consumption to break power produced, animportant parameter that reflects how good the engine Performance is. Stoichiometric air–fuel ratio decreases when the oxygen concentration in air increases. This means that less air is required for complete combustion of diesel fuel. When air mass flow is constant, as in these experiments, the additional oxygen was used to burn diesel and improves combustion. There is about 5 to 8 percent decrease in specific fuel consumption with increase in oxygen concentration from 21 to 27.

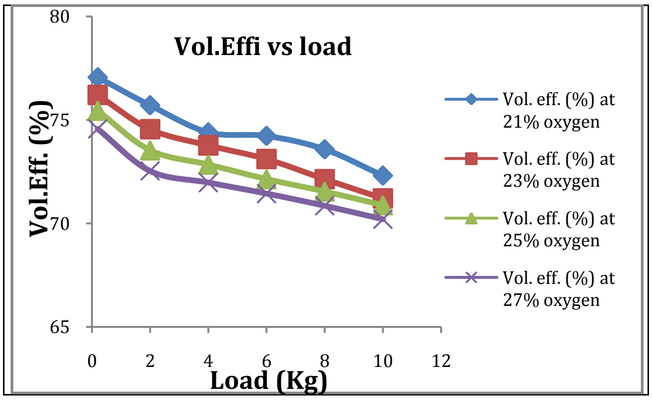

Fig 5 Vol.Effi VS Load

Volumetric Efficiency at the various air composition that is on 21%-27% of oxygen content, There is about 4 to 6 percent decreased in Volumetric efficiency throughout all levels of oxygen enrichment as per the Experimentation results.

Conclusions

The main effect of oxygen enrichment on the engine performance characterised and it is been seen that there is increased brake thermal efficiency& and reduced brake specific fuel consumption.

1. The research show that, as the oxygen concentration in the intake air is increased, the maximum value of cylinder pressure is increased, and the peak heat release rate is increased too. A feature of this study was to consider the power output and combustion performance for

the different levels of oxygen enriched combustion air on engine.

2. As far as the membrane technology is concern there are lots of polymer fibers are available for oxygen enrichment and its Experiments and simulation are performed to evaluate the separation performance of for an example of polysulfone hollow fiber membrane for oxygen enrichment system.
3. It is easy to vary percentage of Oxygen from the atmospheric air by using Membrane technology, so it will be revolution to automobile if its get adopted.

References

P. Baskar, (2016), Effects of oxygen enriched combustion on pollution and performance characteristics of a diesel engine, Engineering Science and Technology, an *International Journal* 19,pp- 438-443.

M.I. Suhaina, ,(2014), Performance evaluation of polysulfone hollow fiber membrane for oxygen enrichment system, 81310 UTM, Skudai, Johor, Malaysia, pp-201-209.

Qing Gao, (2009), Emission and Combustion Misfire of Engine with Oxygen-enriched in Dynamic Start Process, 2009 International Conference on Energy and Environment Technology, Jilin University ChangChun , China,,pp-119-120.

Bingyuan Han, (2011), Performance Monitoring and Acquisition System Design of Gasoline Engines Based on Oxygen Enriched Combustion, 2011 International Conference on Electronic & Mechanical Engineering and Information Technology, Northeast Forestry University College of Traffic Heilongjiang Province, China,,pp-1968-19770.

Li Shengqin, (2010), Study of Oxygen-enriched Combustion Character on Gasoline Engine at Cold-start, 201O International Conference On Computer Design And Appliations (ICCDA 2010), Northeast Forest University Harbin, Heilongjiang Province, China,pp- 110-113.

P. Baskar,(2013), Midhun Antony Joseph, Nijesh Narayanan, Rajesh BabuLoya, Experimental Investigation of Oxygen Enrichment on Performance of Twin Cylinder Diesel Engine with Variation of Injection Pressure,IEEE,pp-683-686.

Jiangwei, (2011), Reducing HC Emissions of Gasoline Engine during Cold-Start by Using a Oxygen-enriched Intake Air System,ICCDE, Northeast Forestry University Harbin 150040, China,pp-8422-8425.

YanjiLi,(2013), Combustion characteristic of Refuse Derived Fuel under oxygen-enriched atmosphere,IEEE,pp-432-465.

Lyle Kocher,(2013) A Nonlinear Model-Based Controller for Premixed Charge Compression Ignition Combustion Timing in Diesel Engines, 2013 American Control Conference (ACC) Washington, DC, USA, June 17-19,pp-4411-4416.

K.Rajkumar, (2010), Impact of Oxygen Enriched Combustion on Heat Release Curves of a Single Cylinder Diesel Engine,IEEE,pp-147-150.

ShamalIndulkar, (2014), POWER ENHANCEMENT USING OXYGEN ENRICHED AIR: A CRITICAL REVIEW, International Journal of Advanced Engineering Technology,pp-3945-3949.