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Experimental Investigation Of Four Stroke Si Engine Using Oxyrich Air Energizer For Improving Its Performance

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Abstract: Conservation of fuel is the key to any nation's economic success, also limitation of pollution through such fuel combustion is a must for the nation's health. The present investigation is to find performance and emission characteristics of a four stroke multi cylinder spark ignition engine (MPFI: Multi Point Fuel Injection) operating with oxyrich air energizer. The oxygen is blended in intake air with different quantity of mass flow rate 5 lpm, 10 lpm and 15 lpm in a four stroke multi cylinder spark ignition engine for different load and speeds. The speed is varied from 1000, 1500 and 2000rpm. For every speed range the load is varied in range 20, 40, 60 and 80N-m. The performance and emissions of engine such as, mechanical efficiency, brake thermal efficiency, brake specific fuel consumption, volumetric Efficiency, carbon monoxide, unburnt hydrocarbons and oxides of nitrogen are to be determined and compared with and without oxyrich air energizer. The aim of this paper is to increase fuel efficiency and to reduce exhaust emission levels.

Keywords: four stroke multi cylinder S.I. engine (MPFI), Oxyrich air, Oxygen enricher, Air energizer, Catalytic conversion, Stoichiometry, efficiencies and emissions.

I. Introduction

Over the past century, need and development of micro-power devices have necessitated the need for studies to look the mediums that can enhance combustion processes of fuels by optimizing system parameters. This is essential so as to utilize the high specific energy content of liquid hydrocarbon fuels. As we know that main source of pollution is carbon monoxide and unburnt hydrocarbons so apparatus is develop which is used as pre-processing unit for the automobile mainly. This method and apparatus for reducing the emissions and improving the performance of an internal combustion engine. An input air stream is separated into an oxygen-enriched air stream. The oxygen-enriched air and a combustible fuel are provided to a combustion chamber of the internal combustion engine and a combustion process is initiated. The application of focused magnetic field converts fuel molecules to a positive charge and sets them in order, which increases the attraction of negatively charged air molecules, boosted by the hared air to compensate for the improper fuel/air mixture of the non-efficient sensor., which is placed in automotive vehicles on the air duct before the air filter to allow for the optimum combustion. This significantly improves the process of oxidation. As a result the corrosion and scale deposits are dissolved and the new ones do not form in the whole cooling system, engine gets back 100% of its heat transfer ability and can be exploited longer. They are installed on the rubber line, preferably on fuel line as close to the engine as possible. The primary factors used in determining the efficiency of a combustion process are: 1) excess oxygen; 2) carbon monoxide; and 3) stack temperature as an indicator of heat available for use. These three parameters combine in complex manner to determine the efficiency. Drop in oxygen percent in stack indicates lowered oxygen emission that is a direct indicator of higher burning efficiency. On natural gas as well as other gasses, there is usually no carbon monoxide given off by the combustion process. This additional oxygen requirement is the exact behavior sought for the increased combustion efficiency and fuel savings. Proper re-airing must be achieved to restore the proper oxygen reading to its reinstallation reading. In most cases, increasing the air feed will bring the combustion efficiency into proper stoichiometric balance.

II. The Oxyrich Treatment of Intake Air With Energizer

The oxyrich treatment of intake air represents a new technology. Many attempts by various inventors worldwide have been far less than satisfactory due to the implementation of what has become known as the blending technique. This is of supreme importance, since it is required to have the necessary power (quantity) to properly excite the electron activity causing the increased oxidation effect. When the unit under investigation is attached to the suction line of an engine, we see an immediate drop in unburned hydrocarbons and carbon monoxide. This is due to the oxygen conditioning of the air, which makes it more reactive. The purpose of a catalytic converter on automobiles is to oxidize (burn) carbon monoxide into carbon dioxide. As related in stoichiometric charts representing ideal combustion parameters, the highest burning efficiency will be achieved at the highest carbon dioxide level, since carbon dioxide cannot be subsequently oxidized. The purpose of a catalytic converter is to reduce all carbon monoxide to carbon dioxide. The increased combustion efficiency is occurring within the engine due to increased fuel reactivity with oxygen (increased oxidation), the main factor responsible for increased combustion efficiency. It is a complete waste to allow an engine to run inefficiently and to burn the excess carbon monoxide in its catalytic converter, the wasted heat merely "heats-up" the exhaust system, instead of providing useful work within the engine. Overall generation of carbon dioxide will drop due to better overall engine efficiency. An air energizer is nothing but a simple pair of magnets which is used to

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magnetize the incoming air. It is installed on intake manifold pipe as well as air intake pipe. After installation of magnets on pipes it creates magnetic field which magnetizes the paramagnetic oxygen in air. This helps to improve combustion in engine. Air energizer is an apparatus which ensures complete combustion in an Internal Combustion (I.C.) Engine. It improves combustion efficiency and gives extra mileage and power of I.C. Engine. It ensures minimum deposition of carbon on the spark plug and on the engine piston head improves compression capacity of the piston helping in the reduction in noise and vibration.

A. Working Principal

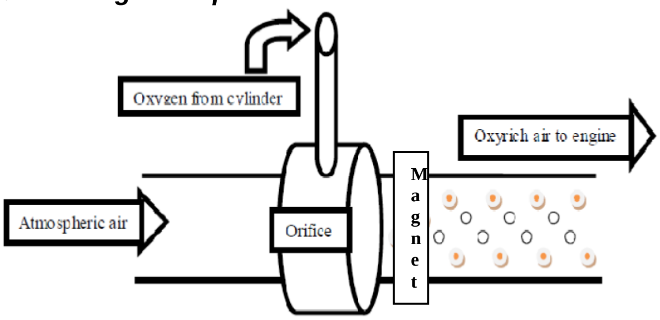


Fig1: Working principal of Oxyrich Apparatus

i) When hydrocarbon fuel (methane molecule) is combusted, the first to be oxidized are the hydrogen atoms. Only then, are the carbon atoms subsequently burned (CH_4+ $2O_2$ = CO_2+ $2H_2O$). Since it takes less time to oxidize hydrogen atoms in a high-speed internal combustion process, in normal conditions some of the carbon will be only partially oxidized; this is responsible for the incomplete combustion. The optimum combustion efficiency (performance) obtained from the oxygen enricher application on air is first indicated by the amount of increase in carbon dioxide (CO_2) produced, which has been validated by state emissions control devices.

III. Experimental Investigation

A. Experimental Set-up

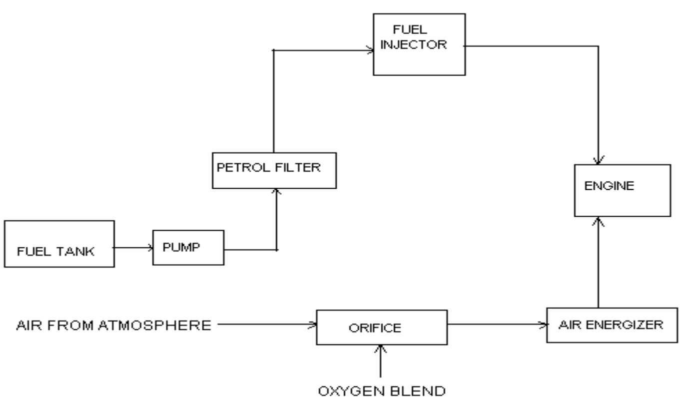


Fig 2: Flow Diagram of Experimental set-up

The engine is a 1405cc 4 stroke, multi cylinder SI (MPFI) engine loaded by an eddy current dynamometer with computer controlled. Table 1 lists some of the important specification of the engine under test. The schematic layout of the experimental set up is shown in fig 2 and the original photograph of experimental set up is shown in fig 3. The engine was coupled to a eddy current dynamometer which is equipped with an instrument cabinet fitted with a torque gauge, electric tachometer and switches for the load remote control. Also EPA software is connected to control panel of this test rig. Five gas analyzer is used to measure the CO, HC, NOx, CO_2 and O_2 pollutants. Fuel consumption was measured by using a fuel tank with electronic weight gauge and a stopwatch with an accuracy of 0.2s.

Fig 3: Photograph of computer controlled 4 stroke SI engine test rig with Experimental set-up.

Fig 4: Photograph of computer controlled 4 stroke SI engine test rig with control panel.

Table.1. Engine specification

Engine	Make Tata Motors, Model Indica ev2
Type	4 Stroke, 4 Cylinder, MPFI, Water cooled, Petrol engine
Bore	75mm
Stroke	79.50mm
Connecting rod	Length-145mm
Compression ratio	9.50:1
Engine Capacity	1405
Power	63.5BHP @ 5000 RPM
Torque	110 N.m @ 3000 rpm
Magnet	1000 gauss permanent magnet
Oxygen cylinder	Size: big, Oxygen quantity: 7 m^3,

	Pressure: 140 kg/cm^2.
Dynamometer	Eddy Current

B. Experimental Procedure

1. First the entire connections have been checked.
2. Fuel tank is filled with petrol.
3. Fuel weight measuring unit placed to ON position.
4. Cooling water pump is started.
5. EPA software is started.
6. Load indicator panel placed on ON position.
7. Ignition switch is put on.
8. Interfaced software system is put on.
9. Engine is started.
10. Accelerated the engine up to 3000 rpm
11. Then set the rpm for observations.
12. Select the load for that rpm.
13. All the corresponding input and output parameter readings have been recorded into respective observation tables.
14. Exhaust gas analyzer sensor is inserted in the engine exhaust gas pipe and measure all emissions.
15. After that change the load and again record all measurements.
16. With oxyrich air for all RPM and all loads set the oxygen flow by rotating the valve.

C. Performance Parameters

1. Mechanical Efficiency, $\eta_m = \frac{BP}{IP}$
2. Fuel consumption,
$$F.C. = \frac{mf * 3600}{\text{Time required} * 1000}$$
3. Brake Specific Fuel Consumption (bsfc) $= \frac{FC}{BP}$
4. Brake thermal efficiency = $\eta_{bt} = \frac{B.P.}{mf * C.V.}$
5. Volumetric efficiency,
$$\eta_v = \frac{\text{Volume of air intake per minute}}{\text{Volume displaced per minute by piston}}$$

IV. Results, Graphs And Discussion

A. Result Tables for Speed @ 1000 r.p.m:-

Table.2: Results of Observation (without oxyrich air energizer)

Symbol	Unit	Load 1	Load 2	Load 3	Load 4
η_m	%	78.90	130.50	155.92	176.39
bsfc	kg/KW.hr	0.68	0.38	0.28	0.22
η_{bt}	%	11.23	19.88	27.50	34.15
η_v	%	96.61	105.50	107.40	108.90
Exhaust Gas Analysis					
CO	%	11.26	9.633	9.244	9.170
HC	PPM	199	356	366	372
CO_2	%	19.60	20.50	19.50	19.70
O_2	%	3.52	3.66	4.13	4.25
NO_x	PPM	177	182	188	203

Table.3: Results of Observation (with oxyrich air energizer-5 lpm)

Symbol	Unit	Load 1	Load 2	Load 3	Load 4
η_m	%	85.12	137.51	164.57	179.47
bsfc	kg/KW.hr	0.64	0.33	0.25	0.20
η_{bt}	%	11.87	23.24	30.84	37.94
η_v	%	99.18	100.86	108.33	114.15
Exhaust Gas Analysis					
CO	%	4.420	4.361	3.664	2.334
HC	PPM	195	319	351	360
CO_2	%	15	18.30	19	20.60
O_2	%	8.44	6.41	6.53	5.52
NO_x	PPM	185	192	198	212

Table.4: Results of Observation (with oxyrich air energizer-10 lpm)

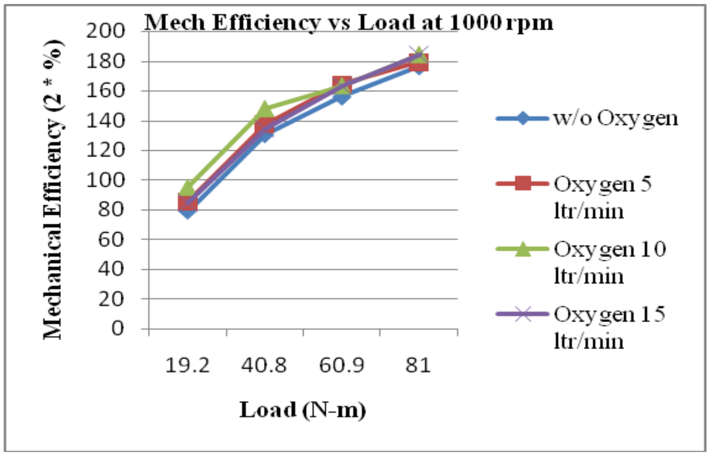
Symbol	Unit	Load 1	Load 2	Load 3	Load 4
η_m	%	95.17	148	163.37	184.30
bsfc	kg/KW.hr	0.47	0.32	0.23	0.19
η_{bt}	%	16.07	24.11	32.72	41.30
η_v	%	79.73	101.73	111.32	115.09
Exhaust Gas Analysis					
CO	%	0.238	0.297	0.307	0.881
HC	PPM	190	256	322	384
CO_2	%	23.10	22.90	24	24.10
O_2	%	8.16	8.44	7.30	6.48
NO_x	PPM	192	204	230	255

Table.5: Results of Observation (with oxyrich air energizer-15 lpm)

Symbol	Unit	Load 1	Load 2	Load 3	Load 4
η_m	%	84.56	134.59	163	184.26
bsfc	kg/KW.hr	0.47	0.32	0.23	0.18
η_{bt}	%	16.15	23.55	33.81	41.99
η_v	%	81.25	108.33	112.26	114.15
Exhaust Gas Analysis					
CO	%	0.147	0.200	0.262	0.273
HC	PPM	189	209	303	322
CO_2	%	22.20	23	23.03	23.89
O_2	%	10.40	9.62	9.22	8.47
NO_x	PPM	203	222	247	264

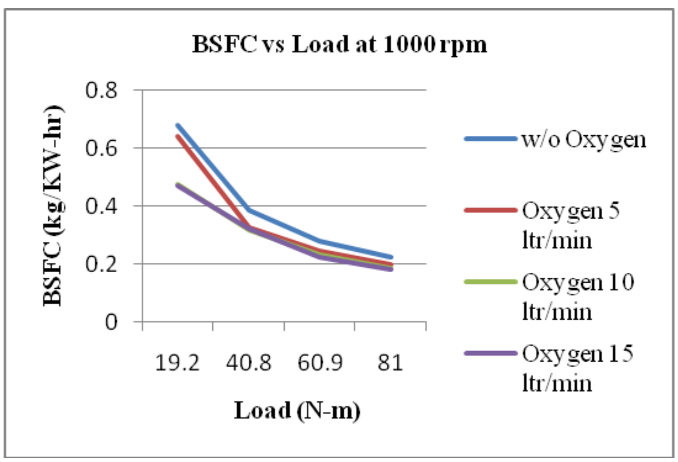
B. Graphs And Discussion:

Graph.1: Mechanical efficiency Vs Load



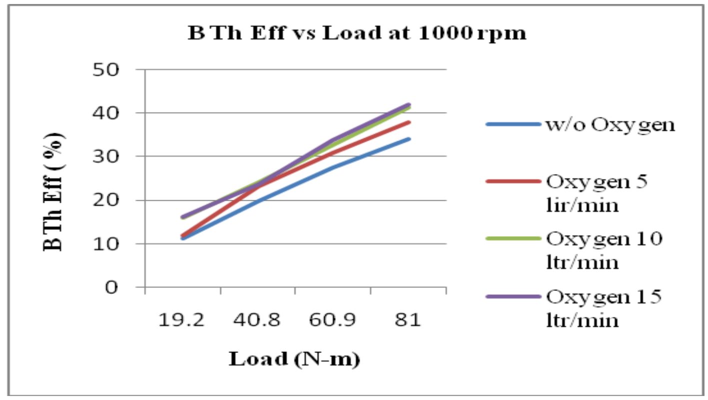
Discussion: Graph of 'Load' Vs. 'Mechanical Efficiency' infers that mechanical efficiency increases with increase in load and oxygen blend quantity. One can observe that the Mechanical efficiency for the 10 lpm of oxygen the highest and least for the gasoline as shown in graph.

Graph .2: B.S.F.C. Vs Load



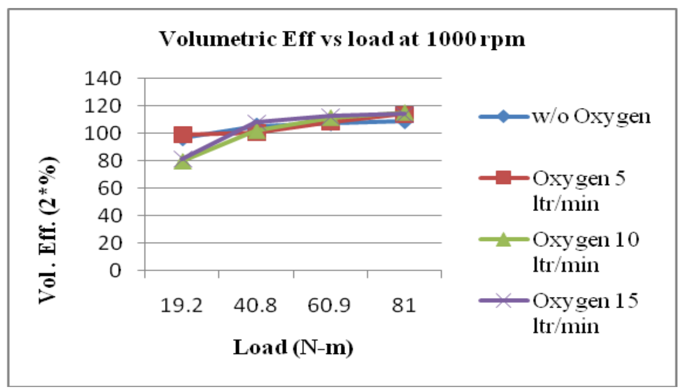
Discussion: Graph of 'Load' Vs. 'Brake Specific Fuel Consumption' infers that bsfc decreases with increase in load and oxygen blend quantity. The quantity of oxygen in air increases it helps to complete burning of fuel. Due to that more oxyrich air helps to reduce fuel consumption.

Graph.3: Brake thermal efficiency Vs Load



Discussion: Graph of 'Load' Vs. Brake 'Thermal Efficiency' infers that Brake Thermal Efficiency increases with increase in load and oxygen blend quantity. The fuel gets utilized properly for combustion at higher loads due to increase in brake power. If there is not enough oxygen in without oxygen blending for proper combustion, the fuel will not burn completely and will produce less energy. As due to increase in oxygen blending there will be good fuel conversion efficiency which reduces the partial burning.

Graph .4: Volumetric efficiency Vs Load



Discussion: Graph of 'Load' Vs. 'Volumetric Efficiency' infers that Volumetric Efficiency increases with increase in load and oxygen blend quantity. In Volumetric Efficiency not more difference in values with and without oxyrich air energizer.

Graph.5: CO Vs Load

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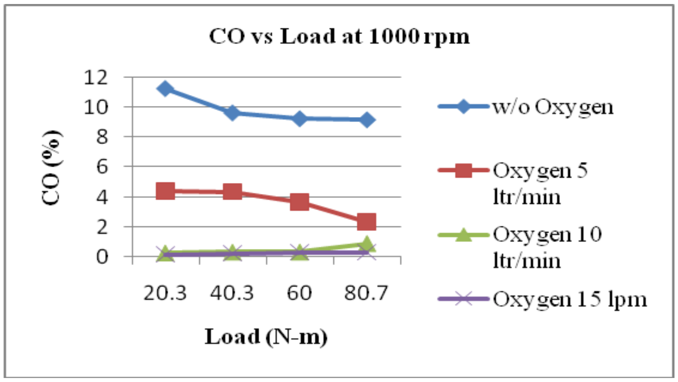
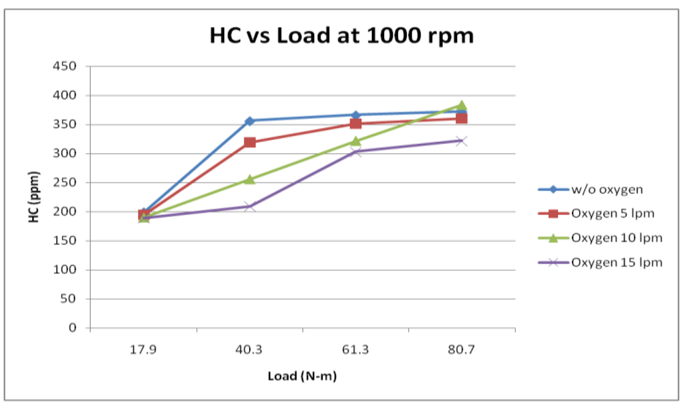


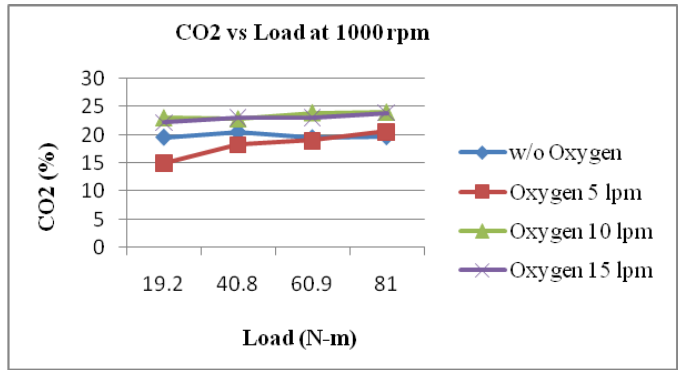
Discussion: Graph of 'Load' Vs. '% of CO' infers that CO decreases with increase in load and increase in oxygen blend quantity. When there is not enough oxygen to convert all carbon to CO2, some fuel does not get burned. Not only is CO considered an undesirable emission, but it also represents lost chemical energy. Maximum CO is generated when an engine runs with rich air fuel charge. On above graph it is concluded that the oxygen blending increases the complete combustion of fuel takes place and therefore CO pollutant in exhaust gas decreases and converted into CO_2.

Graph .6: HC Vs Load



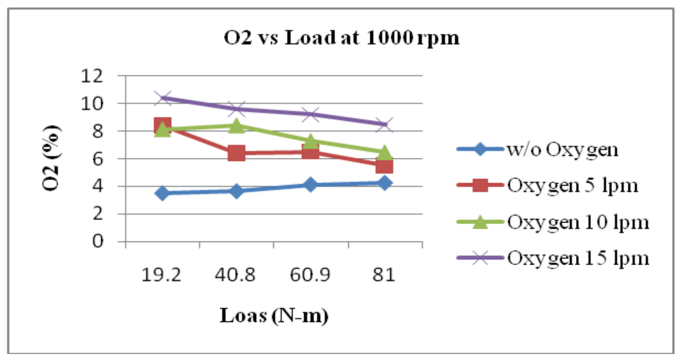
Discussion: Graph of 'Load' Vs. 'HC' infers that HC increases with increase in load, but decreases with increase in oxygen blend quantity. With a fuel rich mixture there is not enough oxygen to react with all the carbon, resulting in high levels of HC and CO in the exhaust products. This is particularly true during starting of engine, when the air fuel mixture is purposely made very rich. It is also true to a lesser extent during rapid acceleration under load. If air-fuel ratio is too lean poorer combustion occurs, again resulting in HC emissions. So proper blending of oxygen the complete combustion takes place, therefore HC emissions reduced.

Graph.7: CO_2 Vs Load



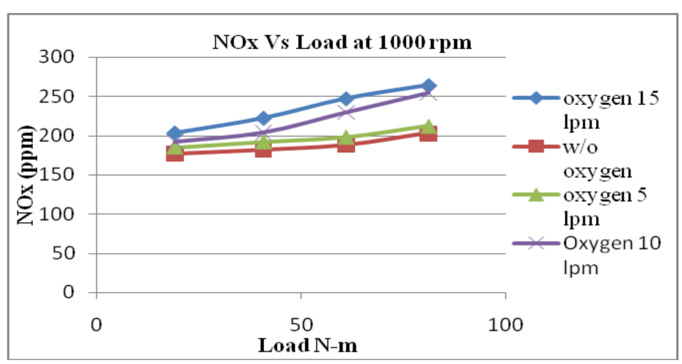
Discussion: Graph of 'Load' Vs. '% of CO_2' infers that CO_2 increases with increase in load and oxygen blend quantity. When oxygen blended in intake air it will get complete combustion of fuel and due to that CO is totally converted into CO_2 and finally percentage of CO_2 in exhaust increases.

Graph.8: O_2 Vs Load



Discussion: Graph of 'Load' Vs. '% of O_2' infers that O_2 decreases with increase in load, but increases with increase in oxygen blend quantity. Pure oxygen is mixed in intake air, therefore quantity of O_2 in the air increases. This affect the percentage of O_2 in exhaust emissions also increases.

Graph.9: NOx Vs Load



Discussion: Graph of 'Load' Vs. 'NOx' infers that NOx increases with increase in load and oxygen blend quantity. At low temperatures atmospheric nitrogen exists as a stable diatomic molecule N2. Therefore, only very small trace

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amounts of oxides of nitrogen are found. The higher the combustion reaction temperature, more dissociation takes place and more NOx will be formed. At this condition flame temperature is still high, and in addition, there is an excess of oxygen that can combine with the nitrogen to form various oxides. Combustion duration also plays a significant role in NOx formation within the cylinder. As the percentage of oxygen blend increases the NOx increases.

V. Conclusion

1. The main conclusion of above dissertation report is due to increasing the oxygen quantity in intake air of 4-stroke petrol engine with magnetic effect on air the complete combustion of fuel should be takes place. Therefore all performance parameters of engine should be increases (10-25%), the specific fuel consumption decreases (saving fuel up to 15%) and the main pollutants of petrol engine (CO & HC) is also decreases. It helps to increase the engine life, reduces the running cost of engine and also reduces the air pollution which affect on human life.
2. Mechanical Efficiency of 4-stroke petrol engine increases with increase in load and oxygen blend quantity. For 10 lpm oxygen blend the Mechanical Efficiency increases maximum (10-25%) as compare to other.
3. Because of oxyrich air the complete combustion of fuel should take place, therefore Brake Specific Fuel Consumption of 4-stroke engine decreases (up to 15%) with increase in load and oxygen blend quantity. It also decreases the running cost of engine.
4. Brake Thermal Efficiency of 4-stroke petrol engine increases with increase in load and oxygen blend quantity. For 10 lpm oxygen blend the Brake Thermal Efficiency increases maximum (10-25%) as compare to other.
5. Volumetric Efficiency of 4-stroke petrol engine slightly increases with increase in load and oxygen blend quantity. Because of small amount of oxygen blended in intake air not so many differences in Volumetric Efficiency of engine without and with oxyrich air energizer.
6. The main pollutants of petrol engine is CO and HC which is harmful for human life, both are reduces only when the complete combustion of fuel should take place. It is done by increasing the oxygen quantity in intake air. In this method these both pollutants are reduced upto 20-30%.
7. The other pollutants of petrol engine are CO_2, O_2, NO_x increases with increase in load and oxygen blend quantity.
8. It is concluded that for 10 lpm of oxygen blending in intake air, 4-stroke petrol engine getting better performance. More than 10 lpm of oxygen gas increases the cost of oxygen and performance is same or below than performance for 10 lpm oxygen blending.

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