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RESEARCH ARTICLE

EXPERIMENTAL INVESTIGATION OF CONVERSION OF 4-STROKE S.I ENGINE INTO COMPRESSED AIR ENGINE

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ABSTRACT

Utilization of better source of energy is always being point of research so keeping this in mind we have written this paper. As we know natural resources such as diesel and petrol are limited in amount so, there is need to maintain their exploitation for future. The excess exploitation of natural resources (especially in our contexts diesel and petrol) is the major cause of concern in the world. In the normal design engine diesel, petrol and natural gases are being utilized. It is challenge for the scientific and the technical individuals to comment with certain fuels other than the above so that the available limited source of our natural resources are maintained. Keeping in the view above social responsibility, the following options are available- Natural air, Bio diesel, solar energy and Water etc Keeping in the view the various pros and cons of the above, it has been decided to work with natural air due to huge availability in the nature. The air driven engine may be the point of research. Air driven engine may help to reduce the demand of conventional fuels. Thus the objective of this research is to design & modify the four stroke petrol engine into the compressed air engine by modification in the cam lobes and also to evaluate the comparison of economic characteristics between compressed air engine and four stroke SI engines. By experimental investigation it is found that compressed air engine can run per kilometer at expense of 60 to 70 paisa. It is hard to believe that only air can run the engine. It seems like impossible but now days it is possible to run the engine on only air. Also now a day's pollution is a major problem standing in front of world. Engine runs on the pure air is very good and cheaper solution on it. Pure air is vastly available on earth surface so there is no need of going anywhere for fuel. Due to these tremendous properties of air, in automobile industry air will play vital role in developing future cars. So in this paper effort is made to study various modification and merits & demerits of compressed air engine.

Key words: Compressed air engine, Investigation, Cam , 4-stroke S.I engine

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INTRODUCTION

Non-Renewable energy sources or conventional energy sources which meet most of the world's energy demand today they are on the way of depletion. Also combustion product of these sources causing problems like pollution, greenhouse effect and ozone layer depletion. To avoid human being from hazardous effect of these sources engineers are trying to develop such vehicle which cause less harm *to* human being and also to the environment. In result of that, hybrid vehicles, electric cars and air car are the new born child of this technology which is more efficient and less harmful. Instead of going to development of a whole new pneumatic system to run the engine, which requires high capital cost and research. The better solution of this is to make modifications in existing four stroke petrol engines and make it suitable for compressed air so that it can run on compressed air.

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The compressed air inside the tank is large amount of energy and this energy can be used to move the piston of an engine, the fourth moment of piston inside the cylinder and result generating of useful work. G Sujay kumar *et al.* [2016] proposed a model to convert internal combustion engine to work on compressed air like closing the transfer port, closing inlet port, removing spark plug from cylinder head and providing an inlet at the place of spark plug. The pressure of inside the storage tank which will be filled by compressed unit is very high and as the continuous injection of compressed air into the cylinder. Reciprocating compressor is used to maintain constant pressure in compressed air storage tank. Rixon *et al.* [2016] investigated about compressed air bike which is an eco – friendly automobile which uses compressed air as the source of energy. Amit kumar jha *et al.,* [2015] studied about modification of 2 – stroke engine to run on compressed air with use of air solenoid valve having dwelling at out dead centre. In the design there is no combustion only pressurization of air is implemented. It's also reduces weight of the vehicle and improve efficiency.

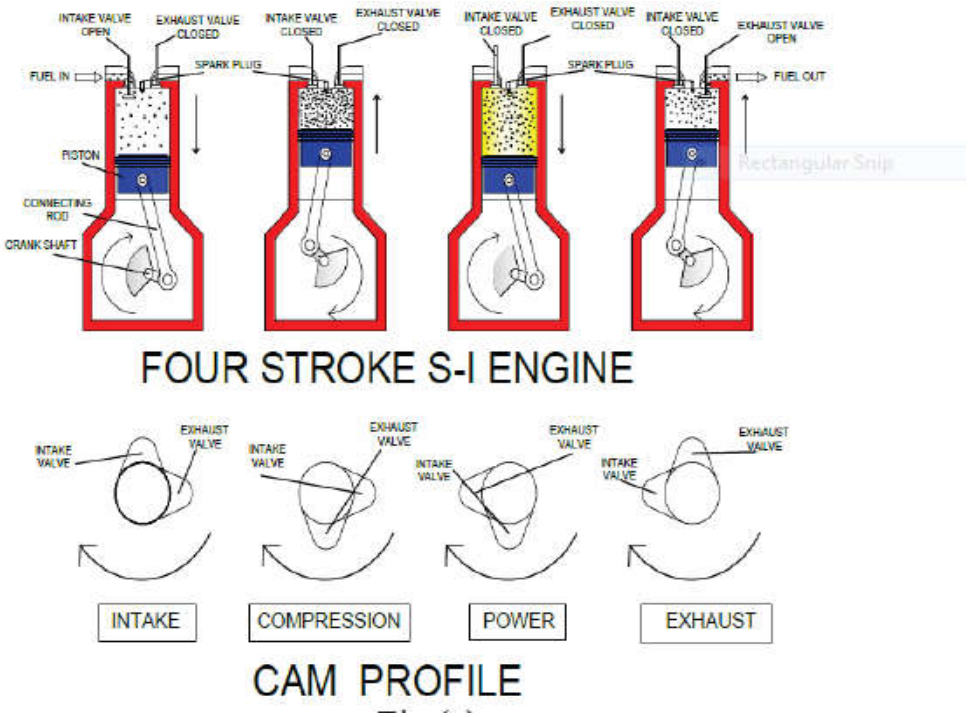

Figure 1. Working diagram of 4-stroke S.I engine

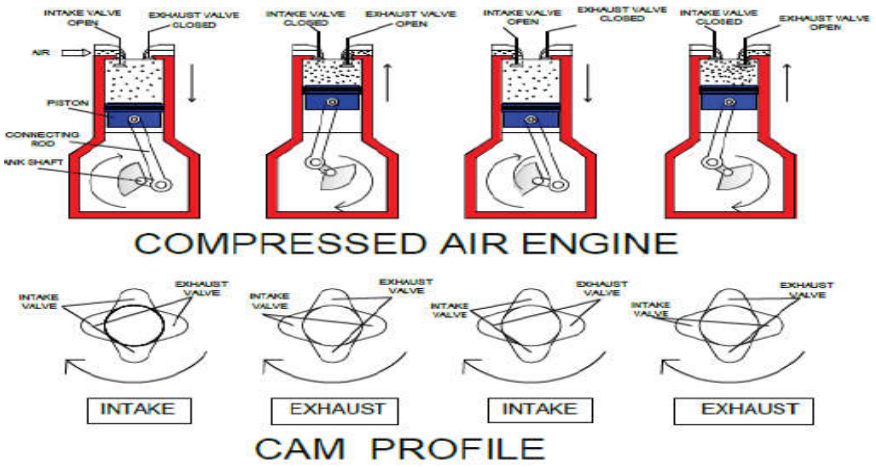

Figure 2. Working diagram of compressed air engine

Sourabh mahendrakar *et al.* [2015] Proposed use of gasoline and compressed air has shown effect related with engines in running the INOC. And overall efficiency of 68‰ and BTE of 38‰. Used compressed air in fifth and sixth stroke has resulted in decrease in cylinder temperature. Sharma *et al.* [2015] Proposed a single cylinder engine is modified to make it work on compressed air. Pneumatic cylinder and solenoid valve were main component introduced to the modified engine. The study show that indicated power was directly proportional to load. Buddapati *et al.* [2015] Proposed Modification of four – stroke engine to two stroke engine the first suction or power stroke and second stroke was exhaust stroke. Cam was designed to the inlet air timing for an air engine performance. Ivlev *et al.* [2014] Investigated Experimental research and mathematical modeling of scroll motor and their result are summarized. Vishal *et al.* [2014] Proposed that Air power engine could be an alternative of internal combustion engine two stroke engine gives 18 rpm maximum speed with running on compressed air. Experiment show that it is efficient and pollution free in nature.

Rohamare *et al.,* [2014] Studied experimental results and concluded that The engine that run on pure air and is very cheap. Pure air is vastly available on earth. The various modifications and merits and demerits of engine while considering alternate fuel, some factors are like availability economy and eco – friendly etc. Kripal raj mishra *et al.,* [10] Studied about working of four stroke single cylinder on pneumatic power. It contributes to reduce air pollution and zero pollution level in atmosphere as operated by compressed air. Some parameters developing the engine like temperature, density, input power, emission control, and no combustion process in compressed air engine technology.

Experimental Investigations

General Description

Compressed air engine operates with the compressed air and is very simple in construction and operation .Here compressed air from the air cylinder pushes the piston giving the power stroke.

In the next stroke piston escape the expanded air from the cylinder. The cycle is completed in two strokes. Therefore, uniform turning effort is obtained unlike four stroke engine Fuel tank and spark plug is eliminated from the conventional four stroke engine. In the case of a compressed air Engine, there is no combustion taking place within the engine. So it is less dangerous and non-polluting. It requires lighter metal only since it does not have to withstand elevated temperatures. As there is no combustion taking place and Carburetor is eliminated because carburetor is used for mixing of fuel and air purpose. There is no need for mixing fuel and air, here compressed air is the fuel and it is directly fed into the piston cylinder arrangement. It simply expands inside the cylinder and does useful work on the piston. This work done on the piston provides sufficient power to the crankshaft. The above experiment and modification has done on the motorcycle engine of Hero Honda (Model- Hero Honda Passion). A four-stroke engine is an IC engine in which the Piston completes four strokes. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four strokes are as follows-

INTAKE: - This stroke of the piston begins at top dead center. The piston descends from the top of the cylinder to the bottom of the cylinder, increasing the volume of the cylinder. A mixture of fuel and air is forced by atmospheric (or greater) pressure into the cylinder through the intake port.

Compression

With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air or fuel-air mixture into the cylinder head.

Expansion

This is the start of the second revolution of the cycle. While the piston is close to Top Dead Centre, the compressed air–fuel mixture in a gasoline engine is ignited, by a spark Plug in gasoline engines, or which ignites due to the heat generated by compression in a diesel engine. The resulting pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward bottom dead centre.

Exhaust

During the exhaust stroke, the piston once again returns to top dead centre while the exhaust valve is open. This action expels the expanded fuel-air mixture through the exhaust valve.

Working of modified compressed air engine

A compressed air engine is an engine in which the piston completes two separates strokes. A stroke refers to the full travel of the piston top dead centre to bottom dead centre or bottom dead centre to top dead centre along the cylinder, in either direction. There are two commonly used termed as follows:-

Intake

In this stroke inlet valve opens and exhaust valve closed. Compressed air enters in the cylinder during this stroke at pressure of 87.02264 Psi or 6 Bar to 94.27452 Psi 6.5 Bar. This stroke of the piston starts at top of the cylinder to the bottom of the cylinder by compressed air, increasing the volume of the cylinder.

Exhaust

In this stroke inlet or intake valve closed and exhaust valve opens. The piston once again returns to top dead centre and compressed air are pushed out to the cylinder into the atmosphere to the movement of piston through exhaust valve

Experimental method

Experimental setup

For carrying out the research, Petrol engine of hero Honda passion pro of 100 cc was used . As petrol is not being used in this experiment, so there was no need of the carburetor and thus the carburetor was removed. There is no combustion taking place inside the engine, so there is no need of a spark plug, so the spark plug is also removed. In the inlet valve a hose (pipe) is attached and a regulator was also attached on the top of the cylinder. So that the starting pressure 87.02264 Psi or 6 bars to 94.27452 Psi or 6.5 bar could be made. When the regulator was opened air entered into the cylinder through the pipe.

When the air entered at a pressure of 6 bar the piston moved from Top dead centre to Bottom dead centre (TDC to BDC).and piston reaches at bottom dead centre. After that, the piston started to move from Bottom dead centre to Top dead centre due to the weight of the flywheel. As piston started to move upwards the engine stopped working. This was because the exhaust valve did not open and the compressed air did not moved out. So, engine stopped there. To overcome this cam was designed. The engine used in the experiment had cam of two cam lobes. To overcome this, in addition to two cam lobes, a new cam lobe was attached. Further, to make the exhaust valve open again one more cam lobe was attached. When the four cam lobes were attached, the engine started to work due to this, the petrol engine started to work as a compressed air engine in which there is no need of petrol and combustion. The specification of an engine is given below:-

Figure 3. Camshaft of an engine with two lobes

Economy Analysis

A metallic cylinder of 60 Inches or 152.4 cm with a diameter 12 Inches or 30.48 cm was taken. The inside pressure was taken to be 140 Psi or 9.65266 Bar in half and 300 Psi or 21.6975 Bar (Maximum). The cost to fill the cylinder was Rs. 6, The engine was started by using this cylinder. The engine runs for 8-10 km (depending upon the conditions). This experiment was repeated several times to check and the resulting average were between 7-9.5, 8-10 & 8.5-10. On an average it can cover 1 km in 0.627 paisa.

Table 1. Air cylinder specification

Type	Metallic/steel
Lenth	60 inches or 152.4 cm
Diameter	1 feet or 30.48 cm
Inside Pressure	140 Psi or 9.65266 Bar to 300 Psi or 21.6975bar
Regulating Pressure	101.526 Psi or 7 bar
Engine Starting pressure	87.02264 Psi or 6 Bar to 94.27452 Psi 6.5 bar

Type	Air-cooled, 4-stroke single cylinder OHC
Displacement	97.2 cc
Max. Power	5.74 kW at 7500 rpm
Max. Torque	0.82 Kgf-m (8.04 N.m) at 4500 rpm
Bore x Stroke	50.0 x 49.5 mm
Carburetor	Side Draft, Variable venturi type with TCIS
Compression Ratio	9.0: 1
Starting	Electric start / Kick start

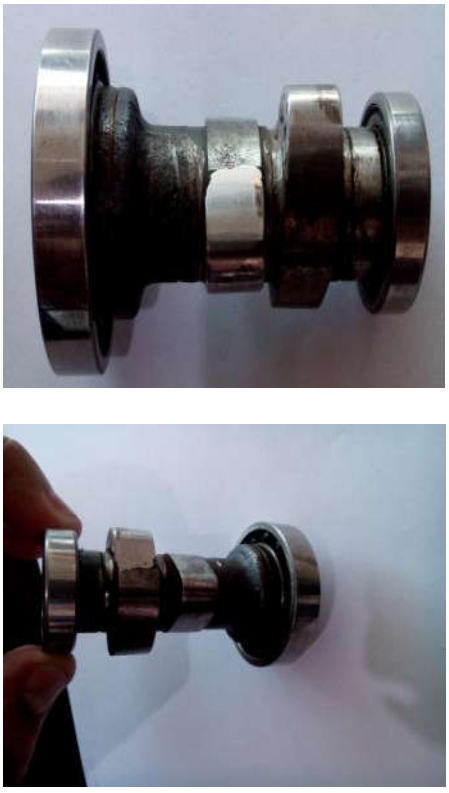

Figure 4. Camshaft of an engine with four lobes

Figure 5. Engine of Honda passion pro (100 cc)

RESULTS AND DISCUSSION

Through this experiment, it has been found that if instead of two cam lobes in petrol or diesel engine, four cam lobes are attached, the engine would start working as a compressed air engine. This compressed air engine does not require petrol or diesel but instead uses natural air for its working. This engine can travel 1 km in .65 paisa which is very less as compared to that of petrol and diesel engine and would further be economical to use. As there is no combustion taking place in the engine, so it is completely environmental friendly. The significant part of experimentation was concentrated on one aspect, Running the engine at different pressures and observing different speed in RPM. The engine was successfully tested at majorly two pressures at 4 bar and 3 bar respectively without load. The pressure required to start the engine is 4 bar while engine will be shut off below pressure 1.5 bar.

Table 2. Pressure (in bar) and speed (rpm)

Sr. No	Pressure(bar)	Speed(rpm)
1	3-4 bar	1650(average)
2	2-3 bar	

From above table it is clear that engine will gives about 4000 rpm at pressure of 10 bar without load.

Conclusion

This engine basically represents the idea about providing an alternative to the current energy scenario by modifying existing vehicles rather than manufacturing new. As conventional sources of energy are limited and due to that, the price of petroleum products also increasing day by day. Also, while considering alternate fuels, some factors are to be considered like availability, economy, eco-friendly etc., based on that compressed air technology is the best technology and demands more attention as it tends to take the engine to zero pollution running on a fuel that is freely available. Start-up power is not required to run this engine, also Exhaust air causes no harm to environment as it is cold and clean.

Drawbacks

- Noise created by engine
- Due to high pressure there is a possibility that cylinder can burst.
- Speed of the engine is less than that of petrol and diesel engine.

Future Scope

- To increase the speed of the engine.
- To reduce the noise

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