

Modification of Single Cylinder IC Engine to Run on Compressed Air-A Review



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Abstract

For the last few decades the development of technology and easy availability of fossil fuels has lead the higher brains to design I.C Engine to run a no. of machines (automotive and locomotive). But the days are near that this availability will lead to scarcity. So use of renewable sources in place of fossil fuels should be brought in application and need to maintain the exploitation of fossil fuel for the future and for global stabilization in nature. As we know the availability of natural air, bio diesel, solar energy, water, etc are very easy. So keeping the various pros and cons of the above in mind, we have decided to work with natural air by compressing it due to abundant availability in the nature. Now is the time when the air driven engine is the point of research. To run the air compressed engine it will need some replacement of parts in the engine and also have to remove and add.

Keywords: Renewable source; Air compressed engine; Global stabilization

Introduction

Modern generation is facing most serious problems which are air pollution and the greatest contribution to air pollution is automobiles which produce harmful gases and release in the atmosphere [1]. The vast majority of vehicles are operating on internal combustion engines which use fossil fuels like petrol, diesel, kerosene as fuel to run and produce many unburnt hydrocarbons which are exhausted into the air and also release gases like carbon dioxide and nitrogen dioxide that are harmful for plants and animals. It is experimentally found that the efficiency of the vehicle ranges from 72-95%. So this can be considered as one of the preferable choices to run the vehicle [2]. There is need for substituting these fuels by more eco-friendly fuels like air. Compressed air is very cheap as compared to other kind of fuels. Air could be compressed by various methods like electricity and windmills. The vehicles that run on compressed air are called light vehicles. Air is found everywhere unlike petrol and diesel.

Compressed air technology

Compressed air engine is a type of engine which works on principle of compression of compressed air. Compressed air engine generally converts compressed energy into mechanical work through rotary motion or linear motion. These types of engines work on piston and cylinder arrangement. Highly

compressed air possesses energy within itself. Compressed air when released freely it expands and release energy and this energy can be used for producing mechanical work [3].

The compressions of air stored of air together are called compressed air technology. This technology can be used in different pneumatic systems.

Compressed air is used in or for

- Air Brakes
- Pneumatic Drills
- Pneumatic Air Guns
- Pneumatic wrenches

Modification of Single Cylinder IC Engines to Run on Compressed Air

A single cylinder IC engines are modified so that it can run on compressed air and this modification can be done by removing some parts, replacing parts and adding some parts in already provided engines. In compressed air engines (CAE) instead of mixing of fuels with air and then burning it to drive piston, compressed air engine uses the expansion of compressed air to drive the engine. Now in modification of IC engines

- A. Firstly, we remove the unnecessary parts of engines.
- B. Secondly, we replace parts which pose corresponding functions in both engines.
- C. Thirdly, we add new parts.

Step 1: In this stage we remove the parts that are not required and this stage is very important in modification because these parts could interrupt the processes of the engine. In this modification, following parts are removed-

- a) Carburetor
- b) Exhaust

STEP 2: This stage includes replacing of several parts in order to work with compressed air. Following parts are replaced-

- a) Spark Plug with air inlet valve
- b) Fuel Tank with compressor

STEP 3: New parts are added in this stage to the engine to complete the modification. Added parts are as follows-

- a) Air Blow Gun to control flow of air in engine.
- b) Timing parameters which include everything that helps in getting perfect inlet timing.

Important Parameters Considered Before Designing Air Vessels

- a) The air vessel should withstand high internal pressure (up to 360 bars).
- b) The outer body of air vessels should be made of material having high strength like carbon fibers.

Converting 4-Stroke IC Engines into Air Driven Engines

The design of four stroke engine is simple.

A four stroke engine consists of namely

- I. Inlet stroke
- II. Compression stroke
- III. Power stroke
- IV. Exhaust stroke

Four stroke engines have inlet valves, exhaust valves and spark plugs. For a modified engine the inlet valve has been permanently closed and spark plug is replaced by inlet pipe from which compressed air will enter and the exhaust valve works with altered timing [4].

Camshaft

The camshaft of original four stroke IC engines had two cams with one lobe which were mutually perpendicular to each other. As the crank rotates, the camshaft also rotates in traditional way and the camshaft at the inlet and exhaust both have functioning

[5]. Modified camshaft is used in compressed air engine. Now in the modified camshaft the lobe of cam working for inlet valve is made circular. Also cam working for exhaust stroke with another lobe opposite to lobe already present is provided. This ensures opening of exhaust and closing of inlet to work at charged timing.

Working of modified compressed air engines

- a) Compressed air enters into the cylinder from the storage tank the position of piston is at TDC. Pressure is exerted by air and drive the piston towards BDC allowing compressed air to expand. This stroke is called power stroke. It is main source of engine power and torque.
- b) Inlet valve is closed and exhaust valve is opened and the expanded air in the cylinder is released outside of cylinder. The pressure of air is more than atmospheric pressure [6].

Literature Review

- a) Mistry Manish K, et al. [7] - The author says that the design and development of single cylinder 4 stroke engine can run on compressed air with few modification and that are main objective of its report. The compressed air can be filled by electricity using compressor and the requirement of compressing air has to be considered while computing overall efficiency. The main advantage of this engine is that there is no need of hydrocarbon fuel because there is no combustion process and if further improvement is carried out with thermodynamic analysis and stress analysis then losses like energy losses may decrease.
- b) Sandeep Tripathi- In this research the author mainly focused for the sustainable solution for the future energy requirements. Since in present study, the 4 stroke engine was modified to run on compressed air, a special design 'articulated connecting rod' has been used for constant volume process of compressed air inside the cylinder. With more modification like this only the proposed engine was theoretically compared with an ideal Otto cycle in terms of efficiency. The thermal efficiency of the proposed cycle (54.6%) was found to be less than ideal Otto cycle (66.17%) under similar operating conditions.
- c) SS Verma, et al. [8] - In this paper the brief introduction of latest development in compressed air engine is given and what various problems faced and their solution associated with technology. Various parameters are considered while designing the CAE like temperature, energy density, requirement of input power, energy release and emission control. Electric powered bike and cars are available in market which gives strong competition to compressed air car in terms of cost and environmental purpose. The technology looks distant but inventors are not from working on it.
- d) Jimil M Shah, et al. [6] - The author explains in this paper that the power which is produced by pressurized gases/air are used for many application and is pollution

free. Therefore we have benefits by converting 4-stroke IC Engine into 2-stroke pneumatic engine. In this conversion various changes in design of camshaft is carried out. Double label cam profile is required for value timing by use of Pro-E software (now called CREO). The cam and camshaft should be manufactured separately and then assembled. Single cylinder compressed air engine can be used as alternate for IC Engine in future. Exhaust of harmful gases is at very low temperature than IC Engine which solve problem of heating of engine. Zero emission of harmful gases, this concept can also be used in stationary application.

e) Arjit Maurya, et al. [9] - In this paper the author says that today's world is concerned about saving the environment and many measures are taken to reduce the pollution in environment. In compressed air technology air is taken as input from intake valve vertically above piston head and modified cam shaft is used to alter the timing of valve. Experimentally speed of 60 km/hr was achieved by the use of this engine. This engine is very efficient as it causes no combustion and therefore no harmful gases are released. The experiment which is performed shows that vehicle runs at 60 km/hr and weight was 18.5 kg which slightly affects the efficiency of engine.

f) Rohamare Pv, et al. [10] - The author says that the engine that runs on pure air and is very cheap. Pure air is vastly available on Earth. In this paper, efforts are made to study various modifications and merits and demerits of engines while considering alternate fuel some factors are considered like availability, economy, eco-friendly, etc. It has seen that engine running on compressed air compared to early to gasoline and electric vehicles in range and power but it may be an ideal mode of transportation once more research and analysis are put in the field.

g) Kripal Raj Mishra, et al. [3] - In this paper the author describes the working of 4-stroke single cylinder which puns on pneumatic power. Many engineers and scientists are attracted towards it as it is an old technique for many years. It contributes to reduce air pollution and zero pollution level in atmosphere as it is operated by compressed air. Some parameters are to be considered while developing the engine like temperature, density, input power, emission control. No combustion process in compressed air engines which is its main advantage.

h) Basau Saxena, et al. [4] - Rate of depletion of depletion of fossil fuel sources is increasing day after day and their combustion products are causing global problems is the main concern of author. Air powered engine will be used by compressing the air and modification in engine with cam.

i) Nitin Parashar, et al. [11] - As the matter of fact that natural resources are very much limited and there is need to maintain their exploitation for future, the author has decided to work with natural air for working of four stroke

petrol engine into compressed air engine by modification in cam lobes.

j) Saurabh Pathak, et al. [2] - The author describes the automotive industry is now using light weight vehicles as they have better handling. Heavy vehicles produce harmful gases like SO₂, CO₂ which is major cause of air pollution. The CAE technology is cheaper comparatively to IC engines at lower maintenance cost. The author concludes that pneumatic technology can be tested and developed using vane type noble air turbine and their efficiency varies from 72% to 47% which is very high comparatively to IC engines and the widespread of this technology helps in controlling serious problems of global warming.

k) Kalpesh Chavda, et al. [12] - In this paper author talks about compressed air engine and the design and development of single cylinder engine which can be run by the compressed air current four stroke engine can be run on compressed air with few modifications. In this paper compressed air filled by electricity using a compressor. Main advantages of this engine are that no hydrocarbon fuel required means no combustion process is taking place.

l) Krishna Kant, et al. [13] - The author has describes the use of fuel from transportation to other sectors. Since fossil fuels are recklessly used with degradation of quality of environment still the humans have come so far that they cannot back out to living without machines. So, the author has coined the need of compressed air technology in which compressed air that is easily available, non-toxic can be effectively used in CAE. Further he reviews the use of compressed air in energy storing devices such as in hybrid cars. There is no requirement of cooling system since there is no combustion.

m) Ankit Sharma, et al. [14] - In this paper , the author analyzed different effects to various parameters on air engines such as capacity of compressor tanks, number of strokes, number of cylinders, air pressure from compressors , use of electric devices , number of inlet and exhaust port , pneumatic guns . In the review , it is found that the engine speed is 3000 rpm was obtained at maximum pressure of 8 bars and high power gain of 0.95KW achieved at (bar at 1320 rpm. The rotating speed was found to be 715 rpm to 965 rpm whereas at high pressure of 25 bars with varying angles the speed ranges from 1191 rpm to 1422 rpm. At low pressure of 5 bars, maximum speed was 28.9 km / hr having travelling distance of 2.5 km and at 9 bars maximum speed was 36.5 km / hr travelling distance of 1.7 km.

n) Amit Kumar Jha, et al. [1] - Author has put the best effort to find the future energy requirement. In this study a 2-stroke engine had been modified to run on compressed air with use of air solenoid valve having dwelling at ODC. It encompasses injection of compressed air a constant volume process inside the cylinder contrary to traditional engines. In the design the

compressed air was supplied by solenoid actuated valves present in spark plug holes that are a distribution system in the time sequence in the separate engine cylinders. A valve timing disc has been used in accordance with engine speed. The engine had been theoretically compared with ideal Otto cycle and has been found acceptable.

o) Qihui Yu, et al. [15] - For avoiding some very serious damage which is done to the environmental system author wants to bring some modification in the automobile system. As their will be modification and cam will be used for controlling compressed air charge and discharge in cylinder.

p) Swadhin Patnaik, et al. [16] - This paper deals with the CAE and air driven engine is a pneumatic actuator that create useful work by expanding compressed air. The working of compressed air technology is very simple. The air is compressed into a cylinder so it would hold some energy within and when this compressed air expands the energy is released to do work. This energy can be used to displace the piston. Compressed air technology can be incorporated in hybrid system. This kind of system is called hybrid pneumatic electric propulsion and additional regenerative braking can also be used with this system.

q) Manjunath Minajagi, et al. [5] - in this paper author wants to reduce the weight of the vehicle as it helps in better handling and increase the efficiency of the vehicle. As the heavy vehicles are known for producing a large amount of harmful gases like CO₂, SO₂, etc. In this paper engine is modified from a four stroke to two stroke engine using a cam system driven by a crankshaft and the intake and exhaust valves have a small lift due to this modification. The electricity requirement will be considered for compressing air while computing overall efficiency.

r) Jogi U Goghari, et al. [17] - In this paper author is concerned about excess use of gasoline and other major fuels in I.C engines releases unburned gases in the environment and are counted in the major source of pollution. In this paper piston of compressed air engine is to compare with the conventional the needs like engine reversing and dynamic analysis of piston are done in CREO and ANSYS for pneumatic engine and I.C engine both.

s) Venkatesh Boddapatic, et al. [18] - In this paper author says that if the air storage tank built with carbon fiber can store air at high pressure at minimum volume space. Air powered technology is most advance technology in field of automotive development of multi-fuel engine that can run on both conventional fuel and air. Compressed air technology reduces use of fossil fuel which in turn reduces pollution and fuel cost is also comparatively reduced as air is available in the atmosphere.

t) Sawan Shetty, et al. [19] - The author has designed a compressed air engine that uses air as the fuel. Thus there is

no combustion but only pressurization of air. It also reduces weight of the vehicle and improves efficiency. This paper emphasizes the conversion of 4-stroke single cylinder S.I Engine into compressed air engine with minimum possible modification of existing design.

u) Sourabh Mahendrakar, et al. [20] - In this paper the author presents its research regarding designing and analyzing a hybrid engines working by compressed air and gasoline. 4-stroke IC engine is modified into 6 strokes using software like solid edge-19 and MATLAB-2010. First four strokes of INCO are exerted by combustion processes and last two are exerted by compressed air. Primary investigation show that the overall efficiency is 60 to 70% and thermal efficiency is 35 to 40% and the hybridization of engines had reduced the emission of Nitrogen Oxide (NO_x) by 13%. Following conclusions have been made by constituent testing and analysis-

v) Use of gasoline and compressed air has shown synergetic effect related with energies in running the INCO. INCO has shown overall efficiency of 68% and BTE of 38%.

w) Using compressed air in fifth and sixth stroke has resulted in decrease in cylinder temperature.

x) G Sujay kumar, et al. [21] - The author explain in this paper that modification are done to convert IC 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 air inside the storage tank which will be filled by compressor unit is very high and as the continuous injection of compressed air into the cylinder. The pressure inside the compressed air tank decrease. Reciprocating compressor is used to maintain constant pressure in compressed air storage tank.

y) Rixon, et al. [22] - In this paper author is very much concerned about environment and talks about compressed air bike which is an eco-friendly automobile which uses compressed air as the source of energy. Here the natural piston is replaced with a turbine.

z) Swamini Chopra, et al. - The author has presented the modification of conventional single cylinder 2-stroke petrol engine into compressed air engine using custom made cam and simple (5/2) DCV. The engine was tested for air pressure from 2 to 9 bar. However DCV started making excessive noise thus increasing chances of damage at pressure above 9 bar. The maximum torque was obtained at 8 bar. It shows the feasibility of modification for practical application such as 2-wheeler and low load vehicles.

Conclusion

Compressed air technology is the best technology for emission of harmful gases because in this no combustion or burning of fuel takes place.

A. It is eco friendly and pollution free and economical and also gives solution to fuel crisis and environment problems.

B. If further research and improvement is carried out with it stress analysis, thermodynamic analysis and to minimize the losses to increase the efficiency. This technology of air driven engine in modern days will become boon to our future generation [23-25].

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