Study and Development of Compressed Air Engine-Single Cylinder: A Review Study

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Abstract— This paper is reports on the review of compressed air engine for the design and development of single cylinder engine which can be run by the compressed air. Current four strokes single cylinder engine (bikes/moped) can be run on the compressed air with a few modifications that are the main objective of the study. Compressed air filled by electricity using a compressor. The electricity requirement for compressing air has to be considered while computing overall efficiency. Nevertheless the compressed air vehicle will contribute to reducing air pollution and tend to zero pollution level and promoting great environment. Main advantage of this engine is that no hydrocarbon fuel required means no combustion process is take place.

Keywords: compressed air engine, Single cylinder, four stroke engines.

I. HISTORY

In fact, two centuries before that Dennis Paper in apparently came up with the idea of using compressed air (Royal Society London, 1687).

In 1872 the Mekarski air engine was used for street transit, consisting of a single stage engine. Numerous locomotives were manufactured and a number of regular lines were opened up (the first in Nantes in 1879).

In 1892, Robert Hardie introduced a new method of heating that at the same time served to increase the range of the engine which in turn helped to increase the distance that could be traveled at a stretch. One of its new features was regenerative braking. By using the engine as a compressor during deceleration, air and heat were added to the tanks, increasing the range between fill-ups.

However, the first urban transport locomotive was not introduced until 1898, by Hoadley and Knight, and was based on the principle that the longer the air is kept in the engine the more heat it absorbs and the greater its range. As a result they introduced a two-stage engine.

Charles B. Hodges will always be remembered as the true father of the compressed air concept applied to cars, being the first person, not only to invent a car driven by a compressed air engine but also to have considerable commercial success with it.

After twelve years of research and development, Guy Negre has developed an engine that could become one of the biggest technological advances of this century. A French engineer by profession, he has designed a low consumption and low pollution engine for urban motoring that runs on compressed air technology. "air car" from Motor Development International is a significant step for zero emission transport, delivering a compressed air-driven vehicle that is safe, quiet, has a top speed of 110 km/h and a range of 200 km. Guy Nègre is the head of Research and Development at Moteur Development International (MDI) cars, where the Zero Emission Vehicle (ZEV) prototypes have been in production since 1994.

Fig. 1: History of compressed air engine model

II. INTRODUCTION

It is hard to believe that compressed air can be used to drive vehicles. However that is true and "air car" as it popularly knows has caught the attention of research worldwide. It has zero emission and is ideal

For city driving condition. MDI (Moteur Development International) is one company that holds the international patents for compressed air car. This review study reveals aim is to run the four strokes bike with help of compressed air, it will try to achieve a 50 km/h speed and range of refilling compressed air is after running of 70-80 km.

Two technologies have been developed to meet different need

- Single energy compressed air engines.
- Dual energy compressed air plus fuel engines

The single energy engines will be available in both Mini cats and City cats. These engines have been conceived for city use, where the maximum speed is 50 km/h and where MDI believes polluting will soon be prohibited with use of compressed air technology which having zero pollution level.

The dual energy engine, on the other hand, has been conceived as much for the city as the open road and will be available in all MDI vehicles. The engines will work exclusively with compressed air while it is running under 50 km/h in urban areas. But when the car is used outside urban areas at speeds over 50 km/h, the engines will switch to fuel mode. The engine will be able to use gasoline, gas oil, bio-diesel, gas, liquidized gas, ecological fuel, alcohol, etc. Both engines will be available with 2, 4 and 6 cylinders, When the air tanks are empty the driver will be able to switch to fuel mode, by car's on board computer.

III. HOW COMPRESSED AIR CAN DRIVE A CAR

The laws of physics dictate that uncontained Gases will fill any given space. The easiest way to see this in action is to inflate a balloon. The elastic skin of the balloon holds the air

tightly inside, but the moment you use a pin to create a hole in the balloon's surface, the air expands outward with so much energy that the balloon explodes. Compressing a gas into a small space is a way to store energy. When the gas expands again, that energy is released to do work. That's the basic principle behind what makes an air car move.

Fig. 2: Air car

Air car will have air compressor built into it. After a brisk drive, we can take the car home, put it into the garage and plug in the compressor. The compressor will use air from around the car to refill the compressed air tank. Unfortunately, this is a rather slow method of refueling and will probably take up few minutes for a complete refill. If the idea of an air car catches on, air refueling stations will become available at ordinary gas stations, where the tank can be refilled much more rapidly with air that's already been compressed.

Filling your tank at the pump will probably take about three minutes. This air car will almost certainly use Compressed Air Motor (CAM) Pneumatic wrench. Air car propelled with this engine will have tanks that will probably hold compressed air to about 11.03bar pressure. Its accelerator operates a valve on its tank that allows air to be released into the hoses and then into the motor, where the pressure of the air's expansion will push against the vanes and turn the rotor. This will produce enough power for speeds of about 15-20 kilometers per hour.

IV. ENGINE WORKING

High pressure air is introduced to the engine that pushes the piston and creates movement. The atmospheric temperature is used to re-heat the engine and increase the road coverage. The air condition system makes use of the expelled cold air. Due to there is no pollution, oil change is necessary every 50,000 km

Fig. 3: Four stroke engines convert into two stroke engine

In fig shows the engine of CD100 bike. We convert the four stroke engine to two stroke engine by changing the crank and cam shaft gear teeth. We are converted both the equal gear teeth. So, there are two stoke inlet and exhaust.

Fig. 4: timing changing of engine

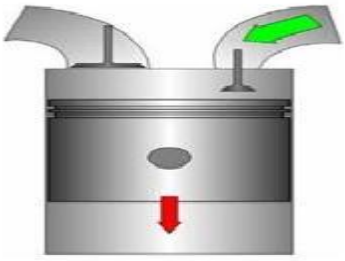

Fig. 5: intet of air

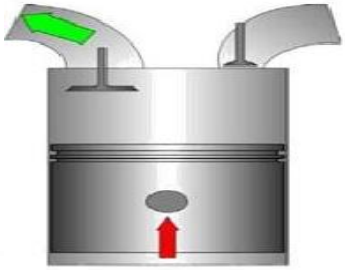

Fig. 6: outlet of air

V. REVIEW OF PREVIOUS RESEARCH WORK

No more working on the single cylinder four strokes engine. But here few researches are outlined as given below related to compressed air engine.

Air fuelled zero emission road transportation: A comparative study Haisheng Chen et al. adopted two technologies typical compressed air and liquid air power systems. Figure shows schematic diagram and working of cycle on temperature – entropy diagram for the both systems. As per author's knowledge and belief only few works reported on this study.

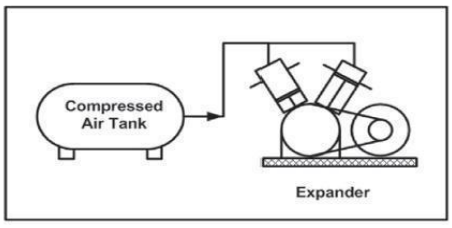

Fig. 7: Compressed air engine

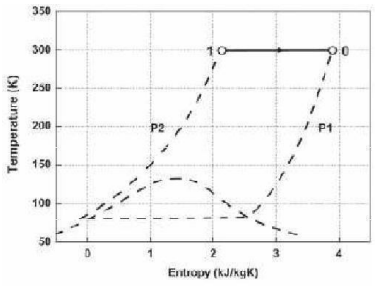

Fig. 8: T–S diagram of engines Compressed air engine

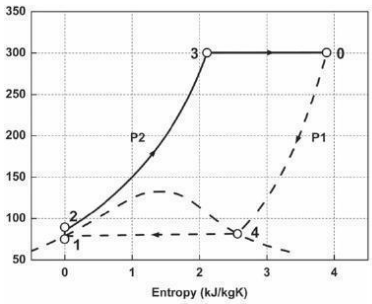

Fig. 9: T–S diagram of engines liquid air engine

Following conditions are used in the analyses Ambient pressure: P1 = 1.013 bar.

Working pressure: P2 = 300 bar. Ambient temperature: T0 = 300 K. Volume of tank: V = 300 lit.

The reasons to consider a fuel tank with 300 lit Volume and 300 bar working pressure include:

(I) 300 l and 300 bar are technically feasible (ii) a High pressure and a large volume are essential to give sufficient work output for an acceptable travel Distance and (iii) compressed air vehicles with a 300 lit fuel tank within initial pressure of 300 bar have been demonstrated practically. They have concluded in their paper is two types of air fuelled engines for zero emission road transportation are compared in terms of their shaft work, coolth, efficiency and energy density. It was found that the shaft work output and the coolth of both the fuels increase with increasing working pressure or temperature. Given the working pressure and temperature, liquid air powered engines have a slightly lower specific work outputs than compressed air powered engines. At P = 300 bar and T = 300 K, the practical net work outputs of the compressed air engine for isothermal ties of γ= 0.75 and 0.90 are respectively 222.8 kJ/kg and 284.2 kJ/kg, whereas the corresponding values for the liquid air engines are 184.1 kJ/kg and 245.6 kJ/kg. The volumetric energy density of liquid air fuel, however, is about 2.45 times that of compressed air fuel, and liquid air engines produce much more coolth than compressed air engines. On the other hand, the efficiency of compressed air powered engine is higher than that of liquid air powered engines, mainly because of its high energy consumption of liquefaction plants. Their analyses also suggested that an effective use of coolth is a key to improve the overall efficiency of liquid air powered engines. A novel compression strategy for air hybrid engines Amir Fazeli et al.have proposed utilizing of two storage tanks which increases the efficiency of regenerative braking of air hybrid vehicles significantly by increasing the stored air mass and, consequently, the storing pressure in the tank. Air hybrid engines have different operational modes. Illustrates the energy flow at different operational mode.

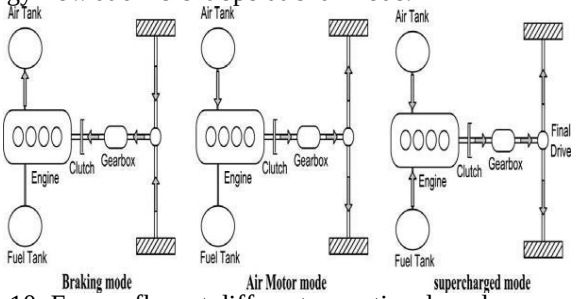

Fig. 10: Energy flow at different operational mode

The theoretical and experimental results showed the advantage of the proposed strategy over the conventional single-storage system. The proposed compression algorithm can be utilized in an air hybrid vehicle to increase the efficiency of energy recovery by the compression braking system. Compared to the double-stage regenerative braking, the double-tank system doubles the air flow rate because only one cylinder is needed to implement the proposed concept and thus, all the cylinders can be connected directly to the main tank. The proposed compression algorithm can be applied not only in air hybrid vehicle compression braking system, but also in any other applications, where higher pressure with higher air mass flow rate is demanded such as typical reciprocating compressors.

VI. SAFETY FEATURES OF THE AIR CAR

- That means that the tanks are prepared and certified to carry explosive product methane Gas. In the case of an accident with air tank Breakage, there would be no explosion or shattering for the tanks that are not metallic but made of glass fiber.
- The tanks would crack longitudinally, and the air would escape, causing a strong buzzing sound with no dangerous factor.
- It is clear that if this technology has been tested and prepared to carry an inflammable and explosive Gas, it can also be used to carry air.

VII. PROCEDURE

A. Step-1

In the Fig shows below there are three components. One is single cylinder engine of Hero-Honda-CD-DAWN-100CC; remaining two components include mounting made from mild steel rectangular and square cross-section pipe and Chain and sprocket mechanism to measure torque and force.

Fig. 11: Experimental setup with three components

B. Step-2

Fig. shows the crank modification to change 4-S to 2-S engine by equalizing the no. of teeth of cam shaft gear and crank shaft gear. Changing Crank Shaft timing gear from 14 teeth to 28 teeth for converting one revolution of crank to one revolution of cam shaft.

Fig. 12: Modified Crank Shaft Timing Gear

C. Step-3

As current compressed air engine is extended to compressed air vehicle so removing some equipment like dynamometer, chain sprocket and using same modified engine to compressor air tank mounted on the chassis fabricated of rectangular section tube.

D. Step-4

After cutting and fabricating the rectangular tube chassis mounting steering mechanism on it by clamps provided on chassis and adjusting the mechanism for turning of chassis and mounting of front wheels on chassis.

E. Step-5

After mounting engine on Wooden ply to avoid vibration to chassis, connecting engine output shaft to rear GI Hollow pipe on which Big sprocket is welded and connected to engine shaft by chain.

Fig. 13: shows mounting of engine

F. Step-6

On mounting rear shaft to chassis by pedestal bearing and connecting wheels at its both end connected by bolt and nuts.

Fig. 14: shows mounting of rear shaft to chassis

G. Step-9

Arranging seat on chassis and finally painting the whole chassis with green and white paint.

Fig. 14: Final Look after Completion of CAV Project

VIII. FUTURE SCOPE

This work of our project will explores performance of CAE (Compressed Air Engine) on the 4-S single cylinder 100cc engine. As per our knowledge and percentage of success on work of CAE can be used in commercial bike, bicycle with a few modifications. That will help to minimize the pollutions level and dependency upon conventional source of energy and also be economical and become a new alternative for automotive purpose.

Following future scopes are possible of this project work.

- The same study can be investigated with new light weight design of piston because of no combustion mean no thermal expect is considering in the design of piston, cylinder and other parts.
- The same study is carried out with other gases having more compressibility and more energy density.
- Engine is completely design for the compressed air which omits the convectional parts like catalytic convertor, spark plug, engine fins, carburetor etc.
- Development is more consent on the storage devices.
- In future same development is carried out with dual energy.

IX. CONCLUSIONS

Nowadays continue need of energy is increases, but basically conventional source of energy is limited due to that rate on price of petroleum is also continues hiked day by day. To satisfy there need alternate fuel or energy is required. But while considering alternate fuel some of factors are to be considered like availability, economy, and environment friendly etc., based on that CAT (Compressed Air Technology) is best technology which tend engine to zero pollutions. If further improvement is carried out with stress analysis, thermodynamic analysis, minimize compressed energy loss and other losses then efficiency of CAE may be further increases.

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