A Review: Compressed Air Engines

Mr. Pankaj Sadana[1], Rahul[2], Rakesh Kumar[3], Abhishek Devgan[4], Rohit Konwar[5], Sandeep Kumar[6]

[1]*Assistant Professor, Dept. of Mechanical Engineering. DAV Institute of Engineering & Technology. Jalandhar*
[2,3,4,5,6]*UG. Dept. of ME, DAV Institute of Engineering and Technology, Jalandhar*

Abstract - In this paper, the reliability of the compressed air used as a working fluid in the engines is demonstrated. The compressed air engines have certain merits and demerits over the conventional engines that we are using on such expensive rates. The applications of the compressed air for using in the various machines or engines is discussed. The main objective of this paper is to conclude why we have to be reliable over the compressed air engine in the future and what were the causes that we do not have been shifted to these engines since long ago.

Keywords: Compressed Air Engine (CAE), Pressure regulator (PR), Solenoid Valve (SV) etc.

I. INTRODUCTION

According to research scholars, the petroleum crisis will happen after some years as the population rate is increasing. So the dependence of industries and the common man on the renewable sources for providing the energy in the machines and automobiles is becoming great. The next generation will be striving to be dependent over the alternative of the fossile fuels as these are diminishing day by day. Also these fuels are so injurious to our health that makes the person to be restricted for their less usage. Therefore air as fuel to drive can be used because of following reasons -Air is all around us. Air will not come to end. Air causes zero pollution. Best of all, air is free. The use of potential energy stored in compressed air for running engines and propelling vehicles can prove to be advantageous. Electric vehicles, hybrid electric vehicles and pneumatic power vehicle are the methods to reduce the use of conventional engines but the electric batteries have disadvantage of disposal so these are not widely used. The basic idea behind the publishing this paper is to demonstrate the concept of green energy with zero emission. A method for operating pollution free engine chamber is by injecting supplementary compressed air, comprising a suction and compression chamber and an expansion and exhaust chamber. The several requirement should be fulfil for converting the existing fuel engine to the compressed air engine. The first one is that the base technology is needed to be economically available. Secondly, the final system should be efficient to operate in hostile conditions. The third constraint is that the new engine should be simple in design and reliable.

II. SYSTEM DESIGN

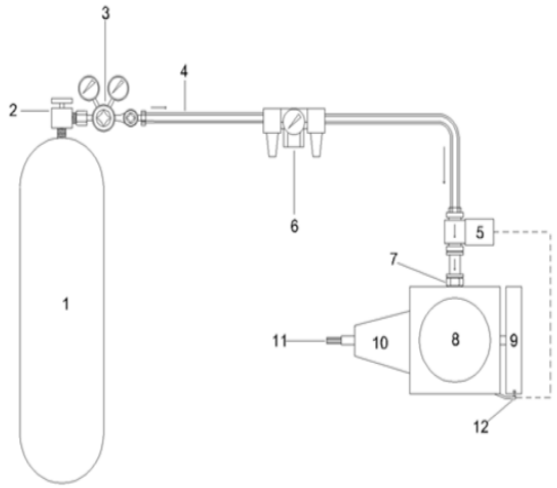

Fig. 2.1 Assembly of CAE

The components of the compressed air engines are less and are easily installed over the engines as compared to the petroleum or diesel based engines. In these engines there is no need of spark plug and carburetor as the air is not being heated and mixed with any other constituent. The components of the compressed air are:-

1. Storage Cylinder
2. Stop Valve
3. Pressure Regulator
4. Hose(Pipe)
5. Solenoid Valve
6. Air Filter and Lubricator
7. Adapter Nipple
8. SI engines
9. Flywheel
10. Gear Box
11. Transmission Shaft
12. Magnetic sensor

Storage Cylinder is used to store high pressurised air ranging from 100bar to 300bar.Stop valve is used to stop the flow of air to the further parts in case when the engine is off and for inspection purpose. Pressure regulator regulate the supply of air to the Engine which alters the torque at the crankshaft. Hoses are the pipes through which the compressed air is passing to the engine. Solenoid valve is an electromechanically operated valve. Air Filter is required to pure the incoming air to engines

preventing seizing of engines. Lubricator serves the purpose of lubrication in moving. Adapter Nipple connects the engine cylinder to solenoid valve .Flywheel serves the purpose of Storing energy when the supply of energy is more whereas it releases this energy when the demand of energy is more.

III. HISTORY OF CAE

Compressed air has been used since 19th century to power mine locomotives and trams in cities such as Paris. During the construction of Gotthard rail tunnel and other tunnel pneumatic locomotives were used. In 1903, the Liquid Air Company located in London England manufactured a number of compressed air and liquid air cars but the major problem in these engines was the lack of torque produced by the engines and the cost of compressing the air. In 1687 Dennis Papin apparently came up with the idea of using compressed air. In 1872 the Mekarski air engine was used for street transit, consisting of a single stage engine. Guy Negre in 2002 mainly tells about the storage of the energy in the form of compressed air at high pressure and high temperature in reserve chamber when the vehicle de-accelerates and brakes are applied. This compressed air provides energy when the vehicle reaccelerates.

IV. PROPERTIES OF COMPRESSED AIR

Air has the property to store energy when compressed. It releases this energy when expands. It occupies less volume as compared to the fuels hereby increasing the mass flow rate of compressed air inside the engines providing high energy output also its constituents are uniformly distributed throughout its volume. Air has the moisture content so it can corrode the components so lubrication is very much required. Inspite of all these, as the air has a low density so seals should be very much tight so that there will not be any leakage that can cause that pressure difference to decline promptly.

V. APPLICATIONS OF COMPRESSED AIR

- Compressed air is used as a working fluid for machines or engines.
- It is used for cleaning processes in manufacturing.
- It is used for controlling robotic machines on assembly lines.
- It is used for the pressing applications and printinng pumps and equipments
- It is widely used for lifting operations,
- Inspite of all these applications it is used for cooling in the welding equipments.

Fig 4.1:- Compressed Air Vehicle

Fig 4.2:-Robotic hand operated by compressed air

VI. MERITS AND DEMERITS OF COMPRESSED AIR SYSTEM

a) Merits of system:-

1. Much like electrical vehicles, the system reduce pollution.
2. Transportation of the fuel does not involved. This presents significant cost benefits. Also, pollution created during fuel transportation would be eliminated.
3. Air, on its own, is non-flammable. So no health hazard is in operation.
4. The mechanical design of the engine is simple, robust that produce significantly tougher operating conditions.
5. Low manufacture cost of the kit as well as easy maintenance.
6. Compressed-air tanks can be disposed of or recycled with less pollution than batteries.
7. Unlike electrical batteries it does not involve the degradation problems.
8. The tank may be refilled more often and in less time than batteries can be recharge.

b) Demerits of the system**:-**

1. When the air expands in cylinder it gets cooled very much so it has to make comparitively hot using heat exchanger.

2. Refuelling the compressed air container using small air compressor requires very long time.
3. Tanks get very hot when filled rapidly. Tanks are sometimes immersed in water to cool them down when they are being filled.
4. The limited storage capacity of the tanks will affect the range of distance to be travel by the vehicle.
5. The leakage problem of air also results into the faul running of the engine.

VII. CONCLUSION

- Compressed air engines are ultimately powered by electricity as a compressor works on electricity but its instantaneous and electrical vehicles take lot of time for charging their batteries.
- Transportation of fuel is not needed, hence its cost efficient and also reduces pollution of environment.
- The temperature generated is not very high hence a cooling system is not needed and also material of lower strength and lower thermal resistivity can be used to build the engine, by which cost can be reduced.
- Disposal of air tanks is easy as compare to disposal of electric batteries.
- The price of filling air powered vehicles is significantly cheaper than petrol, diesel or biofuel. If electricity is cheap, then compressing air will also be relatively cheap.
- The main disadvantage is, it uses indirect form of energy. As air needs to be compressed first and then that air is used in the engine to give the desired output. We all know that in any conversion of energy some energy is always lost hence the efficiency of engine suffers.
- We know that when air expands adiabatically it cools down and since the temperature goes down the movement of piston is affected and again in turn the efficiency is affected.
- The capacity of the tanks has to be known as a large amount of gas but above the sustainable limit of the tank can cause bursting of tanks.
- If safe working is required less amount of air should be filled in tanks, but that would account for frequent refilling of the tanks, due to their low range.

REFERENCES

[1] GM. M. Schechter, New Cycles for Automobile Engines, SAE Paper 0623 (1999).
[2] GS. Trajkovic, P. Tunestål, and B. Johansson, Introductory Study of Variable Valve Actuation for Pneumatic Hybridization, SAE paper 0288 (2007).
[3] GK. D. Huang, S. C. Tzeng, and W. C. Chang, Energy-saving hybrid vehicle using a pneumatic-power system, Applied Energy,81 (2005) 1-18.
[4] GK. D. Huang, S. C. Tzeng, W. P. Ma, and W. C. Chang, Hybrid pneumatic-power system which recycles exhaust gas of an internal combustion engine, Applied Energy, 82 (2005) 117-132 .
[5] GC. Y. Huang, C. K. Hu, C. J. Yu, and C. K. Sung, Experimental Investigation on the Performance of a Compressed-Air Driven Piston Engine, Energies, 6 (2013) 1731-1745.
[6] Ordonez CA, Plummer MC. Cold thermal storage and cryogenic heat engines for energy storage applications. Energy Sources 1997;19(4):389–96.
[7] Chen HS, Cong TN, Yang W, Tan CQ, Li YL, Ding YL. Progress in electrical energy storage system: a critical review. Prog Nat Sci 2009;19:291–312.
[8] Evans A, Strezov V, Evans TJ. Assessment of utility energy storage options for increased renewable energy penetration. Renew Sust Energy Rev2012;16:4141–7.