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AIR CAR
THE EMISSION FREE VEHICLE

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***Abstract*—** Air car is a compressed air vehicle that uses a motor which is powered by compressed air. This paper reports an improved technology in the automobile sector that uses no gasoline or other bio-carbon based fuels, which makes them, emission free at the exhaust. Since air car's source of energy is usually electricity, its total environmental impact depends on how clean the source of this electricity is. Air cars are powered by motors driven by compressed air, which is stored in a tank at high pressure such as 30 MPa (4500 psi or 310 bars). The storage system of a CAES (Compressed Air Energy Storage) is one of the most interesting characteristics of this technology, and it is strictly related to its economic feasibility, energy density and flexibility. The storage tanks of these cars are made up of carbon-fiber that possesses the capability to safely hold air at a pressure somewhere around 4500 psi, making them comparable to steel tanks, thereby eliminating the issues with hydrogen damage and danger involved in high-impact crashes. The cars are designed to be filled up at a high-pressure pump. Compressed air has relatively low energy density. In order to increase energy density, some systems may use gases that can be liquefied or solidified. Refuelling may be done at home, but filling the tanks to full pressure would require compressors having 250-300 bars, which are not normally available for home standard utilization, considering the danger inherent at these pressure levels. To sum it up, they are non-expensive cars that do not pollute and are the need of the hour in today's era of increased pollution (especially in Delhi) and are easy to get around in cities.

Index terms- **CAES, carbon-fiber, compressed air, compressor and energy density.**

I. INTRODUCTION

The air operated motor was first applied to the field of transportation in the 19thcentury. The first successful application of the pneumatic motor in transportation was the Mekarski system used in locomotives. Mekarski engine was first used by Tramway De Nantes on 13th December, 1879 to power their fleet of locomotives, located in Nantes, France. Compressed air has been used since the 19th century to power mine locomotives and trams in cities such as Paris (via a central, city- level, compressed air energy distribution system), and was initially the basis of naval torpedo propulsion. During the construction of the Gotthardbahn during 1872 to1882, pneumatic locomotives were used in the construction of the Gotthard Rail Tunnel and other tunnels of the Gotthardbahn. In 1903, the Liquid Air Company located in London, England, manufactured a number of compressed-air and liquefied-air cars. The major problems with these locomotives are insufficient torque produced by engine and high cost involved in compressing the air.

Fig. 1 – The Mekarski engine

Recently several companies have started to develop compressed air cars and published several scientific works based on a concept of air engine over the past years. In 2008, Liu and Yu published their results of calculations for the air compressed to 200 bars. They concluded that the total system efficiency is 25-32% during compression and 34% during decompression, for a pressure of 10-30 bars. Also, in 2008, India's largest car manufacturer, TATA, has announced that it would introduce world's first commercial vehicle that will run on compressed air.

II. . DIVISIONS

Conventional air cars stop every 50 miles or less to refill with very high pressure air in large tanks that take up a lot of space in a car that is probably underbuilt for lightness. The car weighs a lot less when the tanks are empty than when the tanks are full.

A. Hybrid air cars

These cars have both an air engine and a gas engine. The gas engine runs compressor and the air engine runs the wheels. There is no need for large high pressure tanks since the car has a gas tank that is filled up periodically. The heat from the gas engine can be used to increase the efficiency of compressed air.

B. Closed cycle air cars

These cars use the air engine exhaust and recompress it. Since the air is never expanded to its largest volume (atmospheric pressure), the compressor is smaller, so this would be a good feature. Among free range air cars, many designs are partially closed-cycle, re-compressing only a portion of the air engine exhaust.

C. Conversion air cars

These cars use an existing gas or diesel engine that is modified to run on compressed air.

D.. Free range air cars

Sometimes called self-fuelling, self-sustaining, or extended range air cars, they carry their own compressor. While any air car can and should carry a compressor for regenerative braking, this class of air car is unique in which at least one of its compressors runs almost all the time. Probably not during start but after the car is underway and moving down the road, it has a means of decreasing the energy cost of keeping the tanks full, when compared to conventional compressors. This class of air car and stationary air power plants with similar capabilities focus on the less controversial designs which were enthusiastically covered by the engineering press through 1930.

III. WORKING

Air motor or compressed air engine is a type of motor which does mechanical work by expanding compressed air. Pneumatic motors generally convert the compressed air energy to mechanical work through either linear or rotary motion. Linear motion can be achieved from either a diaphragm or piston actuator, while rotary motion is supplied by either a vane type air motor, piston air motor, air turbine or gear type motor.

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, energy is released to do work. That's the basic principle behind what makes an air car move.

Fig. 3.1 – Air car system

Air cars using this engine will have tanks that will probably hold about 3,200 cubic feet (90.6 kiloliters) of compressed air. The vehicle's accelerator operates a valve on its tank that allows air to be released into a pipe and then into the engine, where the pressure of the air's expansion will push against the pistons and turn the crankshaft. This will produce enough power for speeds of about 35 miles per hour. When the air car surpasses this particular speed, a motor is activated to operate the in-car air compressor which compresses more air on the fly and provide extra power to the engine. The air is also heated as it hits the engine, increasing its volume to allow the car to move faster.

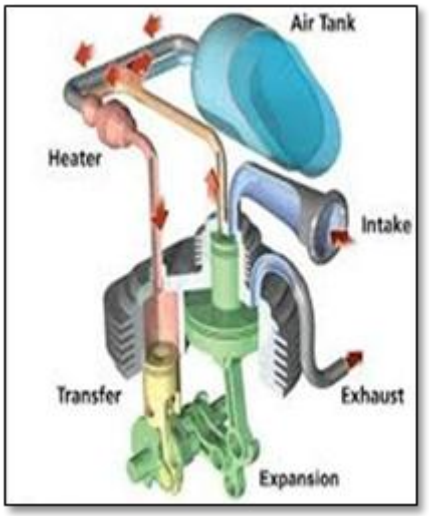


Fig. 3.2 – Compressed Air Engine (CAE)

Most of the work done by an air compressor is during compression stroke, which provides energy to air by increasing its pressure.Compression also produce heat, however, the amount of work required

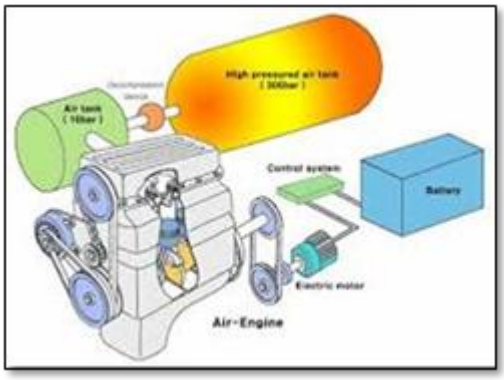
to compress a quantity of air at a given pressure depends on how fast this heat is removed. The compressed work done will lie between the theoretical work requirements of two processes mentioned as below:-

A. Adiabatic Compression

An adiabatic compression is a process in which the entropy remains constant and provides no cooling. Thereby, the pressure rise takes place, which increases the compression work requirements for maximum value.

B. Isothermal Compression

An isothermal compression is a process in which the temperature remains constant during a cycle. In this process, the work required for compression tends to minimum.



IV. Technology and Operation

This section is divided into two sub sections namely

Technology and Operation.

A. Technology

Technology is the collection of techniques, skills, methods and processes used in the production of goods or services or in the accomplishment of objectives, such as working of air car. The various parts and its function are as follows:-

B. High Pressure Accumulator

Air Car uses compressed nitrogen, which is held in a tank called the high-pressure accumulator. (Pt.1 in figure 4.1)

C. Pneumatic Pump and Piston

A hydraulic pump and piston compress nitrogen in the accumulator. When the nitrogen is released (by pressing the accelerator), the pump runs in reverse direction. Acting now as a motor, it harnesses the energy of the moving hydraulic fluid to send power to the wheels. (Pt.2 in figure 4.1)

Fig. 4.A – Air Car -Inside look

c. *Lower Pressure Accumulator*

After the hydraulic fluid passes through the motor, it flows to the low-pressure accumulator, where it is stored for later use. (Pt.3 in figure 4.1)

D. Gasoline Engine

A gasoline engine supplements the air power when accelerating or going up hills. Typical compressed air engines use one or more expander pistons or rotary expanders. It is necessary to heat the air or the engine during expansion. For example, the Mekarski system heated compressed air with steam. This could be an 82-hp, 1.2L, I3 for sub-compacts and a 110-hp, 1.6L, I4 for compacts. (Pt.4 in figure 4.1)

Tanks

The tanks must be designed to safety standards appropriate for a pressure vessel, such as ISO-11439.The storage tank may be made of metal or composite materials. The fiber materials are considerably lighter than metals but generally more expensive. Metal tanks can withstand a large number of pressure cycles, but must be checked for corrosion periodically. One such tank stores air at 4,500 pounds per square inch (about 30

MPa) and hold nearly 3,200 cubic feet (around 90 cubic metres) of air. The tanks may be refilled at a service station equipped with heat exchangers, or in a few hours at home or in parking lots, plugging the car into the electrical grid via an on-board compressor.

E. Operation

Compressed air has a low energy density. In 300 bar containers, about 0.1 MJ/L and 0.1 MJ/kg is achievable, comparable to the values of electrochemical lead-acid batteries. While batteries can somewhat maintain their voltage throughout their discharge and chemical fuel tanks, provide the same power densities from the first to the last litre, the pressure of compressed air tank falls as air is drawn off. A consumer-automobile of conventional size and shape typically consumes 0.3–0.5 kWh (1.1–1.8

MJ) at the drive shaft, per mile of use, though unconventional sizes may perform with significantly less emission output.

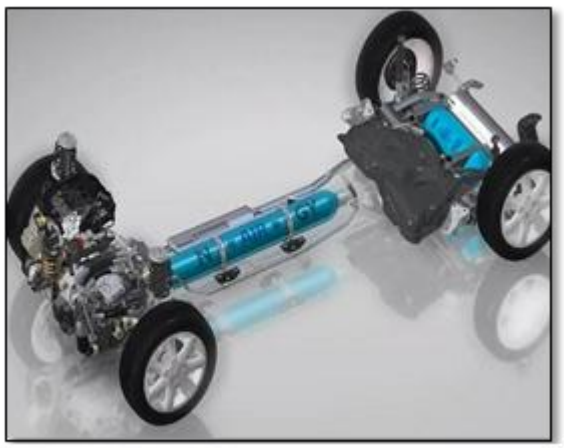


Fig. 4.B – Air Car -Chassis

Like other non-combustion energy storage technologies, an air vehicle displaces the emission source from the vehicle's tail pipe to the central electrical generating plant. Where low emissions sources are available, net production of pollutants can be reduced. Emission control measures at a central generating plant may be more effective and less costly than treating the emissions of widely dispersed vehicles.

Since the compressed air is filtered to protect the compressor machinery, the air discharged has less suspended dust in it, though there may be carry-over of lubricants used in the engine. The car works when gas expands.

V. Advantages

Compressed air is a safe and reliable power source that is widely used throughout industry. In fact, approximately

70% of all companies use compressed air for some aspect of their operations. Compressed air vehicle engine offers higher efficiency than most electric vehicles. Its only emissions are cold air. The feature and the multiple example of use are as follow

- Much like electrical vehicles, air powered vehicles would ultimately be powered through the electrical grid, which makes it easier to focus on reducing pollution from one source, as opposed to the millions of vehicles on the road.

- Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Pollution created during fuel transportation would be eliminated.
- Compressed-air technology **reduces the cost of vehicle production by about 20%**, because there is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
- The engine can be **massively reduced in size**.

The aluminium construction of these vehicles will keep their weight under 2,000 pounds (907 kilograms), which is essential to making these vehicles fuel efficient and will help them go faster for longer periods of time.

- The engine runs on cold or warm air, so can be made of lower strength light weight material

such as aluminium, plastic, low friction Teflon or a combination.

- **The fuel is remarkably cheap**, an important consideration in this era of volatile gas prices

VI. Limitations

The principal limitation is the indirect use of energy. Energy is used to compress air, which, in turn, provides the energy to run the motor. Any conversion of energy between its forms, results in loss. For conventional combustion motor cars, the energy is lost when oil is converted to usable fuel – including drilling, refinement, labour, storage, eventually transportation to the end-user. For compressed-air cars, energy is lost when electrical energy is converted to compressed air, and when fuel, either coal, natural gas or nuclear, is burned to drive the electrical generators.

- Pollution is nonetheless produced when the air is compressed, both while the car is moving and while it's being refuelled.
- Refuelling the compressed-air container using a home or low-end conventional air compressor

may take as long as 4 hours, while the

specialized equipment at service stations may fill the tanks in only 3 minutes.

- Compressed air tanks can be dangerous

 Distance travelled could also become a limitation, depending on your travel habits. The distance that an air car can cover without refuelling is crucial because very few filling stations will have compressed air pumps available at first.

VII. PERFORMANCE IMPROVEMENT TECHNIQUES

A. Replacement of Vane Motor

If the vane motor is replaced by a three-piston radial air motor, the efficiency can be considerably increased. "The three piston radial air motor, which is based on a crank principle, needs much less discharge. It can make our design commercially viable.The American arm of MDI and the company likeliest to produce the first air car for the U.S. market aims to have a car available soon able to travel between 800 and 1,000 miles on one tank of air plus 8 gallons of gas.

B. Storage of Compressed air

It may be possible to store compressed air at lower pressure using an absorption material within the tank. Absorption materials like Activated carbon,or a metal organic framework is used for storing compressed natural gas at 500 psi instead of 4500 psi, which amounts to a large energy saving. Imagine an engine which is powered by compressed air with upto 94% efficiency and zero % polluting emissions.

C. . Rotary Piston Concept

A unique rotary piston concept involves virtually eliminating vibration, internal wear and friction. Wind, solar and hydro power can be used to compress the air, as the thermodynamic process is used to operate vehicle of compressed air engine because air cools down when expanding and heats up during compression.

D. Making Air Tank safe

To make compressed air tanks safe, the air tanks are made of carbon fiber and are designed to crack, rather than shatter, in a crash. This crack would allow the "fuel" to escape harmlessly into the surrounding air. Manufacturers feared that air escaping from one end of the tank could produce a rocket-like effect and propel the car on a jet of air. The valve on the cars' fuel tank has been placed on the side to minimize this effect.

VIII. CONCLUSION

"This paper was inspired from the fact that finding an alternative renewable fuel source has almost become inevitable today with depleting petroleum level and increasing global warming. **If the air compressor is also based on a solar energy fuelled system, compressed air can be considered to be 100 per cent green fuel.** Nowadays the need of energy is on the rise because the use of conventional energy is limited. To satisfy our needs alternate fuel or energy is required .But while considering alternate fuel some factors are needed to be considered viz. availability, eco-friendly etc. Since Compressed Air Technology (CAT) is best technology which leads engine to zero pollutions and through this we can power our cars, ships, train anything except aeroplane. If further improvement is carried out with stress analysis, thermodynamic analysis, minimization of compressed energy loss and other losses then efficiency of CAE may be further increased. By this technology its possible to solve the environment problems we are facing today. Don't you think? Yes, of course we can! We can do anything and everything what we want. Now we have been to the moon and also space. Its time, we act and save our environment.

REFERENCES

1). https://auto.howstuffworks.com

2). https://zeropollutionmotors.us

3). https://en.wikipedia.org

4). https://greencarreports.com

5). https://iosrjournals.com

6). https://popsci.com