International Journal of Advanced Engineering and Technology
ISSN: 2456-7655; Impact Factor: RJIF 5.54
Received: 06-02-2020; Accepted: 05-03-2020; Published: 22-03-2020
www.newengineeringjournal.com
Volume 4; Issue 1; 2020; Page No. 44-46

Air powered cars (Compressed Air Vechicle)

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Abstract
The air powered cars is also called as a low pollution or zero pollution cars. Since the car runs on compressed air it is environmentally friendly. Air powered cars runs on compressed air instead of gasoline. This car is powered by a two-cylinder compressed engine. This engine can run either on compressed air alone or act as an IC engine. Compressed air is stored in glass or fiber tanks at a pressure of 4351 psi. Most likely, it will be the evolution car that is being built by Zero Pollution Motors. The cars have generated a lot of interest in recent years, and the Mexican government has already signed a deal to buy 40,000 such cars to replace gasoline- and diesel-powered taxis in the heavily polluted Mexico City.

Keywords: Compressed Air Vechicle, environmentally, powered

1. Introduction

A compressed air car is a compressed air vehicle that uses a motor powered by compressed air. The car can be powered solely by air, or combined (as in a hybrid electric car) with gasoline, diesel, ethanol, or an electric plant with regenerative braking.

The first piston takes in ambient air and compresses it to approximately 300 psi in the compression chamber during the first cycle of the engine. When the piston pause, a small amount of compressed air from the tanks is released into the expansion chamber to create a low pressured, low temperature volume of about 140psi. Shortly before the valve to the exhaust cylinder is opened, a high-speed shutter connects the compression and expansion chambers. The sudden pressure and temperature difference between the low chambers creates pressure waves in the expansion chamber, thereby producing work in the exhaust chamber that drives the piston to power the engine. The air tanks for storing the compressed air are localized underneath the vehicle. They are constructed of reinforced carbon fiber with a thermoplastic liner. Each tank can hold 3,180 cubic feet of air at a pressure of up to 4,300 psi. When connected to a special compressor station, the tanks can be recharged within 3-4 minutes. They can also be recharged using the on-board compressor 3-4 hours after connecting to a standard power outlet.

These new vehicles incorporate various innovative and novel systems such as storing energy in the form of compressed air, using new materials such as fiberglass to build the car and vegetable oil for the motor lubrication. Numerous innovations have been integrated in the engine design. As an example, there is a patented system of articulated conrods that allow the piston to pause at top dead center. The following graph indicates this movement of the piston in relation to the driving shaft rotation.

The car engine runs on compressed air and incorporates the three laws of thermodynamics.

- The first law states that energy can neither be destroyed nor be wasted.
- The second law describes the disorder within substances.
- The third law defines that only in crystals at 0K, there is absolute disorder.

The car incorporates these laws of thermodynamics in the following way. First, the pressure that is created within on-board tanks during compression is in direct proportion to the energy that has been stored in it. This process is equivalent to the energy stored in a wire spring when it is compressed.

Furthermore, thermal energy is dissipating from the system, thereby lowering the temperature of a compressed gas volume that expands. This process is equivalent to harnessing energy that has been stored. In turning the shaft, shock waves similar to supersonic waves are created when two gases with very different characteristics are mixed together in a certain fashion. All these effects result in a high-powered air technology.

a. Engines

Compressed air cars are powered by motors driven by compressed air, which is stored in a tank at high pressure such as 31 MPa (4500 psi or 310 bar). Rather than driving engine pistons with an ignited fuel-air mixture, compressed air cars use the expansion of compressed air, in a similar manner to the expansion of steam in a steam engine. There have been prototype cars since the 1920s, with compressed air used in torpedo propulsion.

b. Storage Tanks

In contrast to hydrogen's issues of damage and danger involved in high-impact crashes, air, on its own, is non-flammable, it was reported on Seven Network's Beyond Tomorrow that on its own carbon-fiber is brittle and can split under sufficient stress, but creates no shrapnel when it does so. Carbon-fiber tanks safely hold air at a pressure somewhere around 31 MPa, making them comparable to steel tanks. The cars are designed to be filled up at a high-pressure pump.In compressed air vehicles tank designs tend to be isothermal; a heat exchanger of some kind is used to maintain the temperature (and pressure) of the tank as the air is extracted.

c. Energy Density

Compressed air has relatively low energy density. Air at 30 MPa (about 4,350 psi) contains about 50 Wh of energy per liter (and normally weighs 372 g per liter). For comparison, a lead–acid battery contains 60-75 Wh/l. A lithium-ion battery contains about 250-620 Wh/l. The EPA estimates the energy

density of gasoline at 8,890 Wh/l, however, a typical gasoline engine with 18% efficiency can only recover the equivalent of 1694 Wh/l. The energy density of a compressed air system can be more than doubled if the air is heated prior to expansion. In order to increase energy density, some systems may use gases that can be liquified or solidified. "CO2 offers far greater compressibility than air when it transitions from gaseous to supercritical form.

d. Emissions

Compressed air cars could be emission-free at the exhaust. Since a compressed air car's source of energy is usually electricity, its total environmental impact depends on how clean the source of this electricity is. However, most air cars have petrol engines for different tasks. The emission can be compared to half of the amount of carbon dioxide produced by a Toyota Prius (being around 0.34 pounds per mile). Some engines can be fuelled otherwise considering different regions can have very different sources of power, ranging from high-emission power sources such as coal to zero-emission power sources. A given region can also change its electrical power sources over time, thereby improving or worsening total emissions. However, a 2009 study showed that even with very optimistic assumptions, air storage of energy is less efficient than chemical (battery) storage.

e. Working

Air powered cars run on compressed air instead of gasoline. Since the car is working on air there is no pollution. A two-cylinder, compressed air engine, powers the car. The engine can run either on compressed air alone or act as an internal combustion engine. Compressed air is stored in fiber or glass fiber tanks at a pressure of 4351 pounds per square inch. The air is fed through an air injector to the engine and flows into a small chamber, which expands the air. The air pushing down on the piston moves the crankshaft, which gives the vehicle power.This car is also working on a hybrid version of their engine that can run on hybrid version of their engine that can run on traditional fuel in combination with air. The change of energy source is controlled electronically. When the car is moving at speeds below 60kph, it runs on air. At higher speeds, it runs on a fuel such as gasoline diesel or natural gas. Air tanks fixed to the underside of the vehicle can hold about 79 gallons (300 litres) of air. This compressed air can fuel the car upto 200km at a top speed of 96. 5kph.When the tank nears empty it can be refilled at the nearest air pump. The car motors require a small amount of oil about 0.8 litres worth that have to change just every 50,000km.

2. Literature review

Various companies are investing in the research, development and deployment of Compressed air cars. Overoptimistic reports of impending production date back to at least May 1999. For instance, the MDI Air Car made its public debut in South Africa in 2002, and was predicted to be in production "within six months" in January 2004.As of January 2009, the air car never went into production in South Africa. Most of the cars under development also rely on using similar technology to low-energy vehicles in order to increase the range and performance of their cars. Compressed air has been used since the 19th century to power mine locomotives and trams in cities such as Paris and was previously the basis of naval torpedo propulsion. Compressed air was also used in some vehicles for boosting the initial torque or rotary motion. In the 1970s, Willard Truitt invented CAV but sold the design to the US Army & NASA because of financial constraints. In 1979, Terry Miller invented the air car and patented it.

MDI (Motor Development International)

MDI has proposed a range of vehicles made up of AIR Pod, One Flow Air, City Flow Air, Mini Flow Air and Multi Flow Air. One of the main innovations of this company is its implementation of its "active chamber", which is a compartment which heats the air (through the use of a fuel) in order to double the energy output. This 'innovation' was first used in torpedoes in 1904.

Tata Motors

As of January 2009 Tata, Motors of India had planned to launch a car with an MDI compressed air engine in 2011. In December 2009 Tata's vice president of engineering systems confirmed that the limited range and low engine temperatures were causing problems.

Tata Motors announced in May 2012 that they have assessed the design passing phase 1, the "proof of the technical concept" towards full production for the Indian market. Tata has moved onto phase 2, "completing detailed development of the compressed air engine into specific vehicle and stationary applications".

In February 2017 Dr. Tim Leverton, president and head at Advanced and Product Engineering at Tata revealed was at a point of "starting industrialisation" with the first vehicles to be available by 2020. Other reports indicate Tata is also looking at reviving plans for a compressed air version of the Tata Nano, which had previously been under consideration as part of their collaboration with MDI.

According to reports, Tata Motors' new car that is powered by compressed air technology could be launched in India in three years' time. The manufacturer has also successfully completed the first phase of the project. The second stage of the detailed development started a few years ago. Air-powered cars will weigh below 907 kg, which will make them more fuel-efficient. The AIR Pod concept can be driven with the help of a joystick and only costs Rs 70 per 200 km. The production model of the AIR Pod will have a top speed of more than 65km/hr.

Engineair Pvt. Ltd

Engineair is an Australian company which has produced prototypes of a variety of prototype small vehicles using an innovative rotary air engine designed by Angelo Di Pietro. The company is seeking commercial partners to utilise its engine.

Peugeot/Citroën

Peugeot and Citroën announced that they intended to build a car that uses compressed air as an energy source. However, the car they are designing uses a hybrid system which also

uses a gasoline engine (which is used for propelling the car over 70 km/h, or when the compressed air tank has been depleted). In January 2015, there was "Disappointing news from France: PSA Peugeot Citroen has put an indefinite hold on the development of its promising-sounding Hybrid Air powertrain, apparently because the company has been unable to find a development partner willing to split the huge costs of engineering the system." Development costs are estimated to 500 million Euro for the system, which would apparently have need to be fitted to around 500,000 cars a year to make sense. The head of the project left Peugeot in 2014.

APUQ

APUQ (Association de Promotion des Usages de la Quasiturbine) has made the APUQ Air Car, a car powered by a Quasiturbine

3. Conclusion

The CAV fuel cycle is conceptually simple: air is compressed to high pressure at a stationary compressor station, transferred to an on-board storage tank, and slowly released to power a pneumatic motor. The motor converts air power to mechanical power, which is transferred to the wheels and is used to operate the vehicle. In this way, compressed air acts not as an energy source like gasoline but as an energy storage medium similar to an electric battery.

There are advantages as well as disadvantages of the CAV technology-

CAV technology reduces the cost of vehicle production by about 20 per cent, because there is no need to build a cooling system, fuel tank, ignition systems or silencers. The engine can be reduced in size. 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. Compressed air tanks can be disposed of or recycled with less pollution than batteries. The air tank may be refilled more often and, in less time, than batteries can be recharged, with re-filling rates comparable to liquid fuels. Lighter vehicles cause less damage to roads, resulting in lower maintenance cost.

The major problem with all compressed air cars is the lack of torque produced by the "engines" and the cost of compressing the air. The principal disadvantage is the indirect use of energy. Energy is used to compress air, which in turn, provides the energy to run the motor. For compressed air cars, energy is lost when electrical energy is converted to compressed air, and when fuel is burned to drive the electrical generators. Refueling the compressed air container using a home or low-end conventional air compressor may take as long as 4 hours, while the specialised equipment at service stations may fill the tanks in only 3 minutes. Tanks get very hot when filled rapidly. However, if well-insulated, the heat would not be lost but put to use when the car is running.

CAVs are greener and cheaper to operate since they do not consume fossil fuels and produce zero tailpipe emissions while offering the power and performance needed for light-duty vehicle use. A research report (P Saiprasanna Kumar *et al*) suggests that CAVs are the best options which provide the most comprehensive answer to the present urban pollution problems. They are clean, easy to drive, comparatively low cost and do not take a lifetime payoff. Their speed, range and power are limited now, so further research could provide more effective results.

Researchers Pepson, Felix & Schipper observe that although the concept of CAVs has received great attention in the popular press, there have been few studies evaluating the potential of air cars as an alternative to conventional vehicles. Today, CAVs take the form of lightweight passenger cars designed for slow speed city driving. However, unlike those fuels, the efficiency of a CAV is largely dictated by the thermodynamic properties of gases with accompanying inefficiencies of compression and expansion.

It is pertinent to mention that passenger transportation faces very strong challenges including emission of greenhouse gases, health hazards and high import dependence of petroleum products. Several evolutionary solutions are being developed to reduce the impact of motor vehicles, such as increased fuel economy standards and the accelerated adoption of hybrid vehicles. One new approach is found in CAVs which addresses acute urban pollution problems. CAVs will likely become the potential mode of urban transportation in the future. However, further research on their speed, range and power would be needed to make that possible.

Acknowledgement

We wish to express our graditude to all those who provided and cooperation in various ways at the different stages for this project. Also, we would like to express our sincere appreciation to our director sir Mahavir Swami institute of technology, Head of mechanical department Vinay Kumar

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