Enhancements to Compressed Air Powered Cars

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Abstract--- This paper presents an alternative way to power cars and their design. With the continuous depletion of fossil fuels for powering of vehicles has now led to a situation of complete eradication of them. This is where the concept of using compressed air as a fuel to power cars comes in. The air powered engine uses the compressed air in place of the conventional parts (spark plug, valves, etc.) of an IC engine. The pre – heated compressed air is allowed to produce the power stroke by injecting it at correct intervals through a nozzle against the piston inside the IC engine that is operated on a cam shaft. The air storage tank(s) used are made up of carbon fibers which can sufficiently hold higher pressure of air. Since every working part of the car (brakes, suspension, etc) areactuated by air which is abundantly available in the atmosphere, harnessing them would be comparatively easier and also produces more comfort. This method of powering minimizes the losses due to lesser working mechanical parts, lesser heat generation and hence increases the overall efficiency. Adding to this, this kind of vehicles are more eco-friendly, economical in the long run and are more sustainable than the electric vehicles which is believed to be so.

Keywords:-*fossil fuel depletion , compressed air , economical and eco-friendly.*

I. INTRODUCTION

The compressed air powered cars run on air available in the atmosphere purely void of all the conventional fuels that are currently used. This air engine is an emission free piston engine. These engines are similar to that of steam engines as they use the expansion of the jet of air to perform work against the piston.This propulsion technique using pressurized air as fuel was invented by Guy Negre, a French engineer.Since then many advancements have been made to the engine. But these air powered engine haven't been as powerful as that of an IC engine and was also not the issue of concern until the fact that fuel crisis is predicted to have begun. By making cars lighter and introducing reduced storage though dynamic piston its performance could be increased and reliable than what it is in the present stage.On the other hand such types of renewable alternatives needs to be emphasized more so as be in harmony with the nature.

II. ENGINE DESIGN

The engine design is much simpler than the conventional engine. It is designed in such a way that it uses the expansion of compressed air to drive the piston in modified piston engine that has just a nozzle supplying the pressurized air in quick successions with the help of nylon fiber tubes generally used for transferring compressed air or steam at about 25 times per second. This system does not require the presence of spark plug, valves and cam drives for propelling.

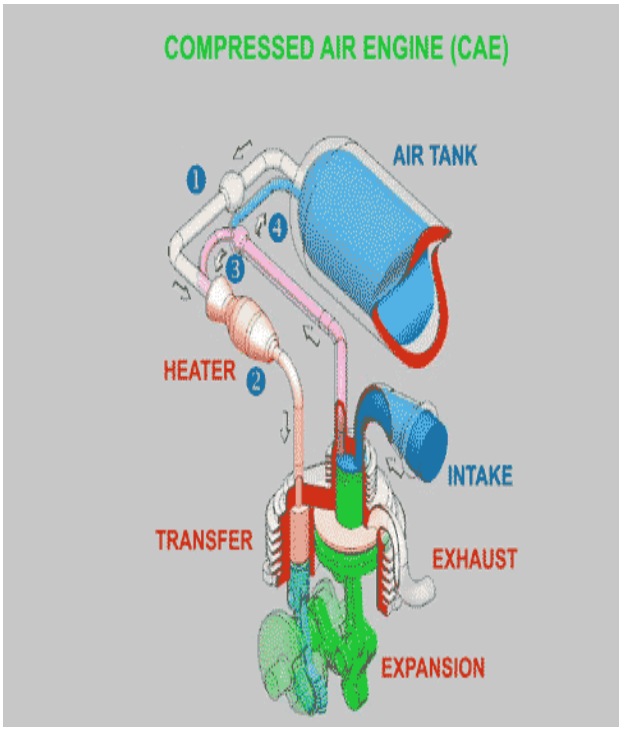

Figure1: Process Flow View Of Compressed Air Engine

The pre-heating is usually done by the surrounding atmosphere itself. In case of cold countries where the surroundings is colder than the minimal required temperature of air at about 30°C ~ 40°C is accomplished using a pre-heater before injecting it into the cylinder body made of Solidteknicswrought iron that is comparatively 1/3rd the weight of cast iron without compromising in its wear resistance and hardness. The two main reasons for pre-heating of compressed air is that high temperature increases the mobility of atoms thereby increasing the kinetic energy and it is also like a second check to ensure that the compressed air has minimal amount of water vapourpresent so that it does not cause any erosion of engines parts or decrease the momentum of injection.The water formed in the reservoir is heavier than the compressed air, causing it to fall to the bottom of the

compressor, so it would be ideal if place the tank in the vertical position.

Drawing air from the top of the compressor will take less moisture with it. If preheating is not prior to storing of compressed air in the reservoir then before ejecting it into the cylinder body it has to be passed through driers like Drying and Distribution Unit (DDU) which would result in the decrease of injection velocity.

Figure 2: Drying and Distribution Unit (DDU)

With a modified crank design the time during which the air is warmed from the source and a two stage process allows improved heat transfer. The implementation of allowing the transmission system to actuate the wheelsdirectly provides a variable torque from zero to maximum with all the possible efficiencies as compared to a previous type wherein fixed torque is used and any change of torque can be brought about only by using a pulley transmission which results in loss in efficiency due to mechanical efficiency.

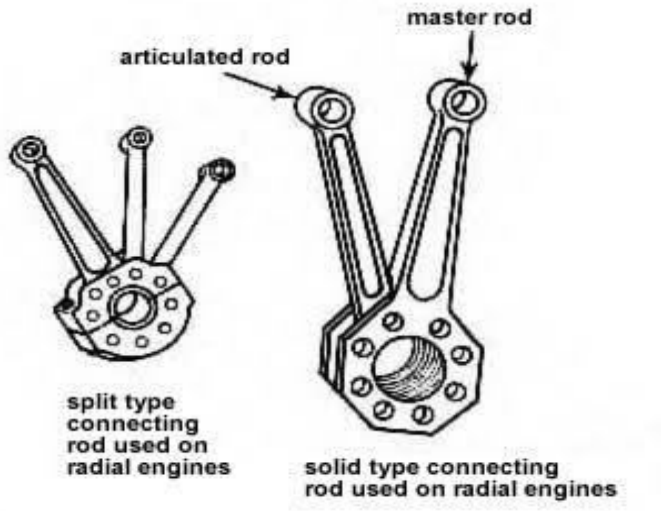

Figure3: Aritculated Con-Rod

The con-rod is the component that allows the piston to be held at the TDC for 70% of the cycle. This way enough time is given to create the pressure in the cylinder. The torque is also better so the force exerted on the crankshaft is less substantial than in the classic system.

III. RESERVOIR TANK

The prime importance comes to the design and the material used for the reservoir tank so as to able to withstand such high pressure and also to ensure an overall efficiency in sustaining its properties alongside with its safety aspects. Usage of reservoir with materials like steel or even tungsten carbide is possible but the overall weight of the car would increase resulting in the drag force and hence loss in efficiency alongside with the higher cost of the tank. Though it is capable of sustaining sudden large impacts during an accident it does not allow for the high pressurized air to escape which might lead to

internal leaks in the tank and might damage the other components of the car.

The compressed air tank is a pressurized glass or carbon fiber epoxy tank that can generally hold upto $90m^3$air compressed to 310 bar. The system is not dangerous in case of accidents as there is no flammable gas or fuel is released and that the tanks give in easily causing an elongated crack so that there is no explosive outbreak of the compressed air called as "rocket effect" but produces aloud but harmless noise.This is vital because if the tank does not crack and if it deforms it would result in an forceful shift of such high pressure air which could even send the car flying a few meters in air. These are the same tanks that are used to carry liquid gas used in busses. The compressed air tank vehicles are composed of interior thermoplastic container which ensures it is airtight. This is held in a coiled and crossed carbon fiber shell so as to sustain a high pressure of 310 bar and temperature range from -40°C to 60°C.

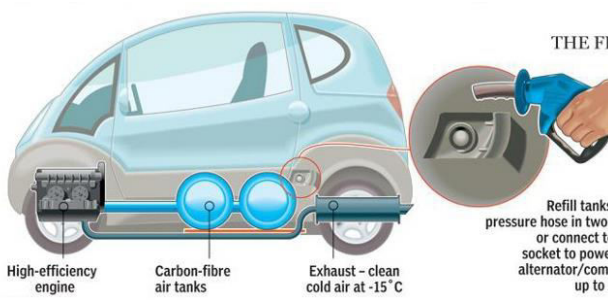

Figure 4: Position and arrangement of reservoir tanks

Also carbon fiber tank could be reinforced with aluminum strips in the inner surface of the tank so that during wreckage of the tank during accidents instead of elongated cracks, the cracks would be formed in spaces between the strips in a curve shaped manner that would create large number of strip like outlets for the air to escape over large area which would be quick and absolutely no jerks would be felt by the passengers. One another addition that could be done to increase the efficiency is by removing the pumps and installing a piston inside the reservoir guided by a pressure sensor that would move up as the air in the reservoir gets used up so that the same pressure is maintained throughout until the entire tank is used up.

IV. OTHER DEVELOPMENTS

A. Distribution and Valves:-To ensure smooth running and to optimize energy efficiency, the engines could use a simple electromagnetic distribution system which controls the flow of air into the engine. This system runs on very little energy and alters neither the valve phase nor its rise.

B. Brake Power Recovery:-The cars could be equipped with a range of modern smart systems like the mechanisms that stop the engine automatically when the car is stationary above 20seconds and also starts it back on almost instantly. The brake power recovery is a feature in the pneumatic system which recovers about 14% of the power used also called as regenerative braking which could be used for other purposes like charging of battery.

C. The Air Filter:-The car engine works with both air taken from the atmosphere and the pre-compressed air in tanks Before compression the air must be filtered to get rid of any impurities that could damage the engine. Carbon filters can be used to eliminate dirt, dust, humidity and other particulate matter. This is the first time that an automobile produces minus pollution i.e. it reduces the incoming pollution to the fullest. With this system the air that comes out of the car is cleaner that the air that went in.

V. ELECTRIC ENGINES – A THREAT

Despite the major shift in the automobile industry towards the use of electric engines the reason why compressed air-powered vehicles is required is because although the electric power serves as the next better alternative and is comparatively cheaper the odds of electric vehicles is so much more than what it is believed to be.

The major source for electricity is obtained from the thermal power plants that primarily use coal. Increase in electric cars would thus increase the exploitation of coal which will again lead to a fossil fuel depletion.

The second and the most important drawback is the mining of lithium which is the major element in electric cars and the mining of lithium is considered as the most hazardous process and over exposure would lead to health issues like cancer.Another demerit of electric cars is that the rate of self-discharge is high. The batteries deplete charge over time if they are left unused for a long.

The battery used is as high as 400 volts and disposal of such batteries is also very difficult and hazardous and this is never going to be green fuel unless the source of electricity is derived completely from renewable sources for which an on-board charging is to be setup so as to make it sustainable and eco-friendly.

VI. NEED FOR HYBRID ENGINE

Compressed air engine is alone capable of propelling the car but upon a completelyfilled tank, it can cover only about 300 km on an average as per the present day scenario and if there existsa situation that there are no refueling stations available then that poses a problem. So a hybrid system of gasoline and compressed air will very much be handy where the gasoline could act as a reserve fuel.

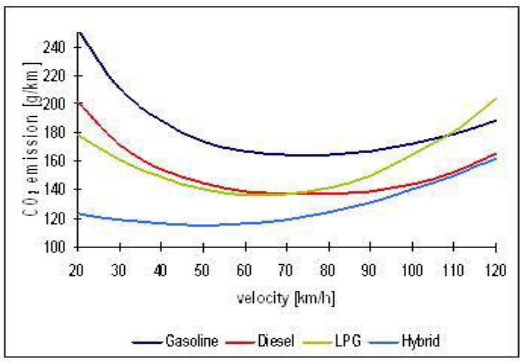

Figure 5: CO_2 emission comparison

Also in order to reduce the use of gasoline one could use a Pneumatic Hybrid Electric Vehicle (PHEV) where the battery voltage is as less as 48 volts which is 8

times less than the purely electric vehicles. This kind of hybrid solves the problem of cold starting and the acceleration is also quite high and once the speed attains the normal cruising speed the electric power could be swapped for higher speeds and the compressed air stored in tank could always be used anytime for propelling.

The cost of production would reduce by about 20% since there exist literally no need to build a cooling system, spark plug, transmission axles, starter motor of mufflers.Although we again need the use of batteries to power the cars it is still comparatively lot lesser in comparison to the purely electric cars.

VII. CONCLUSION

From the observations it can be concluded that the compressed air power car is a revolutionary idea that can prove to be the future vehicles that are non-polluting, eco-friendly and economical. This redressed both the fuel and environmental needs. At the same time, the well to wheel efficiency of the vehicles needs to be improved. Theoretically concepts can be said to prove that these air powered vehicles are efficient than others but excessive research has to carried upon to invent and improvise the technology to completely satisfy the commercial, technical and the economical viability.

REFERENCE

- GANESAN, V. " Computer simulation of spark ignition engine processes" University Press,2002
- HEYWOOD, J.B. "Internal Combustion Engine Fundamentals" Mc-Graw-Hill Book Company,SA,1998
- GUEY NYGER,MDI "The Compresed Air Engine" Barcelona, Spain,2002
- GUEY NYGER, MDI "The Ariticulated Con-Rod" Barcelona, Spain,2002
- SAE 1991-01-0623, Schechter.M "New Cycles for Automobile Engines"

- Internet Website:-
  - https://www.sciencedirect.com/science/article/pii/S1364032116310681
  - https://zeropollutionmotors.us/
  - https://www.theaircar.com
- YouTube Channel:-
  - Auto Comparo
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