Design and Fabrication of Compressed Air Powered Car

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Abstract— This study presents an experimental investigation of an engine driven by compressed air. The compressed air engine is a modified 100 cc internal combustion engine. The engine is modified from a 4-working stroke to a 2- working stroke engine (power and exhaust) by modification of cam-gear system. The maximum pressure used is 8 bar. A temperature decrease from room temperature to 15 ℃ was observed at exhaust. The project was successfully manufactured and tested. Experimental analysis were carried out on this modified engine to find out its performance characteristics like brake power, mechanical efficiency, indicated power, torque etc. It should be noted that pressure higher than that currently employed can result in increased engine performance in terms of output power, torque and speed. Nevertheless, the main advantage of this engine is that no hydrocarbon fuel is required that means no combustion process is taking place, thus the compressed air vehicle will play important role in reducing air pollution. Another benefit is that it uses air as fuel which is available abundantly in atmosphere. This study presents the atmospheric air in can be used in vehicles as the main or auxiliary source of power system.

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I. INTRODUCTION

Compressed Air Powered Car utilizes the power of compressed air to operate the engine. In normal 4-stroke engine the engine working is carried out in four cycles i.e., suction, compression, power and exhaust. In our engine we have converted the four working cycles into two working cycle. This has been obtained by modifying the cam-gear arrangement. Cam gears having same size and same number of teeth are used. Thus the two strokes obtained are power and exhaust. The compressed air drives the engine crankshaft and hence the wheel motion is obtained.

Our environment must be protected against various contaminations produced by vehicle driven on I.C. engine which produces some of the most adverse environmental effects. These emissions, which are above all caused by road traffic damage the flora and fauna and deteriorate human health. For example Nitrogen Oxide (NOx) after oxidation forming nitric acid, contributes to the acid rain which has caused severe forest damage in the past decades. Compressed air powered car are zero emission vehicles. This is so because air is used as fuel and exhaust is also in the form of air. Hence, these vehicles does not release any CO, NOx, hydrocarbons, soot etc. and hence do not damage the environment. Thus compressed air powered car can prove to be the environment friendly vehicle of 21st century.

II. OBJECTIVE

Today fossil fuels are widely used as a source of energy in various different fields like internal & external combustion engines, as heat source in manufacturing industries, etc. But its stock is very limited and due to this tremendous use, fossil fuels are depleting at faster rate. So, in this world of energy crisis, it is inevitable to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved. One of the major fields in which fossil fuels are used is Internal Combustion Engine. An alternative of IC Engine is “Compressed Air Powered Engine”. It is an engine which uses compressed air to run the engine. It is cheap as it uses air as fuel, which is available abundantly in atmosphere. There are several technical benefits of using this engine, like as no combustion takes place inside the cylinder, working temperature of engine is very close to ambient temperature. This helps in reducing wear and tear of the engine components. Also there is no possibility of knocking. This in turn results in smooth working of engine. One more technical benefit is that there will not be any need for installing cooling system or complex fuel injection systems. This makes the design simpler. Thus compressed air powered car has the capacity to satisfy present demand and can prove to be the future vehicles

III. LITERATURE REVIEW

Behavior of compressed air Compressed air is clean, safe, simple and efficient. There are no dangerous exhaust fumes of or other harmful by products when compressed air is used as a utility. It is a non-combustible, non-polluting utility. When air at atmospheric pressure is mechanically compressed by a compressor, the transformation of air at 1 bar (atmospheric pressure) into air at higher pressure (up to 414 bar) is determined by the laws of thermodynamics. They state that an increase in pressure equals a rise in heat and compressing air creates a proportional increase in heat. Boyle's law explains that if a volume of a gas (air) halves during compression, then the pressure is doubled. Charles' law states that the volume of a gas changes in direct proportion to the temperature [2]. These laws explain that pressure, volume and temperature are proportional; change one variable and one or two of the others will also change, according to this equation:

$$(P1\ V1\ ) / T1 = (P2\ V2\ )/T2$$

Compressed air is normally used in pressure ranges from 1 bar to 414 bar (14 to 6004 PSI) at various flow rates from as little as 0.1 m (3.5 CFM - cubic feet per minute) and up. 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 cargo[3]. The first air cars will have air compressors built into them. After a brisk drive, you'll be able to 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 to two hours 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.
The first air cars will almost certainly use the Compressed Air Engine (CAE) developed by the French company, Motor Development International (MDI). 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 (56 kilometers) per hour. When the air car surpasses that speed, a motor will kick in to operate the in-car air compressor so it can compress 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.

The concept of compressed air technology has been taken from various journal papers and studying the various aspects of compressed air technology. The basic concept of compressed air car was taken from the below journal paper. Today fossil fuels are widely used as a source of energy in various different fields like power plants, internal & external combustion engines, as heat source in manufacturing industries, etc. But its stock is very limited and due to this tremendous use, fossil fuels are depleting at faster rate. So, in this world of energy crisis, it is inevitable to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved. One of the major fields in which fossil fuels are used is Internal Combustion Engine. An alternative of IC Engine is “Air Powered Engine”. It is an engine which will use compressed air to run the engine. It is cheap as it uses air as fuel, which is available abundantly in atmosphere Here air is compressed using compressor which in turn uses electricity, to run, which is cheaper and widely used. This adds value to its economic benefits. Also, as discussed earlier, as no combustion takes place which results in smooth working of the engine with minimum wear and tear, this will require less maintenance. So these are some of its economic benefits. One more interesting thing is that the exhaust temperature of this engine will be slightly less than the atmospheric temperature. Terms related to performance and testing of the engine. The various aspects related to the performance characteristics of the engine is taken from this journal. Some of them are;

1. Swept Volume Of The Engine.
2. Torque Calculations.
3. Power Calculations.
4. Efficiency Of Engine.
5. Exhaust Air Temperature

IV. CONSTRUCTION & WORKING

1. FRAME

For mounting of all the accessories the base should be strong. The base here is called as the frame. The material used for the making of frame is mild steel. The hollow type pipes are fabricated to form a rigid construction so as to serve the purpose of frame. The hollow pipe is used to minimize the weight of the vehicle.

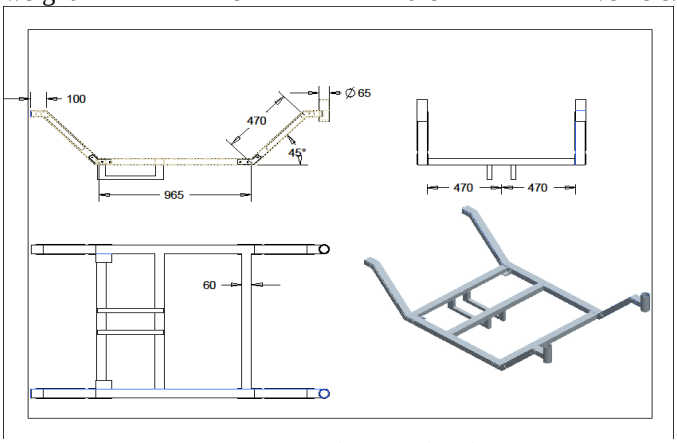


Figure1.1.The specifications of the frame

2. ENGINE

The engine used for compressed air car is 100cc 4-stroke Hero Honda CD100 engine. The slight modifications are done with the engine to serve the purpose of compressed air car. Before modifications the engine was having 28 teeth on camshaft gear while 14 on crankshaft gear. After modification the camshaft gear has been changed with a size equal to crankshaft gear. So, both the gears are of equal number of teethi.e.14 teeth. The other parameters of engine are kept same. The engine contains inlet and exhaust valve operated by two cams, block and piston arrangement, timing chain, crank shaft etc.

Figure2.1.engine

since there is no need of combustion hence there is no need of spark plug.

2.1. SPECIFICATION OF ENGINE

1. Stroke length of cylinder (L)=50 mm
2. Bore diameter of cylinder (D)=50 mm
3. Swept volume of cylinder = 9.8 cm^3

3. STEERING MECHANISM

The complete steering comprises of steering wheel, steering shaft, tie rods, universal joint, ball type arrangement, rack and pinion arrangement, bellows for dust protection. The steering wheel is connected to steering shaft which transfers the motion to rack and pinion arrangement through universal joint. Tie rods provides motion to the wheel to assist the turning. Hence, ultimately front wheels move in right and left direction.

4. SUSPENSION SYSTEM

Independent type of suspension system is used in our project. This system are used for compressed air car consist of coil spring inside which the damper is provided. All the four wheels of our car is employed with this type of independent coil spring suspension. This suspension resists the shocks and provide smooth running of the car.

5. AXLE

The real axle is connected to rear wheels of our car. Both the end of the axle is connected to the wheels through knuckle joint and the chain sprocket mechanism is mounted on it.
The material used in axle is mild steel.
The diameter and length of axle is 25 mm and 950mm.

Figure5.1.axle

6. CHAIN & SPROCKET MECHANISM

The chain sprocket mechanism used in the compressed air car is of CD100 motorcycle. The chain sprocket mechanism is responsible for transmitting the torque generated by the engine to the axle.

Number of teeth on driven gear is 40 teeth and that of driver gear is 14 teeth.

Figure 6.1chain and sprocket

7. CLUTCH

The clutch used is multiplate clutch. The main function of clutch is to engage and disengage the gear. The frictional plate used in clutch helps in increasing the torque transmission capacity. The clutch works on the fact that friction is caused when to rotating disc come in to contact with each other .so, by pressing the clutch pedal engagement and disengagement is achieved.

8. BRAKE

The brake system used is of simple drum brake. Simple brake consists of brake liner which is mounted on the brake shoe inside the brake drum. So, when brake pedal is pressed the liners are moves outward against the action the spring and sticks to brake drum and thus brake engage and car stops. And when brake pedal is released the liner along with brake shoe comes to its original position.

9. ACCELERATOR

The accelerator is used to vary the speed of the vehicle. In our car an accelerator is connected to ball type valve so, when by pressing accelerator the valve opens and more amount of compressed air flows into the engine and hence the speed of car varies.

Figure 9.1 clutch,brake and accelerator

10. TANK

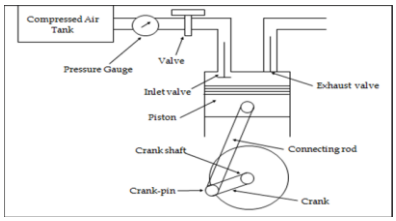
10.1. Specification of tank is as follows:

1) Tank capacity - 130 liter
2) Tank size – Length =42 inch
Diameter =14 inch
3) Type of the compressor - Single Acting Single-Stage reciprocating Compressor
4) Pressure - 200 psi
5) Time to fill - 4 minutes
6) Compressor rpm - 650 rpm

Figure 10.1 tank

V. WORKING

The line diagram of the car is as shown in the figure below. In compressed air powered car, the working of engine is carried out in two cycles. This has been achieved by the modifying the 4-stroke engine. The compressed air is fed to the engine through the receiver tank. The pressure regulator valve regulates the pressure of air which is to be fed to the engine.



The compressed air is fed to the engine from the compressor tank through the pressure regulator valve. The pressure gauge is employed to indicate the pressure in the line. Initially the piston is at the top dead center position. The compressed air is fed through the inlet valve at a high pressure. Due to this high pressure the air forces the piston to move downward from top dead center position to bottom dead center position. Just before the piston reaches to BDC the exhaust valve opens. Due to inertia the piston starts moving towards TDC & forces the retained gas to move outwards through exhaust valve. In this way the cycle continues the output generated at the crankshaft. This output is transferred to the rear axle through chain sprocket mechanism.

VI. .PERFORMANCE AND CALCULATIONS

Experimental analysis were carried out on this modified engine to find out its performance characteristics like brake power, mechanical efficiency, indicated power, torque etc.

To calculate the torque rope brake dynamometer was used. The arrangement is as shown below

Table : 1

	Case 1	Case 2	Case 3
Engine speed (r.p.m.)	3100	2500	1000
output shaft speed (r.p.m)	900	720	140
Weight (kg)	28	24	20.5
Torque	5.08 N-m	4.35 N-m	3.72 N-m
Brake power	0.478 KW	0.327 KW	0.054 KW
Indicated power	1.78 KW	1.43 KW	0.279 KW
Efficiency	26.85 %	22.86 %	19.35 %

Diameter of pulley = 29mm
Diameter of rope = 8mm
Constant pressure from tank = 6.07 bar

VII. . OBSERVATION

1. Tank pressure =7 bar
2. Weight of car = 150 kg
3. Maximum weight of driver =150 kg
4. Car speed =20-25 km/hrs.
5. Time to fill tank/reservoir =3 min.(7 bar)
6. Exhaust temperature $=15^0$c
7. Distance travelled per refill =200m

VIII. CONCLUSION

In this project a preliminary investigation is carried out to run a vehicle on compressed air. From the observation it can be concluded that compressed air power car can prove to the future vehicles. This is a revolutionary engine design which is ecofriendly, pollution free, but also very economical. This redresses both the problems of fuel crises and pollution. These are zero emission vehicle.To sum it up, they are non-expensive cars that do not pollute and are easy to get around in cities.

The cost running the car on electricity need to be considered.At the same time the well to wheels efficiency of these vehicles need to be improved. The performance can be improved by increasing inlet pressure, reducing the vehicle weight etc. However excessive research is needed to completely prove the technology for both its commercial and technical viability.

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