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Design and Fabrication of Plunger Type Compressed Air Vehicle

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Abstract: ***Today air pollution is the major problem in major cities of the world. Climate change is also a big problem we have faced. This project is based on the Design of Air Compressed Vehicle. We used Air as a fuel which is abundantly present in the atmosphere. Increases in petrol prizes and the pollution so this research is the better alternative of the petrol engine. The air compressed vehicle doesn't use any type of hydrocarbon fuel hence this process doesn't emit the combustive gases. Many researchers and scientists are work on the design and fabrication of air driven vehicle equipped with pneumatic system. This project is based on unconventional substitute for transportation challenges as this technology claims to zero emissions while providing the power and performance needed for light vehicle applications. It is the greener type of technology we will be use here and the demand of this technology in future is more. This paper tells us about the description of how a compressed air vehicle using this technology was made.***

Keywords: Pollution free, Simple Design, Noise-free, Lightweight, Pneumatic system

I. INTRODUCTION

Today climate change is the big issue. To lower the effect of greenhouse gases we should find the better alternative of the IC engines that we are used today. Many scientists and researchers are work on the various non-conventional source of energy using this these techniques they can solve the many problems related to climate change.

In India, number of vehicles and their consequent emissions were different for each of the state or UT. Therefore, a decentralized emission inventories were prepared for road transport sector in order to design and implement suitable technologies and policies for appropriate GHG mitigation measures.

Compressed air vehicle deals with the use of air at high pressure and the supply of air to the pneumatic system to move the piston is controlled by the Solenoid valve (5/2). It also provides a pollution free system. Nowadays four wheelers are very popular in urban and rural areas for transportations of goods.

The capacity of our project is to move a single person with some load and it is designed in consideration for small distances that are generally used in industries. In this project we will use a compressor which compress the air from atmosphere at very high pressure approximate 7 to 8 bar and store the air in the reservoir having capacity 50 litre. The air store in the reservoir is then supplied to the pneumatic cylinder with the help of piping system. There is no need for a carburettor, spark plug. Engine run perfectly with the help of high pressure compressed air and our designed chassis, as well as all body of the vehicle, will run perfectly without any issue. Our vehicle carries the load capacity up to 80-100 Kg.

II. WORKING PRINCIPLE

The working principle of air compressed vehicle works on principle of alternatively power supply to the (5/2) solenoid valves. Solenoid valve help to operates double acting pneumatic cylinder which will act as crank and connecting rod. The reciprocating motion of pneumatic cylinder will convert into rotary motion by crank mechanism which will rotates the wheel.

III. BASIC COMPONENTS OF CAV

1) Pneumatic Cylinder: Pneumatic Cylinder is the major component of CAV which we have used in this project. Pneumatic cylinder converts the reciprocating motion into the rotary motion with the help of compressed air.

Bore diameter(D) = 100mm

Stroke Length(L) = 150mm

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2) Solenoid DCV (5/2): We used the (5/2) solenoid valve to give the alternate air supply to the pneumatic cylinder. There are 5 ports in the solenoid valve. Out of five ports two are connected with the pneumatic cylinder and two are the exhaust ports remaining one port is connected to the air reservoir.

Type	=	5/2 DCV
Orifice	=	6mm
Operating pressure	=	6 to 8 bar

3) Air Tank: The air tank stores the air the air which compressed with the help of air compressor.

Material = Mild Steel
Capacity= 50 Litre
Pressure = 6 to 8 Bar

4) Chain and Sprocket: The main function of the chain and the sprockets which are we used is to transfer the motion from crankshaft to rear-wheel shaft to cause the motion of the wheel.

Chain Pitch = ½''
No. of Teeth's = Driver (16)
Driven (32)

5) Limit Switches: We used here the two-roller type limit switches the main function of the limit switches is to control the motion of the double acting Pneumatic Cylinder by sending the electrical signals to the Solenoid valve which gives the direction to the compressed air.

6) Bearings: Bearings are used to reduce the friction between the two rotating parts to reduce wear and tear of the two rotating parts. In our project we used 3 bearings of P-205 type. Two at rear shaft and one is to holding the mounting of crank and driver sprocket with the help of small shaft.

IV. DESIGN ANALYSIS OF CAV

A. *Pulling Force Calculation for Piston*

$$F = \frac{P(D^2 - d^2)}{4}$$

Where, D= Bore diameter =100mm
D= Piston Rod diameter =20mm

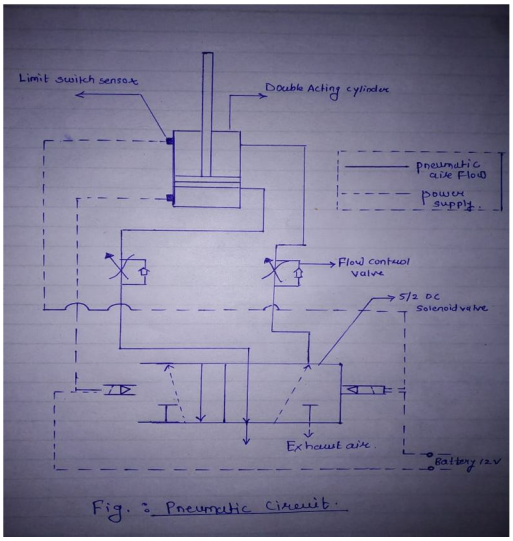


Fig. Pneumatic Circuit

B. Force Calculation in Forward and Reverse Stroke

FOR DOUBLE ACTING CYLINDER:

Bore diam. = 100mm(D)

Piston rod diam. = 20mm(d)

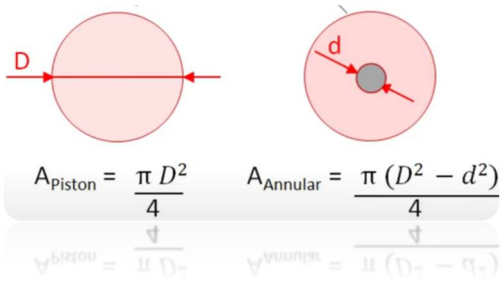
Stroke length = 150mm (L)

Force exerted during the forward stroke:

$F_F = \frac{P\,\pi(D^2)}{4} =$ 1722.5 N

Force exerted during the reverse stroke:

$F_R = \frac{P\,\pi(D^2-d^2)}{4} =$ 1653.6N



C. Calculation for Power

Piston diam. = 100 mm

Piston area = πr^2

A = πr^2

A = 3.142 X $(50)^2$

A = $7855mm^2$

Supply pressure is 100 psi i.e., 689476 Pa

1 Psi = 6894.76 Pa

Atm. Pressure= 14.50 Psi

Req.P = Supply pressure – atm. Pressure

P= 689476-99973.98

P= 589502.02 Pa

P= 0.5895 MPa

Force(F)= P X A

F = 0.5895 X 7855

F = 4630 N

The average speed of standard PNEUMATIC cylinder is about 1.5 m/ sec

V= 1.5 m/sec

Radius of wheel (r)= 0.025 m

N = $\frac{60\,V}{2\pi\,r}$

N = 572.95 rpm for two strokes

Velocity ratio= 1 : 2 …… (approx.)

V= $\frac{572.95}{2}$ = 286.47 rpm for one stroke

V = rw

w = $\frac{2\pi N}{60}$

w= $\frac{2\pi * 286.47}{60}$

w= 30 rad/sec

V= Rw … (Here R=Crank rad. in meter)

V= 0.175 * 30

V= 5.24 m/sec

V= 18.86 km/hr (actual speed of CAV)

18.86 km/hr is the actual speed of CAV.

Rolling Resistance:

F = μ x $\frac{w}{r}$

F= Friction force

μ= Coefficient of friction

= 0.25 …….. (for rubber tyre)

W= Load (dead load)

m = 60 kg ……. (Mass of vehicle)

W= 588.6 N

r = Radius of curvature (0.175m)

Frictional force (F)= 0.25 X $\frac{588.6}{0.175}$

F_{fr} = 840.857 N

F_{fr} it is the frictional force between the rubber tyres and ground surface.

$\boldsymbol{F_{net} = F\text{-}F_{fr}}$

= 4630 – 840.847

F_{net} **=3789.143 N**

For Power,

P = F* V

= 3789.143*5.24

P = 19.855 KWatt

The Power Output is 19.855KWatt.

D. Distance Covered per Charge

For 50 Lit. tank capacity

Volume of Pneumatic cylinder (V)

V= $\pi r^2 h$ – Piston Area

V= π x 50^2 x 152.4 - π x 50^2

V= 1189092.819 mm^3

V= 1.18 Lit.

No. of strokes = $\frac{50}{1.18*2}$

= 21.18 Strokes per charge

Distance Moved in one stroke = D

D= $\frac{21.18*0.025}{2}$

D= 0.264 km

Distance travelled in 21.18 strokes

D=0.264 X 21.18

D=5.5915 Km/Charge

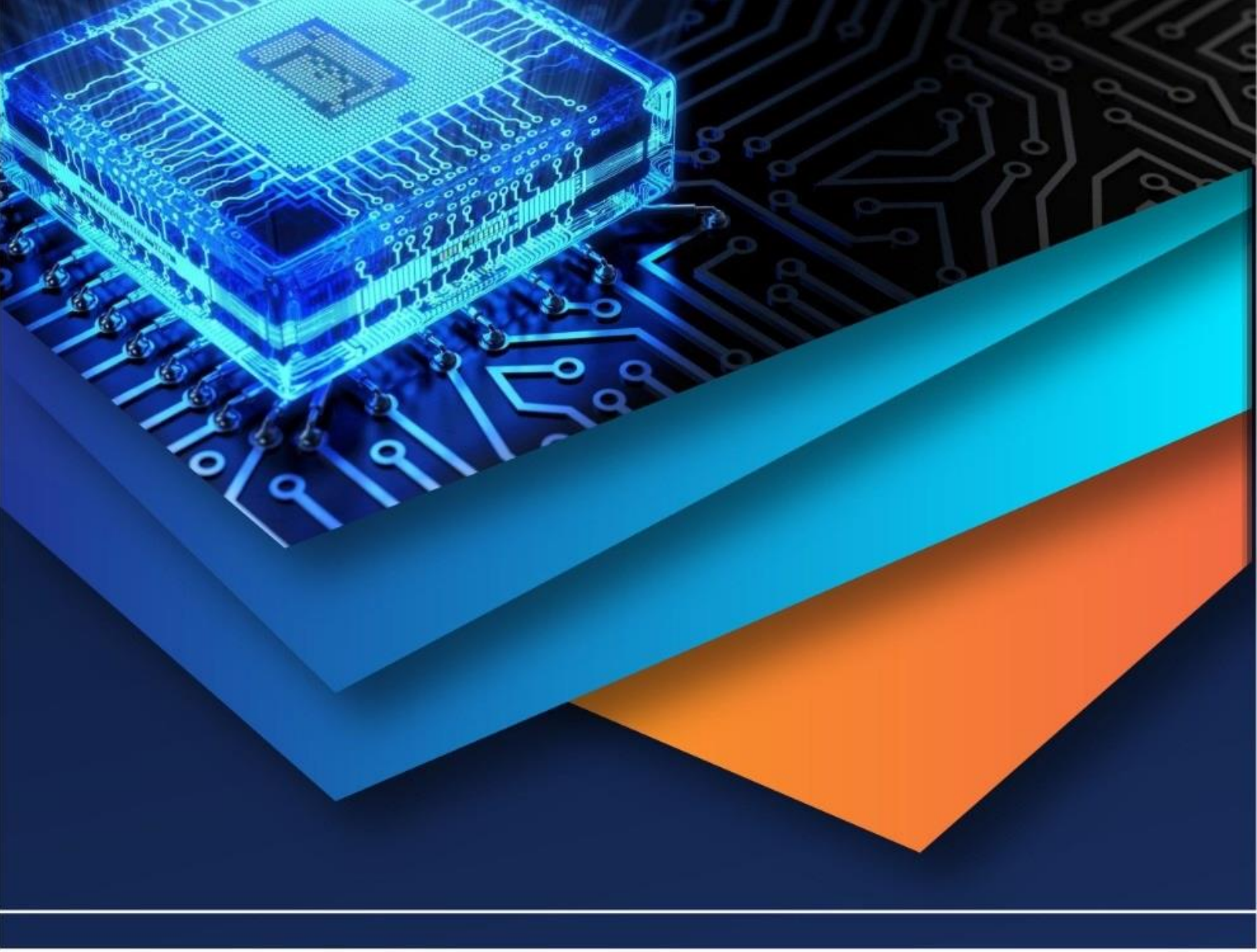
The Distance Covered by the vehicle per Charge is 5.5915 Km

V. CONCLUSION

The air driven vehicle is run on the compressed air. It is pollution free alternative for the environment and there is no use any type of hydrocarbon fuels which are used in IC engines. The compressed air vehicle can make a very important part of the factor that can prove a solution to the use of natural resources and can be the technology of tomorrow. The capacity of CAV is to carry the load up to 130-140kg. we will the compressor tank with capacity of 8 bar. One time filled tank covered the distance of 5.5915 Km with the velocity of 5.24m/s.

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