Design and Fabrication of Compressed Air Vehicle

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Abstract— Today, the whole world is in search of alternative fuel, to fulfill the need of fossil fuel because in coming years there will be scarcity of fossil fuel. There are couples of option of alternative fuel such as solar power, tidal power, geo-thermal power, etc. and one of them is Compressed Air. The important condition for the alternative fuel is it should be renewable and eco-friendly. Compressed Air Engine is a better option to produce power to run automobile, generators etc. Compressed air as the energy source has shown promising results in the field of automobile. Efforts are being made by many organizations to design and develop compressed air-driven vehicle which definitely going to reduce the uses of fossil fuels and its share in the environment. It works on compressed pressure air and hence is pollution free and 100% eco-friendly. The automobiles consume a large number of fossil fuels. However, the consumption of fossil fuels has brought many serious environmental problems, such as global warming, ozone layer depletion and fine particulate matter. To avoid such environmental problems, renewable energy has been applied to automobiles.

Keywords: Compressed Air Engine; Zero Pollution, Air Fuel, Eco-Friendly Engine, Single Stroke Engine, Pneumatic System

I. INTRODUCTION

The exhaust emission standards are getting more and more stringent and there now exists a discussion about the introduction of a mandatory emissions standard for CO2, a greenhouse gas that contributes to the climate change which is an issue of growing international concern. This demand for lower exhaust emission levels together with increasing fuel prices leads to the demand of combustion engines with better fuel economy, which forces engine developers to find and investigate more efficient alternative engine management. Gasoline is already the fuel of the past. Automobile manufacturers know all of this and have spent lots of time and money to find and develop the fuel of the future. An air powered 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 come 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. 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.Over the recent decades, the serious environmental issues, such as greenhouse effect, ozone layer depletion and fog and haze, have drawn considerable attention. Burning of fossil fuels has been considered as the main causeof some serious environment issues. The new energy automobiles, such as electric vehicles, hybrid electric vehicles, pneumatic power vehicles, gradually appear. The typical products of zero-pollution vehicles contain the electric vehicles, while there aretoxic elements within batteries which could spew toxic fumes[1] . Compared to batteries, compressed air is favorable because of a high energy density, low toxicity, fast filling at low cost and long service life. It has zero emission and is ideal for city driving condition. [2].

For city driving condition. MDI (Moteur Development International) is one company that holds the international patents for compressed air car. This review study reveals aim is to run the four strokes bike with help of compressed air, it will try to achieve a 50 km/h speed and range of refilling compressed air is after running of 70-80 km. Two technologies have been developed to meet different need

1) Single energy compressed air engines.
2) Dual energy compressed air plus fuel engines.[3]

Based on the principle of gas expansion, a new structure of reciprocating air-powered engine is proposed. Compressed air does work by expansion to drive the reciprocating motion of rack, through the transmission system, convert to one-way rotary motion of the output shaft. [4]

Energy crisis is due to two reasons, firstly due to population of the world has increased rapidly and secondly the standard of living of human being has increased. This can be reduce and controlled by using compressed air engine to produce energy, which runs on air which is abundantly available in atmosphere. A compressed air engine is a pneumatic actuator that creates useful work by expanding compressed air.[5]

II. WORKING PRINCIPLE

Connections are done as per the circuit diagram as shown in figure. When the accelerator pedal is pressed, air is passed through the solenoid valve from the reservoir to the cylinder. Now the piston inside the cylinder is pushed forward. When it attains maximum position, the reed switch sensor which is connected along the cylinder changes the direction of flow of air. Hence, the piston is pushed backward. Thus the forward and backward movement of the piston is connected to the crank shaft. Hence linear movement of the piston is converted into a rotary motion.

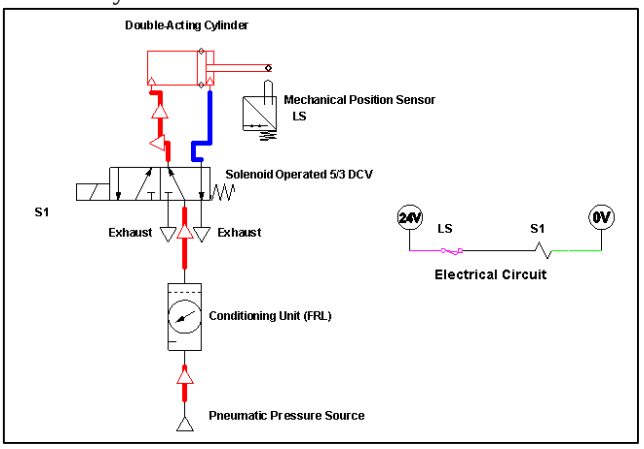

Fig. 1: DAC Solenoid Valve Circuit Diagram

The compressed air goes to the flow control valve. The flow control valve is used to control the flow of air. It is adjustable one. We have to adjust the flow control valve, so that the required pressurized air goes to the Solenoid Valve. In our project, the solenoid valve is used as a direction control valve. This solenoid valve is controlled by the electronic control unit. The compressed air goes to the pneumatic double acting cylinder. The solenoid valve is changing the air flow in the opposite direction according to the piston position. This air flow direction is controlled by the solenoid valve.

III. Design Analysis

A. Structural Analysis of Vehicle Frame

Considering the vehicle base frame, analysis is conducted to determine the load bearing capacity of the frame at various points and its behavior when subjected to bending loads.

B. Rolling Resistance

Rolling resistance, or rolling drag, is the force resisting the motion when a body rolls on a surface. The rolling resistance of the wheel is calculated using the equation and coefficient of friction is assume0.01.

Fr=μ m g

The rolling resistance of the wheel is 8.824N. The total force is 124.84 N. The total power output is calculated using the formula is 95.76N

Pt= Ft ×V

C. Force Calculations

Tractive Force, FTTraction is the force used to generate motion between a body and a tangential surface, through the use of dry friction. The traction force required to overcome by the wheels is95.76N.

Force Required on Incline Assuming incline angle, $\theta=5^0$ and weight of the vehicle, W=882.9N. Force required on incline is calculated using the formula and Fgis found to be 76.94NF g =W × sinθ

Total force required to overcome inertia is found out using the equation and Fi is found to be 181.52N,

Fi = F g + FT + Fr

Fi is found to be 181.52N.

D. Pulling Force Calculation for Piston

$$F = \frac{P \times (D1^2 - D2^2)}{4}$$

Hence, F=140.25 N

Where, D1 = Bore Diameter = 50mm,245

D2 = Piston Rod Diameter = 16mm.

E. Power Calculations

The speed is to the wheel is assuming 420 rpm. The diameter of the wheel, d=635 mm, the velocity for

$V=\frac{\pi d N}{60000}$

Velocity is 13.96 mm/s. Mass of the vehicle is 90kg. Force required for moving the vehicle is 111.6 N.

F. Cylinder Thrust

The Thrust developed in the cylinder that is the piston power is a function of piston diameter, operating air pressure and the frictional resistance. Cylinder thrust can be calculated by using the formula.

$$F = [\frac{\pi d^2}{4}]Pa$$

For double acting cylinder, Piston Diameter d=50 mm,
= 0.6MPa. The cylinder thrust developed will be 1178.20 N.

G. Air Consumption by Pneumatic Cylinder

It is the amount of air required to actuate the pneumatic cylinder. Considering cylinder specifications and various parameters such as pressure, stroke, stroke length, etc it is substituted in equation and values are obtained to determine the size of reservoir in litters. Bore Diameter, D=50mm, Rod Diameter, d= 16mmPressure, P = 6bar, Stroke, S = 100 strokes/min

Stroke length, L = 10 cm.

Air consumption by cylinder in forward and reverse stroke is calculated using the formula and respectively.

$$Acf = \frac{\pi(D^2)}{4} \times l \times p \times s$$

$$Acr = \frac{\pi(D^2 - d^2)}{4} \times l \times p \times s$$

Air consumption by cylinder in forward and reverse stroke is 117.809 liters/min and 105.74 liters/min. Total air consumption is 223.55 liters/min.

IV. Results and Discussion

A. Performance Evaluation Procedure

A Compressed-air engine is a pneumatic actuator that does work by expanding compressed air which is stored in the tank. An air driven vehicle is powered by an air engine, using compressed air, which is stored in a tank.

Compressed air vehicles (CAV) use the expansion of compressed air to drive their pistons.

The performance evaluation of the air driven vehicle is calculated for the different loads at three different pressure conditions. It is noted that as load increased in the air driven vehicle time taken to reach 25m distance also increases. It is observed that the time taken to reach 25m distance when the pressure is lesser in comparison to the high pressure.

Condition Of Pressure (kg/cm^2)	Speed N (rpm)	Velocity V (m/s)	Acceleration A (m/s^2)
15	245	8.14	1.63
20	327	10.87	2.17
25	451	14.99	2.99

Table 1: Speed Calculation of the model

Condition Of Pressure (kg/cm^2)	Load (Kg)	Time taken to reach 25m distance(s)
15	25	7.15
	50	8.32
	75	9.86
20	25	6.91
	50	7.95
	75	8.87
25	25	6.58
	50	8.16
	75	8.45

Table 2: Result of performance calculation of air driven vehicle

V. CONCLUSION

The compressed air driven vehicle is designed and developed which runs with the help of compressed air as the fuel. The pneumatic vehicle is ecofriendly, economical and beneficial for handicapped people and children. The vehicle is operated in three different pressure conditions. The result of then performance test revealed that out of three different pressure conditions, the optimum power generated and transmitted by the engine took place at full pressure condition and the time taken to reach 25 meters distance for the full pressure is lesser in comparison with the low pressure.

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