Conceptual Design of a Compressed Air Vehicle

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Abstract— The Air Driven Engine is an eco-friendly engine which operates with compressed air. An Air Driven Engine uses the expansion of compressed air to drive the pistons of an engine An Air Driven Engine is a pneumatic actuator that creates useful work by expanding compressed air. There is no mixing of fuel with air as there is no combustion. An Air Driven Engine makes use of Compressed Air Technology for its operation The Compressed Air Technology is quite simple. If we compress normal air into a cylinder the air would hold some energy within it. This energy can be utilized for useful purposes. When this compressed air expands, the energy is released to do work. So this energy in compressed air can also be utilized to displace a piston.

Key words: Air Driven Engine, Compressed Air Vehicle

I. INTRODUCTION

A vehicle came from Latin called vehiculum which is known as a mobile machine that transports people or cargo. Typical vehicles include wagons, bicycles, motor vehicles (motorcycles, cars, trucks etc), railed vehicles (trains, trams), watercraft (ships, boats), aircraft and space craft.

A. Energy Source

It is essential that a vehicle have a source of energy to drive it. Energy can be extracted from the surrounding environment, as in the case of a sailboat, a solar-powered car or a streetcar. Energy can also be stored, in any form, provided it can be converted on demand and the storing medium's energy density and power density are sufficient to meet the vehicle's needs. The most common type of energy source is fuel. External combustion engines can use almost anything that burns as fuel whilst internal combustion engines and rocket engines are tailor built to burn a specific fuel, typically gasoline, diesel or ethanol. Another common medium for storing energy are batteries, which have the advantage of being responsive, useful in a wide range of power levels, environmentally friendly, efficient, simple to install and easy to maintain. Batteries also facilitate the use of electric motors, which have their own advantages Electrified rails and overhead cables are a common source of electrical energy on subways, railways, trams, and trolleybuses Nuclear power is a more exclusive form of energy storage, currently reserved for large ships and submarines, mostly military. Nuclear energy can be released by a nuclear reactor, nuclear battery or by Wind energy is used by sailboats and land yachts as the primary source of energy. It is very cheap and fairly easy to use, the main issues being dependence on weather and upwind performance. Compressed gas is currently an experimental method of storing energy. In this case, compressed gas is simply stored in a tank and released when necessary. Like elastics, they have hysteresis losses when gas heats up.

B. Motors and Engines

Fig. 1: Chassis with Steering

When needed, the energy is taken from the source and consumed by one or more motors or engines. Motors are classified based on energy available. Most motor vehicles have internal combustion engines. They are fairly cheap, easy to maintain, reliable, safe and small. Since IC engines burn fuel, they have long ranges but pollute the environment Electric motors are

used in electric vehicles such as electric bicycles, electric scooters, small boats, subways, trains, trolleybuses, trams and experimental aircraft. Electric motors can be very efficient, over 90% efficiency is common. Compressed gas motors have been used on some vehicles experimentally. They are simple, efficient, safe, cheap, reliable and operate in a variety of conditions. One of the difficulties encountered when using gas motors is the cooling effect of expanding gas. Compressed gas motors also lose effectiveness with falling gas pressure.

II. OBJECTIVE

The final goal of the project was to design the vehicle that runs with the compressed air without using any fossil fuels.

III. MATERIAL SELECTION

Bright Mild steel material has used for manufacturing of chassis as shown in fig2 according to the specified dimensions.

Fig. 2: Chassis of the model

Wheel base: 4.5 ft
Ground clearance: 1.5 ft
Distance between rear wheels: 3ft

Chemical Composition	Range
Carbon	0.16-0.18%
Silicon	0.40% max
Manganese	0.70-0.90%
Sulphur	0.040% Max
Phosphorus	0.040% Max

Table 1: Properties of Mild steel chassis

Mechanical Properties	Range	Nature
Max Stress	400-560 N/mm^2	dependent on ruling section
Yield Stress	300-440 N/mm^2 Min	dependent on ruling section
0.2% Proof Stress	280-420 N/mm^2 Min	dependent on ruling section
Elongation	10-14% Min	dependent on ruling section

Table: 2 Properties of Mild steel chassis

IV. ADVANTAGES OF USING BRIGHT FINISHED MILD STEEL BARS

Black mild steel is produced by a hot rolling process, and may have a scaly, rough surface. It is not precise in its dimensions, straightness or flatness.

Suitable machining allowances should therefore be added when ordering. It does not contain any additions for enhancing mechanical or machining properties.

Bright drawn mild steel is an improved quality material, free of scale, and has been cold worked (drawn or rolled) to size. It is produced to close dimensional tolerances. Straightness and flatness are better than black steel. It is more suitable for repetition precision machining.

Bright drawn steel has more consistent hardness, and increased tensile strength. Bright steel can also be obtained in precision turned or ground form if desired.

V. SPECIFICATIONS OF TESTING APPARATUS

Diameter of brake drum D = .12m =120mm
Diameter of rope d = .012m =12mm
Gravitational constant = 9.81

VI. SAMPLE CALCULATIONS

Pressure at 9 bar and 3 kg load
Torque = (w1-w2)*[(D+d)/2]*g = (3-0.1) *[(0.12+0.012)/2]*9.81
Brake power 'BP' = $\left\{\left[\frac{2\pi N}{60}\right] * \left[\frac{D+d}{2}\right] * [w1 - w2] * g\right\} w$
BP = (2*π*438/60) *[(0.12+0.012)/2]*(3-0.1)*9.81 W =45.86 * 0.132 * 2.9 *9.81 watts = 172.22 watts

VII. TESTING PRINCIPLE

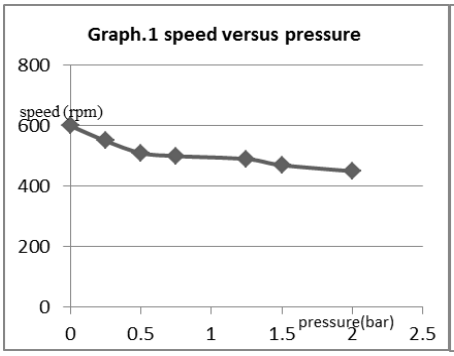
A. Brake Power

Brake horsepower is the measure of an engine's horsepower without the loss in power caused by the gearbox, alternator, differential, water pump, and other auxiliary components such as power steering pump, muffled exhaust system, etc. Brake refers to a device which was used to load an engine and hold it at a desired RPM. During testing, the output torque and rotational speed were measured to determine the brake horsepower. Horsepower was originally measured and calculated by use of a brake drum connected to the engine's output shaft. Brake power is the power produced by the engine as measured by the brake drum.

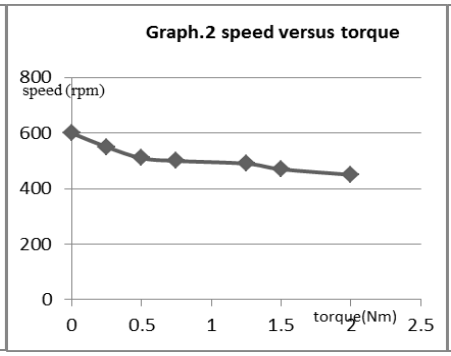
$$\text{Brake power 'BP'} = \left\{\left[\frac{2\pi N}{60}\right] * \left[\frac{D+d}{2}\right] * [w1 - w2] * g\right\} w$$

Where;
w_1 = weight added
w_2 = load shown in spring balance in kg,
N = speed in RPM,
d = diameter of rope in mm,
D = diameter of brake drum in mm
g = gravitational constant.

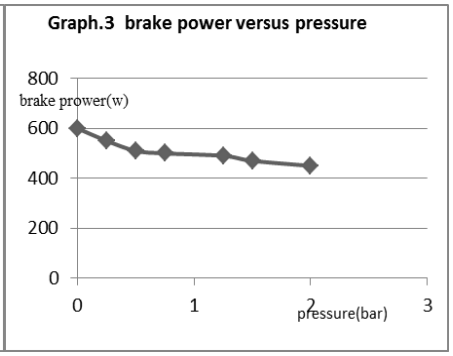
B. Performance Characteristics



Graph 1: Speed versus pressure



Graph 2: Speed versus torque



Graph 3: Brake power versus pressure

VIII. APPLICATIONS

A. Drive for Conveyors

Air driven engines can be used as drives for different types of conveyors such as Belt conveyors, Chain conveyors, Screw conveyors, etc,. it is normally used for slow speed conveyors. Medium load can only be used.

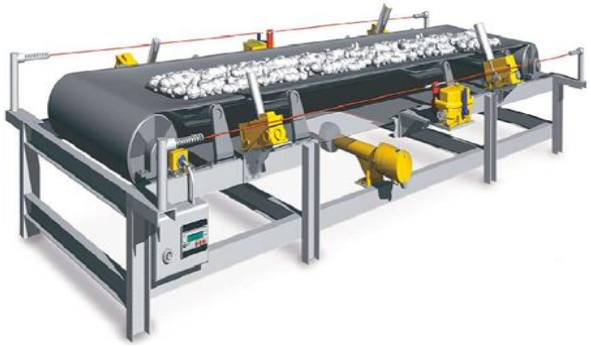


Fig. 3: Belt conveyor

B. Job Clamping

In operations like carpentry job clamping generally requires low loading. Air Driven Engine can provide this low load clamping.

C. Fluid Pumps

Air Driven Engine can also be utilized for small displacement pumps of low pressure capacities.

D. Automobiles

The usage of the Air Driven Engine is possible for automobiles as two wheelers and light motor vehicles.

Fig. 4: Air Car

IX. CONCLUSION

We were able to successfully complete the design and fabrication of the Air Driven Engine. By doing this project we gained the knowledge about pneumatic system and how automation can be effectively done with the help of pneumatic system. We were also able to gain practical knowledge about the basics of the normal IC engine and solenoid valves.

The Air Driven Engine provides an effective method for power production and transmission. Even though its applications are limited currently, further research could provide wider applications.

X. FUTURE SCOPE

- Design and fabrication of a new engine made of light metal will give better results.
- Usage of compressed air tanks for storage and supply will give it more scope in automobiles.
- Much like electrical vehicles, air powered vehicles would ultimately be powered through the electrical grid. This makes it easier to focus on reducing pollution from one source, as opposed to the millions of vehicles on the road. Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Pollution created during fuel transportation would be eliminated.
- Compressed-air vehicles operate to a thermodynamic process as air cools down when expanding and heats up when being compressed. As it is not possible in practice to use a theoretically ideal process, losses occur and improvements may involve reducing these, e.g., by using large heat exchangers in order to use heat from the ambient air and at the same time provide air cooling in the passenger compartment. At the other end, the heat produced during compression can be stored in water systems, physical or chemical systems and reused later. New engine designs; as shown in shows the improved variants of the air engine. With these type of engines; which is more efficient; air powered automobiles could gain a bright scope in future.

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