International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 31, Issue 04, Quarter 04 (2019)
Publishing Month and Date: Oct 24, 2019
An Indexed and Referred Journal with Impact Factor: 2.75
ISSN (Online): 2347-601X
www.ijemhs.com

Experimental Analysis Design of Air Driven Engine

Pankaj Kumar[1] and Amit kumar[2]

[1]M. Tech. Scholar (Machine Design), Department of Mechanical Engineering, CBSGOI, Jhajjar

[2]Assiatant Professor, Department of Mechanical Engineering, CBSGOI, Jhajjar

Abstract

The excess exploitation of natural resources (especially in our contexts diesel and petrol) is the major cause of concern in the world. In the normal design engine diesel, petrol and natural gases are being utilized. It is also a fact that these natural resources are not unlimited and there is a need to maintain their exploitation for future. It is challenge for the scientific and the technical individuals to comment with certain fuels other than the above so that the available limited source of our natural resources are maintained. Keeping in the view above social responsibility, the following options are available-

- Natural air
- Bio diesel
- Solar energy
- Water

Keeping in the view the various pros and cons of the above, it has been decided to work with natural air due to abounds availability in the nature. The air driven engine may be the point of research. Air driven engine may help to reduce the demand of conventional fuels.

Thus the objective of this research is to design & modify the four stroke petrol engine into the compressed air engine by modification in the cam lobes and also evaluate the comparison of economic characteristics between compressed air engine four stroke SI engines. By experimental investigation it is found that compressed air engine can run per kilometre at expense of 60 to 70 paisa.

Keywords: *Compressed air driven engine, Investigation, Cam.*

1. Introduction

It is very known that conventional fuels such as diesel and petrol are the main sources of energy for internal combustion engine but these are increasingly consumed. Continuous consumption of conventional fuels may cause huge problem of scarcity of sources of energy. Depletion of these fuels has led researchers to anticipate the need to search the alternative way to drive the vehicles. Present work utilizes the air as a alternative of petrol or diesel. As we know that air is non polluting and freely available in nature. The utilization of this freely available air is the good idea for automobile sector.

Compressed air technology attracts the researchers and several industries world widely. Compressed air engine operates with the compressed air and is very simple in construction and operation .Here, compressed air from the air cylinder pushes the piston giving the power stroke. In the next stroke piston escape the expanded air from the cylinder. The cycle is completed in two strokes. Therefore, uniform turning effort is obtained unlike four stroke engine .Fuel tank and spark plug is eliminated from the conventional four stroke engine.

In the case of a compressed air Engine, there is no combustion taking place within the engine. So it is less dangerous and non-polluting. It requires lighter metal only since it does not have to withstand elevated temperatures. As there is no combustion taking place and Carburettor is eliminated because carburettor is used for mixing of fuel and air purpose. There is no need for mixing fuel and air, here compressed air is the fuel and it is directly fed into the piston cylinder arrangement. It simply expands inside the cylinder and does useful work on the piston. This work done on the piston provides sufficient power to the crankshaft. The above experiment and modification is done on the motorcycle engine of Hero Honda (Model- Hero Honda Passion).

A Compressed-air engine is a pneumatic actuator that creates useful work by compressed air. A compressed-air vehicle is powered by an air engine, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases, compressed air vehicles (CAV) use the expansion of compressed air to drive their pistons.

They have existed in many forms over the past two centuries, ranging in size from hand held turbines up to several hundred horsepower. For example, the first

mechanically-powered submarine, the 1863 Plongeur, used a compressed air engine.

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.

Some types rely on pistons and cylinders, others use turbines. Many compressed air engines improve their performance by heating the incoming air, or the engine itself. Some took this a stage further and burned fuel in the cylinder or turbine, forming a type of internal combustion engine.

One manufacturer claims to have designed an engine that is 90 percent efficient. Compressed air propulsion may also be incorporated in hybrid systems, e.g., battery electric propulsion and fuel tanks to recharge the batteries. This kind of system is called hybrid-pneumatic electric propulsion. Additionally, regenerative braking can also be used in conjunction with this system.

2. Literature Review

Air can be compressed into small volumes and can be stored in suitable containers at high pressures. Such air compressed into containers is associated with an amount of energy. When the stored compressed air is released freely it expands thereby releasing the energy associated with it. This energy released can be utilized to provide useful work.

The compression, storage and release of the air together are termed as the Compressed Air Technology. This technology has been utilized in different pneumatic systems. This technology has been undergoing several years of research to improve its applications.

Compressed air is regarded as the fourth utility, after electricity, natural gas, and water. Compressed air can be used in or for:

- Pneumatics, the use of pressurized gases to do work.
- vehicular transportation using a compressed air vehicle
- scuba diving
- To inflate buoyancy devices.
- Cooling using a vortex tube.
- Gas dusters for cleaning electronic components that cannot be cleaned with water.
- air brake (rail) systems
- air brake (road vehicle) systems

3. Design of Camshaft

Initially, we having 4-stroke camshaft which do not works for our purpose (i.e. compressed-air engine). Thus we converting 4-stroke into 2-stroke and made slight modifications in camshaft. Previously it was v-shaped for 4stroke, now we converting this to I-shaped i.e. the inlet & exhaust at $180°$. Also for continuous supply of air, to generate more torque we shaped OVAL-CAM to the individual side through$180°$ (i.e. in both inlet & exhaust-cams).

Figure 1: Camshaft

3.1 Design of Timing Gear

You take a 4-stroke engine, and make the following changes:-

Change crank and cam gear ratio to 1:1 instead of 2:1, so for every revolution of the crank, his cams also turn once. Cams profiles have to be changed (new cams of course).

International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 31, Issue 04, Quarter 04 (2019)
Publishing Month and Date: Oct 24, 2019
An Indexed and Referred Journal with Impact Factor: 2.75
ISSN (Online): 2347-601X
www.ijemhs.com

Figure 2: Camshaft Gear

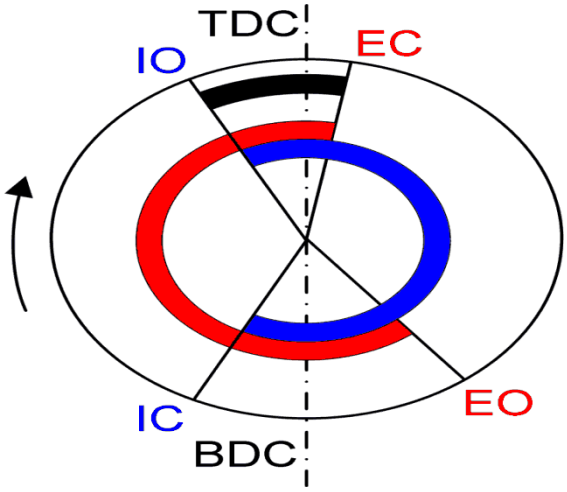

Figure 3: Valve Timing Diagram

Valve Timing as follows -:
Inlet Valve open - 10 degree before T.D.C.
Exhaust Valve open – 20 degree before B.D.C.
Inlet Valve close – 10 degree after B.D.C.
Exhaust Valve close – 5 degree after T.D.C.
Pressure of compressed air - 87.02264 Psi or 6 Bar
R.P.M. of Crankshaft – 650- 700 R.P.M

3.2 Problems Faced During Designing

1. Availability of components of desired specification in market as per the design.
2. To vary the output speed.
3. To prevent the air leakage

3.3 Solutions Adapted

1. As per market survey conducted by us we have selected the components with nearest
Possible specifications as per our design to get the desired power.
2. With the use of air tight joints formed by the connectors we prevent the leakage of air.

4. Experimental Setup

For carrying out the research /experiment on an Petrol engine of HERO HONDA of model 100 cc of PASSON PRO was used . As petrol is not being used in this experiment, so there was no need of the carburettor and thus the carburettor was removed. As there is no combustion taking place inside the engine, so there is no need of a spark plug, so the spark plug is also removed.

In the inlet valve a hose (pipe) is attached and a regulator was also attached on the top of the cylinder. So that the starting pressure 87.02264 Psi or 6 bars to 94.27452 Psi or 6.5 bar could be made. When the regulator was opened air entered in to the cylinder through the pipe. When the air entered at a pressure of 6 bar the piston moved from Top dead centre to Bottom dead centre (TDC to BDC).and piston reaches at bottom dead centre. After that, the piston started to move from Bottom dead centre to Top dead centre due to the weight of the flywheel as piston started.

To move upwards the difficulty faced that the engine stopped working. This was because the exhaust valve did not open and the compressed air was not moved out. So, engine stopped there. To overcome this difficulty a cam was designed. The engine used in the experiment had cam of two cam lobes. And the figure (a) is shown the cam of the engine.

International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 31, Issue 04, Quarter 04 (2019)
Publishing Month and Date: Oct 24, 2019
An Indexed and Referred Journal with Impact Factor: 2.75
ISSN (Online): 2347-601X
www.ijemhs.com

Figure 4: Camshaft of an engine with two lobes

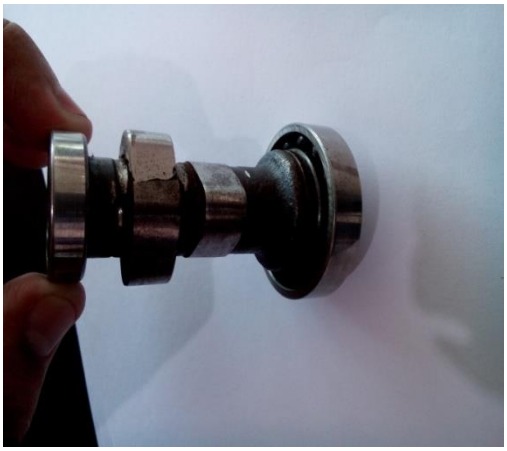

Figure 5: Camshaft of compressed air engine with four lobes

To overcome this, in addition to two cam lobes, a new cam lobes was attached. Further, to make the exhaust valve open again one more cam lobe was attached. When the four cam lobes were attached, the engine started to work due to this, the petrol engine started to work as a compressed air engine in which there is no need of petrol and combustion. The specification of an engine is given below.

4.1 Engine Specification

Type	Air-cooled, 4-stroke single cylinder OHC
Displacement	97.2 cc
Max. Power	5.74 kW (7.8 Ps) at 7500 rpm
Max. Torque	0.82 Kgf-m (8.04 N.m) at 4500 rpm
Bore x Stroke	50.0 x 49.5 mm
Carburettor	Side Draft, Variable venturi type with TCIS
Compression Ratio	9.0: 1
Starting	Electric start / Kick start

Figure 6: Compressed Air Engine

International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 31, Issue 04, Quarter 04 (2019)
Publishing Month and Date: Oct 24, 2019
An Indexed and Referred Journal with Impact Factor: 2.75
ISSN (Online): 2347-601X
www.ijemhs.com

4.2 Economy Analysis

A metallic cylinder of 60 Inches or 152.4 cm with a diameter 12 Inches or 30.48 cm was taken. The inside pressure was taken to be 140 Psi or 9.65266 Bar in half and 300 Psi or 21.6975 Bar (Maximum). The cost to fill the cylinder was Rs. 6. The engine was started by using this cylinder.

4.3 Air Cylinder Specification

Type	Metallic/ Steel/ Regulator and Pressure gauge on the top
Length	60 Inches or 152.4 cm
Diameter	1 feet or 30.48 cm
Inside Pressure	140 Psi or 9.65266 Bar in half 300 Psi or 21.6975 Bar (Maximum)
Regulating Pressure	101.526 Psi or 7 Bar
Engine Starting pressure	87.02264 Psi or 6 Bar to 94.27452 Psi 6.5 Bar
Volume	300 Pond

Figure 7: A metallic cylinder of 60 Inches or 152.4 cm with a diameter 12 Inches or 30.48 cm

5. Result & Discussion

Through this experiment, it has been found that if instead of two cam lobes in petrol or diesel engine, four cam lobes are attached, the engine would start working as a compressed air engine. This compressed air engine does not require petrol or diesel but instead uses natural air for its working. This engine can travel 1 km in .65 paisa which is very less as compared to that of petrol and diesel engine and would further be economical to use. As there is no combustion taking place in the engine, so it is completely environmental friendly

5.1 Advantages

Compressed air engine have the following advantages-.

1. Start-up power is not required to run engine.
2. Use of renewable fuel.
3. Compressed-air technology reduces the cost of vehicle production by about 20%, because there is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
4. Air, on its own, is non-flammable.
5. The engine can be massively reduced in size.
6. The engine runs on cold or warm air, so can be made of lower strength light weight material such as aluminum, plastic, low friction Teflon or a combination.
7. Low manufacture and maintenance costs as well as easy maintenance.
8. The air tank may be refilled more often and in less time than batteries can be recharged, with re-filling rates comparable to liquid fuels.
9. Lighter vehicles cause less damage to roads, resulting in lower maintenance cost.
10. The price of filling air powered vehicles is significantly cheaper than petrol, diesel or bio fuel. If electricity is cheap, then compressing air will also be relatively cheap.

5.2 Disadvantages

Compressed Air Engine (C.A.E.) has some disadvantages, which are:
1. Less power output

2. Probability of air leakage.
3. Tanks get very hot when filled rapidly. SCUBA tanks are sometimes immersed in water to cool them down when they are being filled. That would not be possible with tanks in a car and thus it would either take a long time to fill the tanks, or they would have to take less than a full charge, since heat drives up the pressure
4. Biggest disadvantage is the energy needed to compress the air is greater than the energy stored
5. At the supply station, compressing the air heats it, and if then directly transferred in a heated state to the vehicle storage tanks will then cool and reduce the pressure. If cooled before transfer, the energy in this heat will be lost unless sophisticated low grade heat utilization is employed
6. Within the vehicle, expansion and consequent pressure reduction in the throttle or engine chills the air, reducing its effective pressure. Addition of ambient heat will increase this pressure and this addition leads to a more complex propulsion system.
7. Passenger compartment heating is more difficult since the propulsion system does not provide a source of waste heat. Some form of heat pump, or more likely, an electric heater would be required.
8. Noise created by engine
9. Due to high pressure there is a possibility that cylinder can burst.
10. Speed of the engine is less than that of petrol and diesel engine.

6. Conclusion

Utilization of non-conventional energy sources such as compressed air engine we can set a milestone in the field of green technology because it is the demand of the time to adopt green technology. The model designed by us is a small scale working model of the compressed air engine. When scaled to higher level it can be used for driving automobiles independently or combined (hybrid) with other engines like I.C. engines.

7. Future Scope

1. To increase the speed of the engine.
2. Reduce the noise and anyone can work upon this for eco friendly environment.
3. Design and fabrication of a new engine made of light metal will give better results.
4. Usage of compressed air tanks for storage and supply will give it more scope in automobiles.

References

[1] Papson, A.; Creutzig, F.; Schipper, L. Compressed air vehicles: Drive-cycle analysis of vehicle performance, environmental impacts, and economic costs. Transp. Res. Rec. J. Transp. Res. Board 2010, 2191, 67–74.
[2] Schechter, M. New Cycles for Automobile Engines, In Proceedings of International Congress and Exposition, Detroit, MI, USA, 1 March 1999; SAE International: Warren dale, PA, USA.
[3] Tokhi, M, O, Al-Miskiry, M and Brisland, M.Real Time Control of Motors using a Pneumatic H-bridge. Control Eng Pract. 2001, pp. 449-457.
[4] Huang, K, D, Quang, K, V, Tseng, K, T. Study of Recycling Exhaust Gas Energy of Hybrid Pneumatic Power System with CFD. Energy Conversation Management 2009, pp. 1271-1278.
[5] Thipse, S, S.Compressed Air Car. Tech Monitor 2008, pp. 33-37.
[6] Liu, X, Y, Wang, Y.Overview of Developement of Compressed Air Engine. Machine. 2008, Vol. 35, pp. 1-5.
[7] Shen, Y, T, Hwang, Y, R.Design and Implementation of Air Powered Motorcycles. Applied Energy. 2009, Vol. 86, pp. 1105-1110.
[8] Adder, J. Assessment of Future Vehicle Transportation Options and Their Impact on the Electric Grid; DOE/NETL-2010/1466; National Energy Technology Laboratory: Morgantown, WV, USA, 2011.
[9] Motor Development International (MDI) Home Page. Available online: http://www.mdi.lu/english/ index.php (accessed on 8 March 2013).
[10] Kang, H.; Tai, C.; Smith, E.; Wang, X.; Tsao, T.; Blumberg, P.; Stewart, J. Demonstration of Air-Power-Assist (APA) Engine Technology for Clean Combustion and Direct Energy Recovery in Heavy Duty Application. In Proceedings of SAE World Congress and Exhibition, Detroit,

MI, USA, 14 April 2008; SAE International: Warrendale, PA, USA.

[11] Schechter, M. New Cycles for Automobile Engines. In Proceedings of International Congress and Exposition, Detroit, MI, USA, 1 March 1999; SAE International: Warrendale, PA, USA.

[12] Motor Development International (MDI) Web Page. AIR Pod. Available online: http://www.mdi.lu/ english/airpod.php (accessed on 27 August 2012).

[13] Schechter, M. Regenerative Compression Braking—A Low Cost Alternative to Electric Hybrids. In Proceedings of SAE 2000 World Congress, Detroit, MI, USA, 6 March 2000; SAE International: Warrendale, PA, USA. Energies 2013, 6 1745

[14] Andersson, M.; Johansson, B.; Hultqvist, A. An Air Hybrid for High Power Absorption and Discharge. In Proceedings of 2005 Brasil Fuels and Lubricants Meeting, Rio de Janiero, Brazil, 11 May 2005; SAE International: Warrendale, PA, USA.

[15] Wang, X.; Tsao, T.; Tai, C.; Kang, H.; Blumberg, P. Modeling of compressed air hybrid operation for a heavy duty diesel engine. J. Eng. Gas Turbines Power Trans. 2009, 131, 052802:1–052802:8.

[16] Higelin, P.; Charlet, A.; Chamaillard, Y. Thermodynamic simulation of a hybrid pneumatic-combustion engine concept. Int. J. Thermodyn. 2002, 5, 1–11.

[17] Donitz, C.; Vasile, I.; Onder, C.H.; Guzzella, L. Modelling and optimizing two- and four-stroke hybrid pneumatic engines. Proc. Inst. Mech. Eng. Part D J. Autom. Eng. 2009, 223, 255–280.

[18] Voser, C.; Donitz, C.; Ochsner, G.; Onder, C.; Guzzella, L. In-cylinder boosting of turbocharged spark-ignited engines. Part 1: Model-based design of the charge valve. Proc. Inst. Mech. Eng. Part D J. Autom. Eng. 2012, 226, 1408–1418.

[19] Voser, C.; Ott, T.; Donitz, C.; Vasile, I.; Onder, C.; Guzzella, L. In-cylinder boosting of turbocharged spark-ignited engines. Part 2: Control and experimental verification. Proc. Inst. Mech. Eng. Part D J. Autom. Eng. 2012, 226, 1564–1574.

[20] Huang, K.D.; Tzeng, S.C. Development of a hybrid pneumatic-power vehicle. Appl. Energy 2005, 80, 47–59.

[21] Huang, K.D.; Tzeng, S.C.; Ma, W.P.; Chang, W.C. Hybrid pneumatic-power system which recycles exhaust gas of an internal-combustion engine. Appl. Energy 2005, 82, 117–132.

[22] IDEX_Coporation Gast Airmotor Web Page. Gast Air and Gear Motors. Available online: http://www.gastmfg.com/product_overview_air_motors.aspx (accessed on 8 March 2013).

[23] Tai, C.; Tsao, T.C. Control of an Electromechanical Actuator for Camless Engines. In Proceedings of the 2003 American Control Conference, Denver, CO, USA, 4–6 June 2003; pp. 3113–3118.

[24] Mercorelli, P. A Switching Model Predictive Control for Overcoming a Hysteresis Effect in a Hybrid Actuator for Camless Internal Combustion Engines. In Proceedings of 2011 Workshop on Predictirve Control of Electrical Drives and Power Electronics, Munich, Germany, 14–15 October 2011; pp. 10–16.

[25] IDEX_Coporation Jun-Air Home Page. Available online: http://www.jun-air.com/ (accessed on 8 March 2013).

[26] Phillips, F.; Gilbert, I.; Pirault, J.-P.; Megel, M. Scuderi split cycle research engine: Overview, architecture and operation. SAE Int. J. Engines 2011, 4, 450–466.