*IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*
*e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 14, Issue 4 Ver. VII (Jul. - Aug. 2017), PP 01-05*
*www.iosrjournals.org*

# Compressed Air Engine

Mr.Baddela Saivardhan
*Student, Department Of Mechanical Engineering,*
*JNTUA College Of Engineering(Autonomous),Pulivendula, Andhra Pradesh, India*
*Corresponding Author: * Mr.Baddela Saivardhan*

***Abstract:****This paper work deals with the Compressed-air engine as a pneumatic actuator that converts one form of energy into another. The Air Driven Engine is an eco-friendly engine which operates with compressed air. This Engine uses the expansion of compressed air to drive the pistons of the 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. 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.*

***Keywords:*** *Air, Compressed, Engine, Energy, Propulsion, Pneumatic actuator.*

---

Date of Submission: 08 -07-2017 Date of acceptance: 28-08-2017

---

## I. Introduction

At first glance the idea of running an engine on air seems to be too good to be true. Actually, if we can make use of air as an aid for running an engine it is a fantastic idea. As we all know, air is all around us, it never runs out, it is non-polluting and it is free. An Air Driven Engine makes use of Compressed Air Technology for its operation. Compressed Air Technology is now widely preferred for research by different industries for developing different drives for different purposes. 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. This is the basic working principle of the Air Driven Engine. It uses the expansion of compressed air to drive the pistons of the engine. So an Air Driven Engine is basically a pneumatic actuator that creates useful work by expanding compressed air. This work provided by the air is utilized to supply power to the crankshaft of the engine. In the case of an Air Driven Engine, there is no combustion taking place within the engine. So it is non-polluting and less dangerous. It requires lighter metal only since it does not have to withstand elevated temperatures. As there is no combustion taking place, 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

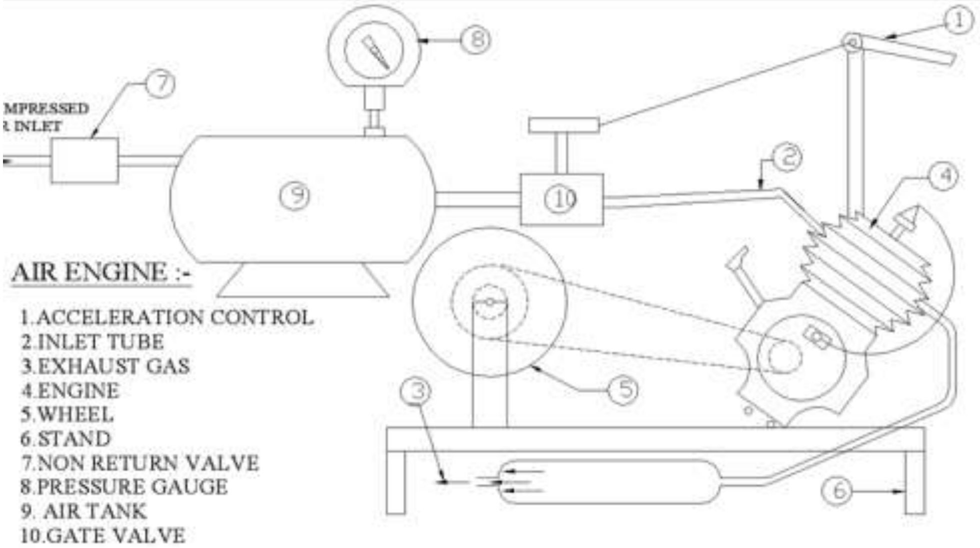
## II. Components

- CYLINDER
- PISTON
- COMBUSTION CHAMBER
- CONNECTING ROD
- CRANKSHAFT
- CAMSHAFT
- CAM
- PISTON RINGS
- GUDGEON PIN
- INLET
- EXHAUST MANIFOLD
- INLET AND EXHAUST VALVE
- FLYWHEEL

## III. Engine Specifications

Type of fuel used : Petrol (previously)
Cooling system : Air cooled
Number of cylinder : Single
Number of stroke : Four Stroke
Arrangement : Vertical
Cubic capacity : 100 cc

## IV. Layout of the Project




(**Fig.1.**project layout)

## V. Compressed Air Engine Principle

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. 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.

**A. Engine**

A Compressed-air engine is a pneumatic actuator that creates useful work by expanding compressed air. They have existed in many forms over the past two centuries, ranging in size from hand held turbines up to several hundred horsepower. 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 can buy the vehicle with the engine or buy an engine to be installed in the vehicle. Typical air engines use one or more expander pistons. In some applications it is advantageous to heat the air, or the engine, to increase the range or power.

**B. Tank**

The tanks must be designed to safety standards appropriate for apressure vessel, such as ISO 11439.
The storage tank may be made of:
1. Steel,
2. Aluminum,
3. Carbon fiber,
4. Kevlar,
5. Other materials or combinations of the above.

The fiber materials are considerably lighter than metals butgenerally more expensive. Metal tanks can withstand a largenumber of pressure cycles, but must be checked for corrosionperiodically. One company stores air in tanks at 4,500 poundsper square inch (about 30 MPa) and hold nearly 3,200 cubic feet(around 90 cubic metres) of air.The tanks may be refilled at a service station equipped with heatexchangers, or in a few hours at home or in parking lots, pluggingthe car into the electrical grid via an on-board compressor.

**C. Compressed Air**

Compressed air has a low energy density. In 300 bar containers, about 0.1 MJ/L and 0.1 MJ/kg is achievable, comparable to the values of electrochemical lead-acid batteries. While batteries can somewhat maintain their voltage throughout their discharge and chemical fuel tanks provide the same power densities from the first to the last litre, the pressure of compressed air tanks falls as air is drawn off. A consumer-automobile of conventional size and shape typically consumes 0.3-0.5 kWh (1.1-1.8 MJ) at the drive shaft per mile of use, though unconventional sizes may perform with significantly less.

**D. Emission Output**

Like other non-combustion energy storage technologies, an air vehicle displaces the emission source from the vehicle's tail pipe to the central electrical generating plant. Where emissions-free sources are available, net production of pollutants can be reduced. Emission control measures at a central generating plant may be more effective and less costly than treating the emissions of widely-dispersed vehicles. Since the compressed air is filtered to protect the compressor machinery, the air discharged has less suspended dust in it, though there may be carry-over of lubricants used in the engine.

## VI. Working Principle

Today, internal combustion engines in cars, trucks, motorcycles, aircraft, construction machinery and many others, most commonly use a four-stroke cycle. The four strokes refer to intake, compression, combustion (power), and exhaust strokes that occur during two crankshaft rotations per working cycle of the gasoline engine and diesel engine. The cycle begins at Top Dead Center (TDC), when the piston is farthest away from the axis of the crankshaft. A stroke refers to the full travel of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).

**A. INTAKE stroke**

On the intake or induction stroke of the piston , the piston descendsfrom the top of the cylinder to the bottom of the cylinder, reducingthe pressure inside the cylinder. A mixture of fuel and air is forcedby atmospheric (or greater) pressure into the cylinder through theintake port. The intake valve(s) then close.

**B. COMPRESSION stroke**

With both intake and exhaust valves closed, the piston returns tothe top of the cylinder compressing the fuel-air mixture. This isknown as the compression stroke.

**C. POWER stroke**

While the piston is close to Top Dead Center, the compressedair–fuel mixture is ignited, usually by a spark plug (for a gasolineor Otto cycle engine) or by the heat and pressure of compression(for a diesel cycle or compression ignition engine). The resultingmassive pressure from the combustion of the compressed fuel-air mixture drives the piston back down toward bottom dead centerwith tremendous force. This is known as the power stroke, whichis the main source of the engine's torque and power.

**D. EXHAUST stroke**

During the exhaust stroke, the piston once again returns to top dead center while the exhaust valve is open. This action evacuates the products of combustion from the cylinder by pushing the spent fuel-air mixture through the exhaust valve(s). In our project we have to modified these four strokes into totally two stoke with the help of inner CAM alteration. In air engine we can design a new CAM which is operate only Inlet stroke and exhaust stroke. Actually in four stroke engine the inlet and exhaust valve opens only one time to complete the total full cycle. In that time the piston moving from top dead center to bottom dead center for two times. A stroke refers to the full travel of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).In our air engine project, we have to open inlet and exhaust valve in each and every stroke of the engine so that it will convert the four stroke engine to two stroke engine by modifying the CAM shaft of the engine.

## VII. Design and Drawings

A. Design of Ball Bearing:
Bearing No. 6202
Outer Diameter of Bearing (D) = 35 mm
Thickness of Bearing (B) = 12 mm
Inner Diameter of the Bearing (d) = 15 mm

$r_1$= Corner radii on shaft and housing
$r_1$= 1 (From design data book)
Maximum Speed = 14,000 rpm (From design data book)
Mean Diameter (mm) = (D + d) / 2
= (35 + 15) / 2
= 25 mm
B. Engine Design Calculations:

**Design and Analysis on Temperature Distribution for Two-Stroke Engine Component Using Finite Element Method:**
1. Specification of Four Stroke Petrol Engine:
Type : Four strokes
Cooling System : Air Cooled
Bore/Stroke : 50 x 50 mm
Piston Displacement : 98.2 cc
Compression Ratio : 6.6: 1
Maximum Torque : 0.98 kg-m at 5,500RPM
2. Calculation:
Compression ratio = (Swept Volume + Clearance Volume)/ Clearance Volume
Here,
Compression ratio = 6.6:1
∴ 6.6 = (98.2 + Vc)/Vc
Vc = 19.64 cc

**Assumptions:**
1.The component gases and the mixture behave like idealgases.
2. Mixture obeys the Gibbs-Dalton law
Pressure exerted on the walls of the cylinder by air is $P_1$
$P_1$= $(M_1RT)/V$
Here,
$M_1$= m/M = (Mass of the gas or air)/ (Molecular Weight)
R = Universal gas constant = 8.314 KJ/Kg mole K.
$T_1$= 303 ºK
$V_1$= V = 253.28 x$10^{-6}$ m³
Molecular weight of air = Density of air x V mole
Here,
Density of air at 303ºK = 1.165 kg/m³
V mole = 22.4 m³/Kg-mole for all gases.
∴ Molecular weight of air = 1.165 x 22.4
∴ $P_1$= {[($m_1$/(1.165 x 22.4)] x 8.314 x303]}/253.28 x $10^{-6}$
$P_1$= 381134.1 $m_1$
Let Pressure exerted by the fuel is $P_2$
$P_2$= $(N_2R\ T)/V$
Density of petrol = 800 Kg/m³
∴ $P_2$= {[($M_2$)/(800 x 22.4)] x8.314 x 303]}/(253.28 x $10^{-6}$)
$P_2$= 555.02 $m_2$
Therefore Total pressure inside the cylinder
$P_T = P_1 + P_2$
= 1.01325 x 100 KN/m²
∴ 381134.1 $m_1$+ 555.02 $m_2$= 1.01325 x 100 --------- (1)
Calculation of air fuel ratio:
Carbon = 86%
Hydrogen = 14%
We know that,1Kg of carbon requires 8/3 Kg of oxygen for thecompletecombustion.
1Kg of carbon sulphur requires 1 Kg of Oxygen for itscomplete combustion.
(From Heat Power Engineering-Balasundarum)
Therefore,The total oxygen requires for complete combustion of1Kg of fuel
= [ (8/3c) + ($3H_2$) + S] Kg
Little of oxygen may already present in the fuel, then

the total oxygen required for complete combustion of
Kg of fuel
$= \{ [ (8/3c) + (8H_2) + S ] – O_2\}$ Kg
As air contains 23% by weight of Oxygen for obtain
of oxygen amount of air required
= 100/23 Kg
∴ Minimum air required for complete combustion of 1 Kg of fuel
$= (100/23) \{ [ (8/3c) + H_2 + S] – O_2\}$ Kg
So for petrol 1Kg of fuel requires
= (100/23) {[(8/3c) x 0.86 + (8 x 0.14) ] }
= 14.84 Kg of air
∴ Air fuel ratio = $m_1/m_2$
= 14.84/1
= 14.84
∴ $m_1 = 14.84\ m_2$------------(2)
Substitute (2) in (1)
$1.01325 \times 100 = 3.81134 (14.84\ m_2) + 555.02\ m_2$
∴ $m_2 = 1.791 \times 10^{-5}$Kg/Cycle
Mass of fuel flow per cycle = $1.791 \times 10^{-5}$Kg cycle
Therefore,
Mass flow rate of the fuel for 2500 RPM
$[(1.791 \times 10^{-5})/3600] \times (2500/2) \times 60 = 3.731 \times 10^{-4}$Kg/sec

## VIII. Advantages

- Compressed air to store the energy instead of batteries.
- Pollution created during fuel transportation would beeliminated.
- Reducing pollution from one source, as opposed to themillions of vehicles on the road.
- There is no need to build a cooling system, fuel tank, IgnitionSystems or silencers.
- The price of fueling air powered vehicles will be significantlycheaper than current fuels.

## IX. Disadvantages

- The temperature difference between the incoming air and theworking gas is smaller. In heating the stored air, the devicegets very cold and may ice up in cool, moist climates.
- Refueling the compressed air container using a home or lowendconventional air compressor may take a long time.
- Tanks get very hot when filled rapidly. It very dangerous ifcaution is not maintained.
- Only limited storage capacity of the tanks. So we cannot optfor a long drive.

## X. Conclusion

The model designed by me 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. The technology of compressed air vehicles is not new. Compressed air technology allows for engine that are both non-polluting and economical. Unlike electric or hydro-gen powered vehicles, compressed air vehicles are not expensive and do not have a limited driving range. Compressed air vehicles are affordable and have a performance rate that stands up to current standards. To summit up, they are non-expensive which do not pollute and are easy to get around in cities. The emission benefits of introducing this zero emission technology are obvious At the same time the well to wheels efficiency of these vehicles need to be improved. This is a revolutionary engine which is not only eco- friendly, pollution free, but also very economical. This addresses both the problems of fuel crises and pollution. However excessive research is needed to completely provethe technology for both its commercial and technical viability.

## REFERENCES:

[1] V.Ganesan, “Computer Simulation of Compression Ignition Engine Processes”.
[2] HEYWOOD,J.B., “Internal Combustion Engine Fundamentals”,Mc Graw-Hill Book Company.
[3] Internet website,www.wikipedia.com
[4] Internet website,www.engineering tool box.com
[5] Internet website,www.how stuff works.com
[6] Internet website,www.youtube.com/Mr.Teslonian