PNEUMATIC BIKE WITH COMPRESSED AIR ENGINE

AZHAGARSAMY R

CHAPTER 1 INTRODUCTION

1.1 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.

1.2 HISTORY

(a) The first compressed air vehicle was devised by Bompas, a patent for a locomotive being taken out in England in 1828. There were two storage tanks between the frames, with conventional cylinders and cranks. It is not clear if it was actually built.(Knight,1880)

(b) The first recorded compressed air vehicle in France was built by the Frenchmen Andraud and Tessie of Motay in 1838. A car ran on a test track Chaillot on the 9th July 1840, and worked well, but the idea was not pursued further.

(c) In 1848nBarin Von Rathlen constructed a vehicle which was reported to have been driven from

Putney to Wandsworth(London) at an average speed of 10 to 12 mph.

(d) At the end of 1855, a constructor called Julienne ran some sort of vehicle at Saint-denis in France, driven by air at 25 atmosphere (350 psi), for it to be used in coal mines.

(e) Compressed air locomotives were used for haulage in 1874 while the Simplon tunnel was being dug. An advantage was that the cold exhaust air aided the ventilation of the tunnel.

(f) Louis Mekarski built a standard gauge self-contained tramcar which was tested in February 1876 on the Courbevoie-Etoile Line of the Paris Tramways Nord (TN), where it much impressed the current president and minister of transport Marechal de MacMahon.

1.3 COMPRESSED AIR TECHNOLOGY

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, road vehicle) systems
- starting of diesel engines (an alternative to electric starting)

- compressed air breathers (such as Suisse Air)
- pneumatic air guns, pneumatic screwdrivers

1.4 BASICS OF PNEUMATICS

The term pneumatics has been derived from the Greek word "PNEUMA", which means air wind or breath.

Pneumatics may be defined as that branch of engineering-science which deals with the study of the behaviour and application of compressed air.

The reasons why air is popularly used as the fluid medium in pneumatic systems are:

1. Air is abundantly available.
2. It is safe to use (as it has fire-proof characteristics).
3. It is very cheap in cost.
4. Easier maintenance and easy handling.
5. It can be exhausted easily and safely to the atmosphere after use.

Composition Of Air

Air is a mixture of gases. Air is invisible, colourless, odourless and tasteless. The main constituents of air by volume are 78% nitrogen, 21% oxygen and 1% other gases such as argon and carbon-dioxide.

1.5 PERFECT GAS LAWS

Air behaves like a perfect gas or an ideal gas with very insignificant deviation from the perfect gas. Therefore all perfect gas laws are equally applicable to air.

1. Boyle's Law

It states that if temperature remains constant, the pressure of a confined mass of gas will vary inversely with its volume.

$PV = \text{Constant}$

2. Charle's Law

It states that pressure remains constant, the volume of a given mass of a gas will vary directly as its absolute temperature.

V/T = Constant

3. Gay-Lussac's Law

It states that volume remains constant, the pressure of a confined mass of a gas will vary directly as its absolute temperature.

P/T = Constant

4. General Gas Law

Boyle's, Charle's and Gay-lussac's laws can be combined to obtain the general gas law and is given by,

PV/T = Constant

1.6 AIR COMPRESSOR

An air compressor is a device that converts electrical power or gas into kinetic energy by pressurizing and compressing air, which is then released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or non-positive displacement types.

Positive-displacement air compressors work by forcing air into a chamber whose volume is reduced to effect the compression. Piston-type air compressors use this principle by pumping air into an air chamber through the use of the constant motion of pistons. They use unidirectional valves to guide air into a chamber, where the air is compressed. Rotary screw compressors also use positive-displacement compression by matching two helical screws that, when turned, guide air into a chamber, the volume of which is reduced as the screws turn. Vane compressors use a slotted rotor with varied blade placement to guide air into a chamber and compress the volume.

Non-positive-displacement air compressors include centrifugal compressors. These devices use centrifugal force generated by a spinning impeller to accelerate and then decelerate captured air, which pressurizes it.

The air compressors seen by the public are used in 5 main applications:

- To supply a high-pressure clean air to fill gas cylinders

- To supply a moderate-pressure clean air to supply air to a submerged surface supplied diver
- To supply a large amount of moderate-pressure air to power pneumatic tools
- For filling tires

To produce large volumes of moderate-pressure air for macroscopic industrial processes (such as oxidation for petroleum coking or cement plant bag house purge systems).

Most air compressors are either reciprocating piston type or rotary vane or rotary screw. Centrifugal compressors are common in very large applications.

Figure 1.1 Air Compressor

1.7 PRESSURE REGULATOR

A pressure regulator is a control valve that reduces the input pressure of a fluid to a desired value at its output. Regulators are used for gases and liquids, and can be an integral device with an output pressure setting, a restrictor and a sensor all in the one body, or consist of a separate pressure sensor, controller and flow valve.

Operation

A pressure regulator's primary function is to match the flow of gas through the regulator to the demand for gas placed upon it, whilst maintaining a constant output pressure.

If the load flow decreases, then the regulator flow must decrease also. If the load flow increases, then the regulator flow must increase in order to keep the controlled pressure from decreasing due to a shortage of gas in the pressure system.

A pressure regulator includes a restricting element, a loading element, and a measuring element:

- The restricting element is a valve that can provide a variable restriction to the flow, such as a globe valve, butterfly valve, poppet valve, etc.
- The loading element is a part that can apply the needed force to the restricting element. This loading can be provided by a weight, a spring, a piston actuator, or the diaphragm actuator in combination with a spring.
- The measuring element functions to determine when the inlet flow is equal to the outlet flow. The diaphragm itself is often used as a measuring element; it can serve as a combined element.

In the single-stage regulator, a force balance is used on the diaphragm to control a poppet valve in order to regulate pressure. With no inlet pressure, the spring above the diaphragm pushes it down on the poppet valve, holding it open. Once inlet pressure is introduced, the open poppet allows flow to the diaphragm and pressure in the upper chamber increases, until the diaphragm is pushed upward against the spring, causing the poppet to reduce flow, finally stopping further increase of pressure. By adjusting the top screw, the downward pressure on the diaphragm can be increased, requiring more pressure in the upper chamber to maintain equilibrium. In this way, the outlet pressure of the regulator is controlled.

Single Stage Regulator

High pressure gas from the supply enters into the regulator through the inlet valve. The gas then enters the body of the regulator, which is controlled by the needle valve. The pressure rises, which pushes the diaphragm, closing the inlet valve to which it is attached, and preventing any more gas from entering the regulator.

The outlet side is fitted with a pressure gauge. As gas is drawn from the outlet side, the pressure inside the regulator body falls. The diaphragm is pushed back by the spring and the valve opens, letting more gas in from the supply until equilibrium is reached between the outlet pressure and the spring. The outlet pressure therefore depends on the spring force, which can be adjusted by means of an adjustment handle or knob.

The outlet pressure and the inlet pressure hold the diaphragm/poppet assembly in the closed position against the force of the large spring. If the supply pressure falls, it is as if the large spring compression is increased allowing more gas and higher pressure to build in the outlet chamber until an equilibrium pressure is reached. Thus, if the supply pressure falls, the outlet pressure will increase, provided the outlet pressure remains below the falling supply pressure. This is the cause of end-of-tank dump where the supply is provided by a pressurized gas tank. With a single stage regulator, when the supply tank gets low, the lower inlet pressure causes the outlet pressure to climb. If the spring compression is not adjusted to compensate, the poppet can remain open and allow the tank to rapidly dump its remaining contents. In other words, the lower the supply pressure, the lower the pressure differential the regulator can achieve for a given spring setting.

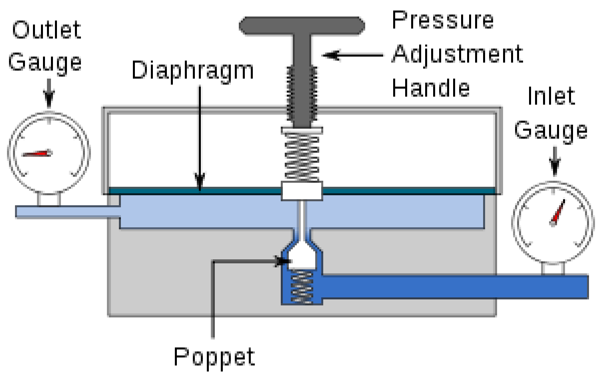

Figure 1.2 Pressure Regulator

Applications

- Air compressors
- Aircraft
- Aerospace
- Cooking
- Water pressure reduction

- Oxy-fuel welding and cutting
- Propane/LP Gas
- Gas powered vehicles
- Recreational vehicles
- Breathable air supply
- Mining Industry
- Oil and gas industry

1.8 FOUR STROKE ENGINE

A four-stroke engine is an internal combustion (IC) engine in which the piston completes four separate strokes while turning a crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

1. **Suction:** It is also known as induction or suction. This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion.

2. **Compression:** This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

3. **Power:** It is also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

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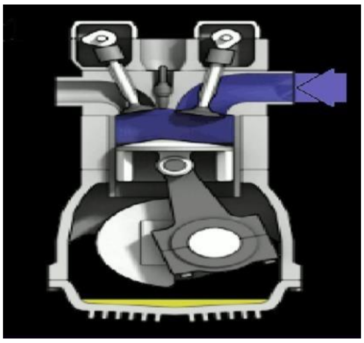
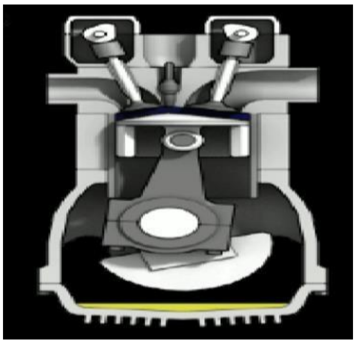
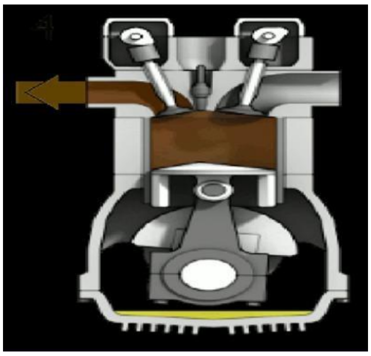
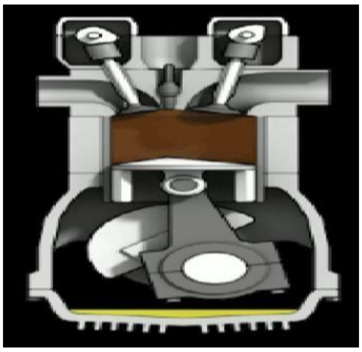
4. **Exhaust:** It is also known as outlet. During the exhaust stroke, the piston once again returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust valve.





(a) Suction (b) Compression





(c) Power (d) Exhaust

Figure 1.3 Four Strokes of Four Stroke Engine

CHAPTER 2 LITERATURE REVIEW

Lohit .V and Imran Mohideen .A (2014) presented The Pneumatic Bike and proceeded with sense of awakening ideas on Eco Friendly Vehicles. They used the electric motor for attain initial torque, the torque Sensor for sense the attainment of initial torque, solenoid valves for compressed air handling and pressure regulators for Speed & Braking.

Basou Saxena, Ayush Kumar Srivastava and Anu Srivastava (2014) modified the already existing conventional 4 stroke SI engine into an air powered engine and they solved the problem of piston locking by creating a hole in the piston.

Jimil.M Shah, Akash.B Pandey and Ujjwell.Y Trivedi (2013) converted the 4-stroke IC engine into a 2-stroke pneumatic engine by changed the design of camshaft. The valve timing diagram was derived for the same. The cam profile of a double lobed cam as required in the valve timing diagram was designed in Pro-e software and was cut on a wire cut machine. The cam and camshaft were manufactured separately and then assembled.

Mistry Manish.K, Dr.Pavin P. Rathod and Prof. Sorathiya Arvind.S (2012) reported on the experiment set up of compressed air single cylinder engine which can be run by the compressed air. Four stroke single cylinder engine can be run on the compressed air with few modifications. The electricity requiring for compressing air has to be considered while computing overall efficiency.

Arjit Mourya et al. (2014) modified the compressed air engine by change the design of the camshaft to alter the timing of the valves. Here this compressed air engine takes the intake of air from the vertically above the piston head.

Nitin Parashar et al. (2014) carried out the research of design and 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.

Kripal Raj Mishra and GauravSugandh (2014) Studied About Engine Operated By Compressed Air (C.A.E): A Pneumatic Power Source and reported that Since engine is operated by Compressed air which contribute to reduce the air pollution and tend to zero pollution level of atmosphere and making a great a environment. While developing it some parameters as like temperature, density, input power, emission control have be mastered for development of safety.

CHAPTER 3 THE COMPONENTS

3.1 THE COMPONENTS

The major components of our compressed air engine consists of:

1. The Engine
2. Air Compressor
3. Pressure Regulator
4. The Pipe System
5. The Pressure Gauge System

3.1.1 The Engine

The basic engine that we have used in the project is a normal four stroke petrol engine. The details of the engine are as follows:

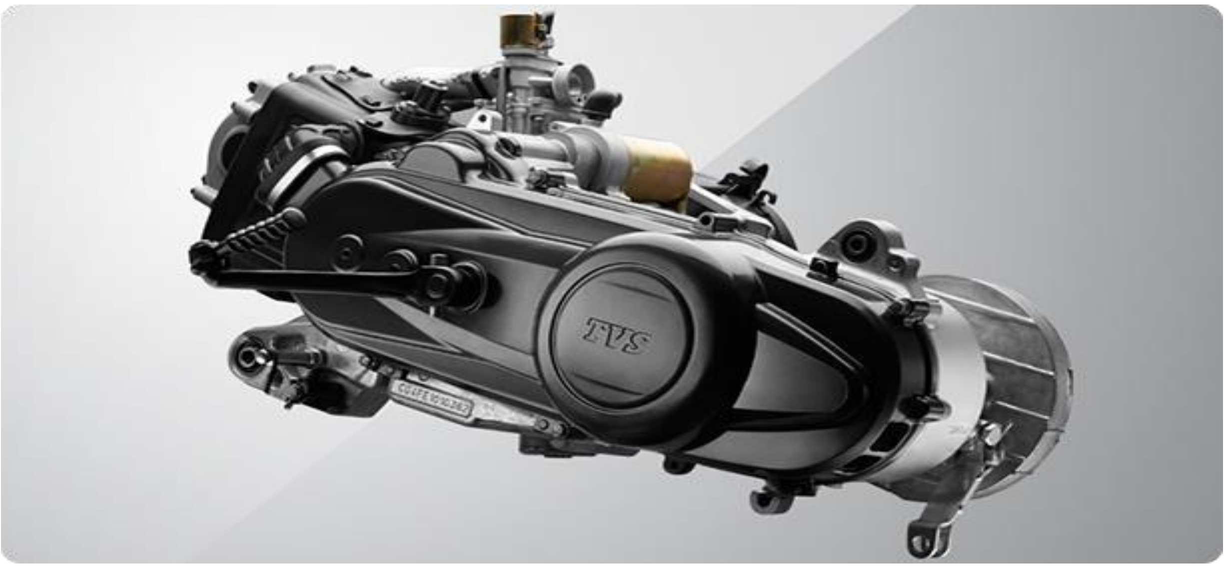


Figure 3.1 TVS Scooty Pep Plus Engine

Table 3.1 Technical Specifications of TVS Scooty Pep Plus Engine

Engine	4 Stroke, Single Cylinder, Air cooled
Displacement	87.8 cc
Bore and Stroke	51 x 43
Maximum Power	5 PS (3.68 kw) @ 6500 rpm
Maximum Torque	5.8 Nm @ 4000 rpm
Transmission	Variomatic
Clutch	Pivoted Clutch Centrifugally Operated

The modifications comprised of:

- Modifying the cam (Grind the exhaust cam)
- Modifying the cam sprocket
- Decreasing the length of the camshaft-crank shaft chain
- Removing the exhaust cam’s rocker arm
- Providing an inlet at the place of the inlet manifold
- Providing a suitable connector at the inlet

3.1.2 Air Compressor

The Air Compressor that we have used for fill the air reservoir in the project is a single stage air compressor. The details of the air compressor are as follows:

Figure 3.2 Air Compressor

Table 3.2 Technical Specifications of Air Compressor

Power	5 HP
Stages	1.0
Tank Capacity	100 L
Phase	Three Phase

3.1.3 Pressure Regulator

The pressure regulator that we have used in the project to regulate the pressure is hand operated air pressure regulator. The details of the pressure regulator are as follows:

Figure 3.3 Pressure Regulator

Table 3.3 Technical Specifications of Pressure Regulator

Type	Hand Operated, Single Stage
Operating range	0 – 10 bar

3.1.4 The Pipe System

The pipe system is used to connect the components involved in the passage of the compressed air. It is used to connect the air reservoir to the pressure regulator and the pressure regulator to the inlet.

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Figure 3.4 The Pipe system

Here polyurethane pipes are used of diameter of 12mm and length of 3m. They are made of hard and flexible material so that they are able to pass the compressed air more efficiently and are highly flexible. These pipes are able to withstand high pressure and so are used to transport compressed air. They are perfectly suited to be inserted to the one touch male connector.

Connectors

Connectors are used to connect the pipes with the components used in this project. The type of connector used is one touch male connector which has an internal hexagonal socket. The specification of the thread is BSPT R1/2 (British standard piping thread). The outer diameter is 21.5mm and the inner diameter is 12mm.

Figure 3.5 Connectors

3.1.5 Pressure Gauge System

The pressure gauges are used to measure or display the pressure at the position at which the pressure gauge is installed. There are different ranges of the pressure gauges. 0 to 10 bar pressure gauges are used in this project. At shaped female connector is used to install the pressure gauge in the system and it also holds the pressure gauge at position.

Figure 3.6 Pressure gauge system

CHAPTER 4 MODIFICATIONS OF PARTS

4.1 MODIFICATION OF CAMSHAFT

We modified the camshaft of the four stroke SI engine for convert the four stroke SI engine into two stroke compressed air engine. For this purpose we grinded the exhaust camshaft as shown in the figures below.

Figure 4.1 Existing Camshaft

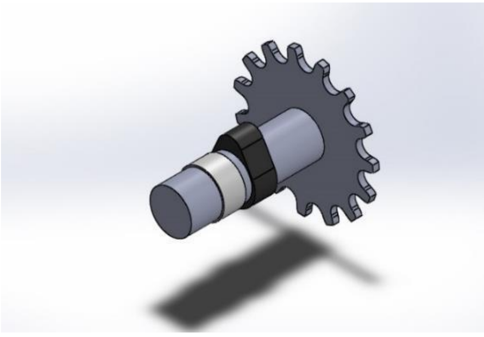

Figure 4.2 Modelling of Modified Cam Shaft

Figure 4.3 Modified Camshaft

4.2 CREATION OF NEW EXHAUST MANIFOLD

We created the new exhaust manifold on the side of the cylinder block as shown in the below figure.

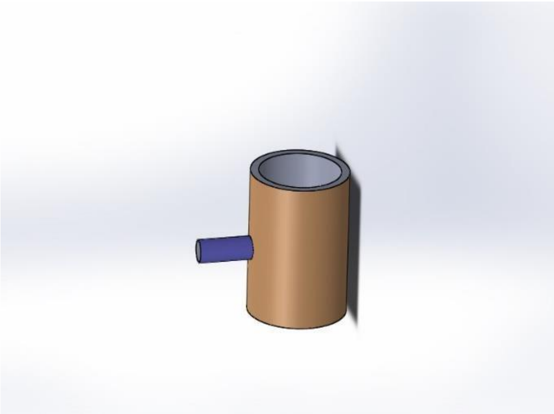

Figure 4.4 Existing Cylinder Block **Figure 4.5 Modelling of Modified Cylinder Block**

Figure 4.6 Modified Cylinder Block

4.3 CHANGING OF CAM SPROCKET

We changed the existing camshaft sprocket as similar to crankshaft sprocket. Hence, both camshaft sprocket and crankshaft sprocket rotate by equal revolutions and then the engine obtained two strokes.

Figure 4.7 Existing Cam Sprocket

Figure 4.8 Replaced Cam Sprocket

CHAPTER 5

WORKING OF COMPRESSED AIR ENGINE

In any engine the charge enters from the inlet valve known as suction stroke then it is compressed by the piston due to crank rotation which is the compression stroke, then sparking takes place through the spark plug, the fuel ignites and combustion process takes place known as expansion stroke and finally the combustion product are let out of the engine by the exhaust stroke. Here air is initially taken up from the atmosphere, then it is compressed with the help of a compressor and sent to the air reservoir. Piston is assumed to be at TDC, the exhaust valve is closed permanently and initially inlet valve also remains closed. The compressed air gets filled in the clearance volume and when a small rotation is given to the crank this piston starts to slide down, the compressed air tends to expand and pushes the piston downwards. The piston moves from TDC to BDC in one stroke. Now the exhaust port opens and due to pressure difference the air filled in the volume of the cylinder moves out and piston moves up from BDC to TDC. In this manner one cycle gets completed in two strokes again the same process takes place and output is obtained.

CHAPTER 6 EXPERIMENTAL IVESTIGATION

6.1 EXPERIMENTAL ANALYSIS OF SCOOTY PEP PLUS ENGINE

Table 6.1 Experimental Analysis Of Scooty Pep Plus Engine

Speed Of Vehicle (v) (km/hr)	Engine Speed (N) (rpm)	H.P.	Power (kw)	Torque (T) (Nm)
10	727	0.003924	0.002926	0.028355
20	1453	0.031388	0.023406	0.113418
30	2180	0.105935	0.078995	0.255191

40	2907	0.251104	0.187248	0.453673
50	3634	0.490438	0.365719	0.708865
60	4360	0.847476	0.631963	1.020765
70	5087	1.345761	1.003534	1.389375

Calculation

$HP = W \times v^3 \times 4.13 \times 10^{-8}$ (HP)

$= 95 \times (10)^3 \times 4.13 \times 10^{-8}$ (HP)

$= 0.003924$ (HP)

Power, $P = HP \times 0.7457$ (kw)

$= 0.003924 \times 0.7457$ (kw)

$= 0.002926$ (kw)

Torque, $T = (HP \times 5252) / N$ (Nm)

$= (0.003924 \times 5252) / 726$ (Nm)

$= 0.028355$ (Nm)

Where,

v – Speed of Vehicle (km/hr) R – Radius of Crank (m)

N – Crankshaft speed (rpm) P – Power (kw)

HP – Horse Power

W – Weight of Vehicle (kg) T – Torque (Nm)

6.1.1 Graphs Of Experimental Analysis Of Scooty Pep Plus Engine

Speed Of Vehicle Vs Engine Speed

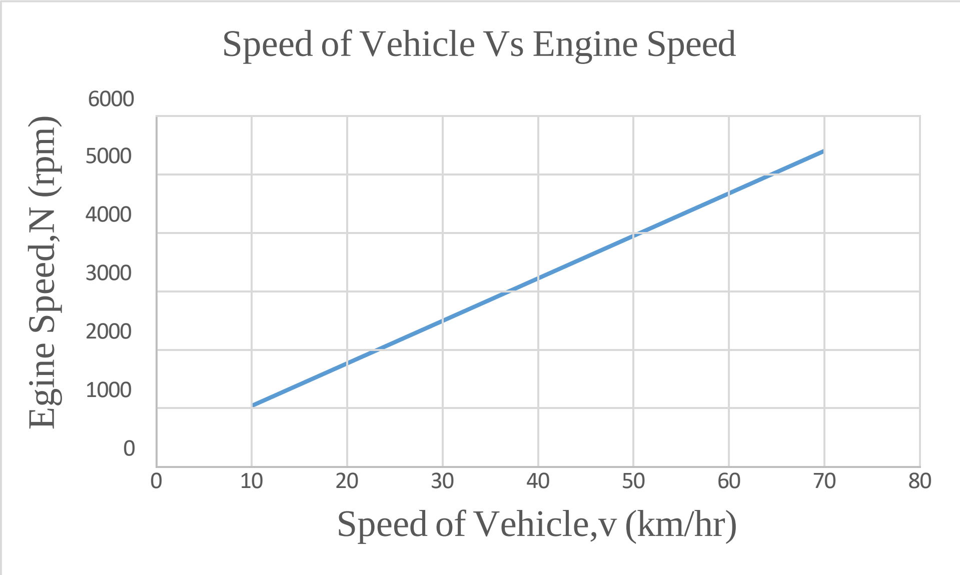

Figure 6.1 Velocity of Vehicle Vs Engine Speed Engine Speed Vs Torque

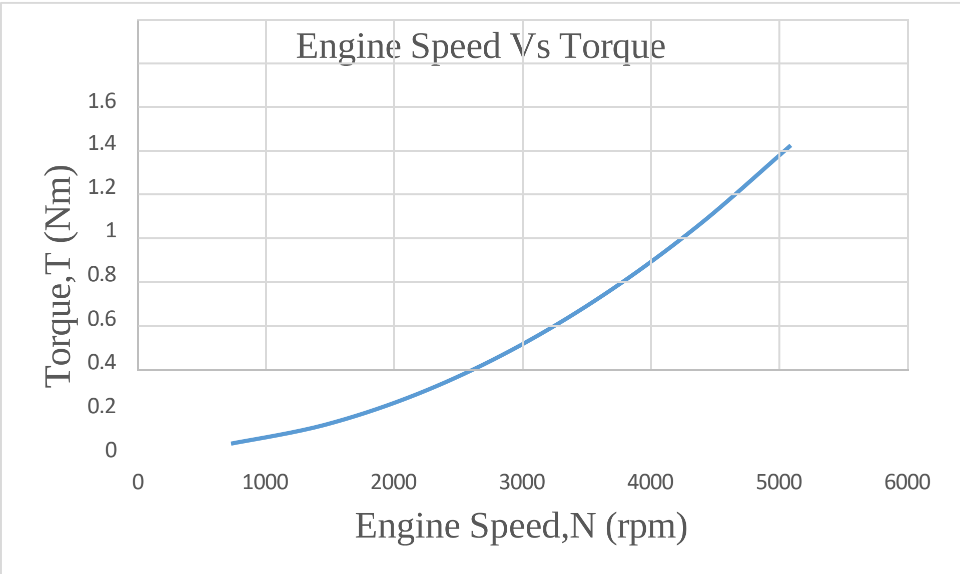

Figure 6.2 Engine Speed Vs Torque

Engine Speed Vs HP

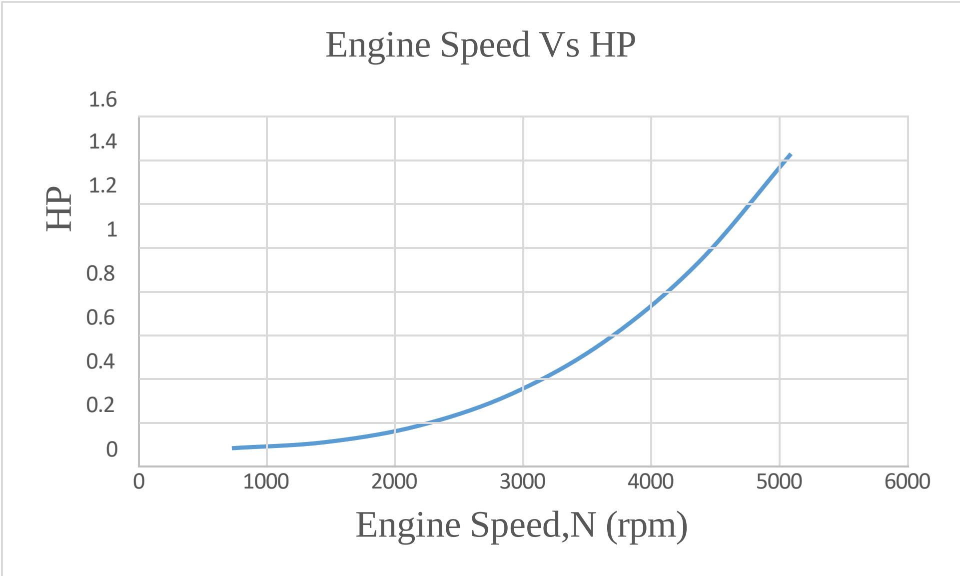

Figure 6.3 Engine Speed Vs HP

6.1.2 Economic Analysis Of Scooty Pep Plus Engine

Petrol price (11/03/17) : **Rs.74.24**

Vehicle weight : **95 kg**

Pay load : **85 kg**

Mileage: city - **45 kmpl**; Highway - **55 kmpl**.

Table 6.2 Economic Analysis Of Scooty Pep Plus Engine

Litre	Km (city)	Km (highway)	Price (Rs.)
1	45	55	74.24
2	90	110	148.48
3	135	165	222.72
4	180	220	296.96
5	225	275	371.2

Calculation Price of Petrol:

Price = Volume of petrol x Price of Petrol per litre

= 1 x 74.24

= Rs. 74.24

6.2 EXPERIMENTAL ANALYSIS OF COMPRESSED AIR ENGINE

Table 6.3 Experimental Analysis Of Compressed Air Engine

Pressure (bar)	Engine Speed (N) (rpm)	Velocity Of CrankShaft (v) (km/hr)	H.P.	Power (P) (kw)	Torque (T) (Nm)
5	445	6.126778	0.001705189	0.001272	0.020125
6	557	7.668798	0.003343936	0.002494	0.03153
7	642	8.839082	0.005120324	0.003818	0.041888
8	711	9.789076	0.006955065	0.005186	0.051376
9	826	11.3724	0.010905172	0.008132	0.069339
10	893	12.29486	0.013779922	0.010276	0.081044
11	975	13.42384	0.017935201	0.013374	0.096611
12	1040	14.31876	0.021766691	0.016231	0.109922
13	1124	15.47528	0.027478393	0.020491	0.128395
14	1196	16.46658	0.033104416	0.024686	0.145372
15	1250	17.21005	0.037793963	0.028183	0.158795

Calculation

Velocity Of Crankshaft, v = R x N x 0.377 (km/hr)

= 0.03652 x 445 x 0.377 (km/hr)

= 6.126778 (km/hr)

HP = W x $(v/234)^3$ (HP)

= 95 x $(6.126778 /234)^3$ (HP)

= 0.001705189 (HP)

Power, P = HP x 0.7457 (kw)

= 0.001705189 x 0.7457 (kw)

= 0.001272 (kw)

Torque, T = (HP x 5252) / N (Nm)

= (0.001705189 x 5252) / 445 (Nm)

= 0.020125 (Nm)

Where,

v – Velocity of crankshaft (km/hr) R – Radius of Crank (m)

N – Crankshaft speed (rpm)

P – Power (kw) HP – Horse Power

W – Weight of Vehicle (kg) T – Torque (Nm)

6.2.1 Graphs Of Experimental Analysis Of Compressed Air Engine

Pressure Vs Engine Speed

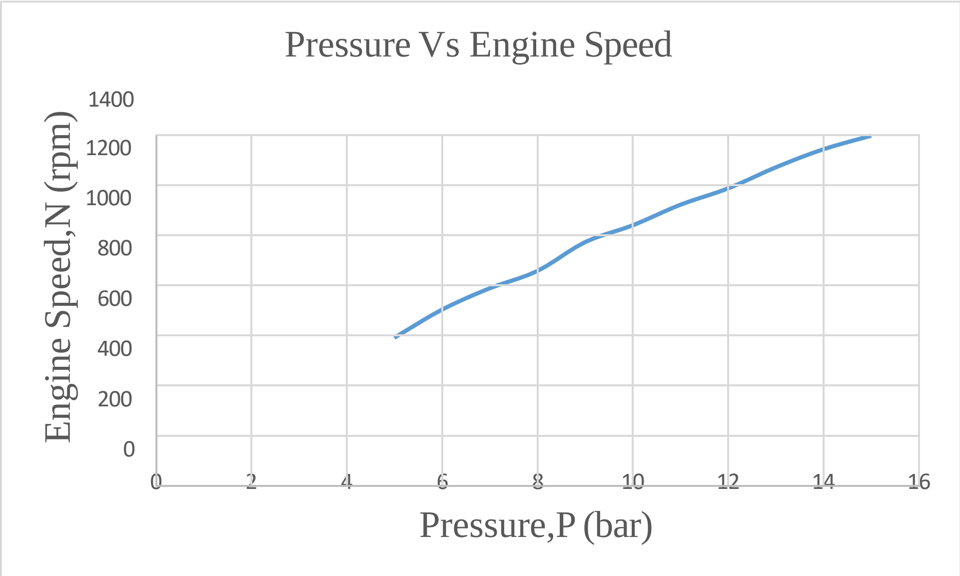

Figure 6.4 Pressure Vs Engine Speed

Pressure Vs Torque

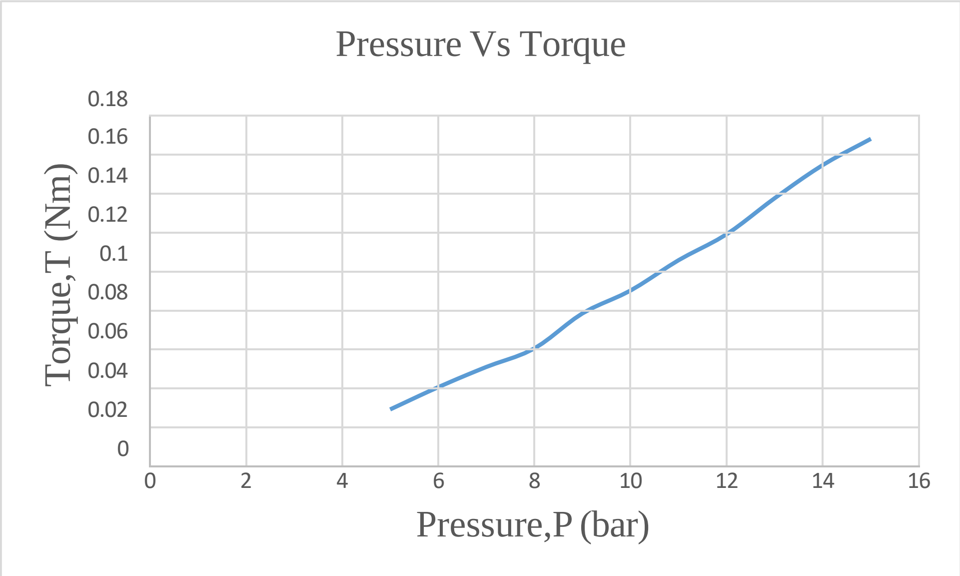

Figure 6.5 Pressure Vs Torque

Pressure Vs HP

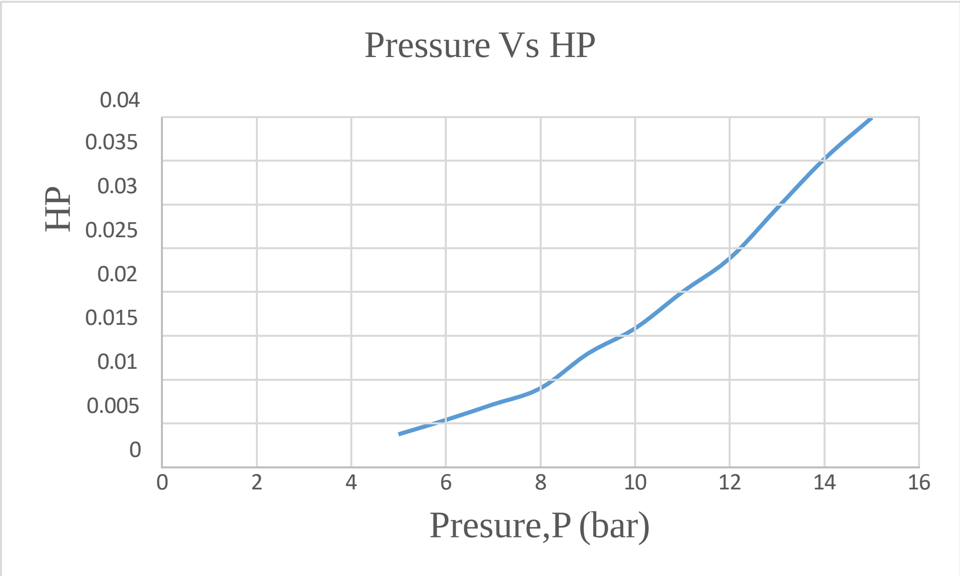

Figure 6.6 Pressure Vs HP

6.2.2 Economic Analysis Of Compressed Air Engine

Table 6.4 Economic Analysis Of Compressed Air Engine

Volume of air reservoir (V) (L)	**Pressure inside the air reservoir (P) (bar)**	**Time taken (t) (min)**	**Energy Consumption (E) (kWh)**	**Electricity Charge (Rs.)**
100	15	8	0.4970	1.50

Calculation

Energy Consumption, E = HP x 0.7457 x t (kWh)

= 5 x 0.7457 x 0.1333 (kWh)

= 0.4970 (kWh)

CHAPTER 7 ADVANTAGES OF AIR DRIVEN ENGINE

- Less costly and more effective.
- The air engine is an emission-free piston engine that uses compressed air as a source of energy.
- Simple in construction. The engine can be massively reduced in size.
- Easy to maintain and repair.
- No fire hazard problem due to over loading. Air, on its own, is non- flammable.
- Low manufacture and maintenance costs.
- Comparatively the operation cost is less.
- Light in weight and easy to handle. The engine runs on cold or warm air, so can be made of lower strength light weight material such as aluminium, plastic, low friction teflon or a combination.
- Compressed-air tanks can be disposed of or recycled with less pollution than batteries.
- Compressed-air engines are unconstrained by the degradation problems associated with current battery systems.
- 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.
- Lighter vehicles cause less damage to roads and Quick response is achieved.
- The price of filling air tanks is significantly cheaper than petrol, diesel or biofuel. If electricity is cheap, then compressing air will also be relatively cheap.

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CHAPTER 8 APPLICATIONS

8.1 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.

Figure 8.1 Belt conveyor

8.2 JOB CLAMPING

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

8.3 **FLUID PUMPS**

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

8.4 AUTOMOBILES

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

Figure 8.2 Air car

CHAPTER 9 BILL OF MATERIALS

Table 9.1 BILL OF MATERIALS

S.NO.	PARTICULARS	QUANTITY	PLACE OF PURCHASE
1	TVS SCOOTY PEP PLUS ENGINE	1	TRICHY
2	PRESSURE REGULATOR	1	MADURAI ROAD
3	PRESSURE GAUGE	1	MADURAI ROAD
4	POLYURETHANE PIPE	1	MADURAI ROAD
5	CONNECTORS	4	MADURAI ROAD
6	TEFLON TAPE	1	MADURAI ROAD

CHAPTER 10 COST ESTIMATION

Table 10.1 COST ESTIMATION

S.NO.	PARTICULARS	COST (Rs.)
1	TVS SCOOTY PEP PLUS ENGINE	2000
2	PRESSURE REGULATOR	455
3	PRESSURE GAUGE	255
4	POLYURETHANE PIPE	264
5	CONNECTORS	180
6	TEFLON TAPE	15
TOTAL		3169

CHAPTER 11 CONCLUSION

We were able to successfully complete the design and modification of the petrol engine into the compressed air engine. It's speed, range and the power are limited now, so further research could provide more effective results.

This project can be directly utilized in the market to modify IC Engine into the air driven engine ineffective cost. Since a number of operations can be performed in a single and simple unit. It is efficient and economical.

We can say that the cost of the modification is very less and the effective results can be achieved.

As we know that in IC engines higher pressures and temperatures are maintained as compared to air driven engine so that in IC engines heavy metal alloys are used but for air driven engine light alloys can be used.

The weight of the engine can be reduced by using aluminium and more light metals. Also the new modified engine and chassis, cast from light alloys can be lighter which will design for the air engine.

The use of heater and reuse of exhaust air improves the efficiency of the vehicle. This project is a successful one because we have stared the 4 Stroke engine is running only on compressed air.

CHAPTER 12 FUTURE SCOPE

- Design and fabrication of a new engine made of light metal will give better results.

- Usage of big compressed air tanks for storage and supply will give it more scope in automobiles. Pressure Boosters can be used for obtain required air pressure inside the air reservoir.

- 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.

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- New engine designs; as shown in figure 12.1 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.

Figure 12.1 Air engine variant

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