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FABRICATING THE DESIGN AND TESTING OF AIR DRIVEN ENGINE

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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

Keywords: Engine, Compressor, Connector and Roller operated pneumatic valve.

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.Prefabricating and Testing of Air Driven Engine,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. MATERIALS

THE COMPONENTS AND ENGINE

2.1 The Engine

The basic engine that we have used in the project is a normal two stroke petrol engine. The details of the engine are as follows: Make: Kinetic ,Displacement: 60 cc., No. of cylinders: 1

Figure 2.1 The Engine

We only needed a simple piston-cylinder arrangement with an outlet and an exhaust. But as we know a normal two stroke engine contained several ports and it also had the spark plug which we didn't require. So, several modifications had to be done on the engine to

2.2. Suit our purpose.

The modifications comprised of:

Closing the transfer port

Closing the inlet port

Removing the spark plug from the cylinder head

Providing an inlet at the place of the spark plug

Providing a suitable connector at the cylinder head

The transfer port was to be sealed to provide maximum sealing of the piston-cylinder arrangement so that the chances of escape of air from the cylinder can be avoided. We made use of m-seal and araldite to seal off the transfer port. First a fine quantity of m-seal was filled in the transfer port fully except for a small clearance to apply araldite. Then the m-seal was allowed to solidify. After that araldite was applied in another layer and was allowed to solidify. Thus the transfer port was closed with the help of the adhesives.

Figure 2.2 Cylinder Block

The inlet port also was required to be closed to avoid mild chances of leakage. It was much easier to close the inlet port. The inlet port contains a Reed valve at its start. This valve is basically a non-return valve. So if we screw it tightly there wouldn't be chances of escape of air through the inlet port. This was carried out to close the inlet port.There is no combustion taking place in an Air Driven Engine. So naturally there is no need for the spark plug. So the spark plug is removed from its respective position that is on the top of cylinder head. It would be great if we provide the inlet for compressed air at the position of the spark plug as it is better to let the air enter from the top of the piston. So the connector which is used to connect the pipe from the compressed air tank has to be fixed at the position of the spark plug. The connector contains an R1/2 thread of BSPT standard. So we tapped the same thread on the cylinder head at the position of the spark plug. Then the suitable connector was fixed on the cylinder head.

Figure 2.3 Cylinder Head

III. 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

.

Figure 2.4 Compressor

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. There are two main types of air compressor's pumps: Oil lubed and oil less. The oil less system has more technical development, but they are more expensive, louder and last less than the oiled lube pumps. But the air delivered has better quality. The best choice depends of the application that the user needs.

3.1. Specification of compressor:

Type: Reciprocating air compressor

Cylinder: 1

Tank: 100 Lt.

A reciprocating compressor is a positive displacement compressor that uses pistons driven by a crankshaft to deliver gases at high pressure. In single stage reciprocating air compressor the entire compression is carried out in a single cylinder. If the compression is affected in one end of the piston & cylinder then it is known as single acting & if the compression is affected in both ends of piston & cylinder then it is known as double acting reciprocating air compressor. The opening & closing of simple check valve (plate or spring valve) is depend upon difference in pressure, if mechanically operated valves are used for suction & discharge then their functioning is controlled by cams. The weight of air in the cylinder will be zero when the piston is at top dead center, if we neglect clearance volume. When piston starts moving downwards, the pressure inside the cylinder falls below atmospheric pressure& suction valve/inlet valve opens. The air is drawn into the cylinder through suction filter element. This operation is known as suction stroke. When piston moves upwards, compresses the air in cylinder & inlet valve closes when pressure reaches to atmospheric pressure. Further compression follows as the piston moves towards the top of its stroke until, when the pressure in the cylinder exceeds that in the receiver. This is compression stroke of compressor. At the end of this stroke discharge/delivery valve opens &

air is delivered to receiver. When it is double acting reciprocating air compressor, suction stroke is in process at one end of piston while at same time discharge stroke is in process at other end of piston. In simple word we can say that suction & compression took place on both end of piston & cylinder in double acting reciprocating air compressor.

IV. ROLLER OPERATED PNEUMATIC VALVE

The roller lever valve with idle return only switches if the movement of the trip cam on the roller lever is in a certain direction. The valve is used as a limit switch for the "position sensing" Care should be taken ensure that the valve is fitted in in the correct direction. Likewise, this type of valve can be used either in the normally open or normally closed position. In the case of normally open position only port 1& 3 need to be inversely connected to normally closed position. The head of valve with roller lever actuator can be can be positioned by 180 degrees.

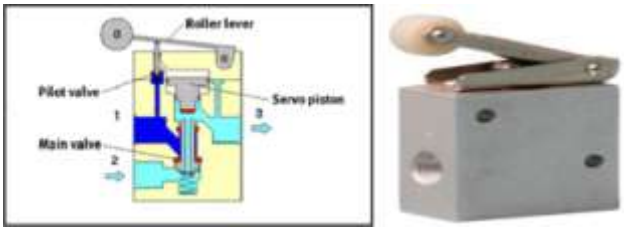

Figure 2.5 3/2 Roller operated pneumatic valve

The roller lever valve is actuated when the roller lever is pressed, for example by the cam of a cylinder. After release of the roller lever, the valve is returned to its initial position.

4.1. Specification

1. Design – Poppet Type , Lever Operated 2) Port / Position – 3/2
2. Pressure Range – 0 – 800kPa (0-8 Bar)
3. Normal Flow rate – 80 l/min

V. VALVE ACTUATION SYSTEM

The valve actuation system is the system used to actuate the valve mechanism. The valve here used is a 3/2 Roller Operated Pneumatic valve. This valve we used here is an always closed valve. This valve works only when force applied to roller by cam / other arrangement to it.

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Figure 2.6 Valve Actuation arrangement

The roller lever valve is actuated when the roller lever is pressed by valve actuating cam arrangement as shown in fig. Then the valve opens and the pressurized air is allowed to enter the cylinder of the engine. Thus the engine works.

VI. FLOW CONTROL VALVE AND CONNECTORS

Flow Control Valves are used to reduce the rate of flow in a section of a pneumatic circuit, resulting in a slower actuator speed. Unlike a Needle Valve, Flow Control Valves control flow in only one direction, allowing free flow in the opposite direction. A finely threaded stem allows gradual adjustment of the amount of controlled flow passing through the valve. Flow enters port 1, travels through an orifice sized by the tapered stem and out port 2. The Flow Control features a by-pass check which then allows rapid free flow from port 2 through port 1

Figure 2.7 Flow Control Valve

Function of a flow control valve is self –evident from its name. A flow control valve regulates the rate of air flow. The control action is limited to the air flow passing through the valve when it is open, maintaining a set volume per unit of time Specification

1) Medium Dry, Lubricated / Unlubricated
2) Maximum Operating Pressure – 10 bar 3) Ambient Temperature – 5-60degree C
3) Connection – ¼

6.1. Connectors:

Figure 2.8 Connector

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.

6.2. Coupling

Figure 2.9 Coupling with connector

A coupling is a very short length of pipe or tube, with a socket at one or both ends that allows two pipes or tubes to be joined, welded, brazed or soldered together. Alternatively, it is a short length of pipe with two female National pipe threads (NPT) or two male or female British standard pipe threads.

6.3. PU Tube:

Polyurethane (PUR) tubing is made from the highest quality, 100% virgin raw materials available and has a hardness specification of Shore A98. It is ether based to provide excellent hydrolysis, oil and cold resistance. Polyurethane tubing is strong, flexible, and offers superior kink resistance compared to other tubing. With its extremely tight outside diameter tolerance,

Figure 2.10 Polyurethane Tube

The pipe system is used to connect the components involved in the passage of the compressed air. Here polyurethane pipes are used of diameter of 8 mm, 10 mm and length of 2m. 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

VII. VALVE TIMING

The converted compressed air engine has been tested fora set of three valve timings. In the first case, the inlet and exhaust cam are set in symmetric in angle in both side of TDC and BDC respectively. The inlet cam gives a

lift of 18mm to the follower. When the piston is at TDC the inlet valve is at fully opened condition and as the compressed air starts entering into the chamber, the valve has to close the inlet port of 10mm diameter before the piston reaches BDC. To ensure the complete closure of the 10mm inlet port, the inlet follower is given a movement of 18mm. When the crank is at 20 degrees after TDC, the closure of the inlet port is started by the valve and it is completely closed when the crank is at 45degrees after TDC. During this period the inlet port remains fully closed and no air is allowed to pass through the inlet port. The inlet port starts to open and allow the air to pass into the cylinder just 45 degrees before the TDC and reaches its maximum opening condition 20degrees before TDC. The exhaust port is at fully closed condition when the piston is at TDC and the exhaust valve starts to open the exhaust port just 75 degrees after TDC. For the next 210degree rotation of the crank, the exhaust port is kept at fully opened condition and the air is allowed to leave the chamber. The exhaust follower is given a displacement of 15mm to completely close the outlet port of 10mmdiameter. Exhaust valve starts to close the outlet port just75 degrees before TDC and it is moved to completely closed condition just when the piston is at TDC. Valve Timing Diagram 3With the modification a second valve timing was tested with inlet valve starts to open at 25º before TDC and fully open at TDC. The total opening time remains the same at 40º of cam rotation. The exhaust valve starts to open at 60º before BDC and closed after 30º of cam rotation before the piston reaches the TDC. With the modification a third valve timing was tested with inlet valve starts to open at TDC and fully open at 25º after TDC. The total opening time remains the same40º of cam rotation. The exhaust valve starts to open at30º before BDC and closed when the piston reaches the TDC

VIII. TESTING

8.1. Testing Apparatus

For load testing our air engine; we made the testing apparatus our-self consisting of brake drum, spring balance, rope and holding frame.

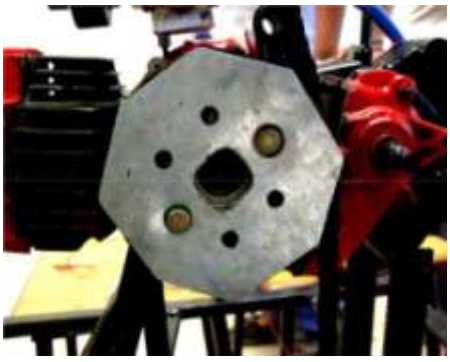

Figure 4.1: Brake Drum

The brake drum of our testing apparatus was made by slightly modifying the clutch disc of our engine itself and coupled it to the crankshaft. The spring balance is held in place to the main frame through a hole drilled into it. The rope is then tied to the hook of the spring balance. The other end of the rope is circled over the brake drum by a single loop in clockwise direction. The weight placing base is attached to the loose end of the rope. Extra care is taken in order to make sure that the spring balance, the rope and the weights are in straight line.

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8.2. Testing principle

8.3. 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.

Brake power 'BP' = —— * —— * *

Where;

w1 = weight added in kg, w2 = 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.

When the engine starts running and gained speed; no load readings of pressure in BAR as indicated by the pressure gauge on the compressor and the speed of the brake drum in RPM as indicated by the tachometer is taken down.

This process is repeated for different values of pressure ranging between 1bar and 9bar and the corresponding readings of speed of rotation are noted.. The readings thus obtained are tabulated in the tabular column.

Figure 4.3 Observations after Testing

WEIGHT	1	2	3	4	5	6	7	8
NO LOAD	344	413	456	484	513	533	545	563
.5	314	384	430	450	476	508	516	526
1	300	363	412	440	465	480	485	490
1.5	210	268	381	400	441	459	469	474
2	202	210	374	385	425	450	460	465
2.5	-	-	312	332	375	420	436	452
3	-	-	300	326	354	363	381	421

Figure 4.4 Testing Image

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IX. RESULTS AND DISCUSSIONS

The engine has been tested with compressed air of 8 bar pressure. In the first design of the valve timing diagram, the engine starts running with the opening of the compressed gas line. But after a full cycle the engine gradually slows down and eventually stops. This may have occurred due to the fact that in the return stroke, the inlet valve opens before TDC. This acts against the piston in the return stroke and eventually slows down the engine. In the second valve timing design, the engine starts running after the compressed air has started to flow into the engine cylinder. But after several full cycles the engine again slows down and stopped. In this case, the inlet valve is started to open before TDC. As the compressed air started to flow into the engine cylinder, before the piston reaches TDC in the return stroke, the compressed air again pushes the piston back in the return stroke. Thus the engine again slows down and stopped. In the third valve timing design, the engine starts running with compressed air flow into the cylinder. This time, the engine runs for half an hour before the pressure of the compressed air dropped below a certain limit. The rpm of the engine has been measured and is found to be 600 rpm

Sample calculations

Pressure at 8 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' = —— * ____* *

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

Performance Characteristics:

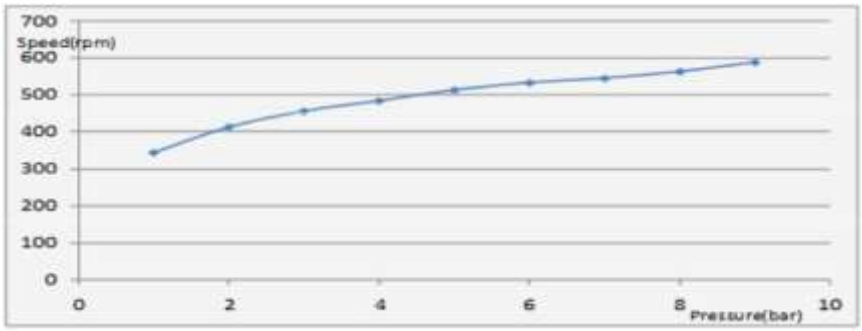

Figure 5.1 Pressure versus speed

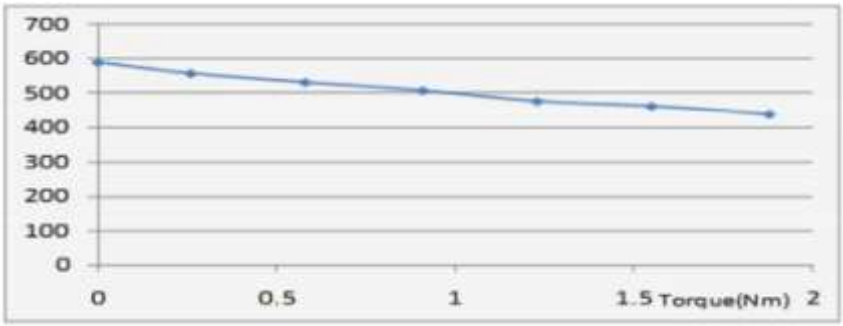

Figure 5.2 Torque versus speed

X. CONCLUSIONS

In Air Driven Engine, the speed is bound to increase with increase in the inlet pressure. The speed versus torque characteristics shows a negative linear variation. The brake power is observed to increase with increase in the inlet pressure.

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