AN EXPERIMENTAL STUDY ON I.C.ENGINE USING COMPRESSED AIR WITH SOLENOID CONTROL CIRCUIT

Bhardwajsinh Mahida¹, Dipak C. Gosai², Dr. Rajesh Iyer³

¹PG Student, Mechanical Department, S.V.M Institute of Technology, Bharuch, India
²Associate Professor, Mechanical Department, S.V.M Institute of Technology, Bharuch, India
³Owner/Manager, Cyra Engines.

Abstract—Now a day the global warming is a prime problem for whole world. Pollution is a major factor to avoid this global warming and the automobile engine is a main factor to produce some harmful gases which is directly affect on environment as well as human body. For reducing this pollution we need the engine which is totally pollution free and less costly. Some researcher is work on compressed air engine in last few years.

The 2-stroke compressed air is modified with solenoid valve circuit. The solenoid operating system this system is flow the air at particular time when it is operated by 12 V DC Battery.

On the study of compressed air engine the engine have get high pressurized air is required to operate. The air pressure tank is 140 bar on reading take at different pressure the pressure range is taken 5 bar to 10 bar and find out the optimum condition when engine is developed high power and torque. After study of two stroke petrol engine the engine is get high power and torque at 7 bar and 8 bar pressure of air the good one reading is that 8 bar when engine is get high torque about 2.2 N.m and power is 109.58 watt with maximum mass flow rate 0.37 kg per minute with 480 rpm of engine. After increasing the pressure 9 bar and 10 bar the engine is get under back pressure of compressed air.

After the study found that the engine is run successfully on compressed air also produces the power and torque to run the vehicle, this engine has not produced any kind of pollution because of only compressed air has the main fuel of engine. This engine has required variable valve timing for inject of air to run on high pressure and produce more power and torque.

Keywords—Two stroke Compressed air engine, Experimental investigation, Solenoid valve, Solenoid operating System

I. INTRODUCTION

In the past few decades, energy conservation and carbon reduction have become very crucial issues worldwide. Scientists have been searching for solutions to reduce the extensive use of conventional internal combustion (IC) engines and/or reduce their carbon dioxide emissions. To find a replacement for conventional IC engines, researchers have studied several types of engines that use green energy to determine the feasibilities of installing these engines in motor vehicles. Examples include electric engines, natural gas engines, and hydrogen engines. Electric vehicles are the most common green energy alternatives, and have been developed and commercialized for decades. However, slow battery recharging and a heavy battery weight are critical issues for electric vehicles. Hydrogen engines and natural gas engines can be used in the motor vehicles; however, the required tank size limits their applications. In recent years, high-pressure compressed air has been considered a green energy source for its advantage of zero carbon emissions and potential applications as a main or auxiliary power system in motor vehicles.
II. BACKGROUND OF TEST RIG

In this test rig the TVS Suzuki’ engine has been used. This engine has run on two stroke otto cycle. This engine has produced more power compare to four stroke engine. When it’s run on petrol the full cycle is completed in 360° of crank revolution also the most benefits when using the less components are used in two stroke engine because of the losses are low when run on compressed air. Below table no.1 is shows that the specification of engine.

<table>
<thead>
<tr>
<th>Engine company</th>
<th>TVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
<td>98.2 cc (2-stroke)</td>
</tr>
<tr>
<td>Valves per cylinder</td>
<td>0</td>
</tr>
<tr>
<td>Max. Power</td>
<td>7.9 PS @ 5500 rpm</td>
</tr>
<tr>
<td>Max. torque</td>
<td>9.8 N.m @ 5000 rpm</td>
</tr>
<tr>
<td>Bore &amp; stroke</td>
<td>50mm × 50 mm</td>
</tr>
</tbody>
</table>

*Table No. 1: Engine specification.*

In the test rig solenoid valve is use for control the flow of air also flow of air at particular time period in to engine. These valves are use in some textile companies, chemical plants, water treatment plants, pumps, Heat exchange, air dryer and where dependable ON/OFF type control is required.

*Table No.2: Solenoid Valve Specification.*

<table>
<thead>
<tr>
<th>Pressure</th>
<th>0.5 to 20 bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-5° C to 85° C</td>
</tr>
<tr>
<td>Coil Voltage</td>
<td>12V DC</td>
</tr>
<tr>
<td>Coil Insulation</td>
<td>“F” class</td>
</tr>
<tr>
<td>Coil Rating</td>
<td>Continuous Rated</td>
</tr>
</tbody>
</table>

*Table No.2: Solenoid Valve Specification.*

In this experimental study 2/2 Way Pilot Operated Diaphragm type solenoid valve is use. Valve technical specification is given below in Table No. 2

In the test rig also used FRL unit which is filter the air, also regulate the air pressure by means of regulator and lubricate the system by lubricator. Fig no. 1 Shows that the FRL Unit.

*Figure No.1 FRL Unit.*
III. EXPERIMENTAL SET UP AND WORKING OF TEST RIG

Before the experimental setup the I.C Engine has changed some parameters, this modified engine has connected with compressed air tank. The two stroke engine has no valves there have three ports (Intake Port, Exhaust Port and Transfer Port). In our case the no spark in the engine so removed the spark plug and at the spark plug air inlet port is provided. Suction port has been closed because of that the transfer port is automatically closed. The air has removed by exhaust port when piston has moved to TDC to BDC.

The solenoid valve has operated by switch and switch has operated by cam. When piston is at TDC after 5° of TDC the cam is operate the Switch and the solenoid is operate, solenoid valve is attach with 12V DC coil which take power from 12V Battery. The solenoid valve is closed after 25° of TDC, total time period of air injection is 20° of crank rotation and because of air pressure the piston is moving.

![Figure No.2: Set Up of Test Rig.](image)

In Figure No.2 Shows that the test rig’s of Compressed air in the test rig for load and power calculation the rope brake dynamometer has been used.

![Figure No. 3: Solenoid operating circuit](image)

In Fig No.3 is shows the solenoid valve operating circuit. When the piston comes TDC position, after 5° of TDC the switch is operate by cam and the switch trigger is moving up side the power is supply circuit is close and solenoid is operate.

Solenoid valve has two port Inlet and Outlet, Solenoid inlet port is connected with Compressed air cylinder and outlet is connected with engine inlet port.
The air has been supplied in to the engine and the time period of solenoid is open 20° of crank rotation. This 20° of rotation the valve is supply the air through high pressure tank to the cylinder. At that time the pressure range is 6 bars to 10 bars.

IV. RESULT AND DISCUSSION

After the experimental study the result has been taken at different pressure (5 bar to 10 bar) below table is shows that the mass flow rate, load and torque of the engine at maximum condition.

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>PR. (bar)</th>
<th>(mf)</th>
<th>RPM</th>
<th>L (N)</th>
<th>B.P (Watt)</th>
<th>T (N.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>0.24</td>
<td>343</td>
<td>19.61</td>
<td>58.11</td>
<td>1.61</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>0.3</td>
<td>434</td>
<td>14.71</td>
<td>55.16</td>
<td>1.21</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>0.36</td>
<td>394</td>
<td>24.52</td>
<td>83.47</td>
<td>2.02</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>0.45</td>
<td>479</td>
<td>26.48</td>
<td>109.59</td>
<td>2.18</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>0.27</td>
<td>480</td>
<td>12.75</td>
<td>52.87</td>
<td>1.05</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>0.36</td>
<td>450</td>
<td>12.77</td>
<td>49.65</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Table No. 3: Result of test rig at different pressure of Compressed air

In table no. 3 shows that the different results at different pressure and this pressure get the maximum load, Brake power and torque as well as the mass flow rate of air has defined. At 8 bar pressure maximum load on the engine is 26.48 N and brake power is 109.59 watt this is the optimum condition of engine because at this pressure engine has run without any disturbance and Vibrations.
Figure No. 5 Mass flow Rate of air

Figure No. 6 Load vs pressure

Figure No. 7 B.P vs Pressure
Above results show that at different pressure engine output the result is taken at different pressure 5 bar to 10 bar at particular time period and different load. The engine giving a good performance at different load the optimum condition has been taken in this result at different pressure. The result is shows that at 8 bar pressure the good efficiency of the engine. In this two stroke engine using solenoid valve the engine give good performance at 7 bar and 8 bar pressure of engine.

Finally found that the 7 bar and 8 bar pressure is supply to engine the engine is work without any vibration but at 9 bar and 10 bar pressure the engine has gone under back pressure in cylinder so that the two stroke engine has not able to high load and also in vibration condition.

The two stroke engine is taken at 8 bar pressure carried out maximum load 26.48 N, B.P of engine is 109.59 Watt, torque at 8 bar pressure is 2.18 N.m.

Mass flow rate is very low at the different pressure because of Solenoid Valve the valve has supply the air at the time when piston is on T.D.C and open 20° of crank rotation so air losses is very low in the engine and engine is run 30 to 32 min at tank pressure of 140 bar. This is very good for the compressed air engine.

V. CONCLUSION

After the experimental study on compressed air engine using solenoid circuit final result and discussion the engine is very eco friendly engine which is not produce any kind of engine, In this two stroke engine obtain highest 701 highest RPM. With using solenoid circuit system the engine is run at different speed and different pressure. In the compressed air vehicle the solenoid valve is supply
air at particular time of injection so that the air losses are reduce by the engine. The design of solenoid circuit is very simple and easy to maintain.

After the study of load analysis the maximum load carrying capacity of the engine is 26 N and the brake power of the engine is 109.58 watt. The conclusion is engine is produce at low load high power is generated and also high torque is generated about 2.58 N.m. Also conclude that the maximum mass flow rate of engine is about 0.4 kg per minute which is very low. The engine is at 8 bar pressure 140 bar of air tank pressure engine is run about 25 min which is very high.

Also find out that the two stroke 100 cc engine is run at low speed even though the vehicles running on the solenoid operating system seem to compare poorly to gasoline and electric vehicles in range and power & their applications severely constrained due to their limited driving range, it may be an ideal mode of transportation once enough research and analysis are put in the field. After the study the optimum pressure when get high torque and power is 7 bar to 8 bar pressure, at this pressure range the engine is develop highest power and torque which is sufficient to carry the load.

End of the conclusion that the fitting of this solenoid circuit in the engine the some modifications are required in the engine like closing the intake and transfer port and also make a circuit to operate a solenoid valve circuit to operate the engine.

REFERENCES