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Investigation of Modified Engine Operated using Compressed Air

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Abstract

Automobile plays a major role in transportation of passengers and goods. The engine is the power source of automobile and uses fossil fuel. However, the consumption of fossil increases emission, cost and demand. This makes the need in search of an alternate source of fuel to meet the demand. Many research are going on alternate fuels and an attempt is made to run an engine using compressed air. The modified engine works by using compressed air as fuel to produce mechanical power output without any emissions which pollutes the environment. The main aim of the project is to modify a Bajaj DTSi four stroke engine to run using compressed air. The engine operates in two strokes that is downward stroke during which the air enters and expands by doing work and the upward stroke to make the piston to reach the TDC. The air engine is tested with different pressures and load. The result showed that the increase in pressure to the inlet of the engine increases the speed and load carrying. At 10 bar pressure the engine runs at a speed of about 3000 rpm. Hence the compressed air can be integrated with conventional IC engine using the same arrangement with piston and cylinder to run a vehicle.

Keywords: Air engine, compressed air, performance, load, pressure

I. INTRODUCTION

In the present scenario, the blind race towards industrialization and modernization has resulted in the several dangerous threats which can destruct mankind and global warming is one of them. One of the major cause of global warming is the pollutant gases being emitted from the exhaust of conventional I.C. engines. I.C. engines convert heat energy into mechanical energy by burning fuel in its combustion chamber called cylinder. Mostly, petrol and diesel oil are used as fuels for I.C. engines. These IC engines powers the automobile which is used for the transportation of passengers and goods from one place to another on the ground. Many Researches are going on alternate fuels like biodiesel extracted from vegetable oils which can be used in IC engines without much modification. Although alternate fuels stands as a best solution there are difficulties associated in using IC engines. This scenario has inevitably shifted research focus on green and economic mobility options with compressed air power being one of them.

B.S.Patel et al. developed a compressed air engine using 4-stroke single cylinder diesel engine with simple modifications. The theoretical analysis and the cost analysis of air operated engine is made, the results revealed that the air engine can be operated with lower cost when compared to normal IC engine [1]. Arjit mourya discussed the performance of single cylinder two stroke engine operated by compressed air. The performance of the engine was efficient when compared to electric vehicle using compressed air. The engine was operated using a modified cam [2]. Mistry Manish.k reports on the review of compressed air engine for the design and development of single cylinder engine which can be run by the compressed air [3]. Due to increasing oil price, emissions and scarcity conventional fuels, there is a need in search of alternative source of energy to run the engine. In this project an attempt is made to convert conventional four stroke two wheeler engine to run on compressed air to reduce the above said problems.

II. COMPONENT DESIGN AND CALCULATIONS

A. Hose Collar Design:

The hose collar is the component used to connect the inlet of the engine with compressor unit to supply air. The table 1. Gives the dimensions of the collar and Fig 1. Represents the diagram of hose collar

Table – 1
Dimensions of hose collar

Particulars	*Dimensions*
Step Turning length	*21 mm*
Thread surface length	*10 mm*
Thread	*M9 Thread*
Collar outside diameter	*10 mm*
Collar inner diameter	*8 mm*
Coupling outside diameter	*15 mm*
Coupling inner diameter	*13 mm*

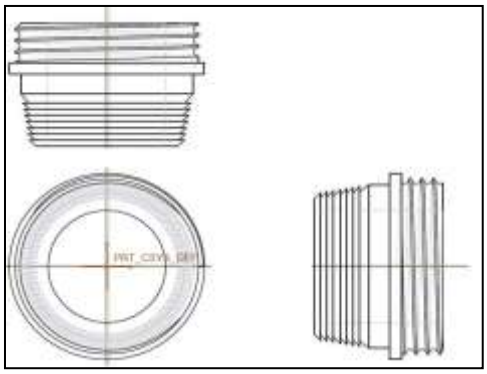

Fig. 1: Hose collar

B. Camshaft Design:

The ordinary engine works on four stroke principle and the cam used in conventional engine has single lobe for actuating the inlet and exhaust valves. The air engine works on two stroke i.e upward and downward for creating thrust on the piston. The modified cam has dual lobes each for operating the inlet and exhaust valve. The fig 2. and fig 3. shows the view of modified dual lobe cam for air operated engine.

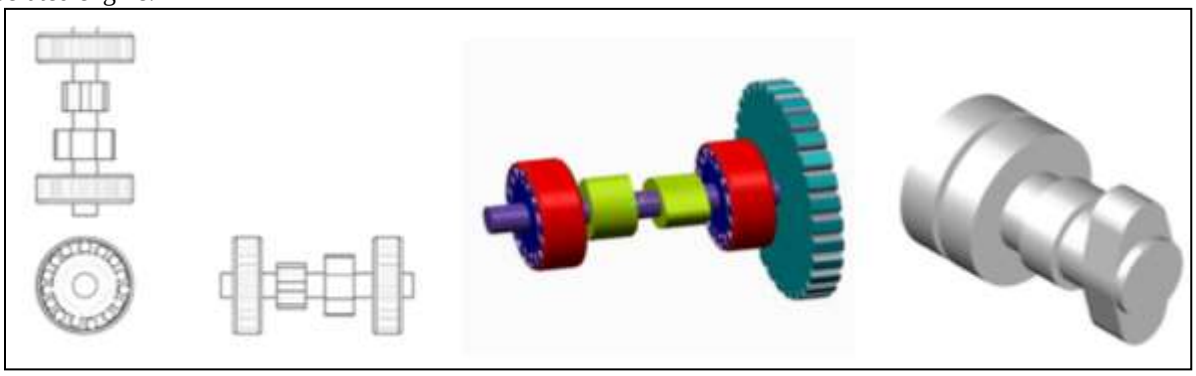

Fig. 2: Model of dual lobe cam

Fig. 3: Actual and Modified cam

Volume-Cubic Inches (CID)= NOC ×0.7854×Bore2×Stroke
= 1×0.7854×57×48.8×10-3
= 124.526 cc
Engine Air Flow Rate - Cubic Force per Minute = CID×RPM×VE/ 3456
= 124.526×1440×0.8/3456
= 41.508 N3/ min

III. WORKING PRINCIPLE OF COMPRESSED AIR ENGINE

In this project Bajaj DTSi-125cc engine is modified to operate in compressed air. In any engine the charge enters through the inlet during suction stroke. At the same time piston moves from TDC to BDC. Then charge is compressed during compression stroke. In compression stroke piston moves from BDC to TDC. In compression stroke pressure and temperature increases gradually. Then the spark is produced by using spark plug. At that time power is produced and piston moves from TDC to BDC. The exhaust valve opens and exhaust gases escapes to the atmosphere.

Fig. 4: Air Engine setup

In compressed air engine, compressor is connected with the engine through the modified inlet. The air is passed through the hose connected to the inlet of the engine. The engine is given an initial torque to set in motion by cranking. The camshaft gets drive from the crankshaft and rotates. In this air engine half revolution of the camshaft causes the inlet and exhaust valve to open once. As soon as the air enters the engine cylinder through the inlet valve opening, the air which is under very high pressure, works on piston and piston moves to bottom dead center. Further rotation of the cam shaft opens the exhaust valve and the upward movement of the piston pushes the air out to atmosphere through exhaust valve.

IV. OPERATION COMPARISON OF IC AND AIR ENGINE

A. Operation: 4-Stroke Engine

1) Suction Stroke:
Mixture of air and fuel is introduced into the combustion chamber. It starts when the piston is at upward (TDC) and about to move downward (BDC). During this period inlet valve is open and exhaust valve is closed.
2) Compression Stroke:
During this stroke both valves are in closed position. Piston moves from BDC to TDC.
3) Expansion Stroke:
During this stroke combustion takes place which produces power for engine by moving piston from TDC to BDC. Both valves are in closed position only.
4) Exhaust Stroke:
The exhaust gases escapes through the exhaust valve where the inlet valve remains closed.

B. Operation: Compressed Air Engine

1) Power Stroke:
High pressurized air which is produced from air compressor is supplied into the combustion chamber in which it drives the piston from TDC to BDC. An initial torque is to be provided inorder to bring the engine into motion.

2) Exhaust Stroke:
In this the air escapes via exhaust valve from the cylinder and the inlet valve gets closed. The exhaust air temperature is practically less than the air temperature

C. *Modification in Cam Design*

The Compressed air engine requires two lobes to operate the power and exhaust stroke.
(i .e) The cam working for the exhaust valve and the inlet valve are provided with another lobe right opposite to the lobe already present. This makes the inlet valve to be closed and exhaust valve to operate with changed timing. This modification was made on the cam shaft, since the air operated engine works on upward and downward strokes.

V. RESULTS AND DISCUSSION

The compressed air engine can be used for producing power upto 20W at 8bar pressure. So it is enough to run the vehicle at all road conditions. It is pollution free technique, it can be used to run three wheelers, cars and trams. The engine is tested for various speeds and loads based on the pressure given to the engine.

A. *Air Engine Speed against Pressure:*

The crankshaft speed depends on the pressure variation of the engine. When the pressure acting on the piston increases correspondingly the crank shaft speed increases. The fig 5. Shows the variation of speed with respect to pressure of air given to the engine. Thus if the pressure used to operate the engine increases correspondingly output speed increases.

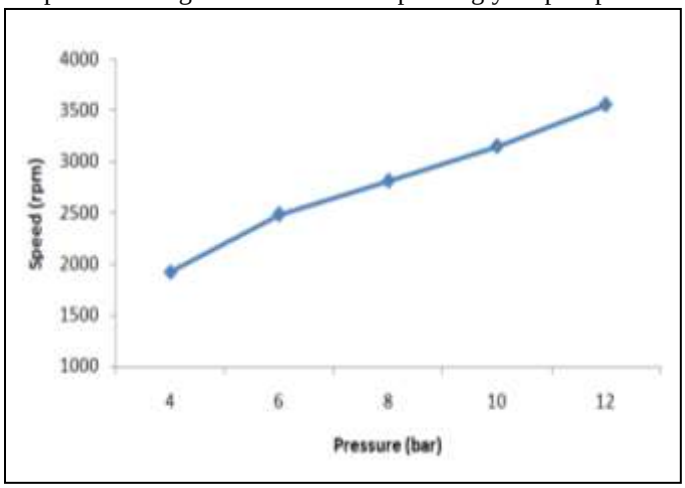

Fig. 5: Speed vs Pressure

B. *Air engine torque against Load:*

The fig 6. shows the variation of torque with respect to load which measured at a constant operating pressure of 12 bar. As the load on the engine is increased the torque increases with corresponding decrease in speed. The graph shows the variation of torque is linear with increase in load.

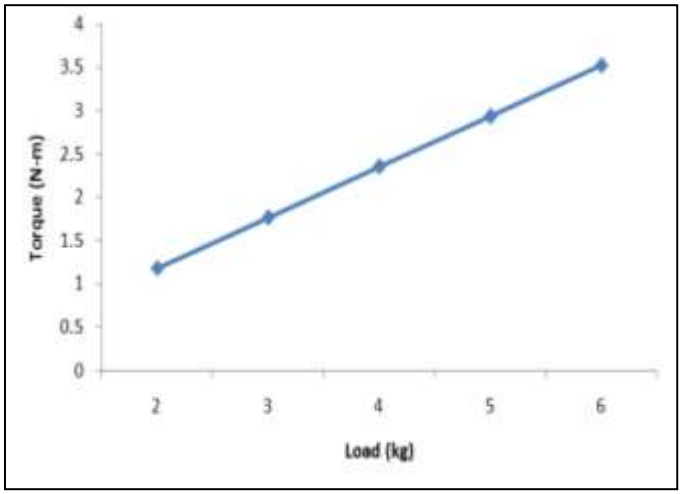

Fig. 6: Torque vs Load

VI. CONCLUSION

The air engine operated using compressed air can be one of the best solution for the pollution caused by conventional engine and it also cost efficient. The air engine with simple modifications can be made to use air as operating fluid. The engine is tested with a maximum pressure of 12 bar and the results have shown better improvement in the performance. From the above result it is concluded that

- The compressed air engine can used in two wheelers, mopeds, cars, trams.
- Based on trial run and test conducted, it was found that the modified engine produces output with respect the operating pressure.
- The speed of the engine increases with increase in pressure supplied to it.
- The torque varies linearly with increase in load acting on the engine.
- The obtained values may not be the exact measures of its potential since it was not very professionally designed.
- Since the air supplied to the engine is of low pressure, power produced is also less. So efficiency of the engine is gradually decreases.

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