THE MODIFICATION OF PNEUMATIC REGENRATIVE SYSTEM FOR I.C. ENGINE

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Abstract: It is difficult to believe that compressed-air can be used to drive vehicles. However, that's true, and therefore the "air car", because it is popularly known, has caught the eye of researchers worldwide. It has zero emissions and is right for city driving conditions. MDI is one of the company that holds the international patents for the compressed-air car. while it seems to be an environmental-friendly solution, one must consider its well to wheel efficiency. The electricity requirement for compressing air has got to be considered while computing overall efficiency. Nevertheless, the compressed-air vehicle will contribute to reducing urban pollution. Compressed air as a source of energy in several uses generally and as a non-polluting fuel in compressed-air vehicles has attracted scientists and engineers for hundreds of years. Efforts are being made by many developers and makers to master the compressed-air vehicle technology altogether respects for its earliest use by the mankind. This project gives a quick introduction to the newest developments of a compressed-air vehicle alongside an introduction to varied problems related to the technology and their solution. While developing of a compressed-air vehicle, it is necessary to control of compressed-air parameters like temperature, energy density, requirement of input power, energy release and emission control need to be mastered for the development of a secure, light and price effective compressed-air vehicle in near future.

Index Terms **– Two- Stroke Engine, Compressed Air Vehicle, Zero Emission.**

I. INTROUCTION

HISTORY

Compressed air has been used since the 19th century to power mine vehicle and trams in cities like Paris (via a central, city-level, compressed gas energy distribution system), and it was earlier the basis of naval torpedo propulsion. During the development of the Gotthardbahn from 1872 to 1882, pneumatic locomotives were utilized in the development of the Gotthard Rail Tunnel and other tunnels of the Gotthardbahn. In 1903, the air Company located in London England manufactured variety of compressed-air and liquefied-air cars. The major problem with these cars and every one compressed-air cars is that the lack of torque produced by the "engines" and therefore the cost of compressing the air. Since 2010, Some companies have begun to manufacture compressed-air cars including hybrid types that also include a petroleum driven engine; none has been released to the general public or have been tested by third parties.

GENERAL OUTLINE

Now–a-days many problems arise out of it such as global warming, climate disruption, desertification, floods, hurricanes, rising sea levels, etc. Scientific research proves that one of the main causes of global warming is carbon emissions and one of the major sources of carbon emission is automobiles. But rapid depletion of fossil fuels (i.e. petroleum, diesel, natural gas and coal) and also the problems associated with their combustion such as greenhouse effect, ozone layer depletion, acid rains, etc. has made the automobile manufacturers aware of the need of having new ideas of this.

An alternative of I.C engine is "AIR COMPRESSED ENGINE". It is an engine which will use compressed air as a fuel to run the engine. It is cheap as it uses air as fuel, which is available in very large amounting atmosphere. There are many benefits uses of using this engine, like as no combustion takes place inside the cylinder therefore it is fully pollution free, carbon less & with a prospective of green energy. Through this project we can solve the major problem of traffic of our country with its compact design.

Today fossil fuels square measure wide used as a supply of energy in numerous totally different fields like power plants, internal and external combustion engine, as heat supply in producing industries, etc. However, its stroke is extremely restricted and thanks to this tremendous use, fossil fuels are depleting at quicker rate. So, during this world of energy crisis, it's inevitable to develop alternative technologies to use renewable energy sources, so fossil fuels will be conserved. One among the main fields within which fossil fuels square measure used is Internal Combustion Engine. an alternate of IC Engine is "AIR steam powered ENGINE". It is AN engine which is able to use compressed gas to run the engine. it's low-cost because it uses air as fuel, that is obtainable copiously in atmosphere.

Various automobile manufacturing companies investing in the research deployment and development of compressed air cars Overoptimistic reports of awaiting production date back to at least May 1999. For instance, the MDI Air Car complete its

public debut in South Africa in 2002,and was expected to be in production within six months in January 2004.As of January 2009, the air car certainly not went into production in South Africa. Most of the cars under development also depend on using similar technology to Low-energy vehicles in order to growth the range and performance of their cars.

MDI has planned a range of vehicles made up o-f Air Pod, One Flow Air, City Flow Air, Mini Flow Air and Multi Flow Air. One of the main improvements of this company is its implementation of its "active chamber", which is a section which heats the air (through the use of a fuel) in order to twice the energy output This 'innovation' was initial used in torpedoes in 1904. As of January 2009 Tata Motors of India had prearranged to launch a car with an MDI compressed air engine in 2011. In December 2009 Tata's vice president of engineering systems definite that the limited range and low engine temperatures were causing problems. Tata Motors announced in May 2012 that they have measured the design passing phase 1, the "proof of the technical concept" towards full manufacture for the Indian market. Tata has stimulated onto phase 2, "completing comprehensive development of the compressed air engine into precise vehicle and stationary applications".

Figure 1 (Actual views of CAV Model)

II. COMPONENT SPECIFICATION

Three main components of our project are as shown below: -

- Two stroke petrol engine (98CC)
- 5/2 DCV (Roller spring operated direction control valve)
- Compressed Air tank (70L)

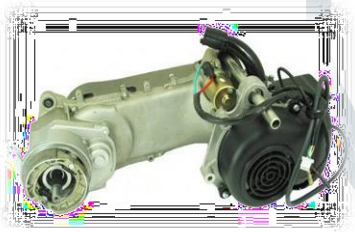

Figure 2

Figure 3

Figure 4

Engine model	Kinetic Honda Two-Stroke
Engine Displacement	98CC
Engine Type	Air Cooled, Two-Stroke
Number of Cylinder	1
Max. Power	7.8PS @5600rpm
Max. Torque	9.8Nm @5600rpm
Bore × Stroke	49 × 52.40 mm
Fuel Type	Petrol

Type of DCV	RLS52-02
Port Size	1/4”
Exhaust Port Size	1/8”
Pressure Range	0 to 10 bar
Max. Inlet Pressure	10 bar
Medium Temperature	-5 to 60 Degree C
Body	Die Cast Aluminum

Capacity	70 L
Dimensions	L × W = 38 × 18
Weight	20 Kg
Maximum Discharge Pressure	9 bar
Maximum Flow Rate	0-20 cfm

Table (1, 2, 3) Specification of Components

III. LITERATURE REVIEW

Vishwajeet Singh. [Mechanical Engineer, M.S. University of Texas] [U.S.A] (2014) [1]

Compressed air engine (CAE) gives the possibility to use ultimate resource of air as a fuel to run the engine. The concept design of (CAE) helps in solving the problem using a fuel which is renewable and at the same time cheaper in use.

Venkatesh Boddapati, S.V.V. Vinod, M. DoraBabu **"Air Powered Vehicle -An Eco Friendly Engine" (2015)** [2]

Compressed air storage tanks built with carbon fibers will carry high amount of pressure with minimum volume space which obviously meets the requirement with the conventional engines with zero emission. Air powered vehicle is realization of most advanced technology in the field of Automotive. It eliminates the use of Non-Renewable energy fuels. We can develop this type of vehicle into Multi-Fuel Engine that runs on both compressed air and/or Fuel (Gasoline)mode.

Pramod Kumar J "AIR POWERED ENGINE" (2016) [3]

In this project, an SI engine is converted into a compressed air engine. A four stroke single cylinder SI engine is converted to two stroke engine which operates using compressed air because of its design simplicity. As we converted the already existing conventional engine into an air powered one, this new technology is easy to adapt. Another benefit is that it uses air as fuel which is available abundantly in atmosphere.

Gaurav Kumar tandan , Gopal Sahu, Prakash Kumar Sen, Ritesh Sharma, Shailendra Bohidar (2015) [4]

Compressed air as a source of energy in different uses as a non-polluting fuel in compressed air vehicles has attracted scientists and engineers for centuries. Compressed air filled by electricity using a compressor. The electricity requirement for compressing air has to be considered while computing overall efficiency. compressed air vehicle will contribute to reducing air pollution and tend to zero pollution. No combustion process is occurring there. Light utility vehicles are becoming very popular means of independent transportation for short distances. Engineers are directing their efforts to make use of air as an energy source to run the light utility vehicles.

IV. DESIGN AND WORKING

WORKING

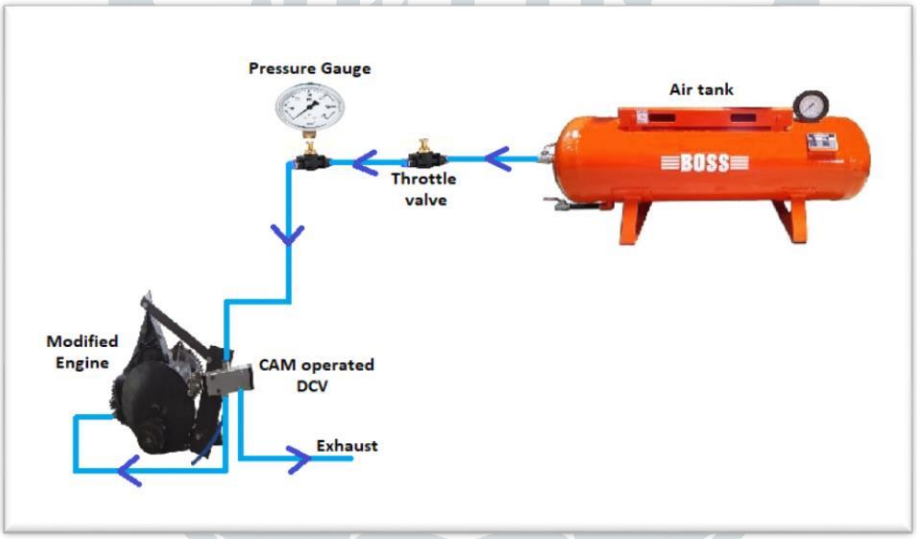

Figure5 (Schematic drawing of compressed air system with photos of engine auxiliary components)

Air is compressed by air compressor and then compressed air supplied to the engine through the inlet port and compressed air generate suitable pressure inside the cylinder and due to the impact of air pressure piston moves TDC to BDC. When piston moves downward one rotation of crank is completed this rotation is transmitted from the engine to the rear wheel shaft. We use Roller Spring operated DCV valve for direction of compressed air.

In the solenoid one roller mounted at the end of solenoid valve, so when roller comes in contact and push than air is supply to the engine. Arrangement of solenoid valve is at specific angle. And dead weight arrangement is like, when crank rotate dead weight comes in contact with the solenoid valve roller which is mounted on one end of the solenoid valve. When air is coming from air tank it supplied through Roller Spring operated valve to engine and compressed air create pressure in the cylinder and piston moves TDC to BDC. When piston moves TDC to BDC dead weight moves downward and comes in contact with roller and air again supplied to the engine. At this moment piston position is on top dead center. When weight comes downward with force due to momentum of the weight it moves upward due to its weight momentum is greater than gravitational force.

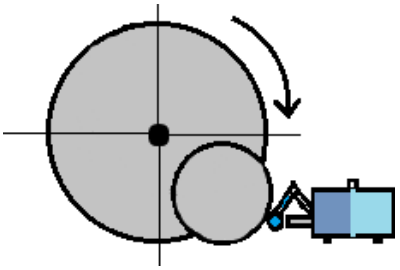

Figure 6 (Arrangement of dead weight and solenoid valve)

DESIGN

By using 3D model software, we design a 3D model of CAV.

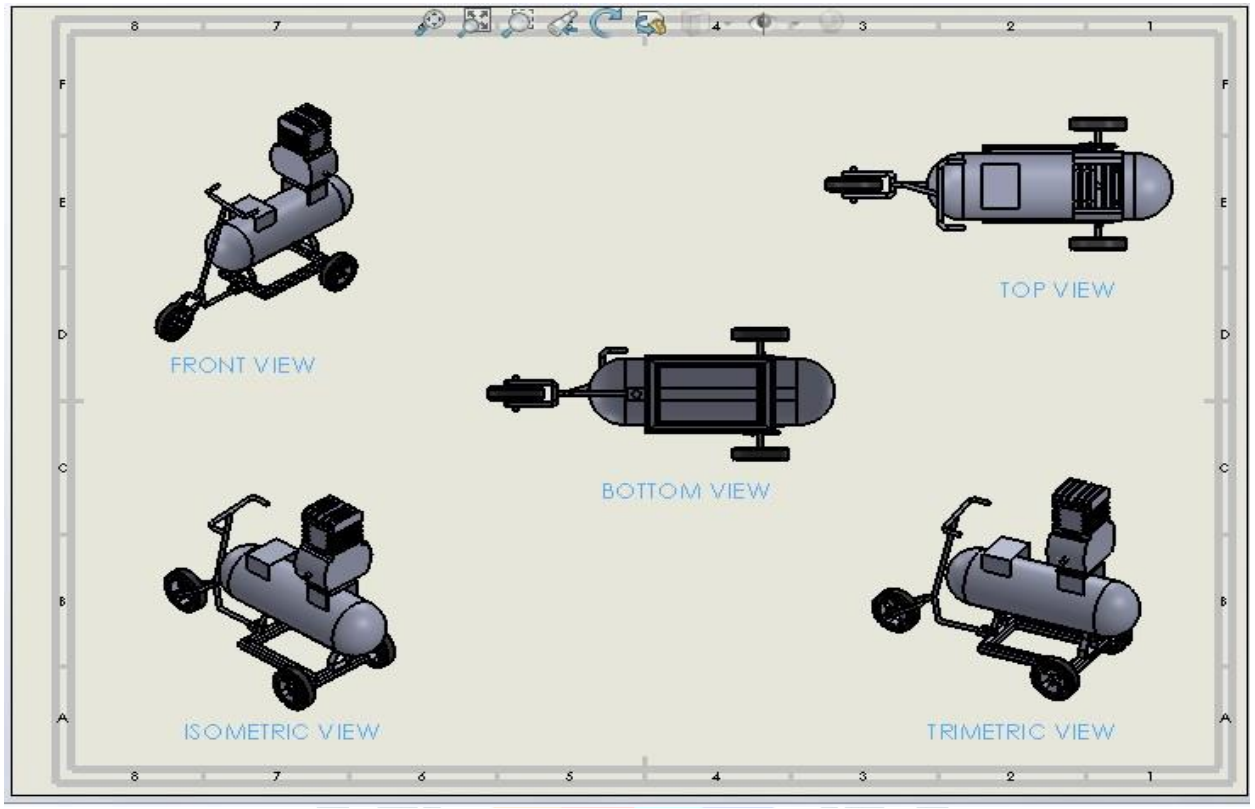

Figure 7 (3D model of CAV)

Body frame dimensions are also find in 3D model software which is shown below,

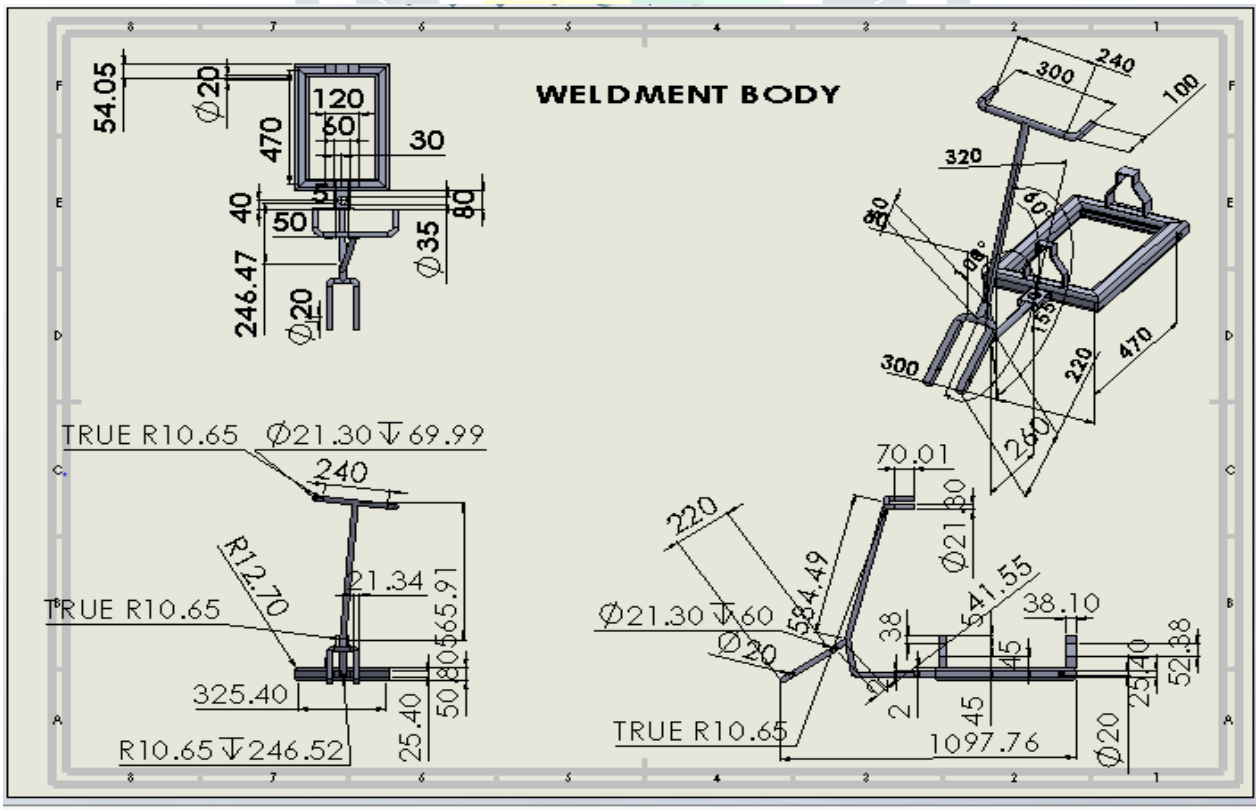

Figure 8 (Frame Dimensions of CAV)

V. SELECTION AND MODIFICATION OF ENGINE

SELECTION OF ENGINE

We are using 100CC two stroke petrol engine for our project. We closed the inlet and outlet of engine and compressed air supplied to the spark plug socket. In two stroke engine one revolution complete in two stroke so efficiency of two stroke engine is higher than the four stroke engine and load carrying capacity also high. All running or completed projects on compressed air vehicle are on four stroke engine but we tried on two stroke engine for high load carrying capacity. Side ports are closed by adhesive and cylinder liner and for reducing the weight of engine we cut the fins which provided for cooling.

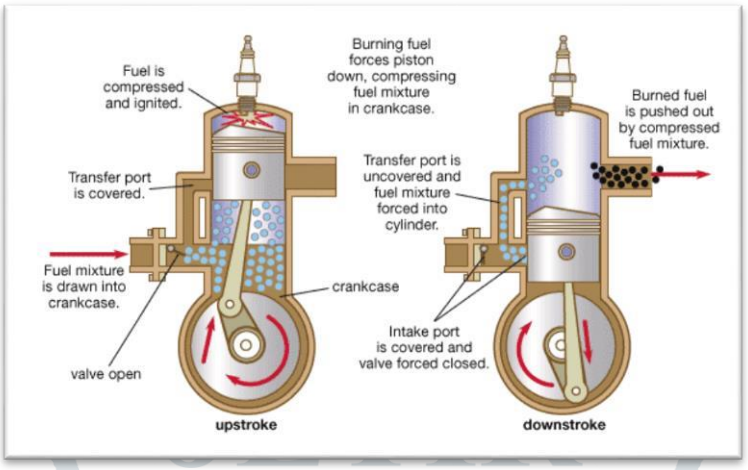

Figure 9 (Two Stroke Petrol Engine)

A two-stroke engine completes all the same levels, but in just two piston strokes. The simplest two-stroke engines do this using the crankcase and the underside of the moving piston as a new charge pump. As the two-stroke piston increases on compression, its underside draws a partial vacuum into the crankcase. In four stroke engine one rotation is complete in four stroke so for CAE it gives low efficiency that's why we are using two stroke petrol engine. All the unnecessary parts are removed for making light weight like casing, cooling fins, carburetor, electric motor, magneto and gear box.

MODIFICATION OF ENGINE

we convert two stroke petrol engine to two stroke compressed air engine. First of all, we closed the inlet and outlet port with the adhesive and side port with the cylinder liner and make a closed chamber. After closing all the ports, we need to make a new inlet for air supply so we make 1.4cm diameter hole on the piston head casing. Weight of our engine is high so we need to reduce the weight of engine by removing all unnecessary components like cooling fins, motor, and casing cover.

In the first trial we use battery operated 5/2 solenoid valve for controlling air supply but timer setting become very difficult for this engine because of the piston movement is unpredictable so we need to use Roller Spring 5/2 DCV valve for controlling compressed air supply. Roller Spring operated DCV valve one roller is attached at the end of solenoid valve. When pressure is applied on the roller by comes in contact with the other end then air is supply to the engine. Dead weight attached to plate witch is mounted on engine shaft.

For arrangement of Roller Spring operated DCV valve we need to find specific angle. and we attached solenoid valve by the welding process. For revolution of crank it is necessary to breakdown of continues air pressure so we decide to modify the main shaft of engine as shown in figure. After constructing the engine base, we need to connect the engine(Driver) gear to rear wheel(Driven) gear in same alignment. We attached a dead weight to the main shaft for making regular contact between crank and Roller Spring operated DCV valve. and other side of main shaft we joint a motorcycle main gear for transmitting rotation from engine to rear wheel. Modified engine is mounted on the compressor for making compact size vehicle.

To control and for the proper flow of the fuel (compressed air) pressure regulators and pneumatic specialized parts are used and proper flow is provided to the engine and pressure is maintained inside the bore. While working with 4 stroke engine it requires more number of modification than 2 stroke in 4 stroke engine first of all number strokes are needed to be made accordingly to the two stroke engine and the camshaft section are needed to be changed while in comparison these kind of changes and modification And more over two stroke engine has more power capacity than 4 stroke .due to 4 stoke engine has two to complete two revolution in one stroke and two stroke completes one revolution in one power stroke. While working with two stroke engine as it has ports and transfer port and mainly the inlet port at the bottom at near to BDC. And due to this there is most of the fuel is been leaked and the piston movement operation is not occurring properly so to over- come this the piston bore is replaced by cylinder linear and all the transfer ports and remaining ports been blocked and the exhaust port is shifted to the top of piston and by this the piston movement is obtained.

Figure 10 (Actual view of Modified Engine)

VI. CALCULATION

Mathematical calculation for engine

- Cylinder bore = 49mm = 0.049m
- Stroke length = 52.4mm = 0.0524m
- Maximum pressure = 8bar = 8×10^{-5} pa

$$\square = (\frac{\square}{\square}) \times \square^{\square}, \square^{\square}$$

- Where,
- A = Area of cylinder
- R = Radius

$$A = \frac{\square}{\square} \times (0.049)^{\square}$$

$$\mathbf{A = 188.47 \times \square\square^{-\square}, \square^{\square} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)}$$

- Cam Radius = 10mm
- Θ = 30º
- Pm = Mean effective pressure = 2 bar

Maximum force generated

- Force = Pressure × Area, N
- F(max) = P(max) × Area
  = 8 bar × 188.47 × 10^{-5}
  = $8 \times 10^{-5} \times 188.47 \times 10^{-5}$

F(max) = 1507.76 N..... (2)

Maximum Torque can be generated

- T= F × r × Sin□
- T(max) = F(max) × r × Sin□
  = 1507.76 × 0.01 × Sin30

Torque = 7.53 N.M..... (3)

Maximum volume of Air in the cylinder

- Maximum volume of air = Cylinder volume
  $= (\frac{\square}{4}) \times D^2 \times L$
  $= (\frac{\square}{4}) \times (0.049)^2 \times (0.0524)$

Maximum volume of air = 9.87 × □□$^{-\square}$ □$^{\square}$ ·····(4)

Efficiency Calculation

- Efficiency = $\frac{\text{Output Power}}{\text{Input Power}}$

Where,

$$\text{Input Power} = \frac{2\times\pi\times N\times T}{60}$$

$$= \frac{2\times 3.14\times 310\times 7.53}{60}$$

Input Power = 244.32 Watt .....(5)

- $\text{Output Power} = \frac{Pm\times L\times A\times N}{60}$

Where,

- Pm = Mean effective pressure
- L= Stroke length
- A = Area od Cylinder
- N = Speed

$$\text{Output Power} = \frac{2\times 10^{-5}\times 0.0524\times 188.47\times 10^{-5}\times 310}{60}$$

Output Power = 102.05 Watt ..... (6)

- Now we have both input and output power as 244.32 and 102.05 Watt Respectively.

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power}}$$

$$= \frac{102.05\text{Watt}}{244.32\text{Watt}} = 0.4176$$

Efficiency = 41.76%

Table shows the change in RPM with respect to the change in pressure

Pressure (bar)	RPM (Engine)	Engine to Wheel (1:3 ratio)	Displacement Km/hr.	Displacement m/min
3	110	330	19	317
4	130	390	23	384
5	180	540	31	516
6	210	630	36	600
7	240	720	41	684
8	270	810	47	783
9	310	930	53	884

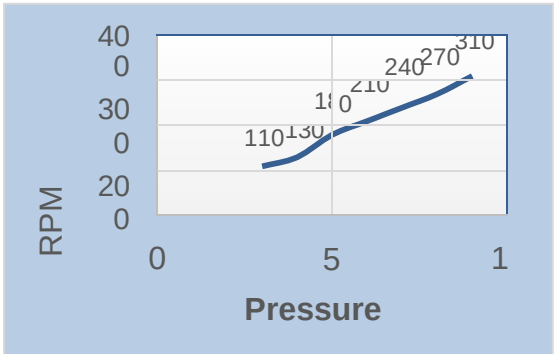

Figure 11 Pressure v/s RPM

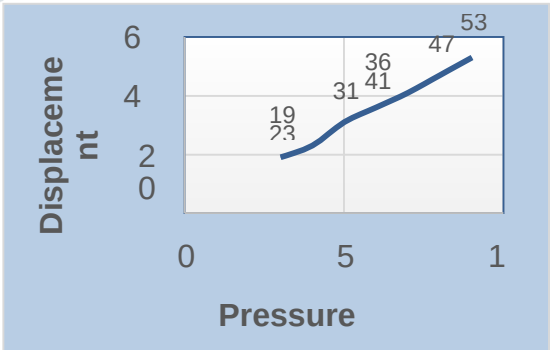

Figure 12 Pressure v/s Displacement

Above graph shows the relation between pressure v/s RPM and Pressure v/s displacement.in the first graph maximum RPM is 310 and minimum RPM is 110 relatively. And in the second graph maximum displacement is 53 km/hr. and minimum displacement is 19 km/hr. achieve with respect to pressure applied to the engine. All the data shown above is under no load condition. Lot of trials are done by our team and these approx. data is achieved by us.

VII. CONCLUTION AND REMARKS

This work modified the four-stroke petrol engine into the CAE (working by compressed air instead of gasoline as a fuel) to solve the problems of fossil fuel depletion and greenhouse gas emissions. The temperature of exhaust air is lower than the ambient air temperature, so no polluting gasses are released. Therefore, the designed engine is eco-friendly, pollution free, and economical.

Due to the utilization of low compressed air pressure, the performance of the investigated CAE is poor, so that it clearly has minor impact in motive power and hinders its commercialization. Presumably, a much higher pressure could provide some degree of energy storage and increases the engine power and efficiency. This work helps to advance the vehicle fuel, engine, power, and gas emission with available cost. In the future, the experimental work will proceed at higher compressed air pressure with different types of engines using different field tests.

Moreover, different computational simulation techniques can be used to be validated with experimental results and help in completing the correct vision.

VIII. FUTURE SCOPE

- An all-new technology combining gasoline burning engine and compressed gas storage is developed. it's developing this vehicle in response to the worldwide would like for energy economical vehicles.
- Demand of hydrocarbon and diesel is high and amount is low than the demand therefore CAE is overcome this downside occurring within the future.
- Air-compressed vehicle is developed with high performance which might run solely on compressed gas.
- This project will cut back the massive quantity of pollution generated by vehicles that is that the major issue for heating downside.
- It is applicable for little operating areas like, colleges, canteen, workshops, industries etc.

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