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Design and development of compressed air engine for hybrid vehicle

Dr. Prof. R.R.Ghorpade[1], Mr. Sahil Bakde[2] , Ms. Sayali Kuthe[3] , Mr. Pulkit Gupta[4] , Ms. Aarti Ghode[5]
[1] *Assistant Professor, Department of Mechanical engineering, MIT Pune.*
[2,3,4,5] *Student , Mechanical engineering, MIT Pune*

Abstract- **The world is in a great danger due to the problems such as pollution, global warming, depleting natural resources etc. Automobiles are a major contributors in it. Thus, it is very important to find alternative ways. Electrifying vehicles is a way out. However, there are problems with it, eg. Cost , batteries discharging, lesser range, heavy weight, batteries' disposal etc. For increasing range there are hybrid vehicles. But, again they use fossil fuel which is expensive, depleting and also causes pollution. These hybrids can be made better by using compressed air as a fuel. The compressed air is cheap, quickly refillable and the exhaust is just clean breathable air.**

I. INTRODUCTION

The use of compressed air is not new. It is widely used in the industry for many applications. The energy stored in the compressed air can be converted to rotary motion using an air engine or an air motor. Thus, this can be used in vehicles to propel the wheels.

An air engine is a modification of a normal gasoline/diesel engine. It uses a piston which turns the crankshaft as an air pressure applies force on the piston head. In this paper, we are focusing on design and development of a compressed air engine using CAD software 'SOLIDWORKS' , Analysis using 'ANSYS' and prototyping on a 50cc two stroke Kinetic Luna engine. Also, we are proposing a model for an Air-Hybrid vehicle.

II. FLOWCHART

III.WORKING & MODIFICATION

The main components of a compressed air engine are Hose, pneumatic pipes, piston & cylinder, connecting rod, crank, cam, 3x2 DCV(Direction control valve),pressure gauge , regulator , flywheel etc.

The working of an air engine is similar to a 2 stroke petrol engine. Only the difference is compressed air entering the cylinder through a hose instead of the charge through inlet port.

Two stroke petrol engine of kinetic luna was modified for the prototype of compressed air engine which was done by replacing spark plug and cam mechanism of the engine.

Following modifications are done to convert IC engine into compressed air engine

- Spark plug of the IC engine is replaced by inlet hose for the supply of compressed air to the cylinder . The pneumatic pipes are used to connect the air reservoir to the engine cylinder .
- Cam mechanism used in the IC engine of luna is replaced by custom made cam for required valve timing.
- 3*2 DCV is used instead of carburetor.
- Special Pneumatic pipes are used for air flow.

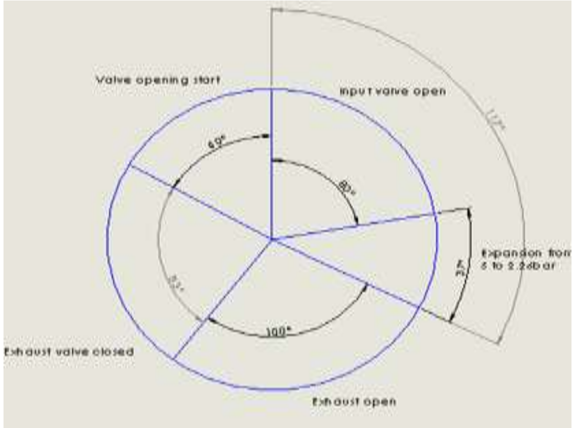


Figure 1Valve Timing Diagram

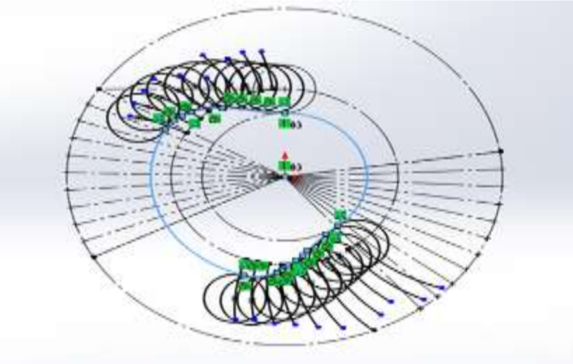


Figure 2 Cam Profile

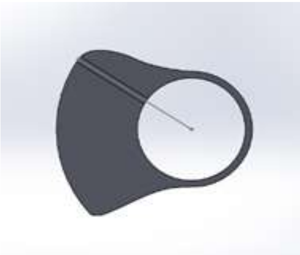


Figure 4 Cam, Figure 3 3x2 Direction control valve Courtesy: Janatics

IV.WORKING CYCLE

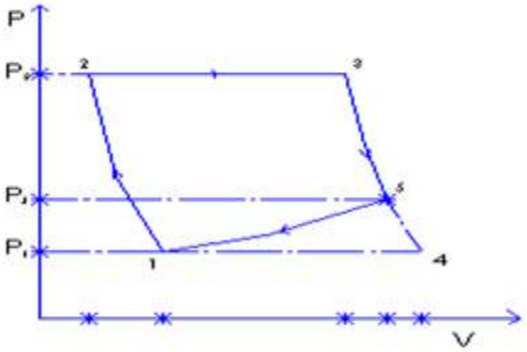


Figure 5 Modified Brayton cycle.

Analysing the engine we found that the engine works on a modified Brayton Cycle, modified in the sense that the exhaust of the engine is not at the same pressure as that of the intake of the compressor.

- Process 1-2: This is the process where compressor takes the air from the atmosphere and compresses to required pressure. This is and isentropic process
- Process 2-3: Intake occurs at constant pressure of 5 bar for 800 of crank angle
- Process 3-4: It is the ideal process that takes place in the ideal bratyon cycle
- Process 3-5 : It is the actual Power stroke of our engine. It occurs for 370 before exhaust port opens.
- Process 5-1: The actual exhaust stroke with pressure drop from the exhaust pressure to atmospheric pressure.

V.CAD & PROTOTYPE

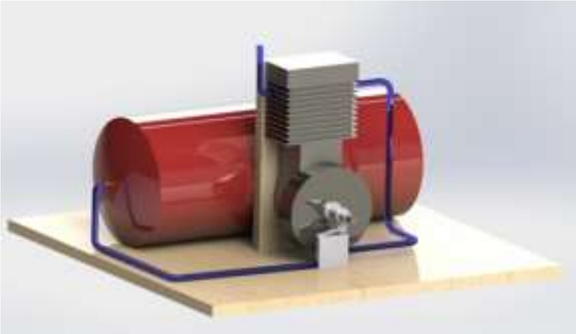


Figure 6 Prototype in CAD

VIII.TESTING

Figure 9 Spring balance reading.

For the load testing of the engine a custom made brake drum dynamometer was used. A metal pipe frame held the dynamometer in its place. Following are the observations and calculations made:

P1 = Load on left side (N)

P2 = Load on right side (N)

N = Speed in RPM

Braking force on the drum = (P1 – P2)

Braking torque on the drum, TB = (P1 –P2) r

Brake Power = (2*π*N*TB)/60

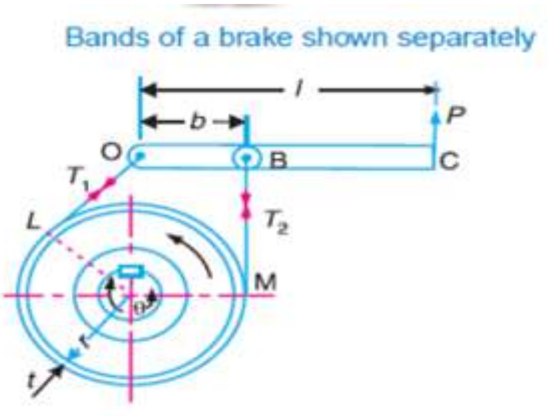


Figure 8 Pony brake dynamometer.

Pressure (bar)	Load (P1+P2) Stationary	Pi(kg)	P2(kg)	P1(N)	P2(N)	Torque(Nm)	RPM	ω (rad/sec)	Power (W)
2		1.8	0.65	17.658	6.3765	0.90252	250	26.16667	23.61594
2		1.8	0.6	17.658	5.886	0.94176	230	24.07333	22.6713
2		1.7	0.6	16.677	5.886	0.86328	260	27.21333	23.49273
Average	1.8	1.766667	0.616667	17.331	6.0495	0.90252	246.6667	25.81778	23.25999
3		1.8	0.5	17.658	4.905	1.02024	385	40.29667	41.11227
3		2	0.5	19.62	4.905	1.1772	350	36.63333	43.12476
3		2	0.55	19.62	5.3955	1.13796	375	39.25	44.66493
Average	1.8	1.933333	0.516667	18.966	5.0685	1.1118	370	38.72667	42.96732
4		1.9	0.6	18.639	5.886	1.02024	570	59.66	60.86752
4		1.8	0.6	17.658	5.886	0.94176	565	59.13667	55.69255
4		1.9	0.6	18.639	5.886	1.02024	560	58.61333	59.79967
Average	1.8	1.866667	0.6	18.312	5.886	0.99408	565	59.13667	58.78658
5		1.8	0.6	17.658	5.886	0.94176	720	75.36	70.97103
5		1.8	0.6	17.658	5.886	0.94176	730	76.40667	71.95674
5		1.8	0.65	17.658	6.3765	0.90252	725	75.88333	68.48623
Average	1.8	1.8	0.616667	17.658	6.0495	0.92868	725	75.88333	70.47133

Table 1 Power calculation at constant load and varying pressure

IX.RESULT

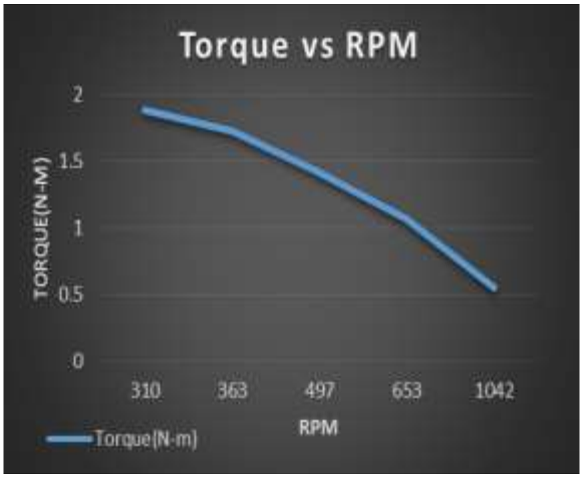
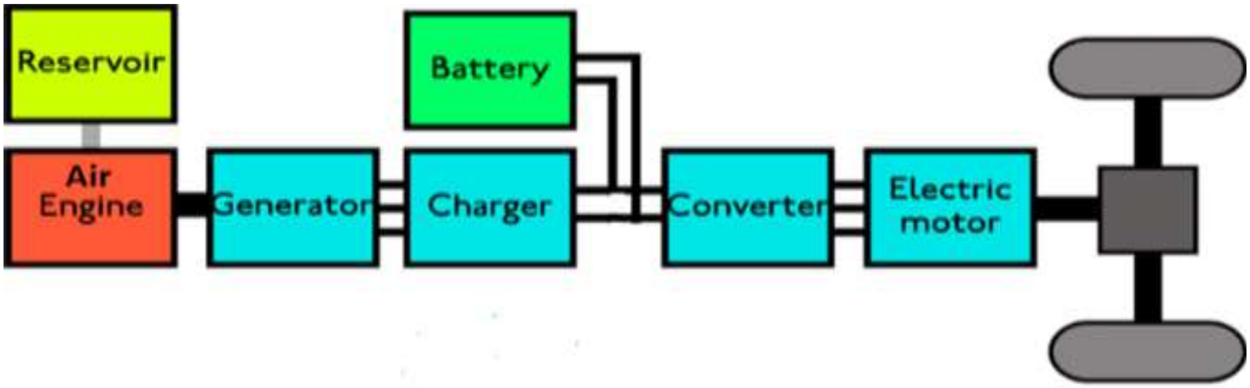


Figure 10 Graph of Torque vs. RPM

Figure 11 Graph of Power vs. Load

Pressure	% Load	P1(kg)	P2(kg)	P1(N)	P2(N)	Torque (Nm)	RPM	ω (rad/sec)	Power (W)
5	100%	4	1.6	39.24	15.696	1.88352	310	32.4466	61.11395
5	80%	3.5	1.3	34.335	12.753	1.72656	363	37.994	65.59892
5	60%	2.75	0.95	26.9775	9.3195	1.41264	497	52.01933	73.48459
5	40%	2	0.65	19.62	6.3765	1.05948	653	68.34733	72.41263
5	20%	1	0.3	9.81	2.943	0.54936	1042	109.0627	59.91467

Table 2 Power calculation at constant pressure and varying load



X. MODEL FOR AIR HYBRID VEHICLE

As a modification in hybrid vehicles the same compressed air powered engine can be used instead of a gasoline or diesel engine. Thus, there will be batteries as primary energy source and air as secondary energy source. The block diagram of the system is as shown in the figure12.

XI. CONCLUSION

The shape of torque and power graphs is almost similar to that of an IC engine hence similar results can be obtained from Air Engines as well if developed further. This technology has the potential to replace combustion based engines hence it is need of the hour to develop this technology so as to save our mother nature. Also the cost of producing compressed Air is far less than petrol and diesel hence this tech is worthy enough to be used in our future cars. Just imagineclean breathable air coming out of and cars' exhaust..!!

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