A STUDY ON COMPRESSED AIR ENGINE TECHNOLOGY: A REVIEW

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ABSTRACT

In his century, it is believed that petroleum and crude oil products will become very scare and costly and fossil fuels are rapidly depleting. The problem of global warming is largely contributed by conventional engine technology. Any alternative technology solve this problem will considered as a bounty and compressed air engine (C.A.E.) is one of them. It is environment friendly, cheaper as well as easily available. It can run only with highly pressurized air as input energy source. Another reason motivating the development of alternate fuel for (IC) engine is the concern over the emission problem of (conventional) gasoline and diesel engines. This technology solves the problem of hot and harmful exhaust unlike diesel or gasoline engine because of no combustion process is done here.

Keywords*: *Compressed Air, Energy, Operation Of Compressed Air Engine, Pollution, Cam Design

I. INTRODUCTION

Now-a-days, conventional fossil fuel meets most of world's energy demand are being depleted rapidly. The product of combustion process of gasoline or diesel engine are causing global problems such as ozone layer depletion air pollution, acid rain, greenhouse effect and global warming effect which are posing ruin for environment and eventually for this planet's lives. One of the best of all alternative is CAE (compressed air engine) in which air is abundantly available. Air can be compressed to comparatively higher pressure at cheaper way. Air has property to get compressed to extremely high pressure and retain it up to long time period. Number of research is going on this field and scientists are trying to improve the effectiveness of compressed air powered engine. An engineer Louis Mekarski developed first compressed air powered vehicle in 1870, that was patented in 1872 and that was tasted in 1876 at Paris [1].

II. BEHAVIOUR OF COMPRESSED AIR

Compressed air is efficient, clean as well as safe in terms of inflammable property. It is not combustible and non-polluting. As per thermodynamic laws, air of atmosphe ric pressure can be mechanically compressed by compressor the transformation of pressure of air is at 1 bar up to 414 bar[2]. According to boyle's law, volume decrease during compression then pressure increase. As per Charle's law volume is directly proportion to temperature. As conclusion of these laws; pressure, temperature and volume are in proportionality relation, changes of one, and makes other change.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_1}{T_2}$$

III. A LITERATURE REVIEW

Prof. B.S.Patel et al. [3] have been tried to develop a compressed air powered engine by modifying single cylinder four stroke engine by replacing spark plug with the pulsed pressure control valve which can create required pressure. Now valve is controlled by supply of electrical signal to it, for this purpose they suggested an electronic timing circuit and hence speed of engine can also controlled by input electrical signal.

Haisheng Chen et al. [4] experimented on typical compressed air engine system figure shown below of working of CAE and diagram of Temperature versus Entropy.

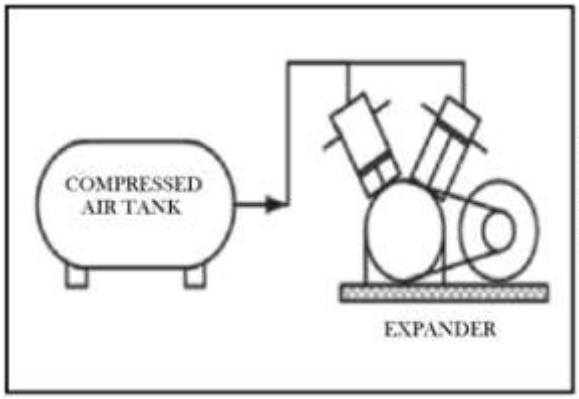


Fig (1): compressed air engine [4]

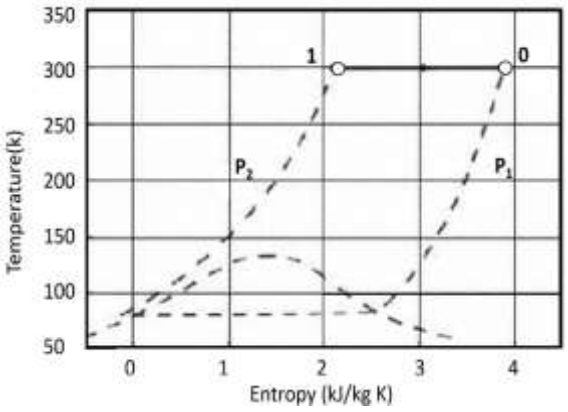


Fig (2): T-S dia. of compressed air engine [4]

Conditions of analyses:

Working Pressure P2 =300bar

Ambient Pressure P3 =1.013bar

Ambient temp. T0 =300K

Volume of tank = 300lit.

At temperature of 300K and pressure of 300 bar the actual work done output for isothermal of =0.90 & 0.75 are respectively 284.2KJ/kg &222.8 KJ/kg.

Bharat R. Singh et al. [2] explained the range of pressure and work output of compressor used for CAE. Compressed air piston operates in between 1hp. To 563hp (0.7 kW to 420kW) and generate working pressure of 1.5 bar to 414 bar (21 to 6004psi). Vane type compressors can operate between range of 1.1kW to 75kW (1.5 to 100hp); producing working pressure of 7 to 10bar (101 to 145psi).

Air has property to fill up any given space of any shape, the easiest way to understand that is balloon inflation. The elastic material of balloon holds the air tightly in inner volume of balloon but at the time when you insert a pin to make a hole in balloon's body pressurize air expands with too much energy. JP Yadav [2] states that compressing a gas into small space is better way to store energy, this is basic key principle behind compressed air engine technology.

IV. COMPARISON OF OPERATION

4.1 General Operation: 4-Stroke Engine

1. Intake/suction stroke: mixture of air and fuel introduced combustion chamber. It starts when the piston is at TDC and about to move downward (BDC). Position of intake valve is open and exhaust valve is closed.
2. Compression Stroke: Both valve are in closed position in this stroke. The mixture which fills entire cylinder volume is now compressed into clearance volume. Piston moves from BDC to TDC.

3. Power/Expansion Stroke: The compressed fuel charge combusted in combustion chamber which produce power for engine by moving piston from TDC to BDC. Both valves are remains closed position.
4. Exhaust Stroke: In this stroke product gases escape via opened exhaust valve whereas inlet valve remains closed. Piston travels from BDC to TDC.

4.2 Operation of CAE: Compressed Air Powered Engine

The working mechanism of compressed air powered engine partially similar with conventional 4-stroke engine. But, it has only two strokes like:

1. Power Stroke
2. Exhaust stroke

4.2.1 Power Stroke

In power stroke of CAE, High pressurize air via inlet valve, supply to cylinder and it will move the piston from TDC to BDC. Problem concerned to working of this engine at starting, it requires initial torque to be provided by other means to bring engine into motion. This can be solved by providing DC powered exciter motor which provides necessary initial torque to be start [3].

4.2.2 Exhaust Stroke

In exhaust stroke of CAE, air escape from cylinder via exhaust valve and inlet valve get closed. One interesting benefit is that the exhaust air temperature of C.A.E. measured practically as low as 17.6 ^{0}C is less than atmospheric temperature.

Conventional four stroke engine is modified into two stroke engine with re-designing of CAM [5].

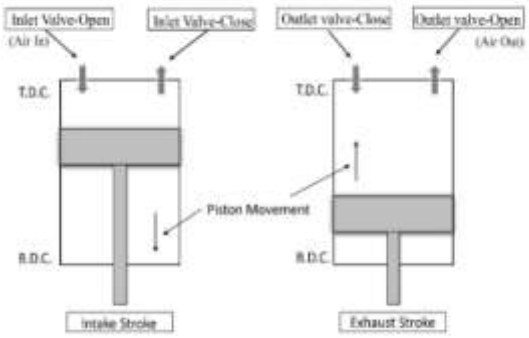


Fig (3): Cycle of Operation of cae[5]

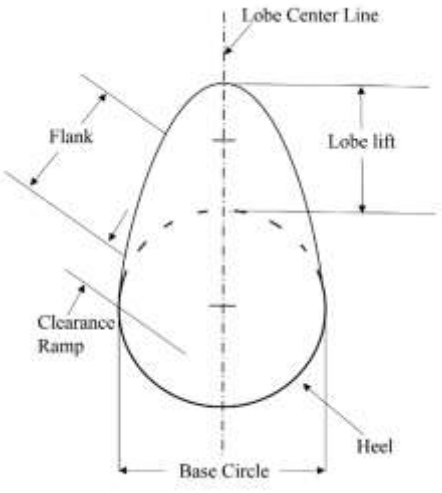
V. COMPARISON OF DESIGN OF CAM

5.1 Conventional Cam Design:

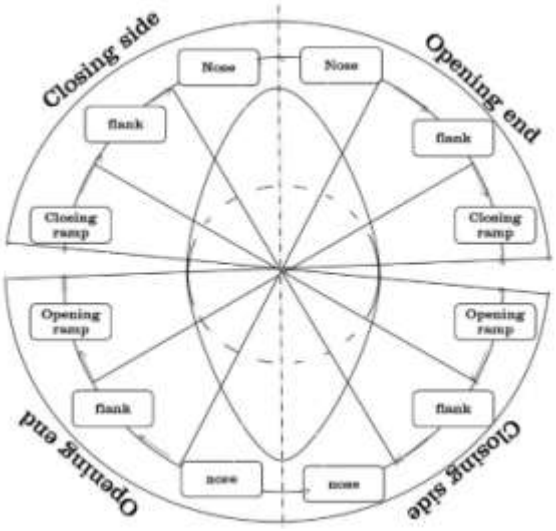
A General Design Only one lobe is involved in general cam design to operate according to valve timing.

5.2 Compressed Air Engine Design :

In compressed air engine cam involves two lobes to operate 2-strokes.



Fig(4): general cam design in four stroke engine[5]



Fig(5): design of cam for compressed air engine[5]

VI. MERITS OF CAE

• Air is economical, inflammable, abundant, easily transportable, storable, and non-polluting.
• Mechanical design for engine is simpler & robust.
• Low maintenance cost, manufacturing cost as well as low operating cost.
• Manufacturing cost reduces because there is no need of fuel tank, spark plug, silencers, cooling system and complex fuel injection mechanism.
• Very less wear& tear of parts, so smooth working is possible.
• There is no possibility of knocking and detonation which is major problem of conventional engines [3].
• Longer life span; Compressed air powered vehicle gives higher efficiency than electric vehicles, which is another technology which fulfils the shortage of fuel and environment friendly.
• Refilling of tank is time consuming than time of batteries to be charged.
• Problem of recycle or dispose of batteries can be eliminate by accepting this one.

VII. IMPORTANT DEVELOPMENTS OF COMPRESSED AIR ENGINES FOR LIGHT VEHICLES

Korean inventor "Beau de Rocha" made zero pollution cars using Quasiturbine and disclosed on Sept'2005 using gasoline [6].

"Guy Negre", a Scientist ,developed compressed air engine run on air and gasoline, claims zero pollution car and got 52- patents registered since 1998 to 2004.The car was demonstrated in 2004 publically[7].

"E.J. Honton" an inventor in 2004 presented the Hydrogen Fuel Car at 15th Annual US Conference & Hydrogen Expo, USA and projected the scope of its market in different country [10].

VIII. CONCLUSION

It is very necessary to develop such tank made of carbon fibers which can carry huge amount of pressure with least volume of space will meet the general acceptance with zero harmful emission. CAE is the realization of

new technology in automobile field.it is also necessary to develop compressed air engine of multi-fuel engine that runs with either Air or Fuel.

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