A Study on Six Stroke Internal Combustion Engine Concept

Priyabrata Nikhandia
Department of Mechanical Engineering
Gandhi Institute of Engineering and Technology, Gunupur, India

Abstract— The new technical decade is facing challenges of engines that can perform well in terms of increased thermal efficiency with decreased fuel consumption and low atmospheric emissions. Thus, a Six stroke engine can serve the purpose of an internal combustion engine which utilizes the exhaust waste heat to use it as useful work output. The six stroke engines have two power strokes in the six-stroke cycle, thereby curtailment in fuel consumption by at least 38%, with reduced percentage of pollution. Thus, an introduction of Six stroke engines in the automobile industry would have an incredible impact on the environment and economy and market as well.

Keywords: IC Engines, Six Stroke IC engine, Thermal efficiency of an IC Engine

I. INTRODUCTION

The Automobile and many Energy producing Industries employ IC Engines for their operation. Since the IC Engines need fossil fuels to run, it is a major cause of concern to think of methods to boost the efficiency. It is anticipated that there will be deficit in the petroleum products and there will be severe crisis due to alarming increase in the number of vehicles. Moreover, the emissions of the IC Engine include gases like CO, CO2, NOX and the other harmful gases which can worsen the environmental condition in the coming few decades. Thus, an efficient design of a six stroke IC engine has the capability to promote the efficiency with reduced fuel consumption and pollution with effective heat-waste management solution.

Enormous quantity of heat is produced in a 4-stroke Engine. Approximately 35-40% of exhaust energy is transformed into useful energy for achieving the rotation of crankshaft whereas the remaining energy is either expelled to the surrounding or simply increases the temperature of the engine. Whereas the six stroke IC engine is the latest advanced technology that employs the use of two additional strokes which consequently develops more power by utilizing the exhaust gases with less emissions to the environment with minimum fuel consumption.

II. ANALYSIS OF SIX STROKE ENGINE

The requirement to build the six-stroke engine is to improve the engine efficiency. The disadvantage of the four-stroke cycle is that only half as many power strokes are completed per revolution of the crankshaft as in the two-stroke cycle and only half as much power would be expected from an engine of given size at a given operating speed.

The four-stroke cycle, however, provides more positive scavenging and charging of the cylinders with less loss but in six stroke cycle, two parallel functions occur in two chambers which result in eight event cycle: four event internal combustion cycle and four event external combustion cycles. In the internal combustion there is direct contact between air and the working fluid, whereas there is no direct contact between air and the working fluid in the external combustion process. Those events that affect the motion of the crankshaft are called dynamic events and those, which do not effect are called static events.

III. MECHANISM OF SIX-STROKE ENGINE

A. *Major Components of Six-Stroke Engine*

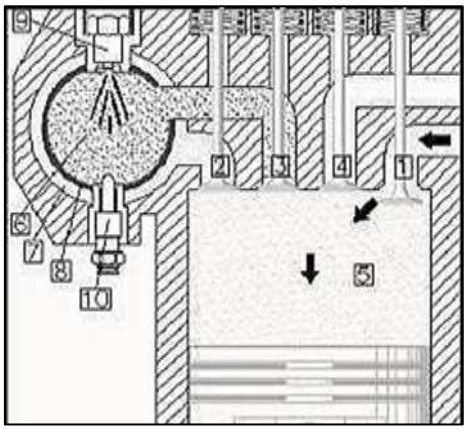

Fig. 1: Components of Six Stroke Engine

1) Intake Valve
2) Heating Chamber Valve
3) Combustion Chamber Valve
4) Exhaust Valve
5) Cylinder
6) Combustion Chamber
7) Air Heating Chamber
8) Wall of Combustion Chamber
9) Fuel Injector
10) Spark Ignition System

B. *Working of Six-Stroke Engine*

The six strokes of the six stroke cycles are as follows:

1) Intake stroke
2) Compression stroke
3) Ignition stroke
4) Recompression stroke
5) Steam expansion stroke and
6) Exhaust stroke

The working principle is as follows:

1) First Stroke (Intake Stroke)

The Inlet valves opens and air- fuel mixture from carburetor is sucked into the cylinder through the inlet valve and piston moves from TDC to BDC which consequently promotes in the formation of a difference in pressure due to which pure air from environment enters into the cylinder.

2) Second Stroke (Compression Stroke)

The inlet valve shuts and the opens the heating chamber valve and the piston moves upward due to cranking, forcing the air into heating chamber. The air at this stage is converted to high pressure due to compression.

3) Third Stroke (Ignition Stroke)

Due to ignition of the compressed air- fuel mixture using a sparkplug, power is developed from the Engine. Both valves

are closed and piston moves from TDC to BDC. Thus, the combustion chamber valve opens and gases of combustion enter the cylinder.

4) Fourth Stroke (Recompression Stroke)

Here the exhaust valve opens to force out the burned gases. The engine cylinder Piston moves back from BDC to TDC.

5) Fifth Stroke (Steam expansion Stroke)

The exhaust valves remain shut and the water Inlet valves open. Fresh water from the water Inlet valves enter into the cylinders through the secondary water Induction system. The pressure thus created helps in pushing the Piston move from TDC to BDC.

6) Sixth Stroke (Exhaust Stroke)

In the final stroke, the water exhaust valves uncover. The water sucked into the cylinder during the fifth stroke is removed to the atmosphere through the water exhaust valve. Piston moves from BDC to TDC and six strokes are completed.

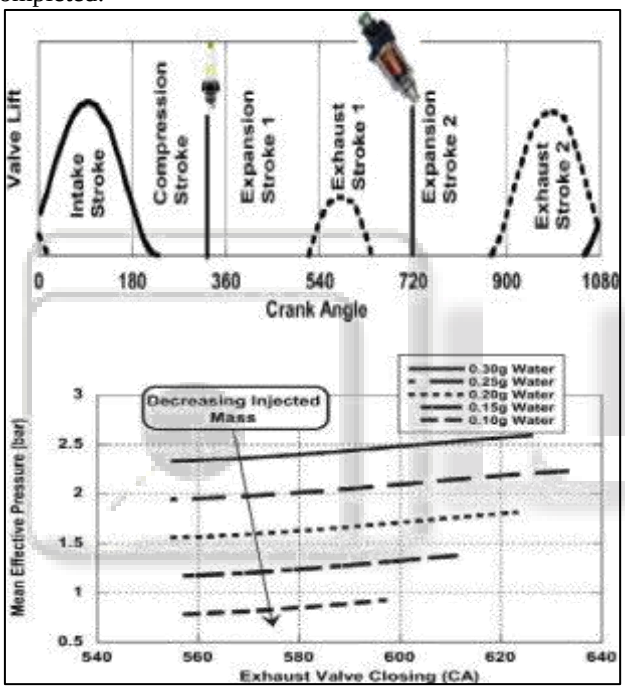

Fig. 2:

IV. LITERATURE REVIEW

Following are the various approaches categorizing the six-stroke engine design:

1) The First Approach
2) The Second Approach

A. The First approach:

There are two additional strokes by the main piston as fifth and sixth stroke along with the conventional four strokes of Internal Combustion Engine. These engines have 2 power strokes: one by fuel, one by steam or air.

- Griffin Six Stroke Engine
- Bajulaz Six Stroke Engine
- Crower Six Stroke Engine
- Velozeta Six Stroke Engine
- NIYKADO Six Stroke

B. The Second Approach:

It uses a second opposed piston which moves at half the cyclical rate of the main piston, thus giving six piston movements per cycle and theoretically replacing the valve mechanism of a conventional engine and also increasing the compression ratio

- Beare head six stroke engine
- Charge pump engine

1) Griffin Six Stroke

The principle of the "Griffin Simplex" was based on a heated exhaust-jacketed external vaporizer, into which the fuel was sprayed. The temperature of operation was around 550 °F (288 °C), sufficient enough to physically vaporizer the oil but not to break it down chemically. This fractional distillation supported the use of heavy oil fuels, the unusable tars and asphalts separating out in the vaporizer.

2) Bajulaz Six Stroke:

The Bajulaz six stroke engine is analogous to a regular combustion engine in design. However, there are modifications to the cylinder head, with two supplementary fixed capacity chambers: a combustion chamber and an air preheating chamber above each cylinder. The combustion chamber receives a charge of heated air from the cylinder; the injection of fuel begins a burn at constant volume which increases the thermal efficiency compared to a burn in the cylinder. The high pressure achieved is then released into the cylinder to work the power or expansion stroke. Meanwhile a second chamber which blankets the combustion chamber, has its air content heated to a high degree by heat passing through the cylinder wall. This heated and pressurized air is then used to power an additional stroke of the piston.

3) Crower Six Stroke:

In a six-stroke engine developed in the U.S. by Bruce Crower in 2004, fresh water is injected into the cylinder after the exhaust stroke, and is quickly turned to superheated steam by absorbing the cylinder heat, which causes the water to expand to 1600 times its volume and forces the piston down for an additional stroke. The phase change from liquid to steam removes the excess heat of the engine.

4) NIYKADO Six Stroke:

The engine was developed, designed and patented by Chanayail Cleetus Anil from Kochi, India in 2012. This is the only engine that is categorized as a fully working prototype. The first prototype was developed in 2004 which used only 2 valves. The second prototype developed in 2007 which was an improved version using 4 valves.

5) Velozeta Six Stroke:

In a Velozeta engine, during the exhaust stroke, fresh air is injected into the cylinder which expands by heat and therefore forces the piston down for an additional stroke. The valve overlaps have been removed and the two additional strokes using air injection provide for better gas scavenging.

C. The Second Approach:

1) Beare Head Six Stroke:

This engine combines the top portion of two stroke engine and the middle section of a four-stroke engine. It is a radical hybridization of two and four stroke engines. Below the cylinder head gasket, everything is conventional, in his design. So, one main advantage is that the Beare concept can

be transplanted to existing engines without any redesigning or retooling the bottom end and cylinder. Beare used a short-stroke upper crankshaft complete with piston, which is driven at half engine speed through the chain drive from the engine. This piston moves against the main piston in the cylinder and if the bottom piston comes four times upwards, upper piston will come downwards twice. The compression of charge takes place in between these two pistons.

2) Charge Pump Engine:

In this engine, similar in design to the Beare head, a 'piston charger' replaces the valve system. The piston charger charges the main cylinder and simultaneously regulates the inlet and the outlet aperture leading to no loss of air and fuel in the exhaust. It is also possible to charge two working cylinders with one piston charger. The combination of compact design for the combustion chamber together with no loss of air and fuel is claimed to give the engine more torque, more power and better fuel consumption. The benefit of less moving parts and design is claimed to lead to lower manufacturing

V. Conclusion

It is commercially obvious that the big market has a good demand for automobile, heavy goods, construction site and farm vehicle industries. The six-stroke engine, reducing fuel consumption and pollution without any effect on performance will enhance its employability. This is a good alternative for the replacement of the internal combustion engine. Only improvements of the current technology can help it progress within reasonable time and financial limits. The six-stroke engine is, no doubt, a good alternative due to the following advantages that were analyzed after study:

A. No External Cooling Required:

In the two additional stokes, the exhaust heat energy present in the cylinders is used up by the air or water to do work. Thereby decreasing the engine temperature and ruling out the need for heavy external cooling systems& radiators.

B. Increased Stroke Volume:

In six stroke engine the change in volume during the compression stroke is slightly higher than four stroke engines after the ports are closed. Also, the expansion stroke is much greater in six strokes than four strokes, both from T.D.C. to B.D.C. and from T.D.C. till the exhaust port is open. Therefore, large volume in the cylinder is obtained, thereby increasing power. Better filling of the cylinder on the intake due to the lower temperature of the cylinder walls and the piston head.

C. Reduction in Fuel Consumption:

The operating efficiency of a 4-stroke petrol engine is approximately 30%. Whereas that of the six-stroke will be of order of 50%. For the same amount of fuel, we get additional two strokes (using air/water) thereby reducing the overall fuel consumption of six-stroke engines. The increase in thermal efficiency compensated for any reduction in specific power. It has less inertia due to the lightness of the moving parts which is another contributing factor.

D. Two Work Cycles in Six Strokes:

As the work cycles occur on two strokes i.e., 8% more than in a 4-stroke engine, the fluctuations in torque is minimal. This led to very smooth operation at low speed, thereby improving performance in stop and go situations as in heavy traffic in a city. Also, there is increase in torque by 35% in six stroke engines.

E. Reduction in Pollution:

Significant reduction in chemical, noise and thermal pollution are reduced. There occurs no problem in combustion due inflammability difference in six stroke engines. Also, the emissions of HC, CO, NOx are reduced.

F. Adaptability to Various Fuels:

It can use the variety of fuels, of any origin which maybe fossil or vegetable, from diesel to L.P.G. or animal grease. It's light, standard petrol engine construction, and the low compression ratio of the combustion chamber.

References

[1] Emre ARABACI*, Bayram KILIÇ, Analyzing the implementation of six stroke engine in a Hybrid Car, International Journal of Mechanical Engineering and Applications2014; 2(1): 1-4.
[2] Lezhong Fu1, Zhijun Wu,XiaoYu1,Jun Deng, Zongjie Hu1,LiguangLi,Experimental Investigation of Combustion and Emission Characteristics for Internal Combustion Rankine Cycle Engine under different Water Injection Laws, The 12th International Conference on Combustion & Energy Utilisation – 12ICCEU,Science Direct,2015
[3] Emre ARABACI*, Bayram KILIÇ, Novel Over-Expanded Six-Stroke Engine Mechanism, BEU Journal of science2018.
[4] Dheeraj Makheeja, A Review on six stroke IC Engines, IOSR,2015
[5] V.patel,Praksh sen,Gopal sahu,,Ritesh sharma,S.Bohidar,A study on Basic Theory of a Six stroke IC Engines,IIJME,2015
[6] Mohsin Raza,A study and Analysis of six stroke IC engine,IJEDR,2017
[7] A.Alkhaniya,A.Kotiyal,A concept of Six stroke Engine,IJMIT,2015
[8] V.Ganeshan, Internal Combustion Engines

