Scientific Journal of Impact Factor (SJIF): 4.14
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 8, August -2016

A REVIEW ON SIX STROKE INTERNAL COMBUSTION ENGINE

[1]SHAARIF HUSSAIN, [2]VINEET KUMAR SINGH, [3]SYED RAZAUDDIN SHAHLAL

[1,2]Student of B.E,Department of Mechanical Engineering, Sir M. Visvesvaraya Institute of Technology, Bangalore
[3]Student of B.E, Department of Mechanical Engineering, SDM College of Engineering and Technology, Dharwad

Abstract —*The prime motive of this paper is to review the Six Stroke Engine, its working, advantages and limitations. This engine has two power strokes out of six strokes. The extra two strokes together produce usable power from waste heat. As there is 2/3 power stroke per revolution as compared to 1/2 power stroke of the 4 stroke engine. The power obtained is higher with higher thermal efficiency. There is alsoa reduction in fuel consumption and pollution to the environment. Nowadays, lots of efforts are being made in the engine technology to increase the engine thermal efficiency without any compromise with performance which is the most difficult challenge. The automobile industry is now in need for a more fuel efficient technique and the Six Stroke Engine may be the counterpart with good design compatibility.*

Keywords- Six Stroke Engine, Four Stroke Engine, efficiency, Otto Cycle, fuel consumption.

I. INTRODUCTION

In this modern era, with more and more use of automobiles as transport and goods carrier has caused an unbalance between demand and availability of petrol and diesel. These petroleum products are limited and exhaustive sources of energy and their depletion has raised the need of alternate fuels and use of efficient technologies to decrease fuel consumption. The six stroke engines are the advanced version of the internal combustion engines consisting of similar components of four stroke engines with the addition of two more valves and working on the same principal of four stroke engines. During the fifth stroke or a second power stroke the heat developed is used for the rapid expansionof the secondary non-detonating fuel (air) which pushes the piston downwards for the second power stroke, rotating crankshaft for another half cycle followed by a sixth stroke or second exhaust stroke. Majorly used secondary fluids in six stroke engines are water and air.

II. TYPES OF SIX STROKE ENGINE

2.1. SINGLE PISTON DESIGN

These designs use single piston per cylinder and a secondary non-detonating fluid. This fluid is injected inside the chamber which uses the waste heat to produce a 2nd power stroke.

2.1.1. GRIFFIN SIX-STROKE ENGINE.

The principle of working of a Griffin Six Stroke Engine is “Griffin Simplex” which uses a heat exhaust jacketed external vaporizer and fuel is sprayed into it. The temperature is maintained at550 ℉ (288 ℃) which is enough to vaporize the oil but not to chemically break it. This engine is non-mobile, large and heavy, but is capable of burning cheaper and heavier grade of oils.

2.1.2. DYER SIX STROKE ENGINE.

This is a six stroke internal combustion water injection engine. It uses pure water as a secondary fluid. Expansion of steam is used to produce 2nd power stroke. It has improved fuel consumption and no cooling system is required.

2.1.3. BAJULAZ SIX STROKE ENGINE.

This is the Six Stroke Engine with few modifications to the regular combustion engine and claims 40% reduction in fuel consumption, reduction in pollution and capability to use multi-fuel. The cylinder head is modified with two supplementary fixed capacity chambers. The second chamber is used as a jacket for the first chamber. The air inside this chamber gets heated up due to the high temperature of the cylinder wall and used to produce an additional power stroke.

2.1.4. NIYKADO SIX STROKE ENGINE.

This engine was designed, developed and patented by ChanayilCleetus Anil, of Kochi, India, in 2012. It claims to be 23% more fuel efficient and lower air pollution. This engine underwent a preliminary round of full throttle test at the Automotive Research Association of India (ARAI), and is the only engine to be categorized as a fully working prototype.

2.1.5. VELOZETA SIX STROKE ENGINE.
This design uses fresh air as secondary fluid and seems to show 40% reduction in fuel consumption and substantial reduction in air pollution. Fresh air is injected into the cylinder after the exhaust stroke which gets heated up and expands. As a result, the piston is forced to do an additional power stroke. The valve overlaps have been removed and the additional strokes facilitate better gas scavenging.

2.1.6. CROWER SIX STROKE ENGINE.
This engine was prototyped in the US by Bruce Crower and estimated upto 40% reduction in fuel consumption. In this design, water is injected into the cylinder after the exhaust stroke, which gets converted into steam, and expands due to the heated cylinder wall. The piston is forced down and an additional power stroke is produced. There is no need for a cooling system, but, this reduction in weight is balanced by an additional water tank.

2.2OPPOSED PISTON DESIGN
These designs use two pistons per cylinder in which the secondary opposed piston moves at half the critical rate of the primary piston. There occurs six piston movements per cycle and combustion between the pistons with higher compression ratio.

2.2.1. BEARE HEAD SIX STROKE ENGINE.
This Six Stroke Engine design was developed by Malcolm Beare of Australia. It uses four stroke engine bottom and the opposed piston which moves at half the critical rate of the main piston. The use of the second piston eliminates the valve mechanism. The combustion occurs between the two pistons with higher compression ratio. This engine claims to increase both power and efficiency.

2.2.2. PISTON CHARGER ENGINE.
This engine has a similar design to the Beare head and uses a piston charger which replaces the valve system. The piston charger is used to charge the main cylinder and also used to manage the opening and closing of the inlet and outlet valves to avoid the loss of air and fuel in the exhaust. Combustion of the fuel occurs in the main cylinder. The advantages of these engines are more torque, more power and better fuel economy.

III. ANALYSIS OF SIX STROKE ENGINE

3.1. MAJOR PARTS OF SIX STROKE ENGINE

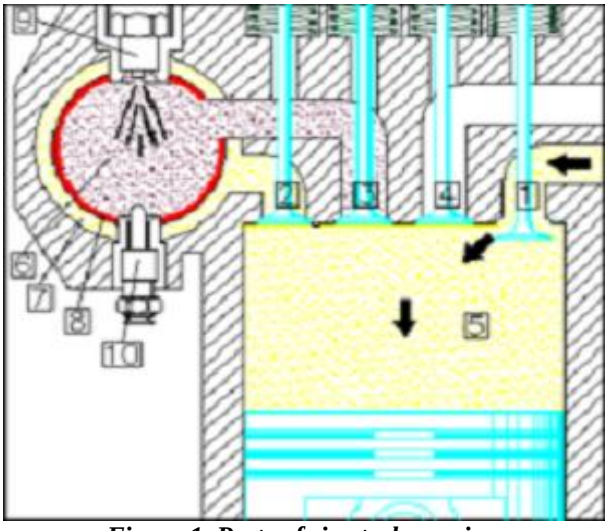

Figure 1. Parts of six-stroke engine

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) Heating plug

3.2. WORKING OF SIX STROKE ENGINE

Six stroke engine consist of six stroke and they are explained below

1st stroke(suction stroke): During the first stroke engine valves open and the piston moves downward from top dead centre to bottom dead centre which results in the formation of pressure difference due to which pure air enters the cylinder.

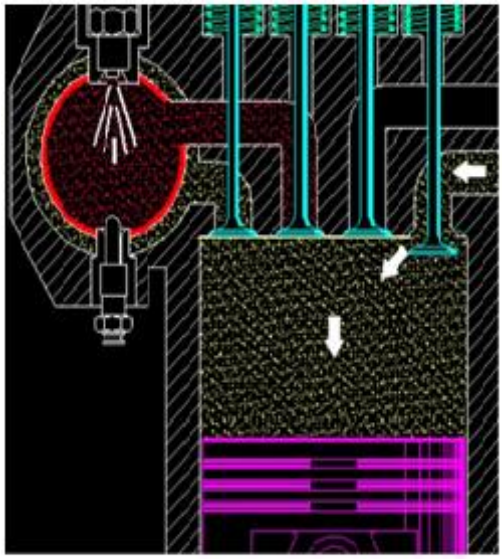

Figure 2.Intake of pure air in cylinder

2nd stroke(compression stroke): During this stroke inlet valve closes and heating chamber valve opens, as the piston moves upward due to cranking it pushes air into the heating chamber where it is compressed to high pressure.

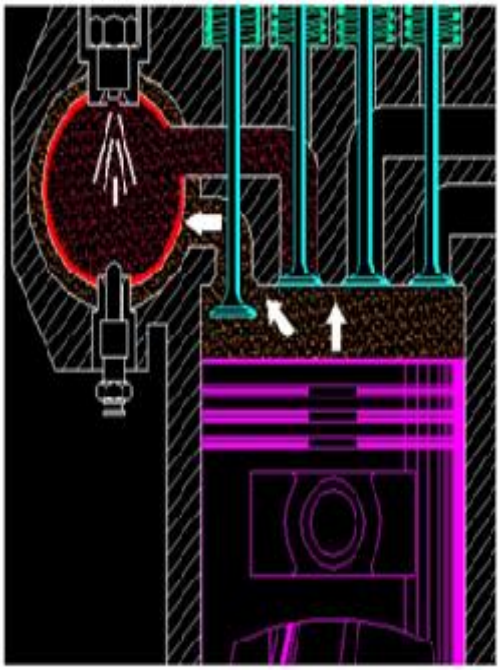

Figure 3.Compression of pure air to high pressure

3 stroke(1st power stroke): Valves of combustion chamber open and gases of combustion enter the cylinder.

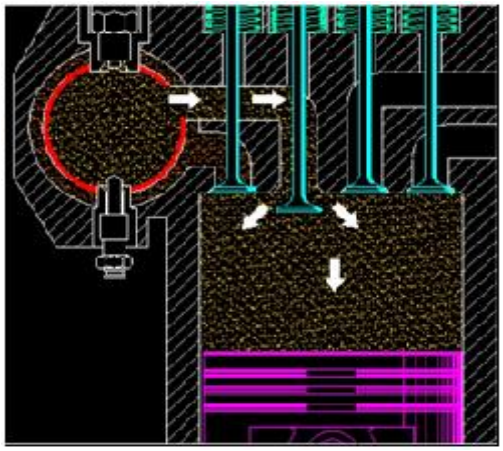

Figure 4.Release of combustion gases in the cylinder

4thstroke(exhaust stroke): During this stroke exhaust valve opens piston moves upward and exhaust gases are removed.

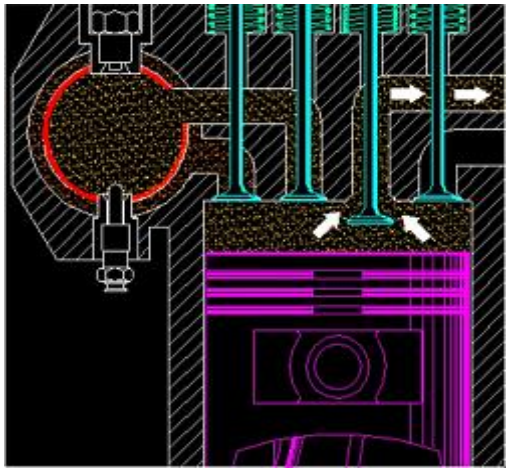

Figure 5.Removal of the exhaust gasses

5thstroke(second power stroke): During second power stroke combustion chamber valve opens and high temperature and compressed air enters the cylinder which does work on the piston hence piston moves downward resulting in a second power stroke.

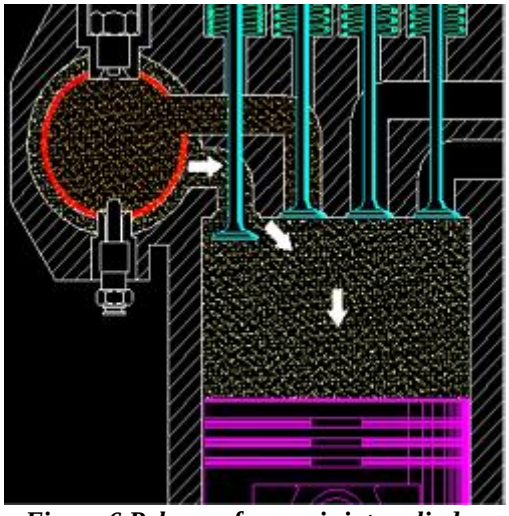

Figure 6.Release of pure air into cylinder

6th stroke: During this last stroke combustion chamber valve opens, piston moves upward which forces the air into the combustion chamber for recompression.

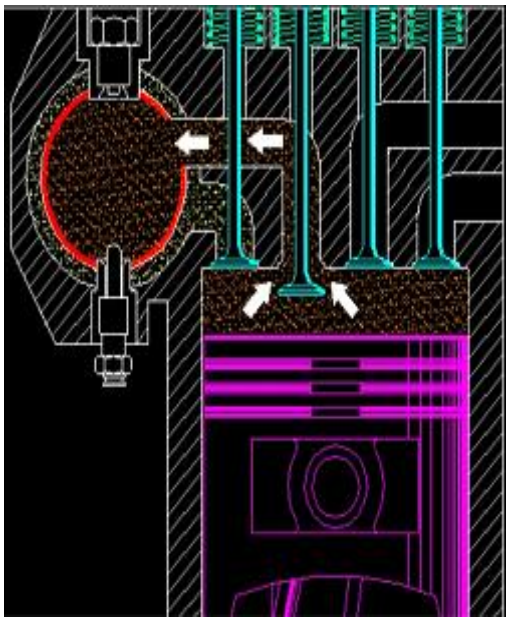

Figure 7.Recompression of the pure air

IV. GRAPHICAL REPRESENTATION

4.1. GRAPHICAL REPRESENTATION OF EVENTS.

Following are the graphical representations of the all the events of the six stroke engine. The crankshaft rotates 1080° during one complete cycle. There are total eight events which are further classified into two sets of events.
Static event- This occurs without the movement of piston
Dynamic event- This occurs with the movement of piston

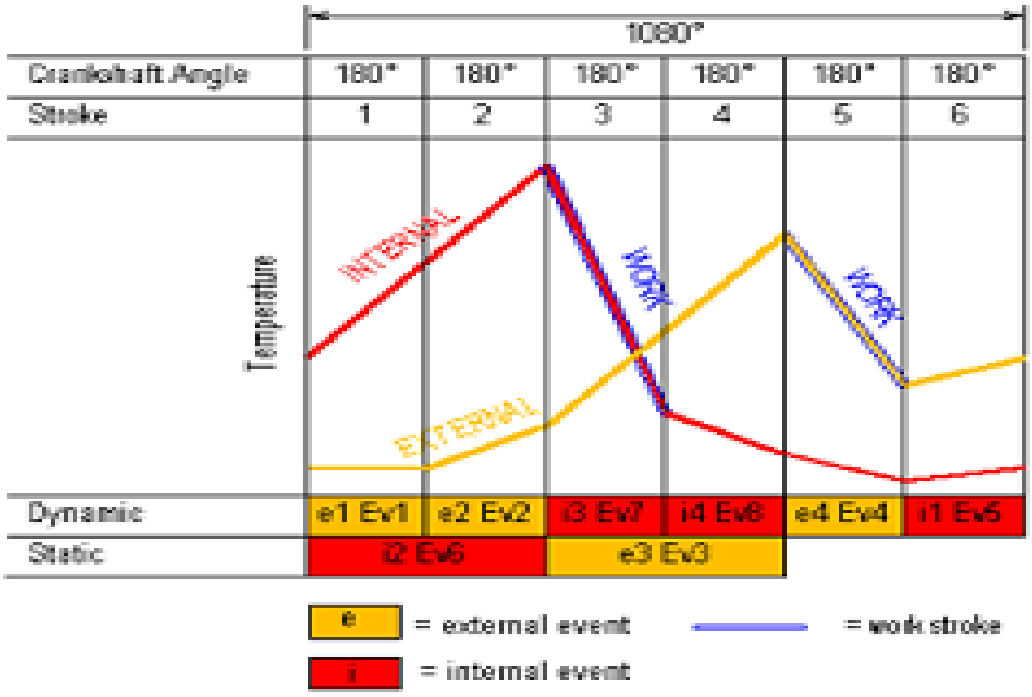

Figure 8. Graphical representation of events

4.2. GRAPHICAL COMPARISION OF SIX STROKE AND FOUR STROKE PETROL ENGINE.

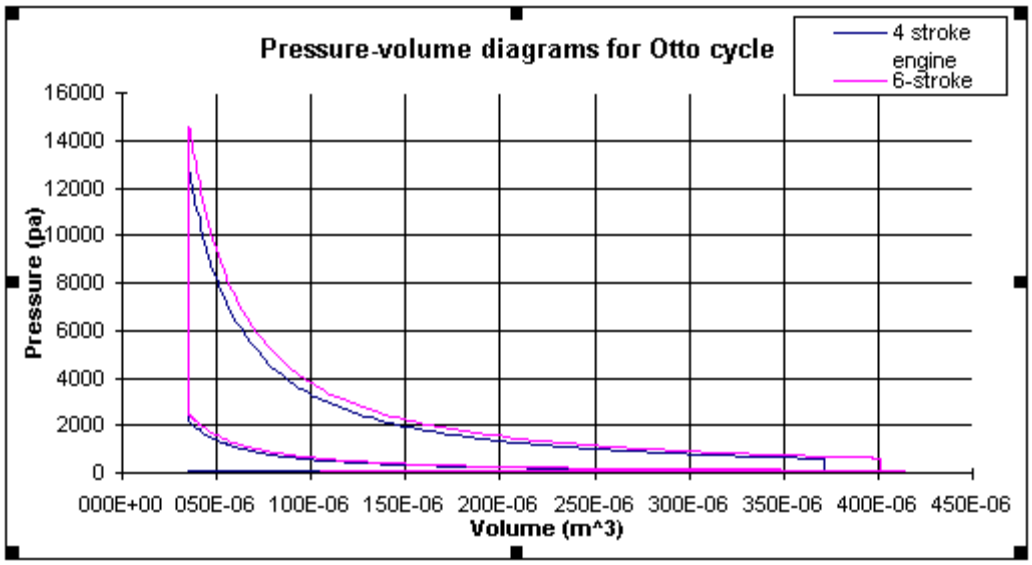

Figure 9.Otto cycle

It can be concluded from the above graph that work done by the six stroke petrol engine is greater than the four stroke petrol engine.

4.3. TORQUE ANGLE DIAGRAM FOR SIX STROKE ENGINE

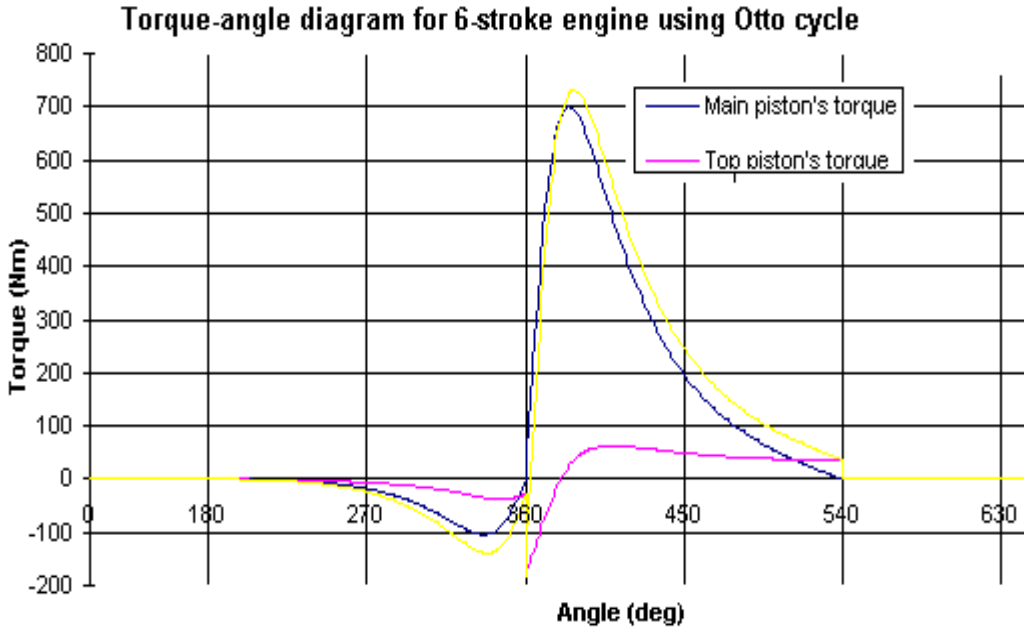

Figure 10. Torque-angle diagram

V. ADVANTAGES AND DISADVANTAGES OF SIX STROKE ENGINE

5.1. ADVANTAGES OF SIX STROKE ENGINE

5.1.1. REDUCTION IN FUEL CONSUMPTION.

The operating efficiency of a general four stroke petrol engine is of the order of 30%. The two power strokes of a six stroke engine leads to increase in thermal efficiency and a significant drop in fuel consumption of the engine. Its operating efficiency is nearly 50%.

5.1.2. IMPROVED TORQUE.
The work cycles of a six stroke engine occur on two strokes (360̊ out of 1080̊) against one work stroke per cycle (180̊ out of 720̊) of a four stroke engine. This results in even distribution of torque and a very smooth operation at low speeds without any compromise with fuel consumption and emissions. These advantages are very useful in improving the performance of the vehicle in city traffic.

5.1.3. REDUCTION IN POLLUTION.
This engine's advantage of reducing pollution is twofold. It reduces chemical, noise and thermal pollution, whereas, the engine's own characteristics help to reduce HC, CO, NO_x emission upto considerable limits. Furthermore, fuels from vegetable origin and weakly pollutant gases can also be used to run this engine. Hence, it is ideal to operate even under strictest emission standards.

5.1.4.MULTIFUEL.
It provides good flexibility in using a variety of fuels like diesel, petrol, LPG and even fuels of vegetable origin. The difference in inflammability or antiknock rating does not cause any problem during combustion.

5.2. DISADVANTAGES OF SIX STROKE ENGINE

1) Designing of parts is more complex. Higher cost of production.
2) Heavier and large in size. Lower power to weight ratio.
3) Complex head design.
4) Complex cam design because of two power strokes.

VI. CONCLUSION

The rising energy requirement of the human population and crisis in energy resources has raised the concern of a more efficient engine technology. The conventional internal combustion engine is the most popular engine, but due to increase in the use of automobiles and heavy vehicles there is a need of improvement in the fuel economy of engines without affecting the emissions as strict emission norms has been set up.
The Six Stroke Engine is a complex modification to the four stroke engine which results in a significant impact on both the fuel efficiency and emission of the engine. The fuel consumption can be reduced upto 40% and can be used under the strictest emission standards. Its adaptation by the automotive industry would have a tremendous impact on the environment and the world economy.

VII. REFERENCES

[1] B. Ramya, "Study and Analysis of Six Stroke Engine",Int. Journal of Engineering Research and Applications, Issue 9, pp. 23-26, September 2014.

[2] Parikh PP, Bhave AG, Kapse DV.Shashikantha, "Study of thermal and emission performance of small gasifier dual fuelengine systems",International Journal of Biomass, Issue 19, pp. 75-97, 1989.

[3] Dheeraj Makheeja, "A Review: Six Stroke Internal Combustion Engine", International Journal of Mechanical and Civil Engineering,Issue 4, PP 07-11, Jul. - Aug. 2015.

[4] Gokul Mohandas, Virendra Desai-Patil, "Review of Six Stroke Engine and Proposal for Alternative Fuels", SSRG International Journal of Mechanical Engineering, Issue 10, pp. 19-24, 2015.

[5] US Patent 4809511 and 4513568.

[6] Indian patent 252642.

[7] http://en.wikipedia.org/wiki/Six-stroke_engine.

