

# Concept of Six Stroke Engine

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**Abstract:** One of the most difficult challenges in engine technology today is the urgent need to increase engine thermal efficiency. Higher efficiencies mean less fuel consumption and lower atmospheric emissions per unit of work produced by the engine. In 1862 a Frenchman Alphonse Beau de Rochas gives his theory regarding the ideal cycle of the internal combustion engine. This theory is applied by a German engineer named Nikolaus A. Otto, who firstly built a successful four-stroke SI engine in 1876. The four-stroke combustion cycle later became known as the "Otto cycle".

In four stroke engine, the piston executes four complete stroke within the cylinder, and the crankshaft completes two revolutions for each thermodynamic cycle.

The disadvantage of the four-stroke cycle is that only half as many power strokes are 2 completed per revolution of the crankshaft. The capacity of the four stroke would be 340cc only. Less torque is generated during the process. Pollution is more in four stroke engine.

In six stroke the engine captures the exhausted heat from the four stroke cycle and uses it to get an additional power and exhaust stroke of the piston in the same cylinder. This heat is used to generate the steam from the water which is further used as a working fluid for the additional power stroke. This steam will forces the piston down. As well as extracting power, the additional stroke cools the engine by water and removes the need for a cooling system making the engine lighter and giving 40% increased efficiency over the normal Otto cycle. The pistons in this six stroke engine go up and down six times for each injection of fuel. These six stroke engines have 2 power strokes: one by fuel, one by steam.

**Keywords:** six stroke engine, water injection, piston cam follower, otto cycle, cylinder, and crankshaft.

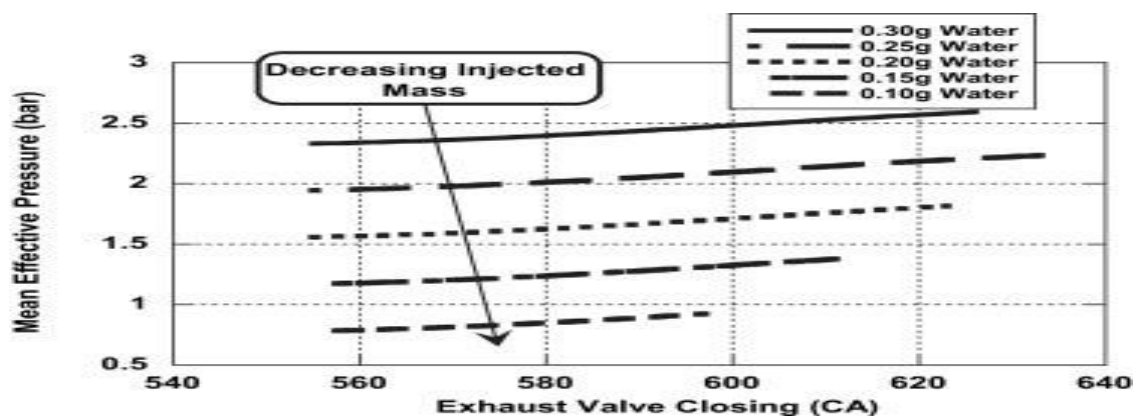
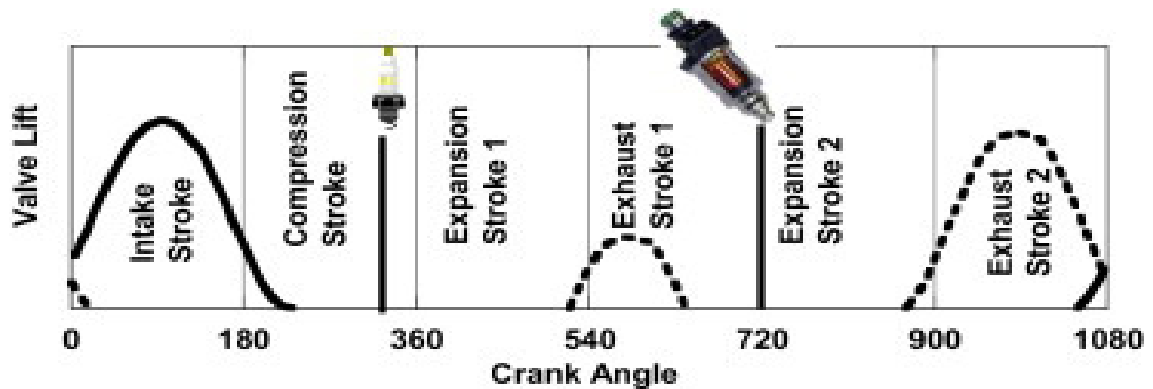
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## I. INTRODUCTION

Firstly, in four stroke engine the inlet valve opens [I.V.O] and the fresh charge of fuel and air mixture is drawn into the cylinder .Then the intake and exhaust valves are closed, and the piston is at its lowest position [B.D.C].During the compression stroke ,the piston moves upward compressing the air-fuel mixture. But before the piston reaches its highest position [T.D.C],the spark plug injected the air-fuel mixture and the mixture ignites, increasing the pressure and temperature of the cylinder .The high pressure gases forces the piston down, which in turn forces the crankshaft to rotate, producing a useful work output during the expansion or power stroke. At the end of this stroke, the piston is at its lowest position, and the cylinder is filled with the combustion products .Next the piston moves upward again, purging the exhaust gases through the exhaust valve and down a second time, drawing in fresh air-fuel mixture through the intake valve. Thus the piston completes four stroke which gives two complete revolutions to the crankshaft.

But in six stroke engine the exhausted gases which are left after combustion is further used. Then water is injected in super heated cylinder. Through hot gases the water changes its phase into steam as the temperature of the hot gases is high. This steam will works as a working fluid which will forces the piston down. This movement will give a additional two stroke for the same cycle. In this cycle, there is no need of external cooling system as the water will cools the system. Less fuel is needed and also increases its power. It reduces the weight and complexity of the engines head by as much as 50%. Torque is increased by 35% and also increases its efficiency.

The four stroke block, pistons and crankshaft remain same. This combination of two stroke and four stroke technology is named as “six stroke engine” (2 + 4 = 6). Functionally, the second piston replaces the valve mechanism of a conventional engine.



Mean effective pressure due to second expansion with water injection

## II. ENGINE MODIFICATION

To make a conventional six stroke engine, a few modifications can be done so that it can be easily run. Below the cylinder head gasket, everything is conventional, so one advantage is that this modification can be transferred in the existing engines without changing the bottom end.

### Crankshaft

In four stroke engine, the crankshaft rotates about 720 degree while the camshaft rotates 360 degree to complete one cycle. But in six stroke engine the crankshaft must rotate 1080 degree to rotate the camshaft 360 degree to complete one cycle. Thus the gear ratio of six stroke will be 3:1 instead 2:1 which is of four stroke engine.

The teeth of gear in crankshaft will be 18 and in camshaft the gear teeth will be 54. The gear used in this is helical type gear which gives high speed and high speed rotation.



OLD

NEW

Crankshaft and camshaft

### Camshaft

When camshaft rotates 360 degree in six stroke engine, the cam has been divided into 60 degree among the six-strokes. There are two exhaust stroke, one will be at the time of fourth stroke through which hot gases or burnt gases are left out and the second one is at the six stroke which pushes the steam out.



OLD



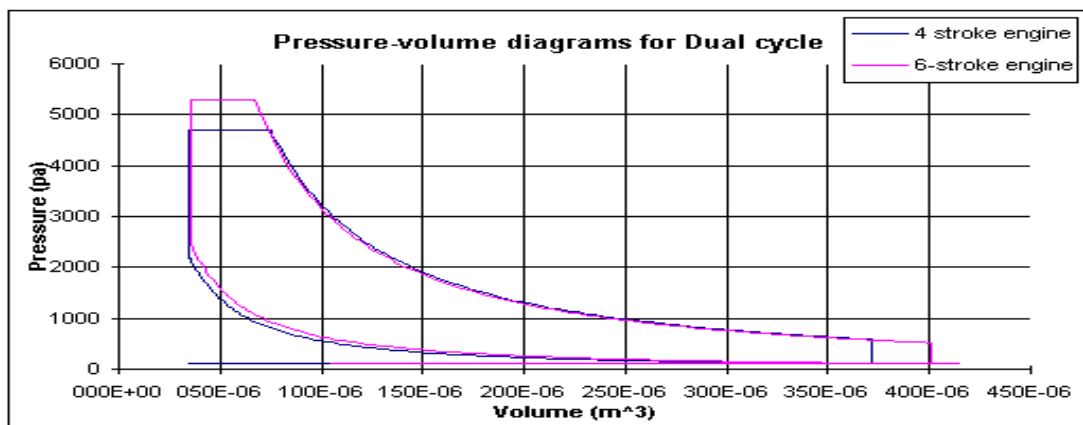
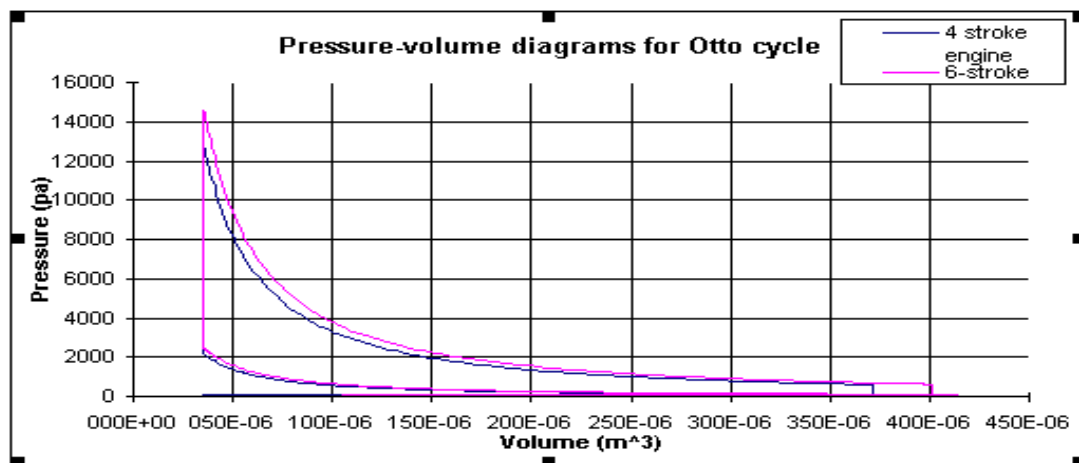
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### Cams and Camshaft

#### Cam Follower

The shape of follower which is used in four stroke engine is flat from the bottom. But when reducing the duration of opening the valve from 900 degree to 600 degree only then the shape of the follower must be changed from flat to O1

#### Comparison of Six Stroke Engine with Four Stroke Engine



### **Advantages of Six Stroke Engine**

1. In six stroke engine the change in volume during the compression stroke is slightly higher than four stroke engine after the ports are closed.
2. The expansion stroke is also 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.
3. More energy is extracted from the expansion stroke in six strokes.
4. Torque is increased by 35% in six stroke engine.
5. Efficiency is also increased in six stroke engine.
6. Reduction in pollution.
7. Reduction in fuel consumption.
8. Lower engine temperature so no need of extra cooling system.

### **III. CONCLUSION**

In this paper to convert a four stroke conventional engine in six stroke engine some modification is required. The modifications are the gear ratio between the crankshaft and the camshaft and also of the cam shaft.

The efforts done in six stroke engine previously was done by solenoid valves and DC- motor to start the engine. In this research it is proven that the six stroke engine can work by same conventional mechanical valve and the conventional engine starter. Higher mean efficiency means lower fuel consumption and lower atmospheric emission.

Due to water injection, the cooling system is improved. It enables lower engine temperature and therefore increases its overall efficiency. This is the main advantage of six stroke engine.

Using this technology by the automobile industry would have a tremendous impact on the environment and world economy, assuming up to 40% reduction in the fuel consumption and 60% to 90% in polluting emissions.

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