Six Stroke Internal Combustion Engine

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ABSTRACT: ***There are two more strokes in the six-stroke engine, namely another power and exhaust stroke. The engine works by harnessing wasted heat energy produced by the combustion of fuel. Water is pumped into the superheated cylinder after the combustion stage. The water bursts into steam and drives the piston down. It helps to cool the engine, in turn. Which led to normal power levels, but much less fuel was used. It also has the benefit of not having an external cooling system necessary. Significant improvements to the standard internal combustion engine must be made in order to achieve these advantages. The modification of the conventional four-stock internal combustion engine to convert it into a six-stroke engine is illustrated in this paper.***

KEYWORDS: ***Internal combustion engines, Six stroke, Water injection.***

INTRODUCTION

The efficiency of internal combustion engines is less than 40 percent[1]. The majority of the energy in water cooling and exhaust, created by burning the fuel in the combustion chamber is lost[2]. A typical energy break in internal combustion engines can be seen in Figure 1, below.

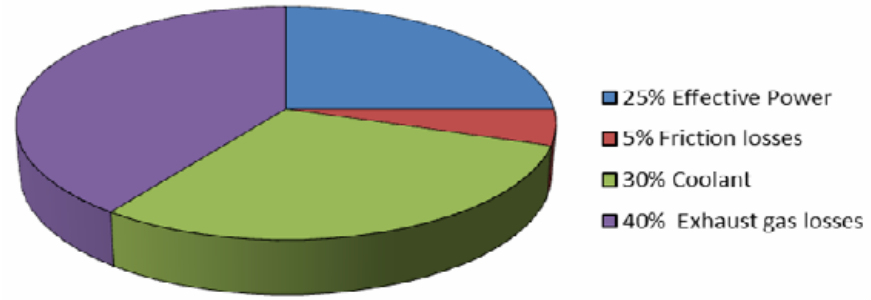

Figure 1: Energy Distribution in the 4-stroke IC engine

In 2006, Bruce Crower managed to develop the first six stroke engine[3]. Using a modified single-cylinder diesel engine Crower converted it to use gasoline, and then machined the necessary parts to create the world's only six-stroke engine. The engine works through harnessing wasted heat energy created by the fuel combustion to add other two-strokes to the engine cycle[4]. After the combustion stage water is injected into the super-heated cylinder and a steam form forcing the piston back down and in turn cools the engine. The result is normal levels of power using much less fuel and no need for an external cooling system. There are two methods when operating six stroke engines, the first method by completely finished the exhaust stoke then inject the water. The second method is by trapping and recompression of some of the exhaust from the fourth piston stroke, followed by a water injection and expansion of the resulting steam/exhaust mixture, Figure 2 shows the six stroke engine cycle[5].

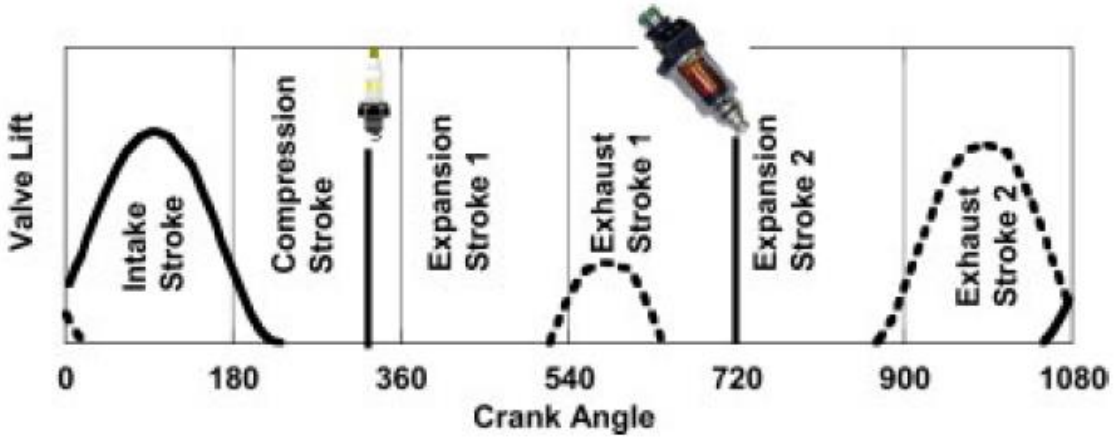

Figure 2: Cycles of the 6-stroke engine

With the second approach, Conklin and Szybist conducted a theoretical thermodynamics study on this six-stroke engine to calculate the effect of this new arrangement on average effective pressure. With the increase in the amount of water injected and also with further delay in exhaust valve cam closure, there is an increase in mean effective pressure. As stated by Andrew De Jong et. the start of the six stroke engine was an issue. A DC motor was used instead of a traditional starter to start the engine[6]. An experimental test will be carried out on a single cylinder four-stroke internal combustion engine in this phase of the project to convert it to a six-stroke engine only to ensure that the engine will run smoothly with six stroke cycles.

Modification of the Engine:

A few changes to unique parts of the traditional engine must be made to create six-stroke engines from the conventional four-stroke engine to ensure that the new six-stroke engine can run successfully. A single cylinder spark ignition engine from Mitsubishi was used to add these modifications to it. Such changes are:

Altering the ratio of the crank to cam-shaft:

The crankshaft gear must rotate 720 times in a traditional four-stroke engine, while the camshaft rotates 360 times in order to complete one cycle. The gear at the crankshaft must rotate 1080 times to rotate the camshaft 360 times for the six-stroke engine and complete one cycle. Therefore, their respective gear ratio is 3:1. Figure 3 shows the previous gear with a standard engine operating at a ratio of 2:1 on a four-stroke engine and the latest gear with a six-stroke engine[7]. There are 18 teeth for the new gear on the crank shaft, and 54 teeth for the cam shaft gear. The type of gear is helical gear because it is ideal for high-speed, high-power and high-speed rotation applications.

Figure 3: Shows the old cam and crank shaft gears used in the 4- stroke engine and the same gears now being used in the 6-stroke engine

Modification of Camshaft:

The 360 degrees of the cam was split into 60 degrees between the six-strokes in the six-stroke engine. The exhaust cam has 2 lobes to open the fourth stroke of the exhaust valve (first exhaust stroke) and to drive the steam out at the sixth stroke. The new cams and the new camshaft are featured in Figure 4.

Figure 4: Shows the new cam and the cam shaft in comparison to the old one

Modification Cam follower:

The flat pattern of the lower form of the usual follower is appropriate for the normal camshaft for the four-stroke engine. The shape of the follower must be adjusted from flat to roller or spherical shape when the length of valve opening is reduced from 9000 to just 6000.

Checking of the Engine:

A test was carried out after adding these modifications to the engine to ensure that the engine could run smoothly with six strokes instead of four stroke cycles. To start the engine, the same starter coupled with the engine was used[8]. The engine was operating smoothly with six stroke cycles after two or three attempts.

CONCLUSION

The change needed to convert the traditional four-stroke engine to a six-stroke engine is shown in this paper. The changes are the gear ratio and adjustment of the cam shaft between the crankshaft and the camshaft. Using solenoid valves and a DC motor to start the engine, the previous efforts made on six-stroke engines were applied, in this research it is proven that the engine can operate with a six-stroke engine using the same traditional mechanical valve systems and the conventional engine starter.

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