Modifications in the 4-Stroke Engine to Convert 4-Stroke into the 6-Stroke Engine

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ABSTRACT: ***Taking into account climate change and the lack of non-renewable energy supplies, one of the prospects for saving energy consumption is the interest in recycling waste heat from internal combustion engines. In an internal combustion engine, due to thermal limitations, a great amount of fuel energy is lost in the form of heat. Around one-third energy is converted to mechanical power and the remaining one is released in the form of mechanical power into the atmosphere. The interest in waste heat recovery has been rising as a result of non-renewable energy resources. The six internal combustion engines would improve the performance of the fuel and reduce the engine's heat dissipation. In six, there are two additional strokes, namely steam power and steam exhaust strokes. Some of the basic changes are made to turn the six-stroke engine into the four-stroke engine. There is modification of the crank shaft, modification of the cam shaft and an injector & ECU which must be required once per cycle for water injection. Significant changes must be made to the standard internal combustion engine. The modifications to the traditional four-stroke internal combustion engine to turn it into a six-stroke engine are demonstrated in this article.***

KEYWORDS: Internal Combustion Engine, Water Injection, Cam Shaft, Steam Power, Waste Heat.

INTRODUCTION

The underlying driving force of an internal combustion engine is fuel combustion. Gas, which is a non-renewable energy source, is bound to be exhausted over time. In 2010, the Oil & Gas Journal reported that there were around 1,354 billion barrels of oil reserves left on the earth[1]. Every year, approximately 90 billion barrels of oil were used. The discovery of any new oil reserves is subject to extremely infinitesimal shifts. For potential use, just 15 years' worth of oil is left. Due to energy losses in the exhaust and engine cooling system, the performance of the internal comb-use engine is poor. In engine technology, the difficult challenges are the urgent need to increase engine thermal management strategies and the combustion process that are required to play a crucial role. Roles for the 21st century in the production of high performance engines. In order to incorporate two additional strokes, the six-stroke engine is a modification of the traditional four stroke engine[2]. This is accomplished by adding an electronic water injector and an additional valve on the head of the engine for the injection and exhaustion of water in the case of a two valve per cylinder engine. The first four strokes are similar to the traditional engine, but by dedicating two existing valves, replacing one with an injector and using the other for water depletion, the final two strokes are obtained. It may also be appropriate to increase the diameters of the air intake and exhaust valves[3]. The six strokes of the engine are:

(a) Intake	(d) Exhaust
(b) Combustion	(e) Water injection/ expansion
(c) Compression	(f) Steam exhaust

In a six-stroke engine, the fifth stroke starts at the end of the exhaust stroke, when the piston is at TDC; the electronic injector will spray water in the cylinder. The water that enters the combustion chamber uses the heat of combustion and turns to steam. Combined with the engine's rotational inertia, this steam expands and exerts pressure on the piston, causing an additional power stroke without using fuel. The exhaust valve opens when the piston enters BDC and the steam is forced out of the combustion chamber by the piston's upward motion. In general, heat is dissipated via the radiator to improve the engine's function. The amount of work obtained from the same quantity of fuel increase thus improving thermal efficiency. In 2006, Bruce Crower managed to use a modified single-cylinder diesel engine to build the first six-stroke engine[4]. Water is pumped into the cylinder after the exhaust stroke and a vapor shape pushes the piston back down and cools the engine in turn. The effect is a normal power level that uses much less fuel and no external cooling system is required. Water is injected only after the exhaust stroke is fully finished, according to Crower's design. A new concept was proposed by J.C.Conklin and J.P.Szybist in 2009 for the recycling of waste heat[5]. The idea is to capture and recompress the fourth piston stroke exhaust gas, followed by water injection and expansion of the resulting mixture of steam exhaust. An current area of active research is improving the performance of the internal combustion engine. The conventional Otto and Diesel cycle has been proposed with several designs. A standard four stroke sequence schematic for an Otto cycle is shown in Fig. 1[6]. The proposed updated cycle here adds two additional strokes that increase the extracted work per one-time fuel energy input. Fig. 2 illustrates a series of six strokes.

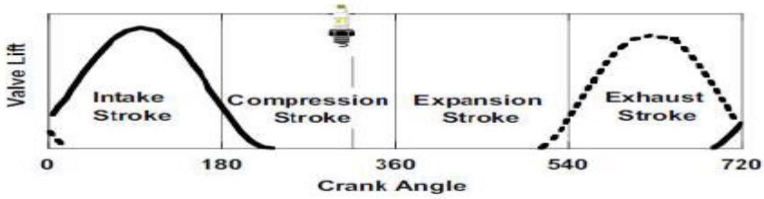

Fig. 1: Cycles of the 4-stroke engines

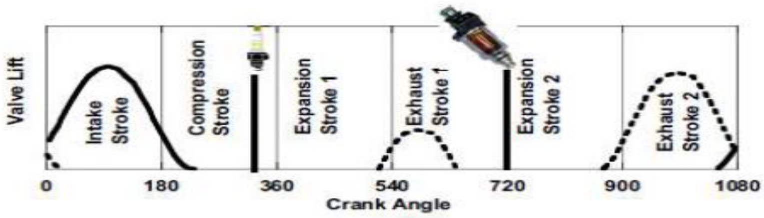

Fig. 2: Cycles of the 6-stroke engines

Modifications in the Engine:

A few changes must be made to make sure that the modern six-stroke engine is working effectively in order to upgrade the six-stroke engine from the conventional four-stroke engine[7].

Modification in the ratio of the Cam and Crank shaft:

The crank shaft must rotate 2 revolutions in traditional four-stroke engines, while the cam shaft must rotate one revolution for one complete cycle. For camshaft rotation, however, the crank shaft must rotate 3 revolutions. It is important to change the crankshaft to cam shaft gear ratio to 3:1[8].

Modification of the Cam Shaft:

There are two lobes for the initial camshaft, one for the intake valve and one for the exhaust valve. Each lobe is in contact with a flat follower pushrod which moves a rocker arm inside the head. The camshaft is shown in Fig. 3. Inside the cylinder, the other side of the rocker arm pushes the valve. The valve inside the cylinder is returned by a valve spring. The valve is restored back to its original position by a valve spring. A steel shaft is used as the foundation and machined down for camshaft adjustment to repair the internal bearing in the crankcase. For more precision, the lobes were cut from steel slightly above scale and ground down. At the correct angle, the lobes are then welded onto the shaft. On a shaft, the gear is positioned and uses a key to lock it into position. The lobe for the inlet valve is not altered, but the exhaust valve lobes are altered.

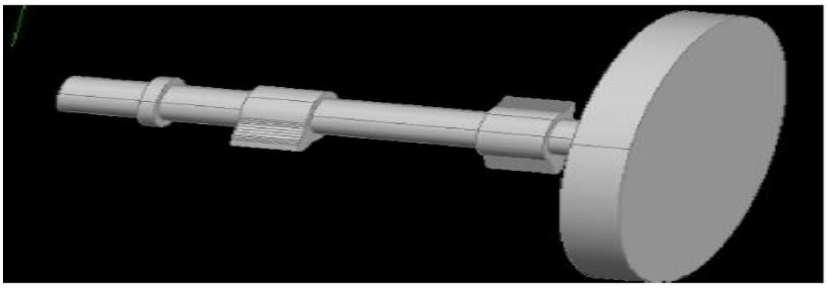

Fig. 3: Cam shaft for the six stroke engine

Change in the Design of the Head:

Water injection is required for the fifth stroke of the six-stroke engine, which involves adding additional hardware to the head. Delete the cooling fin from some Initial head and injector hole drilling. The changed cylinder head appears in Fig. 4.

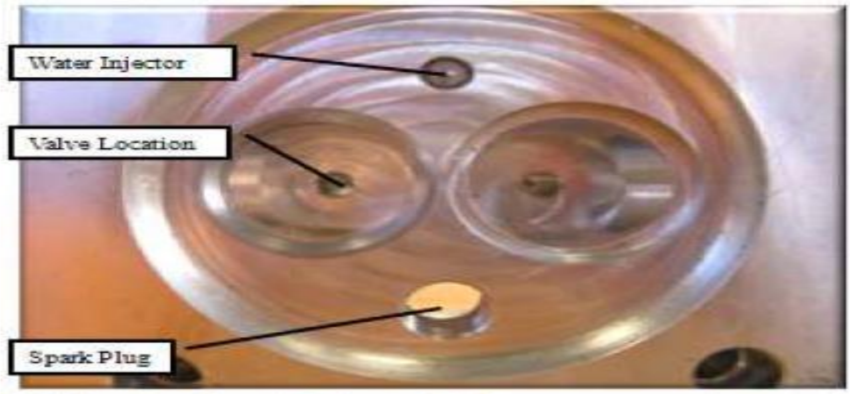

Fig. 4: Shows the modification in the design of the cylinder head

Water Injector and ECU:

The water injection system consists of three main components, the injector and the water injection system, since the water injection must be electronically controlled[9]. Electronic Control System and Pressure System. A software was written and loaded onto the micro controller for the ECU. As shown in Fig. 5, this code takes the input from both the optical sensor and encoder to then create a timing period for the physical component.

Fig. 5: Shows the arrangement of the six stroke engine

CONCLUSION

The fuel consumption of an internal combustion engine is minimized by the six-stroke engine modification. That will boost the engine's fuel efficiency. The water injected is heated from the cylinder by waste heat and the second power stroke is produced without fuel. It increases the engine's thermal efficiency through the production of extra energy from waste heat energy. The world energy demand for fossil fuel supplies will be lowered by the use of waste heat energy. The improvements needed to convert the four-stroke engine to a six-stroke engine are illustrated in this paper. Despite some balancing and vibration issues with the multi-cylinder engine, the production of the six-stroke engine will improve fuel efficiency.

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