Six Stroke Engine

Aarush Joseph Sony
Department of Mechanical Engineering
Saintgits College of engineering, Kottayam, Kerala, India

Carol Abraham
Department of Mechanical Engineering
Saintgits College of engineering, Kottayam, Kerala, India

Boney Mammen
Department of Mechanical Engineering
Saintgits College of engineering, Kottayam, Kerala, India

Ajith P Kurian
Department of Mechanical Engineering
Saintgits College of engineering, Kottayam, Kerala, India

Prof. Sajan Thomas
Department of Mechanical Engineering
Saintgits College of engineering, Kottayam, Kerala, India

Abstract- The six-stroke engine is a type of internal combustion engine based on the four-stroke engine, but with additional two stroke intended to make it more efficient and reduce emissions. It uses fresh air for the second suction i.e. in the fifth stroke. It has a wide range of uses in Automobiles, heavy goods, construction-site and farm vehicles, Motor boats, motor-pumps, generator sets, stationary engines, etc. intended for agriculture and industry. Here we introducing a new and simplest method which is capable for mass producing these engines. This is done by altering an ordinary 4 valve 4 stroke petrol engine. The working of our engine is as follows: - 1st: suction stroke, 2nd: compression stroke, 3rd: power stroke, 4th: exhaust stroke, 5th: 2nd suction stroke where fresh air is sucked, 6th: exhaust stroke. The main changes are in design of camshaft, sprocket, and rocker arm. The engine used is a Bajaj pulsar 135 ls engine. Six stroke engines have a very high relevance now a days. It helps Reduction in fuel consumption, Reduction in pollution, better scavenging and more extraction of work per cycle, Lower engine temperature, and higher overall efficiency. This new engine is ecofriendly.

Keywords – Six stroke, Cam Shaft, Sprocket, Rocker arm

I. INTRODUCTION

One of the major problems faced by the current society is the energy crisis. Poor fuel efficiency, higher rate of pollution are the major problems faced by the existing IC engines. In order to overcome these major two problems we can use the concept of ‘Six Stroke Engine’. The term six stroke engine describes two different approaches in the internal combustion engine, developed since the 1990s, to improve its efficiency and reduce emissions

In the first approach, the engine captures the waste heat from the four stroke Otto cycle or Diesel cycle and uses it to get an additional power and exhaust stroke of the piston in the same cylinder. Designs either use steam or air as the working fluid for the additional power stroke. As well as extracting power, the additional stroke cools the engine and removes the need for a cooling system making the engine lighter and giving 25% increased efficiency over the normal Otto or Diesel 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 or air. The currently notable six stroke engine designs in this class are the Crower's six stroke engine, invented by Bruce Crower of the U.S.A; the Bajulaz engine by the Bajulaz S A Company, of Switzerland; and the NIYKADO Six Stroke Engine designed, developed and patented by Chanayil Cletus Anil, of cochin India, in 2012.

The second approach to the six stroke engine uses a second opposed piston in each cylinder which moves at half the cyclical rate of the main piston, thus giving six piston movements per cycle. Functionally, the second piston replaces the valve mechanism of a conventional engine and also it increases the compression ratio. The currently notable six stroke engine designs in this class include two designs developed independently: the Beare Head engine, invented by Australian farmer Malcolm Beare, and the German Charge pump, invented by Helmut Kottmann.

II. WORKING

First stroke— during the first stroke the first inlet valve opens and air-fuel mixture from carburetor is sucked into the cylinder through the inlet manifold. Here the second inlet valve and both exhaust valves are in closed position. The piston moves from top dead centre (tdc) to bottom dead centre (bdc).

Second stroke— during the second stroke, piston moves from bdc to tdc, both the inlet valves and exhaust valves are closed and the air-fuel mixture is compressed. The compression ratio of the modified engine is same as that of the original four stroke engine 9:1.

Third stroke— during the third stroke, power is obtained from the engine by igniting the compressed air- fuel mixture using a spark plug. Both the inlet valves and exhaust valves remain closed. Piston moves from tdc to bdc.

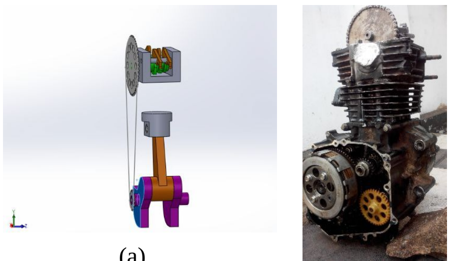
Fourth stroke — during the fourth stroke, the first exhaust valve opens to remove the burned gases from the engine cylinder. Piston moves from bdc to tdc. Here the inlet valves and second exhaust valves are in closed position.

Fifth stroke — during the fifth stroke, the second suction valve opens. Fresh air from the air filter enters the cylinder through the secondary air induction line. Here the first inlet valve and both exhaust valves are in closed position.

Sixth stroke — during the sixth stroke, the secondary exhaust valve opens. The air sucked into the cylinder during the fifth stroke is removed to the atmosphere through the exhaust manifold. Here the both inlet valves and first exhaust valve are in closed position. Fig 4.6 shows the sixth stroke.

III. ENGINE PARTS MODIFIED

In order to modify a 4 stroke engine to a 6 stroke engine we needed a 4 valve engine. Since these valve are independently activated at different times. So we took pulsar 135 model engine for our study and modification. First we have designed the complete engine model using solidworks 2013. Fig 1 shows the model.



(a) (b)

Fig 1(a) solid works model ; (b) six stroke engine

Table I Engine Specification

Displacement	135
Cylinders	1
Max power	13 bhp @ 9000 rpm
Maximum torque	11 Nm @ 7500 rpm
Bore(mm)	54
Strokes(mm)	59
Valves per cylinder	4
Fuel delivery system	Fuel Injection
Fuel Type	Petrol
Ignition	Digital Twin Spark Ignition
Spark Plugs (Per Cylinder)	2
Cooling System	Air Cooled

A. Camshaft / crankshaft sprockets

In the six stroke engine the crankshaft has 1080 degrees of rotation for 360 degree rotation of the camshaft per cycle. Hence their corresponding sprockets are having teeth in the ratio 3:1. In the original four stroke engine the teeth of the sprockets of the crankshaft and the camshaft were in 2:1 ratio. The 32 teeth sprocket of the four stroke engine camshaft was replaced by a 48 teeth sprocket in the six stroke engine. The crankshaft sprockets with 16 teeth remained as such. Material used for fabrication is MS. Fig 2 shows camshaft sprocket.

Fig 2 Camshaft Sprocket

B. Cam lobes/ camshaft

In the six stroke engine the 360 degrees of the cam has been divided into 60 degrees among the six strokes. New two lobes are to be further added to the existing camshaft. Thus a two lobed camshaft is changed to new four lobed camshaft. This four lobes open the valves at different timings. Out of the four lobes two lobes are for suction valves and rest is for exhaust valves. Material used for fabrication is EN8. Fig 3 shows Camshaft.

Fig 3 Camshaft

C. Rocker arms

New rocker arms has been designed using trial and error method. Their main aim is to activate the valve opening by the action of the camshaft. Four different types of same size were made. The basic sizes remains the same. Material used is Mild steel. Fig 4 shows the rocker arm.

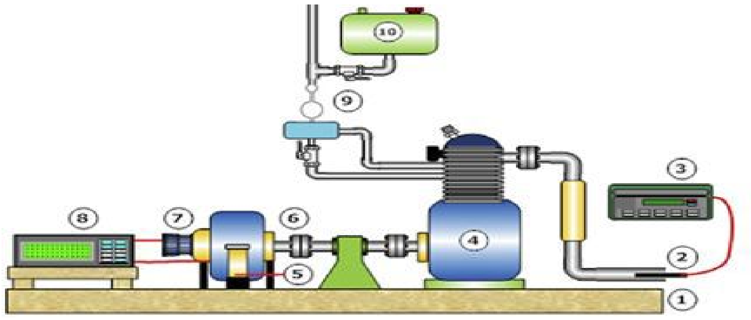
Fig 4 Rocker Arm

D. Secondary air induction system

The secondary air induction system, supplies the air which is used during the fifth and sixth stroke. During the fifth stroke air from the air filter is sucked into the cylinder through the secondary air induction line. The second inlet valve opens to permit the air flow. During the sixth stroke, the air is removed through the exhaust manifold. The second exhaust valve opens and closes during this stroke.

IV. EXPERIMENTAL PROCEDURE

The same engine was altered as four stroke and six stroke to perform the experiments. Load test and pollution test were conducted. The load test was conducted using brake drum dynamometer. The final drive shaft from the engine to the wheel was used for loading during the experiment. The engines were tested for 400rpm under the same loading conditions. The time for consumption of 10cc of the fuel was noted during the experiment. The % vol. of CO in exhaust gas during idling was tested to check the pollution level of the engines. The results of load test and pollution test have been tabulated in table (1) and table (2) respectively.



Schematic diagram of the test engine and exhaust analyzer. (1) Engine chassis, (2) exhaust gas analyzing probe, (3) exhaust gas analyzer, (4) single cylinder petrol engine, (5) load cell, (6) dynamometer, (7) tachometer, (8) control unit, (9) fuel burette, (10) fuel container.

Fig 5 engine test apparatus

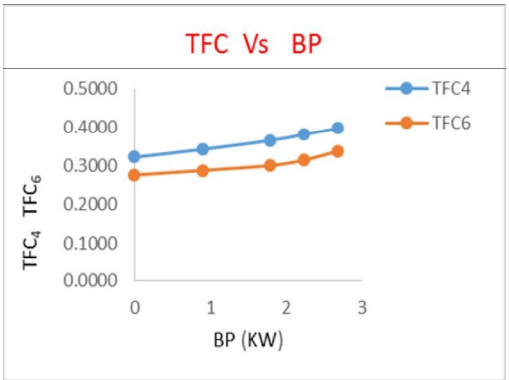
TABLE 2 Load Test Results

N (RPM)	P (Kg)	BP (KW)	T_4 (s)	T_6 (s)	TFC_4 (Kg/hr)	TFC_6 (Kg/hr)	SFC_4 (Kg/KW hr)	SFC_6 (Kg/KWh r)	REDN% (TFC)
400	0	0	84	98	0.3214	0.2755	-	-	14.29
400	4	0.8952	79	94	0.3418	0.2872	0.3818	0.3209	15.96
400	8	1.7904	74	90	0.3649	0.3000	0.2038	0.1676	17.78
400	10	2.238	71	86	0.3803	0.3140	0.1699	0.1403	17.44
400	12	2.6858	68	80	0.3971	0.3375	0.1478	0.1257	15.00

V. RESULTS AND DISCUSSION

A. *TFC Vs BP*

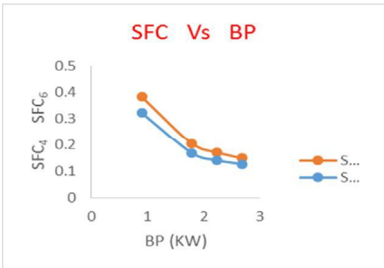
GRAPH 1 TFC Vs BP



Total fuel consumption increases with increase in brake power. It is seen that there is a TFC value when the brake power is zero. It is because of the frictional power. It is also inferred that the TFC_6 is less than TFC_4 for same brake power. It is also inferred that for six stroke engine it takes more time for same 10cc of fuel consumption.

GRAPH 2 SFC vs. BP

B. SFC vs. BP



Specific fuel consumption decreases with increase in brake power. It is inferred that the SFC_6 is less than SFC_4 for same brake power.

C. Pollution test results

Table 3 pollution test

4 Stroke Engine	6 Stroke Engine	% Pollution Redn.
0.92	0.32	65.2

It is inferred that the pollution is reduced by 65% compared to 4 stroke engine. There is a great reduction in CO, because the CO produced during the exhaust stroke by the unburned fuel particles is converted to CO2 by fresh air entering in the 5^{th} stroke. Thus complete oxidation of CO is possible, eliminating CO from the engine.

VI. CONCLUSIONS

The six stroke engine modification promises dramatic reduction of pollution and fuel consumption of an internal combustion engine. The fuel efficiency of the engine can be increased and also the valve timing can be effectively arranged to extract more work per cycle. Better scavenging is possible as air intake occurs during the fifth stroke and the exhaust during the sixth stroke. Due to more air intake, the cooling system is improved. It enables lower engine temperature and therefore increases in the overall efficiency.

One of the Advantage is that it doesn't require any basic modification to the existing engines. All technological experience and production methods remain unaltered. It can be used in Automobiles, heavy goods, construction-site and farm vehicles, Motorboats motor-pumps, generator sets, stationary engines, etc....intended for agriculture and industry.

Our six stroke engine claims a powerful engine with reduction in specific fuel consumption and total fuel consumption. It engine is pollution free engine as literally saying no CO is produced. Better cooling than the 4 stroke engine. The future scope within this project is power can be increased by using a compressor in the second suction line. Improving this same technology for more mass production

REFERENCES

[1] Analysing the implementation of six stroke engine in a hybrid car Published online January 10, 2014 http://www.sciencepublishinggroup.com/j/ijmea) doi: 10.11648/j.ijmea.20140201.

[2] http://www.velozeta.com/

[3] http://www.newindpress.com/NewsItems.asp?ID=IEO20060903112344&Topic=0&Title=Thiruvananthapuram&Page=O

[4] http://www.autocarindia.com/new/Information.asp?id=1263

[5] http://en.wikipedia.org/wiki/Six_stroke_engine

[6] Design Of Machine Elements V.B Bhandari

[7] Fundamentals of machine component design Juvinall R C & Marshek K M

[8] http://www.autoweek.com/apps/pbcs.dll/article?AID=/20060227/FREE/302270007/1023/THISWEEKSISSUE

[9] file:///H:/abc/BEARE-Six%20Stroke%20Engine/Article%20The%20Beare%206%20Stroke%20Ducati%20-%20Alan%20Cathcart.htm

[10] http://en.wikipedia.org/wiki/Crower_six_stroke