Investigation of Two Stroke internal combustion engine fitted with Injection System

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ABSTRACT

This paper deals with the revival of 2-stroke petrol engine using fuel injection system. The introduction of fuel injection system to the engine allows proper mixture of fuel and air, giving complete control of combustion and emissions. As a result of which power output and efficiency increases. fuel injection has been used before to lower the emissions, but when running at low speed things change and problem of the scavenging and the emission goes up. But still by the injection of fuel to the combustion chamber proper fuel-air mixture is obtained and power is increased. Another significant advantage of using fuel injection is that it is economical too as it provides a correct estimation of the quantity of fuel required at proper time and providing control over combustion. Principle parts were made in creo software and the analysis by using ANSYS for a material matrix which is way efficient and more economical.

KEYWORDS: *fuel injection, 2-stroke gasoline engine, engine performance parameters, emissions.*

1. INTRODUCTION

Engines are machines or device that utilize some form of energy and convert it into useful work specifically mechanical work. The engines were introduced in early 18th century in form of Heat Engine that derives heat energy from the combustion of fuel or any other sources and converts this energy into mechanical work. In general energy source comes from burning fuel .Internal Combustion (IC) Engines are those in which product of combustion act as a working medium over the piston head. The heat generated by combustion of fuel increases pressure over the piston head. Due to this pressure it starts moving and so does the crank shaft. The introduction of Internal Combustion (IC) engines has provided a healthy strong and relatively cheaper means of mobility indeed the operating principal of an IC engine has also not changed since their introduction. Gasoline IC engines utilize the four-stroke 'Otto' cycle which was developed around 1867 by Nikolaus Agust Otto. Initially research and development on IC engines concentrated on improving performance and efficiency. However, after a century of their use. IC engine emissions contributed towards global warming and other environmental impact as well as economical effect. Coupled with reducing oil reserves it has became obvious that IC engine research and development is to be shifted towards reducing engine emissions and fuel consumption. World-wide various emission legislation have been put in action in a concerted effort of motivating vehicle manufacturers to produce relatively cleaner and more fuel efficient vehicles

A two-stroke, engine is a type of internal combustion engine which completes a power cycle with two strokes (up and down movements) of the piston during only one crankshaft revolution. This is in contrast to a "four-stroke engine", which requires four strokes of the piston to complete a power cycle. In a two-stroke engine, the end of the combustion stroke and the beginning of the compression stroke happen simultaneously, with the intake and exhaust (or scavenging) functions occurring at the same time.

Two-stroke engines often have a high power-to-weight ratio, usually in a narrow range of rotational speeds called the "power band". Compared to four-stroke engines, two-stroke engines have a greatly reduced number of moving parts, and so can be more compact and significantly lighter.

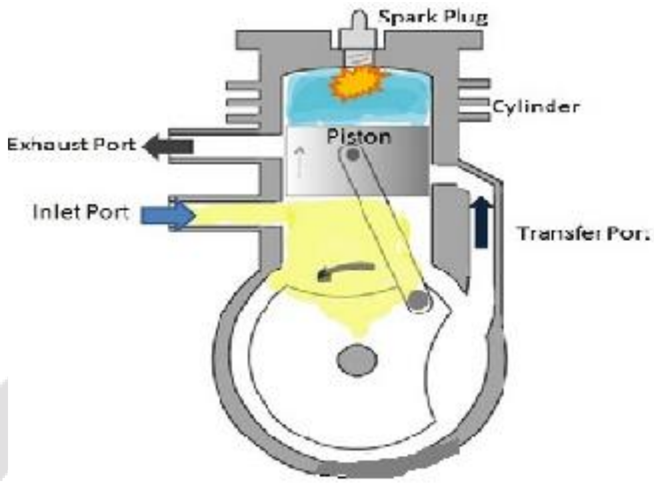


Fig.1 Two stroke Engine

The two stroke engine works without any valves for intake in exhaust. Instead there are ports in the side of the piston wall. The exhaust is generally higher than intake to prevent straight flow from intake to exhaust, this saves on waste fuel. Starting from fuel intake the piston moves up pushing out some remaining exhaust gasses until the exhaust port is closed then the fuel is compressed and just before top dead center (or the top most position for the piston) the spark is sent. The resulting explosion pushes the piston down and the increased pressure drives the exhaust gasses out. The downward movement also pressurizes the fuel in the crank case and when the piston is below the intake port the fuel rushes in. Then the piston begins the compressive stroke the upward motion of the piston creates a vacuum in the crank case and more fuel if drawn in from the carburetor. Again the piston returns to top dead center and the cycle repeats. A four stroke has an intake stroke, a power stroke, a combustion stroke, and an exhaust stroke. Two strokes simply have the compression stroke and combustion stroke.

2.LITERATURE REVIEW

The two-stroke petrol engine was very popular throughout the 19th-20th century in motorcycles and small-engine devices, such as chainsaws and outboard motors, and was also used in some cars, a few tractors and many ships. Part of their appeal was their simple design (and resulting low cost) and often high power to weight ratio. The lower cost to rebuild and maintain made the two stroke engine incredibly popular, until the EPA mandated more stringent emission controls in 1978 (taking effect in 1980) and in 2004 (taking effect in 2005 and 2010). The industry largely responded by switching to four-stroke petrol engines, which emit less pollution. Most small designs use petrol lubrication, with the oil being burned in the combustion chamber, causing "blue smoke" and other types of exhaust pollution. This is a major reason why two-stroke engines were replaced by four-stroke engines in many applications. The two-stroke cycle is also used in many diesel engines, most notably large industrial and marine engines, as well as some trucks and heavy machinery, but two-stroke diesels don't burn their lubricating oil and don't have the emission problems of two stroke petrol/gasoline engines [1].The first successful design of a three-port two-stroke Spark-ignition (S.I) engine was patented in 1889 by Joseph Day & Son of Bath. This employed the underside of the piston in conjunction with a sealed crank-case to form a scavenge pump [2]

Douglas and Blair [3] used manually controlled electronic fuel injection system. Various injectionlocations were considered and injection timing and air/fuel ratio varied at each position to determine optimum power and brake specific fuel consumption requirements. Data were presented on performance, efficiency, emissions and relative cost and they concluded that electronically controlled high pressure injection offers a practical and economical solution for efficient combustion in a diesel engine .

John et al. [4] used four essentials of effective fuel injection, metered quantity of fuel, desired spatial distribution, timing of injection, and complete vaporization prior to the start of combustion. Data presented include details of spray formation and engine performance and reported dramatic reduction in fuel consumption and exhaust emissions. The horsepower of the injection engine was nearly the same as that of the carburetor engine while the BSFC was reduced by 25 to 45% and the exhaust HC emission was so reduced that it became closer to that of a four-stroke engine at medium to high loads. At low loads HC emission did not improve due to misfiring.

Emerson et al. [5] characterized the operation of an air-assisted fuel injector. This characterization involved four sets of tests: fuel and air flow calibration; instantaneous measurements of fuel and air solenoidsignals, internal pressure in the injector, and poppet lift; photographs of the spray; and droplet sizing. The injector poppet was designed to form a spray of 80° included angle. Nitrogen, instead of air, was used to assist the injection of unleaded gasoline into steady, compressed nitrogen at room temperature. The following conditions were used: nominal fuel flow rates of 10, 20, and 30 mm 3 /injection; spray chamber pressures of 0.1, 0.169, and 0.445 MPa; and nominal injections per minute (IPM) of 1600 and 3000. Results showed a linear increase in total fuel mass supplied to the injector as fuel solenoid pulse width was increased, except at the highest IPM and chamber pressure when the total fuel mass tended to level off. The mass of fuel injected showed a linear increase with fuel solenoid pulse width while operating at 1600 IPM, but it tended to level off at 3000 IPM.

MacInneset al.[6]found that spray width, spray tip penetration, amount of spray found in the head vortex, and chamber fuel distribution are strong functions of the internal design of the fuel injector. Particularly important were the drop size distribution and the direction of the flow at the exit of the nozzle.

Michael M. Schechter et al. [7]described a novel air-forced (AFI) fuel injection system for in-cylinder injection in a 2-stroke engine. The system employed compressed air to force a metered quantity of fuel from the fuel injector internal cavity past a spring loaded poppet valve. As a result, an exceptionally fine atomization was achieved. At the same time, the shape of the air-fuel mixture spray could be varied as might be required by engine operating conditions.

Sung Bin Has et al. [8] considered alcohol fuels for use as automotive fuel which have a defect of high latent heat of vaporization. Therefore, in order to improve vaporization of methanol, the authors had made the fuel vaporizing device to heat the mixture and eliminate the fuel film flow. The study was on the characteristics of vaporization and engine performance according to the change of heating water temperature by means of the fuel vaporizing device. The study showed that as the vaporization of mixture improved, the mixture of methanol became homogenized and the fuel film flow decreased, which resulted in the increase of vaporization rate. And the increase of the vaporization rate improved the engine performance of the alcohol-fueled spark ignition engine.

Ghandhi et al. [9] presented results of experiments performed on a direct-injection two-stroke engine using an air-assisted injector. Pressure measurements in both the engine cylinder and injector body coupled with backlit photographs of the spray provided a qualitative understanding of the spray dynamics from the oscillating poppet system. When the air rail pressure was decreased larger drop sizes were observed.

3. WORKING PRINCIPLE

Fuel injection is a system for introducing fuel into internal combustion engines, and into automotive engines, in particular. On diesel engines, fuel injection is a necessity, whilst on petrol engines fuel injection is an alternative to the carburetor. Fuel is injected directly into the main combustion area. The engines would have either one main combustion chamber or a divided combustion chamber made up of a primary and secondary chamber. It reduces hydrocarbon emission with proper design of the injection timing and the positioning of the injector.
In two-stroke engines the cycle is completed in two strokes, *i.e.*, one revolution of the crankshaft as against two revolutions of four-stroke cycle. The difference between two-stroke and four-stroke engines is in the method of filling the cylinder with the fresh charge and removing the burned gases from the cylinder. In a four-stroke engine the operations are performed by the engine piston during the suction and exhaust strokes, respectively. In a two stroke engine suction is accomplished by air compressed in crankcase or by a blower. The induction of compressed air removes the products of combustion, through exhaust ports. Therefore no piston strokes are required for suction and exhaust operations. Only two piston strokes are required to complete the cycle, one for compressing the fresh charge and the other for expansion or power stroke.

In two stroke cycle engines the four events namely suction, compression, power and exhaust take place inside the engine cylinder. The four events are completed in two strokes of the piston (one revolutions of the crank shaft).
The events taking place in petrol engine are as follows:

Suction stroke

During suction stroke inlet valve opens and the piston moves downward. Only air or a mixture of air and fuel are drawn inside the cylinder. The exhaust valve remains in closed position during this stroke. The pressure in the engine cylinder is less than atmospheric pressure during this stroke

Compression stroke

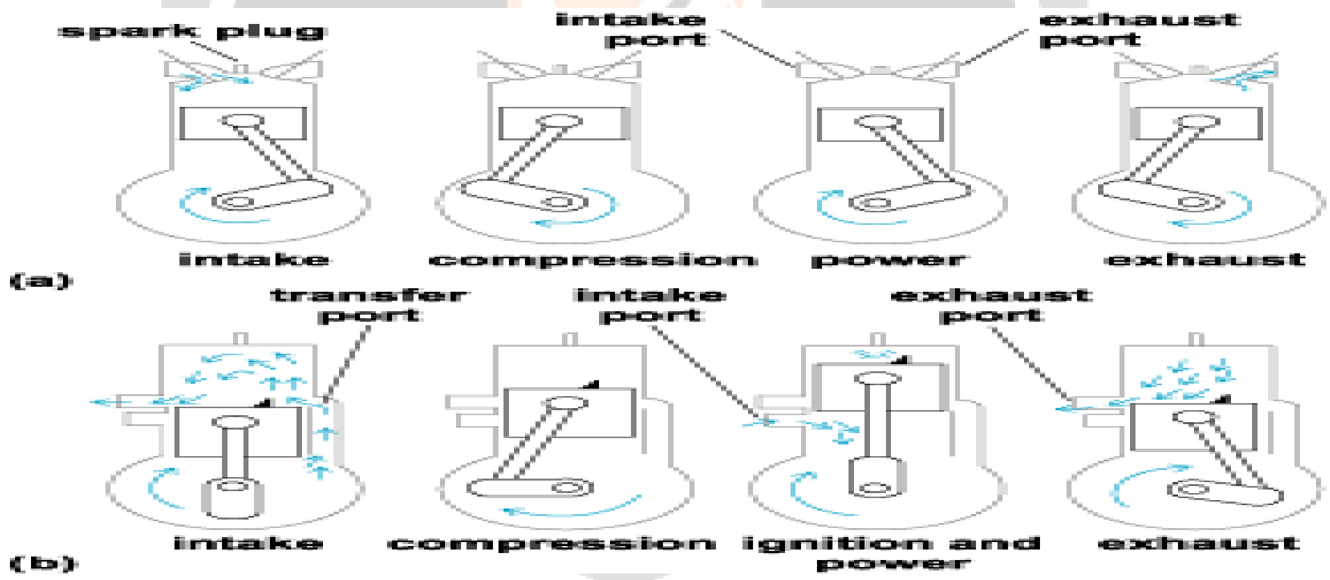
During this stroke the piston moves upward. Both valves are in closed position. The charge taken in the cylinder is compressed by the upward movement of piston. If only air is compressed, as in case of diesel engine, diesel is injected at the end of the compression stroke and ignition of fuel takes place due to high pressure and temperature of the compressed air. If a mixture of air and fuel is compressed in the cylinder, as in case of petrol engine, the mixture is ignited by a spark plug.

Power stroke

After ignition of fuel, tremendous amount of heat is generated, causing very high pressure in the cylinder which pushes the piston downward. The downward movement of the piston at this instant is called power stroke. The connecting rod transmits the power from piston to the crank shaft and crank shaft rotates. Mechanical work can be taped at the rotating crank shaft. Both valves remain closed during power stroke.

Exhaust stroke

During this stroke piston moves upward. Exhaust valve opens and exhaust gases go out through exhaust valves opening. All the burnt gases go out of the engine and the cylinder becomes ready to receive the fresh charge. During this stroke inlet valve remains closed.



4. RESULT AND DISCUSSION

The fuel consumption and emission in two stroke SI engine can be reduced by optimizing theparameters like air-fuel ratio, bore-stroke ratio, delivery ratio andprocesses like combustion and scavenging energy in combustion chamber.
The optimization of injection timing greatly reduces the specific fuel consumption and exhaust emission due to better control over the air fuel ratio.
The use of fuel injection systems can very well control amount of fuel injected. Hence the working of fuel can be reduced as compared to conventional two stroke engines.
The use of injector, fuel pump, crank angle encoder and ECU with various series can replace the carburetor and its various disadvantages.

5.FUTURE SCOPE

The development of direct injectionsystemin 2-stroke engine is beneficial in numerous fields like agricultural, heavy duty works and applications where the operating conditions vary with load. The scarcity of fossil fuels has urged the use of alternative fuels which are less costly and less harmful to the environment. As biofuels are eco-friendly, their use in direct injection engines can lead to additional advantages in the time of high price of petroleum based fuels. The biofuels like ethanol, methanol, butanol and their blends with petrol can be successfully used in direct injection engines. With the use of biofuels in direct injection engines, the pollution can be reduced and efficiency can be increased

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