In the internal combustion engine a critical review of the fuel injection, lubrication system in the Engine

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***Abstract**:- In this manuscript, review on internal combustion engines is discussed. The objective of this project is to provide a means of renewable fuel utilization. The development of a high efficiency, low emissions electrical generator will lead to establishing An IC engine is one in which the heat transfer to the working fluid occurs within the engine itself, usually by the combustion of fuel with the oxygen of air.This paper presents the critical review to study the effect of fuel injection timing, lubrication and cooling on the combustion and emission characteristics of a single cylinder four stroke, air cooled direct injection diesel engine. It is well known that injection strategies including the injection timing and pressure play the most important role in determining engine performance. However, the injection timing and pressure quantitatively affect the performance of the diesel engine.*

Keywords:- four stroke engine, lubrication, cooling system

1. INTRODUCTION

A heat engine is a machine, which converts heat energy into mechanical energy. The combustion of fuel such as coal, petrol, and diesel generates heat. This heat is supplied to a working substance at high temperature. By the expansion of this substance in suitable machines, heat energy is converted into useful work

Internal combustion engines are seen every day in automobiles, trucks, and buses. The name internal combustion refers also to gas turbines except that the name is usually applied to reciprocating internal combustion (I.C.) engines like the ones found in everyday automobiles. There are basically two types of I.C. ignition engines, those which need a spark plug, and those that rely on compression of a aid. Spark ignition engines take a mixture of fuel and air, compress it, and ignite it using a spark plug. Figure 1 shows a piston and some of its basic components. The name `reciprocating' is given because of the motion that the crank mechanism goes through. The piston-cylinder engine is basically a crank-slider mechanism, where the slider is the piston in this case. The piston is moved up and down by the rotary motion of the two arms or links.

The crankshaft rotates which makes the two links Rotate. The piston is encapsulated within a combustion chamber. The bore is the diameter of the chamber. The valves on top represent induction and exhaust valves necessary for the intake of an air-fuel mixture and exhaust of chamber residuals. In a spark ignition engine a spark plug is required to transfer an electrical discharge to ignite the mixture. In compression ignition engines the mixture ignites at high temperatures and pressures. The lowest point where the piston reaches is called bottom dead centre. The highest point where the piston reaches is called top dead centre. The ratio of bottom dead centre to top dead centre is called the compression ratio. The compression ratio is very important in many aspects of both compression and spark ignition engines, by defining the efficiency of engines.[1]

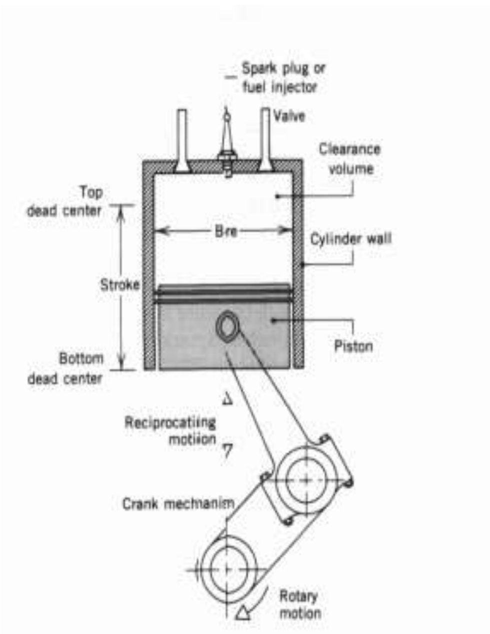

Fig.1.- Combustion chamber

In this gasoline is mixed with air, broken up into a mist and partially vaporized in a carburettor (Fig. 2). The mixture is then sucked into the cylinder. There it is compressed by the upward movement of the piston and is ignited by an electric spark. When the mixture is burned, the resulting heat causes the gases to expand. The expanding gases exert a pressure on the piston (power stroke). The exhaust gases escape in the next upward movement of the piston. The strokes are similar to those discussed under four-stroke diesel engines. The various temperatures and pressures are shown in Fig. 3. The compression ratio varies from 4:1 to 8:1 and the air-fuel mixture from 10:1 to 20:1. [2]

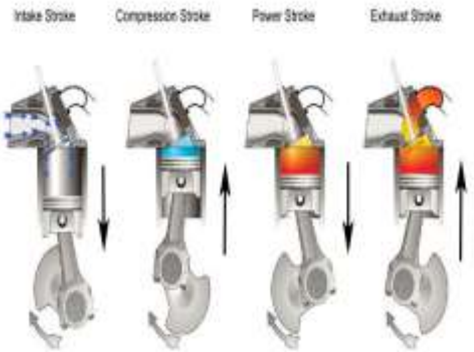

Fig.2.-Four stroke combustion process

2. Spark Ignition Engines

Spark ignition engines use an air to fuel mixture that is compressed at high pressures. At this high pressure the mixture has to be near stoichiometric to be chemically inert and able to ignite. Stoichiometric means that there is a one to one ratio between the air and fuel mixture. So the mixture in order to ignite needs not to be either with too much fuel or too much air but rather have an overall even amount. There are several components to the spark ignition engine. Chamber design, mixture and the injection system are some of the most important aspects of the spark ignition engine. The importance of the chamber design will be discussed. The four basic designs for combustion chambers are as follow:

a) the distance travelled by the flame front should be minimised.

b) the exhaust valve and spark plug should be close together.

c) there should be sufficient turbulence.

d) The end gas should be in a cool part of the combustion chamber.

The first design requires that the distance between the end gas and the spark plug be close in order for combustion to progress rapidly. If combustion is sped up then, (i) the engine speed is increased and therefore power output is higher, and (ii) the chain reactions that lead to knock are reduced. From the second design criteria the exhaust valve, since it is very hot, should be as far from the end gas in order to prevent knock or pre-ignition. The third design criteria suggest that there should be enough turbulence in order to \promote rapid combustion", through mixing. (Stone, p.126) Too much turbulence, however, will lead to excessive heat transfer from the chamber and too rapid combustion which causes noise. Turbulence in combustion chambers is generated by squish areas or shrouded inlet valves. The fourth design requires that the end gas be in a cool part of the combustion chamber. The cool part of the combustion chamber forms between the cylinder head and piston.[3]

3. COMBUSTION IN SI ENGINES

Combustion in SI engines is divided into three categories. Ignition and flame development is the first phase of combustion where only about 5% of the air- fuel mixture is consumed. During flame development combustion has barely started and there is very little pressure rise, so there is no significant work done. The second phase consists of the propagation of the flame. This phase consumes about 80-90% of the air-fuel mixture. During this phase there is significant pressure rise, which provides the force that produces the work in the expansion stroke. The third and final phase of the combustion process is the flame termination. This phase consumes only about 5% of the air-fuel mixture. During this phase the pressure quickly decreases and combustion ends. Figure.3 shows the pressure as a function of the crank angle. The maximum pressure is reached after TDC which supplies the force necessary in the expansion stroke to provide useful work.[4]

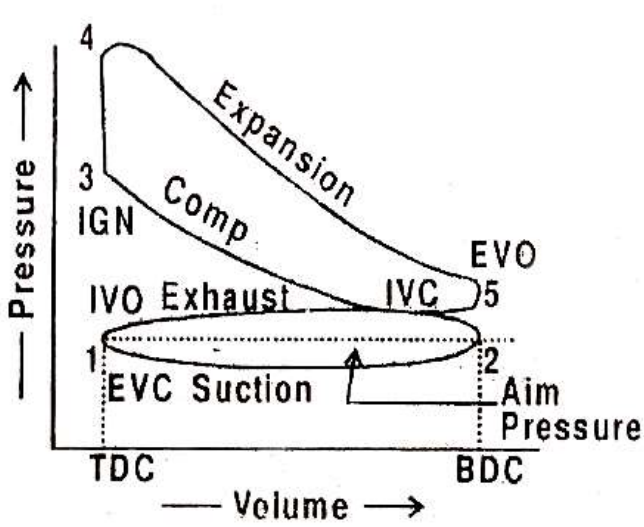

Fig.3. - indicator diagram for a four stroke engine

Ignition of the air-fuel mixture is initiated by an electrical discharge across the electrodes of a spark plug. This explosion usually occurs 10-30_ degrees before TDC. When this ignition takes place, combustion reactions follow in an outward direction. The voltage necessary to cause the plug to spark is 25,000-40,000 volts with a maximum current o about 200 amps. This amount of energy dissipation only last about 10 necks since the spark of the plug is instantaneous. This amount at current and voltage cause a maximum peak temperature of about 60,000 K. The actual temperature of the plug at time of ignition is only about 6000 K with spark discharge lasting around 0.001 second. The energy delivered by the spark plug is on the order of 30 to 50 mj, which is sufficient to start combustion since only about 0.2 to 0.3 mJ of energy is necessary for stoichiometric mixtures and non-stoichiometric mixtures, respectively.

One method to produce this high voltage is by using a coil in the battery. Most automobiles use a 12-volt battery that is not sufficient enough to cause the spark. A coil in combination with the battery is used to multiply the voltage many times and provide the necessary voltage. The _ring of the spark plug and flame propagation are related by how much pressure is in the cylinder. When the electrical discharge causes the air-fuel mixture to ignite the flame is very small and it travels very slowly because of its size.[5] Since the flame is very small and does not propagation fast it does not generate enough energy, the pressure in the cylinder is not high enough to cause combustion. When 5-10% of the mixture is burnt and the rise in pressure due to the compression stroke is high then flame propagation starts. Having a rich air-fuel mixture around the electrodes of the spark plug speeds up ignition, gives a higher flame speed, and gives a \better start to the overall combustion process." (Pulkrabek, p.232) For this reason spark Plugs are generally placed near the intake valve to assure a rich mixture.[6]

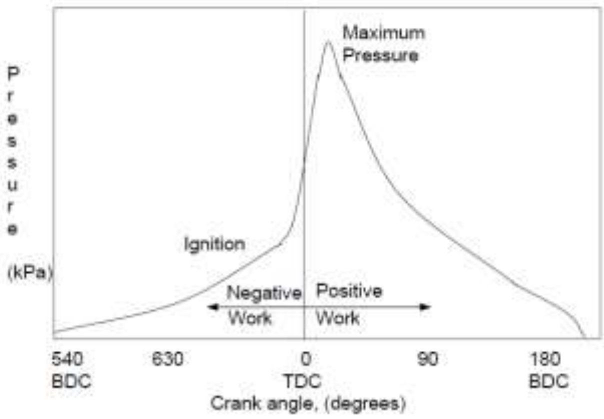

Fig.4. - pressure and crank angle curve

4. Lubrication

When there is contact between two surfaces friction develops because of the relative movement between the two surfaces. Friction between metal surfaces causes wear. To decrease friction, the two mating surfaces have to be separated by a lubricant. A lubricant is a thin fluid film that separates to surfaces so as so reduce the friction between them. By reducing the friction between surfaces wear is reduced, hence increasing the life of the machine. If a proper lubricant is used, wear of parts will be minimized. This chapter talks about thin fluid _lm lubrication. The two types of fluid film lubrication are hydrodynamic and hydrostatic lubrication[1]

4.1. **Hydrodynamic Lubrication**

In hydrodynamic lubrication pressure is self induced by the relative motion of the walls. This type of lubrication is the most useful in terms of its applications. There are two design variables that are considered in the analysis. The pressure that is self induced by the relative motion of the walls is one design that is strived for. By having an understanding of the pressures generated the maximum load applied on the fluid film can then be determined. The second design to strive for is the _lm thickness. If you have a load applied, then you know the force applied on one of the walls. If you know the force that is applied on an area, then the pressure needed to keep the surfaces from contact is known. The fluid film can then be calculated from knowing pressure.[7]

4.2. Hydrostatic Lubrication

The second type of fluid film lubrication is hydrostatic lubrication. In this type of lubrication there is very little relative motion between the surfaces. In this case it may be desirable to introduce a thin fluid film lubricant from an external high pressure source through a cut or groove. Since the lubricant is Being pressurized into a clearance the pressure is not self induced but rather externally induced. This is known as externally pressurized lubrication. In this type of lubrication the bearing surfaces are kept separated at all times even if the surfaces are stationary. Relative sliding motion does not occur.[8]

The rigidity or stillness of the lubricant film is an important variable of the design. Bearing have been designed to support loads of about 25 to 30 million pounds per inch. This amount of rigidity means that the fluid film in the clearance space of the bearing has the same rigidity as a cube of steel with a side of 10 inches. Thus lubricants can provide the necessary rigidity and can provide a bearing film that is stiffer than the actual metal structure.[9]

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