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Energy Conservation Study on Internal Combustion Engines

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Abstract: ***There is an increasing worldwide demand for energy usually in the form of heat and electrical energy. Energy costs are rising due to the demand of energy and limited availability of conventional sources (coal, oil and gas). The initial investment for non - conventional sources is somewhat high. The immediate most direct and cheapest way to tackle the problems is to use existing sources most efficiently. The energy conservation is one of the methods to find the ways to utilizing the existing sources efficiently. In Internal Combustion Engines, there is no transportation system from energy produced place to utilization place. There is no chance for losses due to transportation system. In this study, we concentrated the efficient utilization of energy and various losses due to the exhaust gases, cooling and friction and unaccounted losses.***

Keywords: Energy conservation, Internal combustion engine, Power output, Energy Distribution, Energy losses

1. Introduction

The Internal combustion engines are used in automobile vehicles to propelling the vehicles, to pump the fluid like water and power generating units. The engine produce heat energy from the combustion of fuel, that engine is called heat engine. The heat engines are classified into External Combustion Engines and Internal Combustion Engines. In external combustion engine, combustion takes place in furnace and work done takes place in other place. In internal combustion engine both combustion and work done takes place in the cylinder itself. So heat loss due to transportation is avoided in Internal Combustion Engines. According to stroke, the engines are classified into two stroke engines and four stroke engines. Based on fuel, the engines are classified into Petrol engine, diesel engine and gas engines.

2. Internal Combustion Engine Parts and Terminology

The typical diagram of an internal combustion engine shows in figure1. The engine contains the following parts.

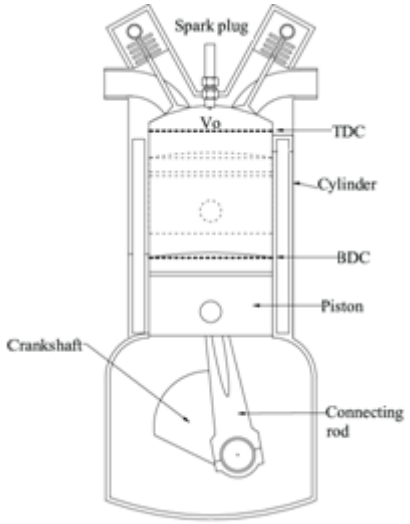

Figure 1: Schematic diagram of an Internal Combustion Engine (Duarte Forero, J et. al 2013)

- **Engine Cylinder:** Engine cylinder is a round sleeve into which a lose fitting piston, can side and make strokes. The cylinder is closed by the cylinder head at one end and the other end is covered by the moving piston. The cylinder head contains the provisions for placing inlet and exhaust valves. Combustion of fuel takes place inside the cylinder.
- **Piston:** The piston is connected to a mechanism which controls its sliding within the cylinder. The movement of the piston changes the volume of the cylinder and provides the combustion space. It consists of piston rings to maintain pressure tight seal between the moving piston and the cylinder wall. The piston pin connects piston to the upper end of the connecting rod.
- **Valves:** Valves are needed to allow the air and/or fuel into the cylinder and also to exhaust the burnt gases after they have done the work. But two stroke engines have only ports at the cylinder walls and have no values.
- **Connecting Rod:** It is attached to piston by piston pin. It converts the reciprocating motion of the motion into rotary motion of the crankshaft.
- **Crankshaft:** It receives the power from piston and connecting rod and transmits this power to the drive.
- **Crank Case:** It is a cast iron case, which holds the cylinder and the crank shaft; it also serves as sump for the lubricating oil.
- **Cooling Water Jackets:** Normally, the cooling water enters the jackets in the cylinder head which is comparatively hotter and passes on to the jackets for the cylinder. The purpose is to keep the combustion space walls cool. In case of air - cooled engines, it has fins in the outer side of the cylinder wall to dissipate the heat.
- **Flywheel:** It is a big wheel, mounted on the crankshaft. Its function is to receive the power in working stroke and distribute to the remaining strokes.

Terminology

- **Bore:** The inside diameter of the engine cylinder is known as bore of the engine. It is always mentioned in mm.
- **Top Dead Centre:** It is top most position of the cylinder unto the piston will move. For horizontal engine, it is named as Inner Dead Centre.

- **Bottom Dead Centre:** It is the bottom most position of cylinder up to the piston will move. For horizontal engine, it is named as Outer Dead Centre.
- **Stroke:** It is the linear distance, measured parallel to the axis of the cylinder between the top dead centre and bottom dead centre.
- **Compression Ratio:** It is ratio of maximum cylinder volume to minimum cylinder volume.

3. Working of Internal Combustion Engines

The engine is having four strokes such as suction stroke, compression stroke, working stroke and exhaust stroke. During suction stroke, air and petrol mixture is sucked into cylinder. In this condition, inlet value is opened, outlet value is closed. During compression, petrol and air mixture is compressed; the two values are in closed position. At the end the compression, spark plug is ignited, the fuel will be burned, so hot gases with high pressure produced. It pushes the piston downward direction during the working stroke. During exhaust the burned gases are pushed out from the cylinder through outlet value. The operations are shown in figure 2. In the case of Diesel engine, during suction stroke air only sucked and the diesel will be injected instead of spark plug ignition. In two stroke engine, the above four operations are done in two strokes of piston movement.

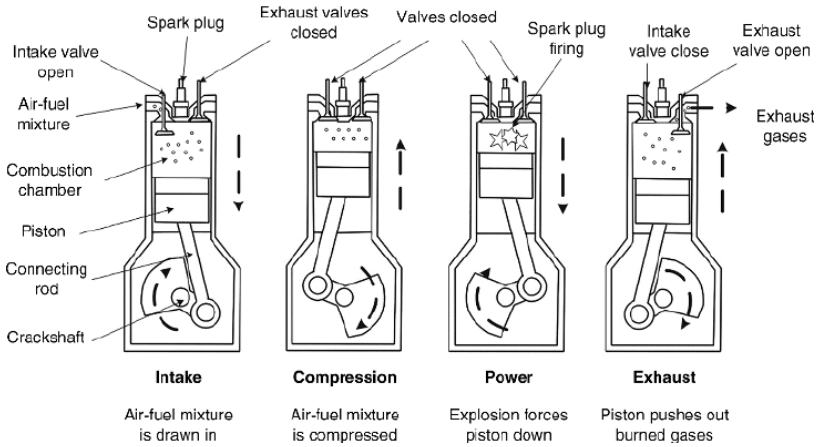

Figure 2: Four Stroke Petrol Engine operations (Amir Khajepour et al.2014)

4. Energy and Internal Combustion Engines

- **Energy routes of oil and gases:** The energy route is started from oil refinery to utilization place i. e., electrical power or mechanical drives through Internal Combustion Engines. In refinery, refine the ore and separate the petrol, diesel and natural gas and those are used as the fuels for two stroke and four stroke engines. Finally, we get the mechanical or electrical power. Presently some additional bio gas and bio fuels are used in Internal Combustion Engines. In energy distribution two types of losses are there, one is thermal losses and another is Mechanical losses.
- **Energy Flow Diagram For I. C. Engines:** Figure 3 indicates the energy flow diagram indicates the useful work done and various losses occurred in the Internal Combustion Engines.

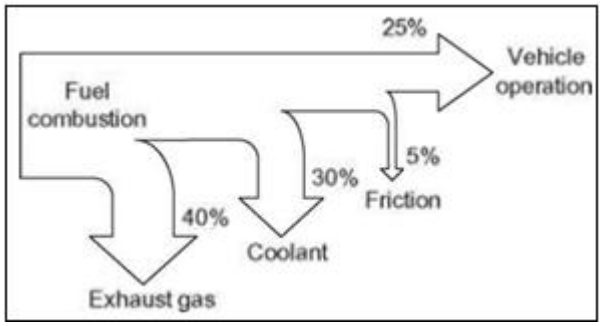

Figure 3: Energy Flow diagram of an Internal Combustion Engines (Eleni Avaritsioti, 2016)

The engine gets heat from the combustion of the fuel. Fuel may be petrol, diesel, biogas and natural gas etc., the exhaust gases carry most amount of the heat energy. We utilize that heat energy for some other purposes like to heat the water. The exhaust gases having more pressure, temperature also. At that time the flue gases are used to increase the pressure of the incoming charge using turbo charging. Some part of heat energy is converted to work done. It is also called power. In Internal Combustion engines two types of power one is indicated power and another is Brake power.

Theoretically, the thermal efficiency of the engine will improve if there is no cooling system. But actually, the engine will cease to operate. It is mainly because of high temperature, the metals will lose their characteristics and piston will expand and cease the movement. The heat must be dissipated to the surroundings. In order to seize, cooling of the engine is must. So this loss is the unavoidable one. In Internal Combustion Engines two type of cooling are commonly used, one is water cooling and another is air - cooling. Some frictional losses and some uncounted losses also exist there.

5. Experimentation in Internal Combustion Engine

For experiment, the four stoke diesel water cooled engine is considered and conducted the experiment. The energy distribution in internal combustion engine is shown in the figure 3 in the form of pie chart

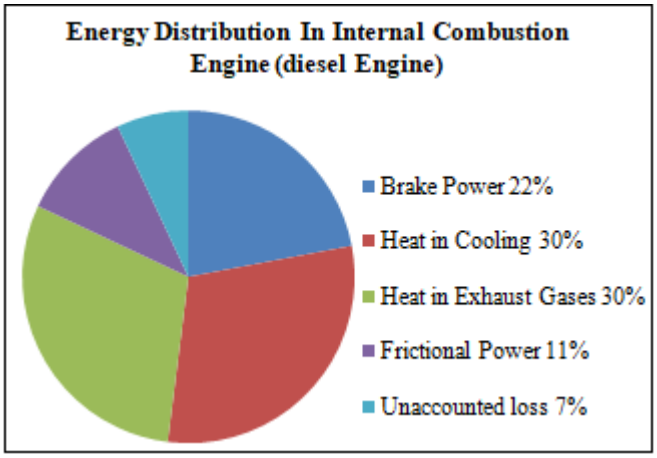

Figure 4: Energy Distribution in Internal Combustion Engine (Diesel Engine)

From this study, the heat loss in the exhaust is 30% and the heat in cooling is 30% and frictional power is 11% and unaccounted loss is 7% and finally the power output (Brake Power) is 22% only.

6. Conclusion

Energy conservation study is the suitable solution for energy utilization and used to find the way to save the existing energy sources. In this study, the work done, heat losses in exhaust, cooling, friction and the various losses are obtained. The pie chart clearly indicates the heat distribution in various areas in Internal Combustion engine. From this, easily identify the areas and take the alternate solution to minimize the losses and increase the total efficiency and minimize the cost.

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