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REVIEW STUDY ON EXHAUST OF A DIESEL ENGINE THERMAL STORAGE

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ABSTRACT

Exhaust gas which occurs as a result of the combustion of fuels such as natural gas, asoline/petrol, diesel, fuel oil or coal. It is discharged into the atmosphere through an exhaust pipe or flue gas stack. The main objective of the proposed project is to utilize heat from the exhaust gases of a diesel engine and convert heat to useful work. Energy supplied to an engine is the heat value of the fuel consumed. But only a part of this energy is transferred into useful work. From heat balance sheet of a typical CI engine we find out that the total heat loss is around 33-45%, of which 33% is due to exhaust gases and the rest is lost to the surroundings. If we can reduce this figure by 10% also then it will be a substantial contribution.

Keywords: combustion of fuels such as natural gas, gasoline/petrol, diesel, fuel oil or coal, exhaust gases, boiling point fluid.

I. INTRODUCTION

In case of a diesel engine the total heat loss is around 33-45%, of which 33% is due to exhaust gases and the rest is lost to the surroundings. Here, conditions in the engine are different from in a spark-ignition engine, because power is controlled by controlling the fuel supply directly, not by controlling the air supply. As a result, when the engine is running at low power, there is enough oxygen present to burn the fuel, and diesel engines only make significant amounts of carbon monoxide when running under load.

In thermal power stations, mechanical power is produced by a heat engine that transforms thermal energy, often from combustion of a fuel, into rotational energy. Most thermal power stations produce steam, and these are sometimes called steam power stations. Not all thermal energy can be transformed into mechanical power, according to the second law of thermodynamics. Therefore, there is always heat lost to the environment. If this loss is employed as useful heat, for industrial processes or district heating, the power plant is referred to as a cogeneration power plant or CHP (combined heat-and-power) plant.

1.2 Present methods to reduce exhaust gas temperature

i) Turbocharging

ii) Exhaust gas recirculation (EGR)

1.3 Turbocharging

A turbocharger, or turbo, is an air compressor used for forced-induction of an internal combustion engine. The purpose of a turbocharger is to increase the mass of air entering the engine to create more power. However, a turbocharger differs in that the compressor is powered by a turbine driven by the engine's own exhaust gases. The major parts of a turbocharger are turbine, wheel, turbine housing, turbo shaft, compressor, compressor housing and bearing housing. A turbo is a small radial fan pump driven by the energy of the exhaust flow of an engine. A turbocharger consists of a turbine and a compressor on a shared axle. The turbine inlet receives exhaust gases from the engine causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure, resulting in a greater mass of air entering each cylinder. In some instances, compressed air is routed through an intercooler before introduction to the intake manifold. The objective of a turbocharger is the same as a supercharger; to improve upon the size-to-output efficiency of an engine by solving one of its cardinal limitations. A naturally aspirated automobile engine uses only the downward stroke of a piston to create an area of low pressure in order to draw air into the cylinder through the intake valves. In the automotive world, boost refers to the increase in pressure that is generated by the turbocharger in the intake manifold that exceeds normal atmospheric pressure. Turbocharger parts are costly to add to naturally aspirated engines.

Heavily modifying OEM turbocharger systems also require extensive upgrades that in most cases requires most (if not all) of the original components to be replaced. Turbochargers require numerous additional systems if they are not to damage an engine.

1.4 Exhaust gas recirculation

The main objective of this method to reduce the amount NOx produced. EGR works by re-circulating a portion of an engine's exhaust gas back to the engine cylinders. Intermixing the incoming air with re-circulated exhaust gas dilutes the mix with inert gas, lowering the adiabatic flame temperature and (in diesel engines) reducing the amount of excess oxygen

EGR in Diesel Engines:- In modern diesel engines, the EGR gas is cooled through a heat exchanger to allow the introduction of a greater mass of re-circulated gas. Unlike SI engines, diesels are not limited by the need for a contiguous flame-front; furthermore, since diesels always operate with excess air, they benefit from EGR rates as high as 50% (at idle, where there is otherwise a very large amount of excess air) in controlling NOx emissions. Adding EGR to a diesel engine reduces the specific ratio of combustion gases int the power stroke. This reduces the amount of power that can be extracted by the piston. EGR tends to reduce the amount of fuel burned in the power stroke. This is evident by the increase in particulate emissions that corresponds to EGR.

1.5Economisers

Economisers, are mechanical devices intended to reduce energy consumption, or to perform another useful function like preheating a fluid.In case of coal fired power stations they are referred to as feedwater heaters and heat the condensate from turbines before it is pumped. Economizers are commonly used as part of a heat recovery steam generator in a combined cycle power plant. In an HRSG, water passes through an economizer, then a boiler and then a superheater. The economizer also prevents flooding of the boiler with liquid water that is too cold to be boiled given the flow rates and design of the boiler. A common application of economizers in steam powerplants is to capture the waste heat from boiler flue gas and transfer it to the boiler feedwater. This raises the temperature of the boiler feedwater thus lowering the needed energy input, in turn reducing the firing

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rates to accomplish the rated boiler output. Economizers lower stack temperatures which may cause condensation of acidic combustion gases and serious equipment corrosion damage if care is not taken in their design and material selection.

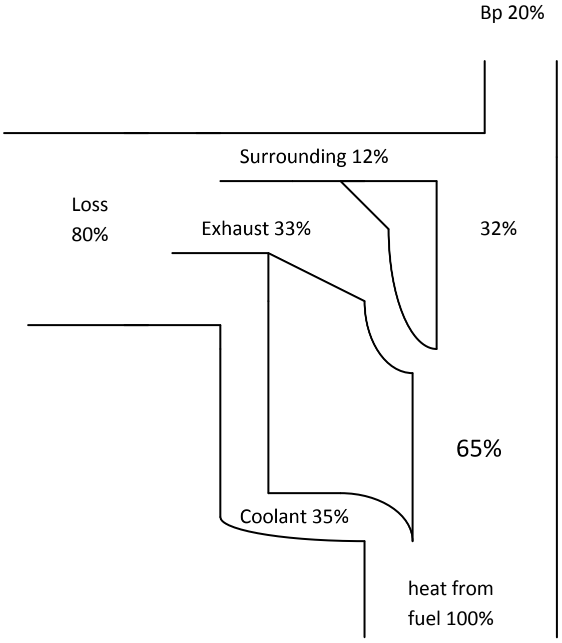

Figure 1 Sankey Diagram

II. DIESEL ENGINE

2.1 General

A diesel engine is an internal combustion engine which operates using the diesel cycle. Diesel engines have the highest thermal efficiency of any internal or external combustion engine, because of their compression ratio. Diesel engines are manufactured in two stroke and four stroke versions. The diesel internal combustion engine differs from the gasoline powered Otto cycle by using a higher compression of the air to ignite the fuel rather than using a spark plug for this reason it is known as compression ignition and the petrol engine is referred as spark ignition engine. In the diesel engine, only air is introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15 and 22 resulting into a 40 bar (about 600 psi) pressure compared to 14 bar (about 200 psi) in the gasoline engine. This high compression heats the air to 550 °C . At about this moment (the exact moment is determined by the fuel injection timing of the fuel system), fuel is injected directly into the compressed air in the combustion chamber.

2.2 Four stroke CI engine

The ideal sequence of operation for the four stroke CI engine is as follows:

i) Suction stroke:- Only air is inducted during the suction stroke. During this stroke intake valve is open and exhaust valve is closed.

ii) Compression stroke:- Both valves remain closed during compression stroke.

iii) Expansion or power stroke:- Fuel is injected in the beginning of the expansion stroke. The rate of injection is such that the combustion maintains the pressure constant. After the injection of fuel is over the products of combustion expand. Both valves remain closed during the expansion stroke.

iv) Exhaust stroke:- The exhaust valve is open and the intake valve remains closed in the exhaust stroke.

2.3 Valve timing diagram

The typical valve timing diagram for a four stroke CI engine is as follows:

IVO up to 30 degree before TDC

IVO up to 50 degree after BDC

EVO about 45 degree before BDC

EVO about 30 degree after TDC

Injection about 15 degree before TDC

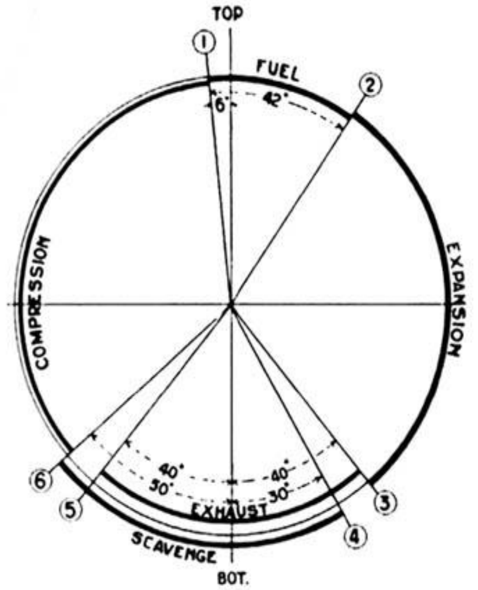

Figure 2 Valve timing Diagram

2.4 Two stroke CI engine

i) Intake begins when the piston is near bottom dead centre. Air is admitted to the cylinder through ports in the cylinder wall (there are no intake valves). Since the piston is moving downward at this time, aspiration due to atmospheric pressure isn't possible. Therefore a positive displacement blower or hybrid turbo-supercharger (a turbocharger that is mechanically driven from the crankshaft at low engine speeds) is employed to charge the cylinder with air. In the early phase of intake, the air charge is also used to force out any remaining combustion gases from the previous power stroke, a process referred to as scavenging. As the piston passes through bottom dead center, the exhaust valves will be closed and, owing to the pressure generated by the blower or turbocharger, the cylinder will be filled with air. Once the piston starts upward, the air intake ports in the cylinder walls will be covered, sealing the cylinder. At this point, compression will commence. Note that exhaust and intake actually occur in one stroke, the period during which the piston is near the bottom of the cylinder.

ii) As the piston rises, compression takes place and near top dead center, fuel injection will occur, resulting in combustion, driving the piston downward. As the piston moves downward in the cylinder it will reach a point where the exhaust valves will be opened to expel the combustion gases. Continued movement of the piston will expose the air intake ports in the cylinder wall, and the cycle will start anew. Note that the cylinder will fire on each revolution, as opposed to the four-stroke engine, in which the cylinder fires on every other revolution. There are two ports inlet port and exhaust port. At first stroke both the suction and compression takes place.

2.5 Advantages of a diesel engine over other internal combustion engine

i) They burn less fuel than a gasoline engine performing the same work, due to the engine's high efficiency and diesel fuel's higher energy density than gasoline.

ii) They have no high-tension electrical ignition system to attend to, resulting in high reliability and easy adaptation to damp environments.

iii) They can deliver much more of their rated power on a continuous basis than a gasoline engine.

iv) The life of a diesel engine is generally about twice as long as that of a gasoline engine due to the increased strength of parts used, also because diesel fuel has better lubrication properties than gasoline.

v) Diesel fuel is considered safer than gasoline in many applications. Although diesel fuel will burn in open air using a wick, it will not explode and does not release a large amount of flammable vapour

III. RESULTS AND DISCUSSIONS

The twin cylinder diesel engine was operated by initially taking diesel oil as the working fluid and then introducing a low boiling point fluid i.e. diethyl ether which will extract the heat from the exhaust gas and hence convert it into steam.

The mass flow rate of the low boiling point fluid was determined for optimum heat recovery. Due to the heat exchange, the liquid will become vapor and then it will be directed to the transducer.After conducting the experiment we find that the exhaust gas temperature increases with increasing load and reaches a maximum of 440^0C for full load condition. The experiment was carried out at different loads starting from 5 kg to 30 kg.

IV. CONCLUSIONS

In this experiment we found out that while using a low boiling point fluid i.e. diethyl ether and testing it at different loads starting from 5 kg to 30 kg the exhaust gas temperature is reduced and the heat from the exhaust gas when passed through a blower with increased pressure can save input for multi stage compression. The exhaust gas temperature shows a reduction by 5-7% which may be explained due to the heat extracted by the low boiling point fluid.

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