Course Name: Engine System and Performance
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Lec 5: Description of Engine Components

I welcome you all to the session on engine systems and performance, and today we shall try to learn about several engine components and their arrangements. You have studied internal combustion engines in your undergraduate course, and then you have seen that there are several components in an engine, and all these components are essential. All components are there to serve certain purposes, and those components are interlinked to bring together the best performance of an engine.

So, if we look at the schematic depiction, we can see that there are many components. In this schematic, I have shown a few major components, but these are not the only components we should discuss today; there are even more components, and we shall discuss them in our subsequent classes. So, to start with, we shall focus on the most important component, which is the block. So, what is a block?

The engine block, you can see, houses the engine cylinders, and for older engines, this block used to contain valve ports. So, this block is basically an important component in which we can see that the cylinder is there, and inside the cylinder, there will be a piston that we will discuss later. Not only that, but if you look at it, this block also contains the water jacket. We have discussed earlier that this water jackets are important because if it is a water-cooled engine we need to supply water as a coolant to transfer certain amount of heat from engine cylinder into the coolant.

So as to prevent mechanical failure of several other components, such as the water jacket. If the engine is not water-cooled but air-cooled, then for air-cooled engines, the block includes exterior surfaces, and these exterior surfaces have fins to promote heat transfer. Next, if we go to the block, as I said, the block is an essential element that contains a cylinder or cylinders. Not only these cylinders, but the block houses the cylinder if it is a single-cylinder engine. If it is a multi-cylinder engine, then of course, multiple cylinders. The block also includes a water jacket to supply coolant through that jacket, and a certain amount of heat can be transferred from the cylinder into the coolant essentially to save a few mechanical components and other components from probable mechanical failure. If

it is an air-cooled engine, then the block includes exterior surfaces having some fins, extended structures. So, the block includes exterior surfaces with extended structures to promote heat transfer.

Next, if we go to discuss that is again very important, that is the camshaft. So, if we focus our attention over here, you can see there is a camshaft. What is this camshaft? So, you can understand that the cam and follower mechanism is there. Perhaps if you try to recall in one of the previous classes, I had shown a schematic diagram to demarcate, to define several components, to give you a brief description about engine nomenclature. And then, therein we had seen the cam and follower mechanism. So, this camshaft is essentially a rotating shaft. So, this is for the block camshaft. So, this is a rotating shaft used to push or open valves at a proper time in the engine cycle. So, this is the camshaft. So, the shaft is a rotating shaft, and it is used to push the valve to open the valve because valves are, closed by default, spring-loaded valves.

So, to open the valve at a proper time in the engine cycle, this rotating shaft, the camshaft, which is nothing but a rotating shaft, allows to push or open the valves. And how can this camshaft open or push the valve through mechanically or hydraulic linkage. So, this is either through mechanical or hydraulic linkage. So, that is the purpose of having this camshaft. We shall discuss about the safe material and all these things in the next class. So, today, just you should know about this component, that is the camshaft, which is nothing but a rotating shaft, which is used to push or lift or open the valves through mechanical arrangement or hydraulic linkage.

So, depending upon the requirement, most modern automobile engines have either one or two camshafts. Next, we should go to the next slide. Here, another important part that we should now discuss is the combustion chamber. Just I am Encircling this combustion chamber, so what is this combustion chamber? This is the place where combustion occurs, so this is, end of the cylinder.

So, this part is the end of the cylinder and this is the place between the end of the cylinder and the piston face, or this is basically the head. So, if I write, this is the place between the end of the head, which we shall discuss a little later, and the piston face where combustion occurs.

Now, try to understand, so this is the head and the piston face. So, the gap between these two components is the combustion chamber. Now, since the piston is moving or

reciprocating between two locations that we have discussed in the previous class, essentially, the combustion chamber space is also variable. It is not fixed.

So, the combustion chamber, the space would be more when the piston is at bottom dead center, and the space of the combustion chamber will be less when the piston is at TDC. So, this is not a fixed space but a variable space. Then we will come to discuss another part, which is the connecting rod. What is this?

So, you can see from the schematic definition that the connecting rod connects the piston with another shaft. So, it transfers the energy which is available at the piston face into the shaft.

So, the connecting rod is the linkage connecting the piston with the rotating crankshaft. So, the mechanical linkage which is used to connect the piston with the rotating crankshaft. So, the linkage connecting, so the name is connecting rod. That means the purpose is to transmit the energy which is available on the face of the piston to the shaft, that is the crankshaft.

So next we can go to identify another important component. The component that is the crankcase. What is a crankcase? So, the bottom part of the block that you can see from the schematic depiction. So, this is the block, this is the bottom part of the block, this crankcase houses the crankshaft that you can see from the schematic depiction.

Not only that, it also connects to the oil pan. So, I will discuss this. So, if we go to the next slide, that is the crankcase. So, the crankcase, if we write now briefly, is not separate but rather together. These two keywords, crankcase, so what is the crankcase? It is part of the engine block, surroundings the rotating crankshaft. That means this is also part of the engine block, but towards the end, it houses the crankshaft. That is the crankcase, and with this, in many engines, the oil pan that you can see from this schematic definition, another important component, the oil pan. So, in many engines, the oil pan makes up part of this crankcase. So, that is something you should know. Then is the crankshaft the next component that we should now look at? It is the crankshaft. It is also a rotating shaft, and you can say that this connecting rod, which is used to connect the piston with the crankshaft. So, the crank is mounted on a shaft. This is also a rotating shaft through which the engine work output is supplied to the external system. So, that means our objective is to convert the reciprocating motion of the piston into the rotary one, and that is done by or through the arrangement of the crank and connecting rod mechanism. So, the connecting rod, which connects the piston with the crankshaft, and that the energy is

not converted, getting transmitted to the crankshaft, and that shaft is also connected, to an external system.

So, the crankshaft is the crank mounted on a shaft. That shaft is also connected to an external system, so there is an offset distance. The connecting rod connects the piston to the crankshaft. The connecting rod connects the crank to the shaft, which is the crankshaft. And that is essentially used to supply work output to the external system. So again, as I said a few minutes back, we shall be discussing their shape and also the materials of several components in the next class. So next is the cylinder. If we now focus on this component, that is the cylinder.

If it is a single-cylinder engine, certainly one cylinder will be there. Otherwise, if it is a multi-cylinder engine, then multiple cylinders will be there. You can see this is basically a cylindrical shape. If I write, this is a circular cylinder. In the engine block, which houses the piston, and inside the cylinder, the piston reciprocates, so this is the cylinder.

What next? The exhaust manifolds. This is the component. So, if we write here, exhaust manifold, we have discussed that the exhaust manifold is essentially a piping system through which combustion gases are allowed to leave from the combustion chamber during the exhaust stroke. So, this arrangement must be there, and that is what we can see from this schematic depiction. So, if we write now here, exhaust manifold, that is a piping system that is equipped to the block for the exhaust gases to leave. For the exhaust or combustion gases to leave from the cylinder.

So, this is the exhaust manifold. Now, Again, we shall discuss the material of the exhaust manifold and its arrangement in the next class. But today, you can see that the exhaust manifold is on the head of the engine. That is on the upper part of the block.

Next, we shall discuss the head. That is what we have already mentioned in the context of one component before. So, the head. So, the top part of the block that you can see. Probably, we had mentioned somewhere here that this is the place between the end of the head.

So, this is the head, the end of the head, and the piston face. So, this is the end of the head. So, what is the head? You can see that it is the top part of the block. The head also houses several other components.

So, let us briefly write here head. This is the part that closes the end of the cylinder. Usually containing part of the clearance volume of the combustion chamber. So the part

that you can see that closes the cylinder, so basically this is the cylinder. Now, this is the cylinder end, so the head closes the end of the cylinder. Not only that, a small part of this, the combustion chamber, that is the clearance volume, is also there in the head of the engine. So, that is the head.

So, probably just for your information, you can also see from the schematic depiction that in the head there are many other components. The valve is there, and most importantly, the spark plug is there. So, if it is an SI engine, that spark plug will be there, or fuel nozzle. So, this is for the CI engine, and the spark plug is for the SI engine. So, the head also houses the spark plug if it is an SI engine; otherwise, it will also include the fuel nozzle or injector if it is a compression ignition engine.

So, that is the head. So, it contains the spark plug for an SI engine and a fuel injector for the CI and some SI engines. So, this is the head. So, if we go to the next, then we can identify another component, that is the intake manifold.

So, this is also very important, by this time. The intake manifold is again a piping system which is used to supply fresh air if it is a CI engine or a fuel-air mixture if it is an SI engine to the engine cylinder. So, the piping system is used to supply air if it is for a CI engine and an air-fuel mixture for the SI engine to the engine cylinder. Sometimes, the intake manifold also houses a heating system so as to allow fuel to evaporate before it comes into the engine cylinder.

Now, if it is a single-cylinder engine, sometimes this intake manifold, this individual pipe to a single-cylinder engine, is known as a runner. So, just I am writing the individual pipe to a single cylinder is called a runner. Next, very quickly, we have to, discuss a few other major components. One is the oil pan, which we have already discussed. So, just I am writing oil pan. So, it is an oil reservoir, essentially an oil reservoir, usually fitted to the bottom of the engine block and making up part of the crankcase. That is what we discussed a few minutes back. So, the oil pan, you can understand that this is an oil reservoir, which is usually fitted to the bottom of the block, making up part of the crankcase, which is what we discussed a few minutes back. And essentially, if you see the schematic, then you will understand that it acts like a reservoir of oil sump.

Next is a very important component, which is the piston. So, what is a piston. Cylindrical shape.

A mass that reciprocates between two identified locations, which are BDC and TDC. The top part of the piston is known as the crown, which is very important. The side part of the piston is known as the skirt. So, this is what we have seen today. Now, if we look at another important element, it is the piston rings. Let me briefly write here. Piston rings are very important. I told you that if we do not provide piston rings, there will be several problematic issues. What are those issues? First of all, piston material is very special, which we will discuss in the next class. Now, the piston will reciprocate between two identified locations, which are BDC and TDC. The piston will move or reciprocate inside the cylinder, so we need to reduce friction and wear. If we need to reduce friction and wear to increase the life of the piston, we need to provide some piston rings in the outer periphery of the piston, right?

So, piston rings increase the lifetime of the piston. Not only that, try to understand that on the top of the piston, the entire combustion will occur. And then, inside the cylinder, the pressure and temperature will be very high. In fact, the pressure and temperature of the working substance.

There will be a possibility that high-pressure combustion products will leak through the passage between the piston and cylinder inner wall into the crankcase. So, if we do not provide a piston ring, that will be the probable case. Therefore, piston rings are provided with the piston to increase the piston's life and also to prevent or restrict the possible leakage of high-pressure combustion gases through the passage formed between the piston's outer surface and the cylinder's inner wall, that gap. So, these are the metal rings. That fit into circumferential grooves around the piston, and form a sliding surface against the cylinder wall.

Typically, close to the top of the piston, two or more cylinder rings are provided. Near the top, of the piston, two or more compression rings are provided. And these rings act like a seal to prevent or restrict the possible leakage of high-pressure combustion gases into the crankcase through the gap between the cylinder's inner wall and the piston's outer surface. So, this is near the top surface and below the compression rings. One oil ring is provided. So, that oil ring is provided just to provide lubrication to the cylinder wall. Below the compression ring, one oil ring is provided. The purpose of this oil ring is to supply sufficient lubrication to the cylinder wall.

So, the next important element is the piston rod that you can see, or I should say, the push rod, not the piston rod. So, this is the push rod. So, what is the push rod? The push rod is

a mechanical linkage between the camshaft and valves on an overhead engine. With the camshaft in the crankcase. So, this is basically, the push rod because, the push rod is essentially that rod responsible for lifting the valve by depending on the requirement, that is, at a proper time in the engine cycle, and that connects the camshaft and valves overhead. This is the camshaft, and these are the valves to the crankshaft because essentially, the entire power is coming to the crankshaft. So, to operate the valve, the spring-loaded valve, to operate the valve, we need to again have some energy, and that energy will come from the crankshaft. So, that is the push rod.

And next, very quickly let us discuss the spark plug that you have seen. So, the spark plug is again an important element for the SI engines. So, it is an electrical device which is used to initiate a high-voltage spark between the electrodes. As such, we shall be discussing the sparking circuit later in this course. So, this spark plug is an electrical device which is used to create or develop a high-voltage spark across the electrode gap, and that is the spark plug.

So, if I write here, electrical device. Used to initiate combustion in the SI engine by creating a high-voltage discharge spark across the electrode gap. For the sake of completeness, I have written it down here.

So now we have valves. If we go to the next slide. So, we have a valve that you can see from here, and we have a water jacket. So, the water jacket that we have already discussed, these jackets are basically attached to the cylinder in the block itself. This water jacket is attached to the cylinder wall, and through this water jacket, water as a coolant is supplied. So, when we are supplying coolant, it will reduce or it will take away a certain amount of heat from the cylinder.

And probably if we do not supply coolant, if it is a water-cooled engine, or if we do not provide an extended surface over the periphery of the engine cylinder, then an excessive rise in temperature during combustion will allow or invite several problematic issues. So, this coolant is circulated through the cooling water jacket to reduce the temperature of the engine cylinder. And valves, you can see these valves, which are provided to control the flow of air, the flow of the air-fuel mixture, and also the exhaust gases. So, these valves are given here, and that means the flow of several fluids is controlled through the valve, and in most engines, these valves are known as or used as poppet valves, which are spring-loaded. Initially, they are spring-loaded, so they will remain seated, and we need

to open them using a mechanical linkage, which is through this cam and follower mechanism, either through a mechanical linkage or a hydraulic system.

So, to summarize today's discussion, we have tried to learn about several important or essential components of an engine, be it an SI engine or a CI engine, and we have tried to understand their functionalities. And also, today, we have roughly understood their arrangements. In the next class, we shall discuss their shapes and, most importantly, the materials used to construct those components in detail. So, with this, I will stop here today, and we shall continue our discussion in the next class. Thank you.