Course Name: Engine System and Performance
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Lec 6: Design and Constructional Features of Engine Hardware

I welcome you all to the session on engine systems and performance. In today's class, we shall discuss the design aspects of several components, particularly valves, the engine block, and cylinder arrangements. Finally, we shall discuss the materials used to construct several components of the engine. So, to start with, let us discuss the design aspects of valves, specifically the constructional features of valves typically used in engines. So, if we write here that Constructional features of valves.

We have seen that valves are used. Typically, we have seen intake and exhaust valves. These two valves are very important to control the flow of incoming air and also the combustion gases. Timely, flow or timely intake of fresh air or charge and also timely expelling of all the combustion gases from the cylinder is very important for the efficient operation of the engine.

So, valves play an important role in controlling the flow of incoming air as well as the expulsion of combustion gases from the engine cylinder. So, if you draw the constructional features of the valves in several arrangements, one is known as valves in block. So, case a), when the valve is in the block of the engine. So, if we draw here, so this is the valve. You can see the valve is placed in the block itself. And this type is known as Flat head or L-head engine. So that means what we have understood is that.

The valve is placed in the block itself, not in the head. If the valve is placed in the head, then if we draw the second type b) and So, this is the valve, and you can see the valve is placed in the head of the block or head of the engine. This type of engine is known as an I-head engine. So, the valve is placed in the head, and this is known as an I-head engine. So, you can see, just we could classify engines again depending on the constructional feature of the valve.

So, firstly, we had seen about the type of L-head engine wherein the valve is placed in the block itself. Now, we can see this type of engine is known as an I-head engine wherein the valve is placed in the head itself. We also can classify another type, if we draw that,

may be depending on the requirement of the engine. So, this is valve 2, and also one valve will be here.

So, this is valve 1. So, we can see that in this particular type there are two valves. One valve is in the head, and the other is in the block. And this type of engine is known as an F-head engine.

So, one valve is in the block and the other is in the head. This type of engine is known, as an F-head engine. So, what we have seen is that the valve can be placed in the head, the valve can be placed in the block, valves can be placed both in the head and in the block. We can also have another type wherein This is type c), and we can have finally type d). So, let us draw the constructional feature, then we shall discuss this particular type of valve of this particular type of engine. So, we can have So, this type of engine, you can see that both valves are placed in the block, and this type of engine is known as a T-head engine. So, I am writing here: both valves are placed in the block, and this type of engine is known as T-head engine.

So, we have seen, based on the constructional feature of the valve arrangement, we could classify engines into four different categories: F-head, L-head, T-head, and I-head. Now, let us look into the arrangement of the cylinder. So, if we go to the next slide, that means until now we have discussed engine classification or the arrangement of different arrangements of valves, and based on that arrangement, we could classify engines into four different categories.

Now, we can also have different arrangements of engine cylinders. So, let us now discuss that particular part, which is cylinder arrangements. So, like the classification of engines based on the constructional feature of valves, we can also classify engines based on the cylinder arrangements. So, the first type is very simple, which is called a single-cylinder engine.

I should say Single cylinder arrangement. So, let us draw the schematic depiction of this particular type very straightforward. So, we will be having a valve here and So, this is the crank and connecting rod mechanism. So, you can see that a single cylinder and piston are there, and the piston will reciprocate between two identified locations, that is, top dead center and bottom dead center.

So, the engine has a single cylinder and the piston is connected to the crank and crankshaft. So, the piston is connected to the crankshaft. So, this is the most simple type of cylinder arrangement. Then, let us, discuss the most common types.

That is the most common type in most of the automobiles. So, this is b) the most common type arrangement of engine cylinder. So, let us draw that one and all these, so this is the most common type arrangement, and this is called, inline. It is called inline arrangement, so if I write here, this is called inline cylinder arrangement. So here, you can see that I could draw only four different cylinders where, in what you can see, cylinders, are positioned in a straight line, one behind the other, along the length of the crankshaft.

So, this is the crankshaft, which is rotating, and the cylinders are arranged along the line or in a straight line, one behind the other, along the length of the crankshaft. This type of arrangement is most common in automobiles. Typically, 4 to 6 or, depending upon the requirement, 4 to 8 cylinders can be used. So, depending upon the power requirement, the number of cylinders to be used inline should be designed or selected, and I am writing here, this inline arrangement is common in most automobiles and other applications. I would like to mention here that engines are not only used in automobiles There are many other places or many other applications like ships, aircraft, power plants, or different industries where engines are used.

So, this most common type, that is, the inline arrangement, is common in automobiles and other applications. Depending on the requirement of the power output, we can have 4 to 8 cylinders. So, this is b) type. If we go for the next type, that is called the V-type arrangement.

So, this is c). So, we are mainly talking about this particular arrangement, that is, the cylinder arrangement. So, let us now draw schematically. So, this angle is θ. So, you can see that the shape is V-type or V-like, and we have a common crankshaft. So, this is the common crankshaft, and this angle is θ.

It is basically 15 to 120°. It can vary from 15 to 120°, but the common range is 60 to 90°. This angle can vary. What we can see is that two cylinders are connected to a common shaft. We will be getting power output from these two cylinders or two arrangements, and we can drive one common crankshaft. So, this is common in luxury and high-performance vehicles. So, just I am writing, commonly used in luxury and high-performance vehicles. So next, let us look at another type, which is the opposed cylinder type d).

Opposed cylinder arrangement. Let us draw the schematic depiction of this particular type, then we will discuss the working principle. So, you can see that one common crankshaft. And so, basically, there are two cylinders that we can see as if they are opposing each other. Each cylinder has one piston, and these two pistons are now connected to a common crankshaft. And this is also known as a flat engine.

It is typically used in small aircraft and some automobiles. So, this is the opposed cylinder type or opposed cylinder arrangement. Now, let us look into the opposed piston arrangement. So Again, we have to draw the schematic depiction, then we can discuss the working principle.

So, if we draw. So, this is, you can see, this is an opposed piston type, as if the pistons are opposing each other. Now, in this particular type, the specialty is the combustion chamber is in the center between two pistons. So, this is the combustion chamber.

The combustion chamber is in the center between two pistons, and very important, since there is a single combustion chamber, certainly the power stroke will be executed by both pistons at the same time. So, this is the important aspect of this particular type of arrangement.

Since there is a common combustion chamber, both are executing power and exhaust stroke at the same time. So, both cylinders or pistons, rather it should be pistons, will execute power and exhaust stroke at the same time. So, this is very important, but still, this particular type of arrangement has two different crankshafts. So, this is the crankshaft 2, and this is crankshaft 1.

Still, there are two different crankshafts, but we could see only one combustion chamber, which is the common combustion chamber. Since there is a single combustion chamber, both pistons will execute power and exhaust strokes. At the same time and this is used, I mean, used for power plants, ships, and submarines. So, this is the application.

This is very important: this particular type is used for power plants, ships, and submarines. As I said to you a few minutes back, engines are not only used in automobiles, but engines are also used in many other applications or many other places. So, this is the opposed-piston type. So, another important thing is that there are two pistons that we can see in a single cylinder. So, two pistons in each cylinder.

So, if we have multiple cylinders, then each cylinder will have two pistons, and it is as if the pistons are opposing each other. Now, let us look into the next type, which is called

the W engine or W-type arrangement. W-type arrangement. So, again, we have to draw the schematic diagram to understand the operational principle.

So, again, this is sort of an extension of the V type. So, if we draw the schematic depiction of this particular type, again, there will be a common crankshaft, okay, and So, this looks like the W type, and this is basically, an engine of three different cylinder arrangements. While connecting rods are connected to a common shaft. So, three cylinders (all connecting rods) are connected to the same shaft.

Though we have seen this particular type, we are going to discuss or we are discussing this particular type. This is not very common. So, this type is not common, though, but some racing cars and luxury cars of the late 90s had this type of engine. So, this is very important. So, that means we have discussed the W type arrangement. In this arrangement, we can see from the schematic depiction that three cylinders are connected to a common shaft. So, now, let us discuss the final type, which is the radial type arrangement.

So, radial arrangement. We can draw the schematic depiction first, and then we can discuss. So, this is the schematic depiction of the radial cylinder arrangement. We can see from the schematic depiction that there are eight cylinders, and all connecting rods are connected to the common crank that you can see.

So that is the common crank. So, this, radial flow engine, what we can see from this depiction of the engine with pistons positioned in a circular plane. Though I could not draw all these cylinders to scale, but all these cylinders, all these pistons are positioned in a circular plane.

As if, so that you can see now this connecting rod is connected to this common shaft. So, all these are in a circular plane. And the common plane and the connecting rods of the pistons are connected to a master rod that I had shown over here by this circle. Field circle, so all connecting rods are connected to a master rod, which in turn is connected to a common crankshaft.

I should write. So, this is the radial flow arrangement. Now, what about the applications? So, typically, in a radial flow arrangement, typically this is not always the case, but a bank of cylinder, or I should say a bank of cylinders, because there are 8 cylinders or a bank of cylinders in a radial flow arrangement. But before using the word always, I should say almost always has an odd number of cylinders.

So, this is very important that a bank of cylinders. So, this is a bank of cylinders. 1, 2, 3, 4, 5, 6, 7, 8. So, if I start counting from here, 1, 2, 3, 4, 5, 6, 7, 8.

So, a bank of cylinders in a radial flow arrangement does not always, but almost always, have an odd number of cylinders. So, this is not always the case, which is why I have used 'almost always.' From the schematic depiction, we can see there are 8 cylinders, but it is not always the case. So, typically, the bank of cylinders for this particular type of arrangement has an odd number of cylinders. So, the application, if we write here, is large ships and aircraft engines.

What is the reason behind this? You can see that in this particular arrangement, we can see there are eight cylinders. It is not always the case that there will be only eight cylinders. It can have even 16 cylinders, 20 cylinders, or even 30 cylinders. But as I said, typically for this type of arrangement, the bank of cylinders has an odd number of cylinders. Since there are many cylinders, the power output will be more. Since the power output will be more, we can use this particular arrangement in places where we really need high power or high work output, such as large ships and aircraft engines.

So, to summarize today's discussion, we have discussed the constructional features of engines, focusing on valve arrangement and, finally, the cylinder arrangements. And we have seen, based on the arrangement or constructional features of valves and also the cylinders, we could classify engines into several categories. So, with this, I will stop here today, and we shall continue our discussion in the next class.