Fundamentals of Automotive Systems
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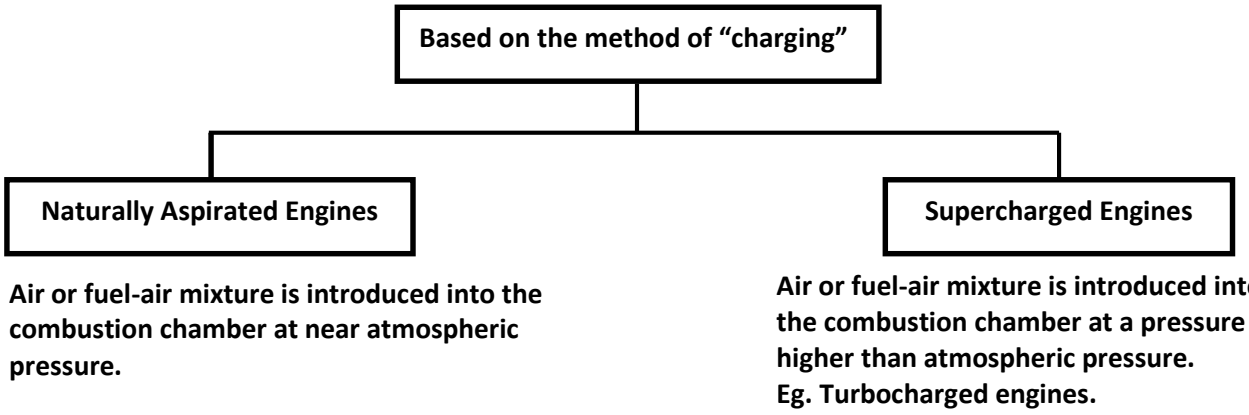
Lecture-02
Course Overview and Classification of Internal Combustion Engines-Part 02



Then another attribute by which we classify engines is based on the mechanism of charging okay as I just mentioned what is charging, it is a process by which fuel or mixture is taken into the combustion chamber of an internal combustion engine and prepare it for combustion okay. So we learn what is called as mixture preparation as we go along right. So we need to prepare the fuel air mixture okay in the combustion chamber.

And the process charging is a process by which we take fuel and air from, let us say fuel tank and atmosphere respectively and bring it into the combustion chamber okay, that is the process of charging. So, based on the method of charging we have what are called as naturally aspirated engines and supercharged engines. So, that is a classification based on the method of charging. So, what is this right.

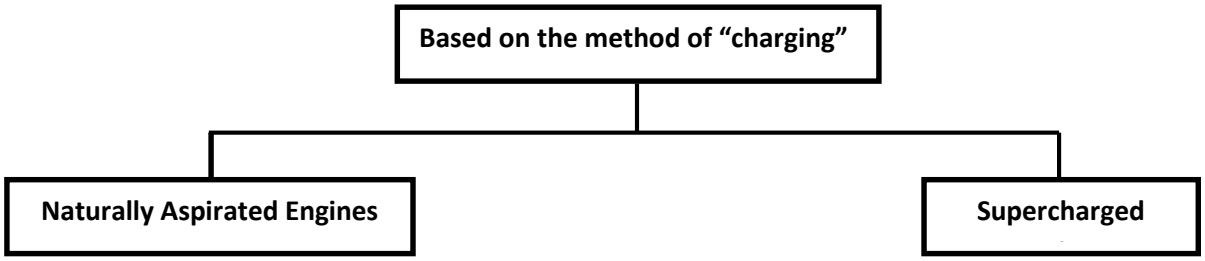
In naturally aspirated engine is one where either the air or the fuel air mixture is introduced into the combustion chamber at near atmospheric pressure okay. So that is a naturally aspirated engine okay, natural aspirated engine is one where the fuel air mixture or air okay is typically introduced into the combustion chamber at near atmospheric pressure okay. What about in a

supercharged engine right, here air typically okay or let us say sometimes even fuel is introduced at high pressure right the fuel air mixture is introduced into the combustion chamber at pressure higher than atmospheric okay.

So that is the difference here okay. So what we do is it like, for example, you know like we use a device called a turbo charger okay. So we will look at that. So if you go and buy a diesel powered car today, right, but the chances are that most of them will be what are called turbocharged vehicles right. So, a turbocharger is a device which will essentially compress air and introduce that air into the combustion chamber of a diesel engine at pressures higher than atmospheric pressures, okay.

And we will see how they work and what are the advantages due to turbocharging okay, so this example is a turbocharged engine. The general term given to such engine is that it is a supercharged engine, a turbocharged engine is a specific example okay. So, that is the there is another classification we look at both okay. So, these are some broad ways in which we classify engines internal combustion engines.

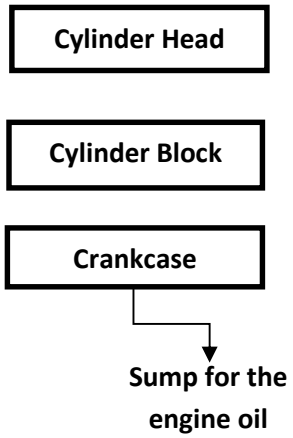
You know like as discussed you know we are going to look at internal combustion reciprocating engines. And we look at both spark ignition and compression ignition engines, okay.



And we will also look at 4 stroke and 2 stroke engines, will also look at naturally aspirated and supercharged engines okay. So that is the broad classification of internal combustion engines. Now, what we will do is that like we will go and look at the components of an IC engine okay. So we look at what are the typical components okay often IC engine. So to begin with right let us consider a 4 stroke engine.

We will come back and look at a 2 stroke engine and then like identify in what way a 2 stroke engine differs from a 4 stroke engine later on. To begin with, let us consider a 4 stroke engine let us identify what are the components in a typical 4 stroke engine right.

So, broadly if you look at a 4 stroke engine you know like you can picturize you know like the internal combustion engine into a set of 3 block of components okay. So, let me just draw a very, very simple block diagram and then we look at the actual components as they are realized in an engine okay. So, typically we have what is called as a cylinder block in the middle okay, these comprises what are called as cylinders and pistons okay that is where the combustion happens.



And chemical energy is converted to thermal energy and thermal energy is converted to kinetic energy okay, that is what is called as a cylinder block. And on top of the cylinder block, we have what is called as a cylinder head. So, cylinder head contains mechanisms that are used to introduce air, fuel you know like, into the combustion chamber in the cylinder block and also mechanisms to control these so called valves you know like which introduce air and fuel air mixture.

And also they contain the spark plugs in SI engine a fuel injector in a diesel engine and so on okay, all these components are contained in the cylinder head okay. And the third block of components is below the cylinder block which we will call as the crankcase. So, essentially at the

end of the day, you know like we can see that in if you consider a road vehicle, the components that we can see from outside is a rotation of the wheel assembly and the tyre.

So, as we discussed in the internal combustion engine, the thermal energy is converted to reciprocatory motion, right. So, kinetic energy and that is in the realized as a reciprocatory motion of the piston. Now, the reciprocatory motion of the piston is converted to a rotary motion of what is called as a crankshaft and then the crankshaft is connected to the clutch, the gearbox and the final drive and to the wheels okay.

That is the path of energy transfer okay in a typical engine power transmission. So, this component called crankshaft you know like is mounted in the crankcase, and in a 4 stroke engine, the crankcase also serves as a sump for collecting engine oil. So, you have engine oil for lubrication right lubricating the components in the what to say engine. So, the crankcase also acts as a sump for the engine. So, even if you park your vehicle right so, the oil will drip into the crankcase right and it will be stored there.

And then when the engine is operational the oil is going to be circulated right through the engine and it will go and lubricate various components right. So crankcase also performs that function okay. So, these are the 3 broad set of components, okay. So, if you consider a typical 4 stroke internal combustion engine, you have the cylinder block in the middle, cylinder head above it crankcase below the cylinder block.

So, now let us go and start looking at what are all the components in each one of them, and then we will go right. So first I am going to look at cylinder block and one interesting aspect you know like even about the scores and the field of automotive engineering in general and it keeps it very interesting is the fact that there is always continuous change, right.

So, even if you take a petrol engine, there are quite a few number of variants of the petrol engine, right, depending on the manufacturer, the same manufacturer will have various variants of the engine.

So, that makes it very interesting to learn this field and keep up to date with the developments that are happening in the field of automotive technology. The challenge that it creates, is that like it is very difficult to teach all variants in a typical course. So, what we are going to learn in this course, is only the base set of components, which are by and large common, you know like to most of these variants, okay.

So, if you go and look up, I would strongly encourage you to look up actual engines, we will see some small variations right from what I am discussing in class and that is to be expected okay. So that is something which is important for us to remember.
So let us look at us look at cylinder block, okay. So let me put this, okay. So this is a typical cylinder block, okay, so as we can see, I hope it is visible.

CYLINDER BLOCK

So you can see that this is a core mechanical structure, which supports the engines, reciprocating components, right and it needs to also provide a lot of structural strength because combustion happens in these cylinders. So, the cylinder block has to provide structural support okay.

Because you are going to have a lot of mechanical loads okay within quote and as well as thermal loads right because a lot of heat energy is going to be generated and you will see that the

engine is going to get very hot right I am sure you would have realized is in practice also when you drive your car and park it right, so you go near the hood of your car right you will see the heat radiating out of the engine right.

So it is going to get very hot okay. So it has to provide what to say structural support to all the components and overcome these loads right. So I what to say essentially take up these loads and typically these cylinder blocks are made of cast iron for the strength you know like some manufacturers also use aluminum alloys you know like for light weighting and better heat dissipation characteristics and so on okay.

So those are typical materials use for manufacturing these cylinder blocks and in the photograph that I am showing you, you can see that there are 4 cylinders okay. So this is a cylinder okay which essentially as the name indicates is a cylindrical cavity and basically doubles up as the combustion chamber okay. So, you will see that this terminology is interchangeably used the cylinder or the combustion chamber, right in what to say when we talk about engines.

And you can also see lot of these water jackets okay or the coolant jackets, these are the pathways through which water or coolant engine coolant is pumped and circulated to cool down the engine by convection okay because we do not want the temperatures to increase beyond a certain range, certain level okay. So, there are water jackets or coolant jackets **we** which we typically used.

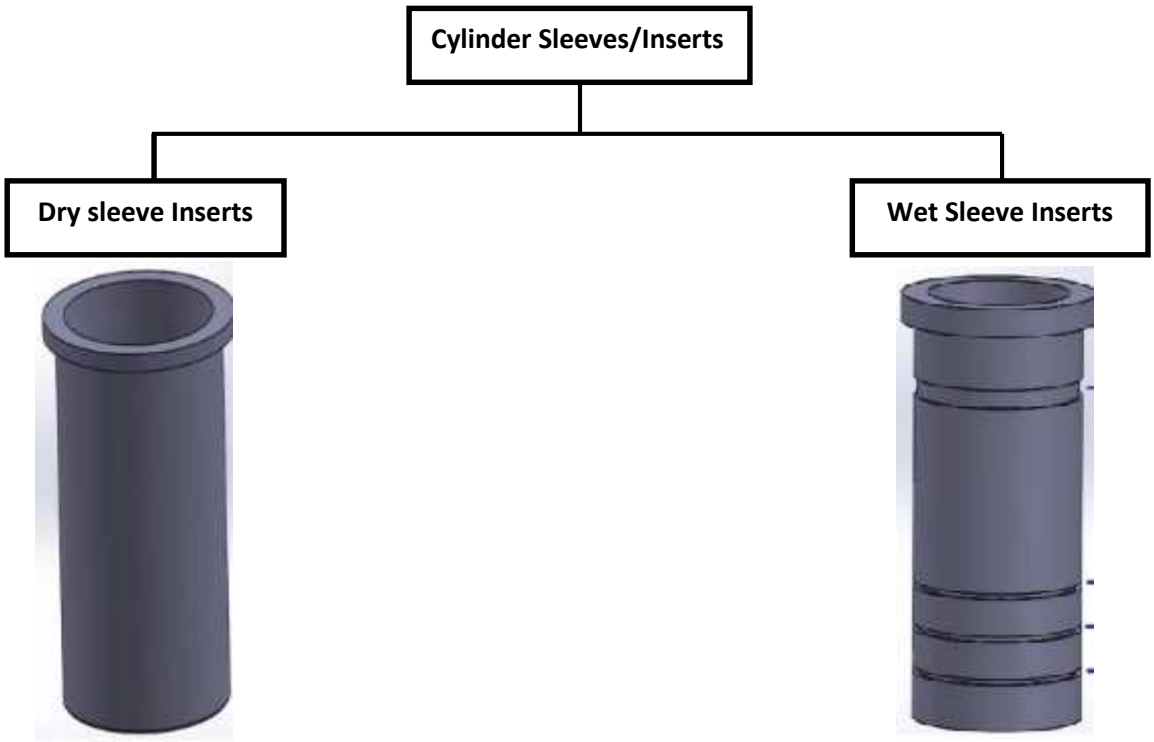
So, that is why you know like there are water called as water cooled engines right and there are also what are called as air cooled engines right. So, air cool engine is you will see in typical lightweight motorcycles and so on right, in air cooled engines, you know the flow of air over the engine cools it and then we have structural features like what are called fins, which provide you and extended that contact area right for the flow of air which ensures a greater rate of heat dissipation through convection okay.

So you have fins to essentially enable faster better heat transfer right through convection. So, but typical 4 wheeled vehicles you know what we are constrained will have water cooling because of

obvious reasons right so okay. So, and you can see that you know like there is a pump which will pump the coolant or the water through these jackets and the cylinders will contain the pistons which we are going to look at shortly.

And the cylinder head is placed on top of this cylinder okay, and then using a gasket and then like bolted to it right, the cylinder head is bolted to the cylinder block okay, so that is what happens to the cylinder per se okay. Now you can immediately see that the cylinder is going to experience a high amount of mechanical load and thermal load as we already discussed why because combustion is something you know where you generate a lot of heat energy, right.

And that is going to result in a tremendous increase in the pressure of the gases due to combustion due to the heat energy that is released and that needs to be supported and the temperature also increases okay. So it is extremely important to have a lot of structural rigidity so that the cylinder does not deform, even by accident, right due to the continuous motion of the piston and also all the loads can what is acting on it.



We do not want the cylinder to deform and any way there is going to be some wear and tear with continuous usage. Now, if you want to essentially what to say correct a deformed cylinder that is going to be a very expensive process right because if the cylinder deforms, right and goes out of shape, you can see that it is all obviously going to inhibit the motion of the piston right inside the cylindrical cavity.

And consequently the efficiency of the entire process is going to get affected okay. And then you need to take out all these engine components and then like do what is called a reboring of the cylinders because during manufacture itself the cylinder block is cast and the cylinder is bored that means to ensure that the tolerances are very, very small, right, the manufacturing tolerances are kept to be, very small.

So if it gets deformed you need to rebore okay, and that is a quite an expensive process. So in order to address that, you know, like we use what are called as cylinder sleeves or inserts. So, what are these cylinder sleeves or inserts.

So they are just an insert you know like which you can place in the cylindrical cavity okay and then make the piston move inside okay, so what you do is that this is what is called as a dry sleeve okay or a dry insert okay. So what do you do is that like you just put it inside the cylindrical cavity right and let the piston move inside that is about it right. So because then if this gets worn out what do you do just take it out, replace that is it okay.

Why is it called a dry sleep okay, we will shortly understand what is the counterpart of it and then like, why there are 2 variants right. So there is also something as a called wet sleeve okay, so which is slightly thicker than a dry sleeve. So what is a wet sleeve. So, this is a wet sleeve or an insert. So what happens is a following right in a dry sleeve the sleeve thickness itself is very, very small.

And the cylinder still provides the structural support okay. A wet sleeve is thicker okay and it is in direct contact with the coolant to enable better heat dissipation okay. So on the outer surface the outer periphery or the outer what to say periphery area of the wet sleeve is in direct contact

with the coolant in the cylinder cavity right. So the wet sleeve has to provide all the structural support.

So, obviously, it is thicker, right. The dry sleeve does not provide structural support and just to take the wear and tear, but the cylinder still should have material on the periphery to take up the loads and the cylinder is still in contact with the coolant okay, so the pros and cons are evident, right. A dry sleeve is very simple okay, you can just simply replace it when it is worn out whereas the limitation is that like, you still need to enable heat conduction through the sleeve through the cylinder walls then to the cooler right.

In a wet sleeve that has overcome because the sleeve is directly in contact with the coolant enabling better heat transfer, but the limitation is that like it is thicker, okay so if it gets worn out or goes out of shape you need to what to say replace the entire sleeve okay. So these are what are called as sleeves or inserts, okay which are placed in the cylinder cavity okay. So I think I maybe I will stop here for today. And then like we will continue tomorrow, we will look at the other components of the engine and then like, we will go and learn about engine operation okay.