Course Name: Engine System and Performance
Professor Name: Pranab Kumar Mondal
Department Name: Mechanical engineering
Institute Name: Indian Institute of Technology, Guwahati
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Lec 3: Engine Classifications and Nomenclature

I welcome you all to the session on engine systems and performance. In today's class, we shall discuss the classification of engines, and then we shall briefly touch upon the nomenclature of engines. I mean to understand the different parts of an engine. What I would like to discuss today is the classification. Probably, you have studied this part in your undergraduate internal combustion engine course. So, engines are classified into several categories.

Broadly, internal combustion engines can be classified into two categories, but these two categories are not the only classification of engines. There are many other categories that we will discuss today. So, if we just write engine classification. As I said, engines can be broadly classified into two categories. Let us revisit those two categories first.

The first category is based on the number of strokes, and based on this point, we can classify engines into two categories: one is the four-stroke engine, and another category or subcategory is the two-stroke engine, though two-stroke engines are now almost obsolete. So, what is a four-stroke engine? A four-stroke engine, as I said, is something you have studied in your undergraduate internal combustion engine course.

In a four-stroke engine, two rotations of the crank per cycle, whereas in a two-stroke engine, only one rotation of the crank occurs per cycle. I'm not going to discuss in detail about what is, crank rotation. Probably there are four, in a four-stroke engine, you could classify four distinct strokes, like intake, then compression, third is the power stroke, and finally exhaust. So, as I said, four-stroke engine, what are the four different strokes?

Intake, then compression, finally power stroke and certainly the combustion gases, combustion products should be expelled out from the combustion chamber, so there must be the last stroke that is the exhaust stroke. In a two-stroke engine, the, first three strokes are, combined together. And exhaust stroke will be there. So, in a two-stroke engine, intake, exhaust, compression, and power, all these strokes will be there, but out of these four strokes, three different strokes should be combined together. I mean, in one stroke,

in one go, these three events will occur, and finally, the power stroke will be there. So, that part I am not going to discuss here in detail. Second is that is, very important, that is, types of combustion.

Based on this point, again, the engine can be classified into two categories, subcategories. One is SI engine and the last one is Compression ignition or CI engine. So, this SI is spark ignition, and this is compression ignition. So, this is based on the type of or types of combustion.

In a spark ignition engine, the fuel or air-fuel mixture, which is also known as charge. The charge cannot combust automatically, and there is a necessity of an external agent, which is the spark plug, and that spark plug helps to ignite the charge, and thereafter, the entire combustion will take place. On the other hand, in a compression ignition engine, there is no need for an external agent like a spark plug. Instead, the thermodynamic state of the compressed air at the end of the compression stroke helps the fuel to ignite the moment when fuel is sprayed into the combustion chamber. So, this is basically the second type of classification.

Probably, you have studied these two in your undergraduate course, but not only these two. So, if I write here, these two are the broad classifications. Next, let us discuss another type. So, I am writing the third type, which is valve location. Very quickly, I shall try to complete this because these are not very important, but just to recapitulate in the context of the subject I am discussing.

Valve location. So, again, it can be, right, this is called an overhead valve, this is also known as an I-head engine, then it is a valve in block. So, overhead valve in the valve is in the top, then this is called valves in blocks. This is called, a T-head engine.

So, overhead engines have valves in the head. And one in the head typically means intake and one in the block. This is called an F-head engine. But this particular type is not very common.

While the first two are very common, the last one is less common. So, this classification is based on the valve location. What next? Then comes the basic design. So, in this course, we shall mostly discuss the engine system, engine structure, several components, and several control systems.

So, this type is very important, that is the basic design. So, this classification, based on this point, we can also classify engines like reciprocating type and another type is rotary

type. So, this classification is based on the basic design. Reciprocating engine, as you have studied, the piston needs to travel between these two locations, the piston needs to reciprocate between these two locations.

Top dead center or inner dead center, or the bottom dead center or the outer dead center. While the rotary type, there is a special arrangement. In fact, we shall be discussing this particular type when we discuss the engine structure. So, this is the basic type. Then, if we go to the next one, that is position and number of cylinders in a reciprocating engine.

So, knowing that engines can be classified into two categories based on their basic design, that is, reciprocating type and rotary type. In the reciprocating type, the piston reciprocates between these two locations, and those locations are bottom dead center and top dead center, or outer dead center or inner dead center. Again, the reciprocating engine can be further classified depending on the position and number of cylinders. So, if we again look at this particular type, then we can have a V engine, V shaft, then opposed cylinder type, radial engine, and opposed piston type.

So, you can understand these sub-classifications are basically depending on the arrangement of the cylinder, piston, etc. And this particular classification is applicable for a reciprocating type engine. Then, the sixth is the air intake process. This particular type, is not applicable to any specific type of engine.

So, the air intake process again, if we look at several, sub-classifications, then it we can write or we can classify it into several subcategories. The first one is naturally aspirated. What does it mean?

That means to suck air into the engine cylinder or for air to be drawn into the engine cylinder, there is no need for an air intake, boost-up system. So, just I am writing, no air intake pressure, boost system. See, you have studied that when there is an intake stroke, the piston comes down from the top dead center to the bottom dead center, and that movement of the piston from TDC to BDC or inner dead center to the outer dead center automatically allows air to be drawn into the cylinder. There is no need for any air intake pressure boost system. So, this is naturally aspirated.

Then, what is the second type? It is supercharged. Supercharged means just because of the movement of the piston from TDC to BDC is not sufficient to get the required amount of air for the combustion. We need to have a special device, that is, a small compressor,

and that compressor will boost up or pressurize air to go into the combustion chamber. So, this is supercharged.

There is also another subtype called turbocharged. So, basically, the exhaust gas or exhaust gases come out from the engine or combustion chamber. Instead of directly discharging those combustion gases into the ambience, we can take those gases to run a small turbine, to propel a turbine, and the turbine will give some amount of power. While the turbine is moving, we can also connect another small compressor to that common shaft of the turbine.

That small compressor will now allow air to be drawn into the engine cylinder with relatively higher pressure. And that is the turbocharge. Finally, this is also not very common that the crank is compressed. I hope you have understood that essentially when you need to have an air intake pressure boost-up system, that means we need to increase the pressure of the incoming air, whether we are increasing pressure by having only a supercharged system or by having a coupled turbine compressor, which is a turbocharged system. It depends on the requirement, but we can also have. We can also pressurize air or intake air using a crankcase compressed system.

So, this is the sixth type. We can move to the next one, which is based on the method of fuel input. That is again not applicable for SI engines. This is for compression ignition engines. So, we can have direct injection.

In this case, Fuel is supplied directly to the combustion chamber. And subtype b) is indirect injection. In this case, certainly you can understand, instead of supplying fuel directly to the combustion chamber, fuel is supplied to the secondary chamber first. So this is the indirect type.

So, again I am telling this type is applicable for CI engines, compression ignition engines, because we all know by this time that in a spark ignition engine, fuel is supplied into the engine cylinder through the carburetor, a special device wherein fuel is allowed to mix with the incoming air. Then Next type is based on the method of fuel input. As such, I should have discussed this particular type before discussing the previous one, that is the method of fuel input for CI engines.

Method of fuel input, it can be through carburation, that is carbureted. As I said, in SI engines, fuel is mixed with the fresh air in a special device that is called a carburetor, and that fuel-air mixture is supplied into the combustion chamber. So, this is basically called

the carburation system or carbureted fuel input. b) is called MPFI, that is very important, and in most of the modern engines, this system is equipped with that is multiport fuel injection to bring the economy of the fuel, rather to increase the overall efficiency of the engine.

For conversion efficiency, instead of supplying fuel through only one port, we can supply fuel through multiple ports. So this is the modern engine modification, or rather, I should say, modern engine system. So, multiple port fuel injection. c) is throttle body injection. Throttle body injection is, the injection of fuel where the fuel is injected upstream in the intake manifold.

So, injection upstream in the intake manifold. So this is called throttle body injection, and this gasoline direct injection is again mostly for the CI engines, and what we have discussed just before that is the method of fuel input for CI engines. Now, when you are supplying gasoline, It can be supplied directly into the combustion chamber or it can be supplied to the secondary chamber. So that classification you have already discussed.

Then, the next type is the fuel used. This is very common. So, it can be gasoline type. So, we can use gasoline as a fuel. We can use diesel, we can use gas, we can use LPG, we can use alcohol, ethanol, and we can also use dual fuel.

So dual fuel is very common nowadays, and in most engines, a provision is there that allows us to run the engine for a long time using either alcohol or LPG, but we need to start the engine using either diesel oil or any other fuel oil. So this classification is basically based on the type of fuel used. And the last one that I used to discuss, which is very common, is the types of cooling. So this is very important because you can now recall that in the last two classes, we have discussed that the cooling system is an important system for the engine.

Now, the cooling can be done using air as a coolant, or the engine can be cooled using water. So, depending on whether we are using air or water as a coolant, we can name engines either air-cooled engines or water-cooled engines. So, these types of coolant can result in either air-cooled engines or water-cooled engines.

So, all these are basically, several classifications of internal combustion engines. Though there are two broad classifications that we have discussed today, the first one is the number of strokes, and the second one is the types of combustion. Still, there are many other classifications that you probably have not studied in your undergraduate course, and

also, as I said, just to recapitulate, we have discussed all these types today. And now we shall discuss, engine nomenclature. Engine nomenclature is just to know about several components, several parts which are responsible for operating an engine efficiently and smoothly. We have seen this schematic depiction in our previous two classes. But today we shall discuss this in a little more elaborate way.

So, what we can see is that this is the schematic depiction of a spark ignition engine because you can see the spark plug is there. If we remove this spark plug and if we just place one fuel injector over here, then the engine can be a compression ignition type engine. So, if we replace this spark plug with a fuel injector or fuel nozzle, then we can call it a compression ignition engine. I mean, all other components will be the same.

So, you can see that this carburetor is a device that we have placed over here, and this carburetor is an important and essential element for the spark ignition engine wherein Fuel and air, these two streams are coming, and they are mixing together. The function of this carburetor is to supply a stoichiometric air-fuel ratio to the engine depending upon the requirement. Then we have a throttle valve because the throttle valve is used to supply the air-fuel mixture just to monitor the quantity of the air-fuel mixture to be supplied into the engine cylinder. Then we have an intake manifold and an intake valve.

So, this is, a very old system wherein the valve opening and closing is controlled by a cam and follower mechanism. So, a spring-loaded valve, since it is a spring-loaded valve, the tendency of the valve will always be to close. So, by tuning this cam follower system, we can open the valve depending upon the requirement. Then, as I said, we have the spark plug, which is again an important element for the spark ignition engine because the air-fuel mixture, which is also known as charge to be drawn into the engine cylinder during the intake stroke, won't be able to combust automatically until and unless we initiate a spark using this element, that is, the spark plug.

So, we shall discuss this spark plug circuit and how we can get a spark in detail in our subsequent lectures. Then this exhaust manifold is there because through which the combustion gases after the combustion process, all combustion gases will leave through this manifold that is the exhaust manifold into the ambience. As I discussed today, instead of directly discharging all these combustion gases into the ambience, we can take that high-pressure, high-temperature gases to run a small turbine to rotate a small turbine, and the turbine will be you also can connect a small compressor to the common shaft of the turbine so that we also can run a compressor. The compressor can compress the air

that intake air so this is called turbocharged. And then you can see that there are two locations that is top dead center and bottom dead center.

So top dead center and bottom dead center, these two centers are basically very important and the piston travels between these two locations. And the distance between these two centers is known as stroke length. So the piston can travel between these two locations. You can see this is the piston and there is an essential element that is the water cooling jacket. So, it is the water-cooling jacket because that water is supplied through this jacket just to reduce the temperature of the cylinder wall.

As I said to you in one of the previous classes, temperature that will produce or that will develop due to the combustion, that temperature if we do not allow that temperature to reduce, then there will be several other problematic issues. Thermal cracks might generate and that may lead to damage of the engine cylinder. Also the piston. So though it is very confusing because the objective is to have efficient combustion, the objective is to have energy which is remaining stored in the fuel that energy should be converted into heat energy and that heat energy is converted eventually into another form of energy that is in the form of work and through this crank and connecting rod mechanism.

So, this is, the connecting rod, and this is the crank. So, that energy, that heat, will be converted into work. Now, the question is, it is not possible to convert, the entire heat into an equivalent amount of work. So, we must take a certain amount of heat through this, supply of coolant, and that is why this cooling water jacket is important.

And you can see piston rings are provided. So, piston rings, basically act like a seal, so that combustion gases cannot leak out through the gap between the piston and the piston outer wall and the cylinder inner wall. And also, because, the piston is continuously, reciprocating between these two locations, the friction between these two mating components can also reduce the lifetime of the piston. But now, since, piston rings are provided, the piston rings can be replaced, and the piston lifetime can be increased.

The connecting rod and crank mechanism is there just to convert the reciprocating motion of the piston into rotary motion so that we can get some useful amount of work at the shaft. This oil pan is there, and you have also discussed the lubrication system in one of the previous classes. So, this oil pan, this crank, by virtue of its charging action, supplies or sprays lubricating oil into the inner wall of the cylinder so that it can reduce the friction between the piston ring and the cylinder inner wall. It supplies or sprays lubricating oil into the inner wall of the cylinder so that it can reduce the friction between

the piston ring and the cylinder inner wall. So, basically, I have just tried to briefly describe the parts and major components of an engine, and all parts will be there even in a compression ignition engine. But only the spark plug should be replaced by a fuel nozzle or fuel injection system. So, to summarize today's class, we have discussed engine classifications, and then we have discussed several components or important or essential elements of both SI and CI engines.

With this, I will stop here today, and in the next class, we shall discuss the basic cycles and try to mathematically describe the thermal efficiencies of both CI and SI engines. Thank you.