IC Engines and Gas Turbines
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Lecture – 03
Classification of IC Engines

So, we will continue our discussion on IC Engine. Today we will discuss about the you know two-stroke engine, although the discussion topic of discussion today is classification of IC engine cycle of operation types of fuel used types of ignition types of cooling arrangements etcetera.

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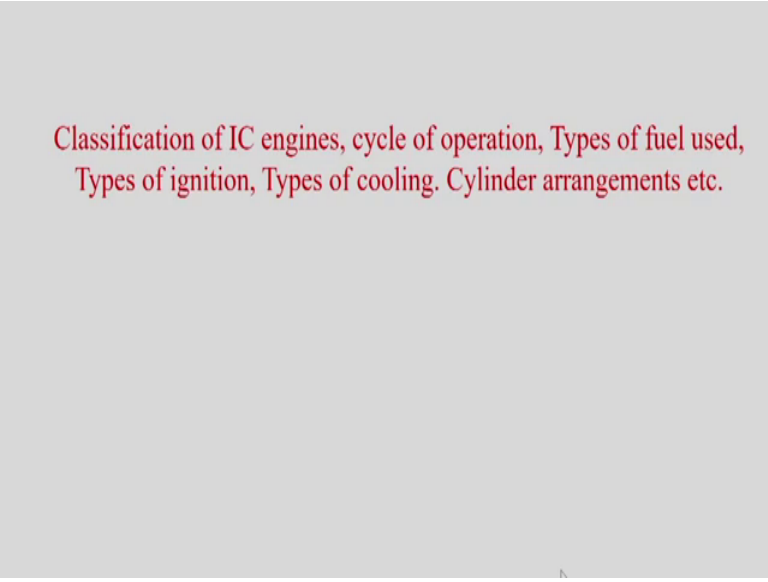

But we will discuss about the you know its cycle of you know classification of IC engine that is what we have did earlier, that we have discussed earlier that it can be classified based on the you know number of strokes and types of ignition, four-stroke and two-stroke and also we have discussed about that can be classified best on the you know SI and CI engine.

Then types of ignition that we have disused about that in case of a SI engine normally what do we do we have an external design which that is spark plug. So, at the end of the compression stroke when in case of SI engine when we are introducing air plus fuel through carburetor during the intake strokes. So, at the end of the compression stroke

when the pressure and temperature of the charge that is air fuel mixture is irritably high, then we switch on the spark plug essentially to initiate combustion.

On the other hand we have discussed that in case of CI engine we do not have any external design to initiate combustion rather or is done at the end of the compression I mean in a CI engine we have discussed that air is taken through air manifold. I mean intake manifold, air is introduced in the during in intake stroke and at the end of the compression I mean whenever air is coming towards I mean when piston coming towards TDC at the end of the compression, then pressure and tem of the air compressed air is high enough that the moment at which fuel is injected it mean I will combustion will start. So; that means, you are utilizing the high pressure and temperature of the you know air to ignite the fuel and combustion will start. So, we do not require any external agent.

On the other hand, you also have discussed that you know what is happening because I will discuss that that you know in IC engine maybe we can you know map the processors what do you see know I undergoing a cycle. I mean, whenever we are compressing air we are compressing air fuel mixture the, then we are introducing fuel in case of a CI engine, thermodynamic state will change at each and every slope at the end and beginning of each and every stroke. So, we need to map all those stead points and all those steads in a thermodynamic plane in a to discuss about the pressure temperature changes change in volume pressure tem in case of a SI engine, we map all those processes comparing the cycle and which is known a Otto cycle.

But in case of a CI engine normally you know we use diesel cycle to compare the thermodynamic state, whether to to obtain the rather to map the processors what is happening inside the engine cylinder, I mean for at the during each and every stroke. And that is what is this you know diesel cycle and normally we do not call it a thermodynamic cycle, because it is very important rather we can call it mechanical cycle.

So, this is very important that I can write that should we call it a thermodynamic cycle and it is very important. No matter whether Otto cycle diesel cycle we are concentrating to map the processes, you know to map this thermodynamic state at each and every in each and every stroke. In a thermodynamic plane, we use Otto cycle to compare the change in pressure temperature in SI engine while we use diesel cycle essentially to

obtain the pressure and temperature at the beginning and end of each stroke for CI engine.

But whether it is Otto cycle diesel cycle to compare the to obtain the thermodynamic you know properties, rather pressure temperature change in volume, we call it Otto cycle diesel cycle, but these are not thermodynamic cycle. So, the question is never the cycle is considered the thermodynamic cycle.

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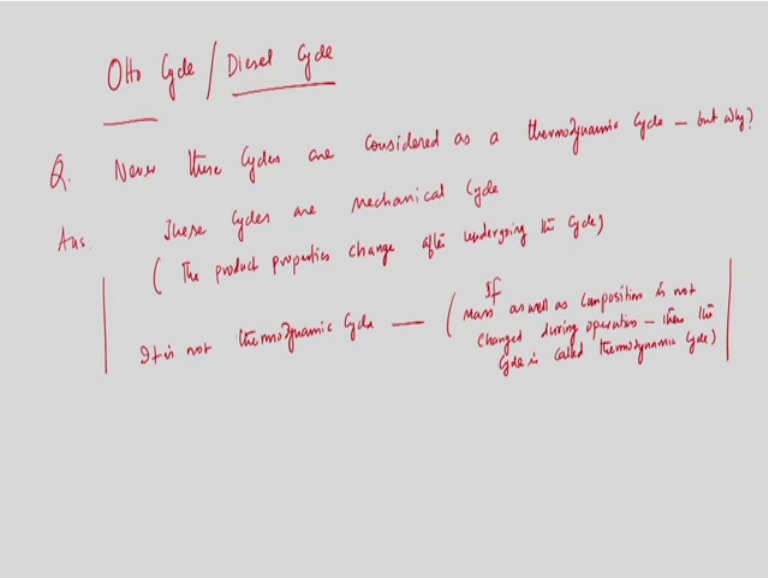

So, the very important that Otto cycle and diesel cycle; this is I mean, this is very important because whether you can consider Otto cycle and diesel cycle. You know we cannot call it thermodynamic cycle, but I will discuss why we cannot call it you know diesel cycle and otto cycle. So, question is never this cycles you know are considered as you know a thermodynamic cycle right, but why?

So, Otto cycle, diesel cycle; these cycles are not considered as a thermodynamic cycle, but why? Rather you can call this cycle is a mechanical cycle. So, here the cycles are so answer is these cycles are mechanical cycle, the cycle is a mechanical cycles. The product properties changes after run within the cycle, very important. So, the product properties, change after undergoing the cycle; that means, the properties of the products the rocking substance is no longer even got same rather it changed the in a properties of working substance change after undergoing the cycle. But in case of a thermodynamic

cycle it is very important, it is not the thermodynamic cycle because we call it mechanical cycle.

We can call it thermodynamic cycle if the mass as well as compositions is not changed during you know operation. You can call it a thermodynamic cycle; if the mass as well as composition remains same you know during the operation. But since, in a Otto and diesel cycle mass as well as compositions rather properties, product properties change after undergoing the cycle. So, it is not a thermodynamic cycle rather it is mechanical cycle.

So that means, mass as well as composition; mass as well as compositions is not changed during operation. If mass as well as composition is not changed during operation, then the cycle is called thermodynamic cycle so, this is very important. So, in a Otto and diesel cycles product properties change after undergoing the cycle, hence we cannot call it a thermodynamic cycle rather you should call it mechanical cycle ok.

So, this is what is you know cycles, type of fuels seems to be discussed later because you require one extra one total lecture to discuss about the fuel is used. Type of ignition that is what we have discussed again we will discuss you know in detail in detail about the types of ignition. Then today we will discuss about because in the last lecture I have discussed about the sequence of operation, I mean different sequences in a four-stroke engine. So, if you can recall that we had intake stroke, compression stroke, then power stroke and then finally, exhaust.

So, we will now see that in a two-stroke engine. So, of course, the name itself implies that there will be 2 strokes. So, what are the 2 different strokes rather I mean in a, as compared to 4-stroke engine in a two-stroke engine there are two strokes. So, what are the where other strokes are, why other strokes? Intake, compression, power and exhaust. So, power stroke has to be there because we need to get power stroke in a of course, otherwise how why you can you know run wheel. So, power stroke should be there.

Apart from power stroke what is the other stroke, I mean in a 2-stroke engine that we need to see and if it is 2-stroke engine I mean if it is, since it is 2 strokes and then, we have to have at least intake exhaust compression because without compression we cannot ignite we have to have power stroke and of course, we have to introduce air fuel mixture or air in case of a SI and CI engine respectively into the engine cylinder. So, you should

have at least intake stroke and we need to spill out all the combustion product through from the cylinder. So, of course, you should have again exhaust stroke.

So, we should have this intake exhaust power and compression, but in a two-stroke engine we have to see that why rather how the you know, all the you know processers I mean intake, compression, power and exhaust are you know completed with only two two-stroke

So, today we will initially draw a schematic because we have seen that in a four-stroke engine, we have discussed about in detail about the different strokes and I mean, how an engine operates and we have identified that we had only one power stroke versus there are three idle strokes. So, in a 2-stroke engine you see that from the one power stroke should be there. So, of course, there will be one idle strokes.

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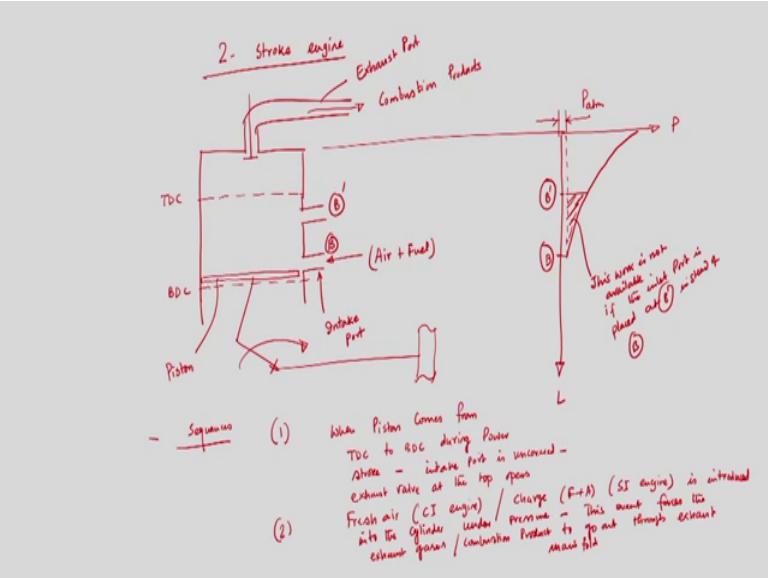

So, if I draw a schematic of a two-stroke engine; so, 2-stroke engine. So, if I draw the 2-stroke engine we have this is top dead center and this is bottom dead center right, and we have piston. So, I am giving if it is so, this is intake port, this is exhaust port through which combustion product go out.

So, this is bottom dead center this is you know this is piston and this is intake. So, we should have air fuel mixture to be supplied in a cylinder in case of a SI engine, but only

you can have air if it is CI engine. In that case if it is CI engine, then we should have a fuel injector; if it is SI engine, we have a spark plug fine.

So, now question is if we draw the, this is L and this axis is pressure. So, if we draw this is you know this is and this is so we will have atmospheric pressure right. So, this is atmospheric pressure P atm and it increases like this. So, this much amount of what we will discuss in later.

Now so, this is intake port. So, let us say this is B and this is B prime B and B prime are two different locations of intake stroke we will discuss, that if we have inlet location or intake location of the intake port is as b prime, then what will be the consequence fine.

So, we will discuss then in case of a two-stroke engine what is happening, I mean we should have one power stroke that is obvious because otherwise we cannot run a wheel. And of course, we should have compression stoke otherwise if we do not compress the air fuel mixture that is known as charge or air in case of a CI engine. We it is a possible to initiate combustion. So, in case of a CI engine we have to have compression because we need to raise the pressure and temperature of the air to at the end of the compression stroke to a level; so, that the moment when we introduce fuel or inject fuel combustion will start immediately.

So, the sequences are whenever piston is coming from TDC to BDC right, during power stroke. So, we are assuming that somehow in most of the cases nowadays we are having known as self starting need that is we use initially the cylinder piston cylinder is you know electric motto fine

So, whenever piston is coming from TDC to BDC and the moment when it crosses the intake port, rather is very important that the whenever piston is coming from TDC to BDC and the moment when it cautious the intake in intake port that is when intake port is uncovered. So, fine so, I will write sequence. So, sequence sequences first that power stroke we know that piston has to come from TDC to BDC, that is what is power stroke. So, here it is connected with one flywheel; so this is flywheel. So, sequence 1 is when piston comes from TDC to BDC, during power stroke right and intake port intake port. So, while piston is coming from TDC to BDC during its travel intake port is uncovered.

That means an exhaust valve. So, you there are it is I am discussing about the sequences, so piston is coming from TDC to BDC during power stroke intake port is uncovered; that means, the moment at which it crosses the intake port intake port uncovered. And then exhaust valve or exhaust port at the top opens very important. Now what is happening? Piston is coming from TDC to BDC during power stroke inside the cylinder I mean we are having little less pressure and the pressure is even lesser than the atmospheric pressure or sometimes you need to forcefully send air fuel mixture or air. So, the moment at which it you know crosses the intake port intake port is uncovered immediately exhaust valve at the top opens.

So, when intake port is uncovered you know and exhaust valve opens, number 2I am writing that you know fresh air in case of a CI engine I am writing or charge that is fuel plus air mixture in case of a SI engine engine right is introduced into the cylinder under pressure. So, may be the pressure difference between atmospheric pressure and the pressure inside the cylinder is not good enough to have a sufficient flow of charge or air from the through the intake manifold into the cylinder. So, what we will have to do? We have to introduce fresh air or charge into the engine cylinder under pressure right.

And whenever charge or fresh air is coming into the cylinder under pressure very important, then what is happening? You know this event forces the you know exhaust gases stroke combustion product to go out through exhaust manifold right. So, piston is coming from TDC to BDC in power stroke, the moment at which it crosses the intake port, intake port is uncovered that is intake port opens and also the exhaust valve opens at the top, fresh air. So, whenever it is coming from TDC to BDC then we may have a pressure which is in the cylinder is less than the atmospheric pressure, but this pressure difference may not be sufficient to have a enough flow rate of fresh air or charge into the cylinder that is required for the efficient combustion.

So, what you have to do? The moment at which intake manifold opens as well as the exhaust manifold at the top opens, we need to send fresh air or charge under pressure into the cylinder. So, whenever fresh air or charge is coming into the cylinder, since piston has come from TDC to BDC following the combustion power stroke. So, entire cylinder is filled up with combustion product or exhaust gases. Now the incoming fresh air or charge whenever is introduced under pressure, this event you know forces the

combustion product or exhaust gases to go out from the engine cylinder through the exhaust manifold.

That means from here we can see that whenever piston is coming from power stroke, during power stroke from TDC to BDC as a consequence of this travel of the piston as a consequence of this stroke, this stroke itself allowing other two strokes to be completed without having two different strokes separately this is very important. That means. Whenever piston is coming from TDC to BDC during power stroke the power stroke itself allowing other two different strokes that is intake and exhaust to occur simultaneously without having two different strokes separately.

The next stroke will be definitely piston will move from BDC to TDC so; that means, entire cylinder is now filled up with fresh air or charge in case of a CI or SI engine respectively. May be it is not always possible to expel out all the combustion product from the cylinder, there will be remaining some amount of, you know there will be a residue of the combustion product and also we will discuss a critical issue that whenever fresh air or charge. In case of a SI engine a charge is coming because you are in a SI engine you are supplying air fuel mixture in a gaseous stage.

So, that air fuel mixture, when it is introduced into the engine cylinder under pressure then since incoming air fuel mixture and it allows the combustion product to go out. So, definitely some amount of air fuel mixture will go out with the exhaust product. So, there will be a loss of the fuel. So, that is what we will discuss again.

Anyway so, this is very important that during the movement of the piston from TDC to BDC in power stroke itself allowing other two strokes that is intake and exhaust other two strokes to happen simultaneously without having these two strokes separately.

Anyway, next stroke is what is the consequence at the end of the power stroke engine cylinder is filled up with fresh air or fresh charge and then piston is thus piston movement is very instantaneous. So, when piston is moving from BDC to TDC again, the moment at which it crosses the intake manifold intake valve closes and exhaust valve also closes. So, during the movement of piston from TDC BDC to TDC in the next stroke that is compression stroke cylinder is filled up with air fuel mixture, piston is moving towards TDC both the port intake force and exhaust ports are closed, then it compressed the air fuel mixture or air through a level. So, that a combustion will be

completed towards the, you know when piston is approaching towards to TDC, that is compression stroke.

And again whenever it is coming towards the TDC that is at the end of the compression stroke we have to have combustion either through you know spark plug in case of a we have to initiate combustion either through spark plug in case of a SI engine or through utilizing the high pressure condition of high pressure and temperature of the you know air itself. So, combustion will be completed whenever piston is approaching TDC or reaching at TDC.

Now, the next to be power stroke; so we have only two strokes power stroke and the compression stroke, again when power stroke is having that is piston is coming from TDC to BDC this sequences 1 and 2 will be completed. So, theoretically you are having two different strokes one is power stroke another is compression stroke. So, here power stroke we are getting power and that is remaining stroke in the flywheel, but we need to have another stroke that is compression stroke and for that stroke we are again borrowing energy from the flywheel. So, here we are having one power stroke versus one idle stroke fine.

So, we will write again before I go to the next slide to discuss another you know other sequences, here I am telling that whenever if I have the for location of the intake port is at B prime. So, if this is the B and this is B prime; so, if I have location of the intake port at B prime we will get less power less power output because this amount of the you know hatched portion the walk up you know given by the hatched portion is not available

This is very important; that means, location of the intake port plays a crucial role in case of a two-stroke engine essentially to have the power output; that means, in that you know placed at b prime from that less amount of work out to this what is that available. So, this work is not available if the inlet port is placed at B prime instead of B. So, if the inlet port is placed at B prime in instead of B or you will get this amount this the hatched portion that work under the area of hatched portion is not available.

So, you will get less work output fine. So, next we will discuss about other time sequence you know other cons other sequence that is we have discussed till now that we have you know power stroke and then. So, power stroke is related that is power stroke is

responsible for two other stroke to happen, 2 other strokes to happen without having to they took simultaneous I mean separately, that is intake and exhaust are having simultaneously you know simultaneously.

So, next we will discuss about the same thing. So, this is what and the process is repeated. So, you know that is as I showed you said you that the when piston reaching to the TDC combustion takes place, it creates a thrust on the piston cylinder I again comes to the BDC and this process continuous and we are getting a cycle of operation. So, this is a in a time of 2-stroke engine. So, as write I will write that this is whatever I have drawn in the last slide.

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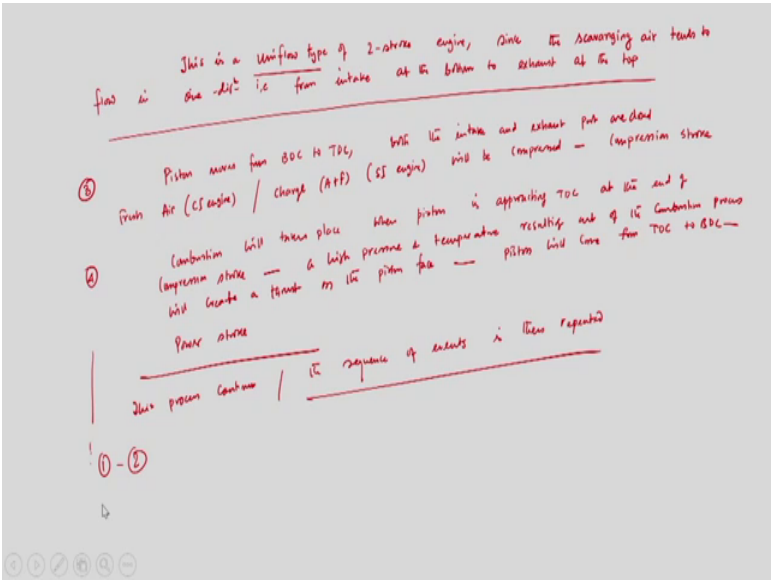

And this is known as this is uniflow type, this is very important I am underlying this line uniflow type of, this is a uniflow type of 2-stroke engine since, since the scavenging air tends to flow in 1 direction that is from intake at the bottom full exist in the top. Since this scavenging air tends to flow, tends to flow in one direction in one direction that is from intake at the bottom to top to the exhaust at the top exhaust at the top.

So, this is very important this is an uniflow type of 2-stroke engine, since the scavenging air I will write what is scavenging. Scavenging means see as it the air which is coming to the inlet to this into the cylinder during intake stroke it allows the, you know exhaust product to the soaked away from the cylinder. So, this process is known as scavenging.

So, the scavenging air tends to flow in one direction that is from intake manifold at the bottom to the exhaust at the top and this is known as uniflow type 2-stroke engine.

So there are other basic type of you know there are other basic types of basic types which are no valves with intake and exhaust being controlled by quote unquote this term, in some intake and exhaust manifold are located up to the direction of a cylinder while others. So, in some engines may have that intake and I will draw that intake and exhaust are exactly located in the opposite direction. So, I will discuss I will draw the schematic also.

So, now question is that in a two-stroke engine. So, if I go back to my previous slide that face here charges cylinder then I will write. So, I will write here that sequence 3 that. So, then piston moves from BDC to TDC intake both the intake the moment at which it crosses the intake manifold, both the intake and exhaust port are closed.

So, fresh air is coming when piston is travelling from BDC TDC to BDC during power stroke under pressure. So, the fresh air is introduced into the cylinder under pressure that incoming fresh air allows the exhaust work to go out. So, next stroke is that is to be come from BDC to TDC, both the intake and exhaust stroke port are closed and air, fresh air in case of a CI engine fresh air or charge that is air plus fuel mixture in case of a SI engine will be compressed fine this is an this is compression stroke and this is compression stroke.

Number 4; so, as I said you that whenever fresh air or charge is getting compressed at the end of the compression stroke. So, combustion will takes place when piston is approaching TDC at the end of compression stroke, at the end of compression stroke. As I said you in last lecture that it is not possible that combustion will be completed within a fraction of second. So, it is not possible that at the moment when piston will be exactly at the TDC entire combustion will be completed, is not like this. So, may be combustion will start when piston is little bit away from TDC and further it will be completed when is piston is travelling back from TDC, rather during the power stroke.

So, combustion will takes place when piston is approaching TDC at the end of the compression stroke and for that I am going to discuss we will require spark plug for SI engine or you can utilize the high pressure temperature of the air itself when fuel is injected through fuel injector into the engine cylinder. So, this is the compression stroke.

And then a high pressure and temperature, high pressure as well as and consequently the temperature I am not writing high pressure and considering the high temperature resulting out of the combustion process we will create a thrust on the piston phase. So, piston will come from TDC to BDC and this is again power stroke. So, we started our discussion from power stroke and we have ended our discussion to power stroke that means, but mind it we have only two different stroke compression stroke power stroke, but whenever piston is coming from.

So, this process this process continuous, is very important this process is continuous rather the sequence of event sequence of events is then repeated, fine. The process continuous the sequence of events is then repeated; that means, again we have to go back to sequence 1 and so 4, then 1, then 2. So, these process continuous sequence are even repeated, but what you have observed that we are having only two different strokes, one is power stroke another is compression stroke. But while we are having power strokes the engine construction rather operational principle itself allows to other strokes to happen simultaneously without having this two-stroke separately.

So, this is the cycle you know you know sequence of operation so sequence of within a 2-stroke engine, very important I will discuss two different issues. You know I will discuss in next slide that if I compare four-stroke engine two-stroke engine.

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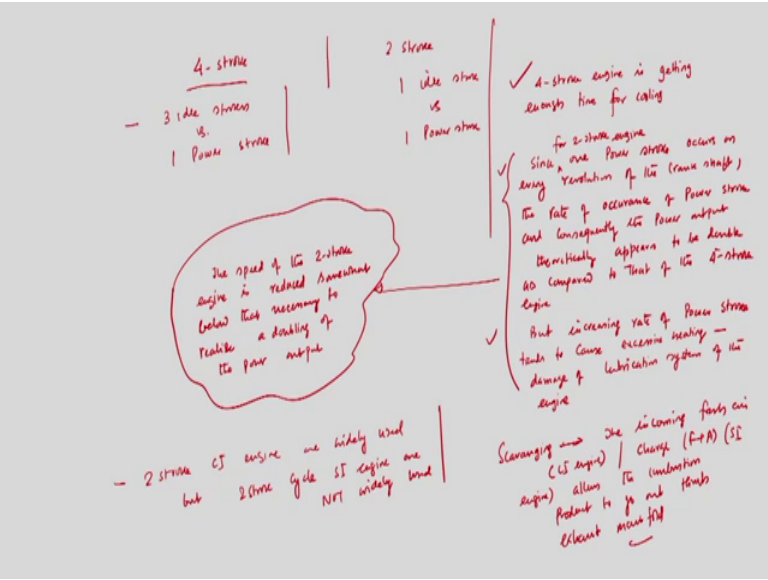

So, if I compare four-stroke and two-stroke engine four-stroke as 2-stroke engine. So, four-stroke engine we have 3 idle stokes versus 1 power stroke right in a 2-stroke engine we have one idle stroke versus 1 power stoke. So, because of this 4-stroke engine is getting enough time for cooling right four-stroke engines are getting enough time to cooling, you know on the other hand in case of a, but increasing the rate of power stroke ends to cause excessive heating this whole engine port and then can produce.

So, you know since 1 power stroke occur only every revolution. So, this is one, since one power stroke 1 power stroke since one power stroke is very important since one power stroke occurs on every revolution of the crank shaft on every revolution on the revolution of the crank shaft. Since 1 power stroke occurs on every revolution of the crank shaft this is very important, the rate of rate of occurrence rate of occurrence of power stroke and the consequent power output, the rate of occurrence of power stroke and the consequent and consequently the power output and consequently the power output appears to be double, theoretically appears to be double as compared to 4-stroke engine. Theoretically appears to be double as compared to that of the sorry 4-stroke engine whether it is SI or CI no matter 4-stroke engine.

Since for 2-stroke engine, 4-stroke engine but next point, but increasing power output increasing rate of power stroke rather the increasing rate power output rather, increasing rate of power stroke as you like the increasing rate of power stroke the increasing rate of power stroke it is very important tends to cause excessive heating. Tends to cause excessive heating very important for the surrounding engine port and can produce breakdown of the excess heating to the excessive heating leading to a damage of lubrication system lubrication system of the engine.

Although we have a engine cooling system, but increasing rate of power stroke tends to cause excessive heating leading to a damage of lubrication system of the engine, this is very important. So, and this is quite obvious that is what I have written in the left hand part of this slide that in a 4-stroke engine we have 1 in power stroke versus 1 3 idle stroke. So, of course, engine is getting enough time to cool down or cooling, but in 2-stroke engine is not happening. So, excessive heating may cause even damage of the lubrication system of the engine or sometimes it may try to create you know fat you know the thermal crack of the engine cylinder

So, it is very difficult. So, because of these 2 events what is done normally, because of this two it is very important that that speed of the 2-stroke engine2-stroke engine sometimes reduced to realize the doubling of the power output. So, because of the because of this the speed of the, speed of the 2-stroke engine2-stroke engine is reduced. So, because of this; so, since 2-stroke engine one power stroke apart from every revolution of the crank shaft the rate of rotation of power stroke and consequently the power output theoretical levels to be double as compared to that of the that of the 4-stroke engine.

But thus increasing rate of power stroke tends to cause excessive heating to the surroundings of the engines and sometimes it may leads to damage of the lubrication system of the engine. So, and because and but it is not desirable for the engine operation. So, what is done consoling this the speed of that 2-stroke engine2-stroke engine is reduced, it is very important is reduced somewhat whether that necessary, somewhat below that necessary to realize to realize a doubling of the power output, doubling of the power output. So, this is very important that this is very important. So, sometimes two steps speeder the 2-stroke engine is reduced, that is necessary to realize the doubling of the power output.

So, 2-stroke engine and I am writing two stroke, two-stroke CI engine although sometimes it is not problematic. But two-stroke you know SI engine are not used, very important that two-stroke cycle CI engines are not used very important that two-stroke cycles CI engines are widely used, two-stroke cycle CI engine are widely used. But two-stroke cycle, SI engines are not used you know are not are not widely used, are not widely used why? Because, as I said you that the process is known as scavenging; that means, scavenging is very important process, scavenging is the incoming fresh air fresh air for CI engine or charge that is fuel plus air in case of a SI engine allows the combustion product to go out through exhaust manifold and this process is known as scavenging.

But if it is CI engine we do not have any problem, because in CI engine we are taking air. So, may be incoming air is fresh air is coming a part or portion of the air will be going with the exhaust gas. So, we do not have any problem, but whenever it is SI engine not only here as of change is coming into the engine cylinder that is air fuel mixture. So, during the scavenging process so fresh charge is used to expel out the combustion

product a portion of the fresh charge I mean, fuel also will be lost with the exhaust gas or combustion product. So, efficiency will drop down that is when it is not you know it is not you know, desirable that that some portion of the fuel will go out with the exhaust product.

So, that is why 2-stroke engine2-stroke engine SI engine are not widely used rather 2-stroke engine2-stroke engine CI engines are widely used second thing very important that I will discuss that is very important that you know that one process. The scavenging process that is what I told you that it is eventually a process by virtue of which we can remove combustion product through the induction of fresh air or through the induction of charge, in case of a CI and SI engine respectively. So, it is really impossible, see if I talk about if I again draw the you know schematic of a SI a 2-stroke engine.

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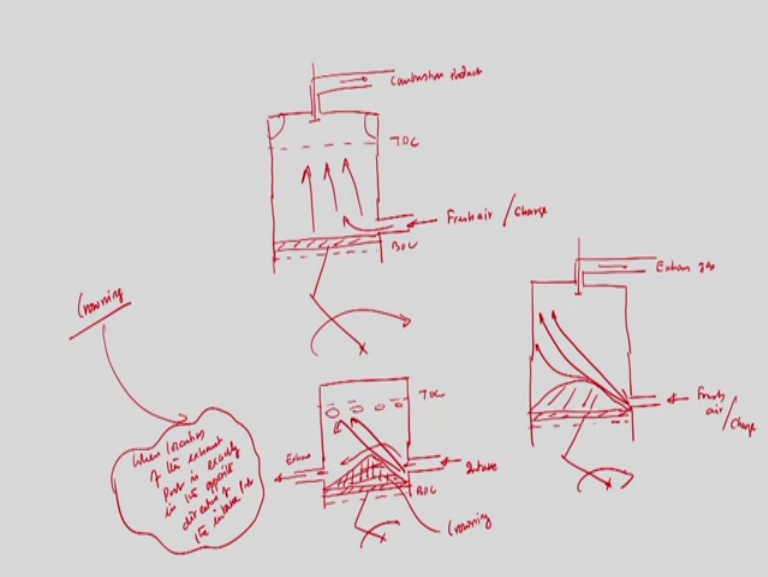

So, if it is schematic of SI 2-stroke engine, suppose as I said you sometimes you know. So, I am trying to define cases. So, this is either fresh air or charge. Now so, this is lets this is piston and this is BDC and this is TDC and this is combustion product.

So, we will have valve, this is valve. So, question is whenever pressure is coming and it is going out it is allowing the combustion product to go out, pressure is coming like the in this direction. So, it will go away and it will move in this direction. This is what unidirectional, in that case it is very difficult that the combustion product that is there in the remote location, remote location remote location will go out.

So, what is done normally to have a efficient you know removal of combustion product since, we do not have exhaust and intake port intake you know stroke separately these two strokes are happening simultaneously as a consequence of the power stroke. So, a special construction is done on the top of the engine cylinder, engine on the top of the piston phase so that at least the combustion product that is there in the remote corner can be removed, I mean to the extend postural and that is known as crowning.

So, what is done again what is done that we have so, you have a piston. So, we have piston and this is exhaust gas, this is fresh air or charge so here we have valve. Now since, this is unidirectional type of four type a 2-stroke engine, so essential to allow rather that the you know every combustion product that is there in the corner will go out. In particularly instead of having exhaust gas, exhaust port at the top, see suppose if we do not have exhaust suppose we have. So, crowning what is done, we are providing a safe like this. So, that it will go like this, air will go and it will allow the combustion product that is there at the corner to go out.

If the intercode is located at the top still we do not have the problems that much, but as I said you that there might be a case where, exhaust port might be exactly located of in the opposite direction of the intake port. So, in that case intake port and that is exhaust port right.

Now, if piston is located over here and this is BDC, this is TDC either you have a fuel injector at the top I did not draw fuel injector or spark plug in this case because these are obvious, we should have in case of a CI engine and SI engine respectively. So, it is the case even if the exhaust port is located exactly in the opposite direction of the intake ports; so, then fresh air might come and it may go like this and it may move in this direction. So, the combustion product that is there over here that may remain over there. So, in that case the when location of the exhaust port crowning is essential, when location of the exhaust port is exactly in the opposite direction of the intake port. So, this is very important.

Crowning is essentially a special type of construction which is placed at the top of the piston so, that since in a 2-stroke engine2-stroke engine we do not have a intake and exhaust stroke separately and it is happening as a consequence of the power stroke and these two-strokes are happening simultaneously. Crowning is special type of

arrangement which allows fresh air to go at the corner portion so, that the combustion product that is there at the corner portion the corner locations will go out. So, this is essentially to remove there are to efficient removal of the combustion product and this is very much essential when exhaust and intake port are exact, located exactly at the opposite direction to each other.

So, now in that case we have to have crowning, we have to have crowning like this that is m this is called crowning. So, this is crowning, so that fresh air will go like this and it will allow the combustion product to come from the remote areas ok. Another important part is that in case of a you know multi-cylinder engine. You know I will discuss in the context of that in case of multi-cylinder engine.

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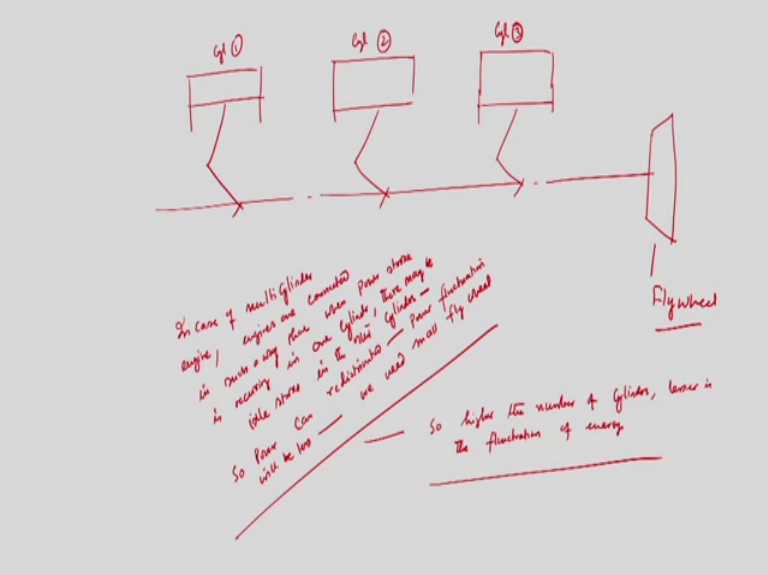

Suppose you have multi-cylinder engine umm we have a common shaft so this is flywheel; so this is flywheel right. So, in case of a multi-cylinder engine, in case of a multi-cylinder engine at least we have another one cylinder. So, in case of multi-cylinder engine you know engines are connected in such a way that so I am writing, in case of multi-cylinder engine you know engine shaft engine, engines are connected in such a way that when power stroke is occurring in one engine rather in one cylinder. So, this is cylinder 1, this is cylinder 2, this is cylinder 3. So, occurring on 1 cylinder there may there may be idle strokes in the other cylinders. So, power can be redistributed, power fluctuations will be less and we need small flywheel.

I will discuss again, maybe I require another one to two minutes time flywheel. So, from there we can take till. So, greater the number of cylinder so higher the number of cylinder, higher the number of cylinders lesser is the fluctuation of energy. So, this is very much important. So, in case of multi-cylinder engine engines has to be connected in such a way so if you connect engines in such a way that whenever you know that at a time for in all cylinder power stroke is happening. So, there will high you know huge power fluctuations and you have to have to observe all powers at a same at a given time we have the higher flywheel. And to observe that higher fluctuation you have to have higher flywheel of flywheel mass will be increased

But rather if you can arrange in such a way that, may be when you know power stroke is happening in that one cylinder 2 and cylinder 3 we have idle strokes. So, we can redistribute the power rather fluctuation will be less and still we can have you know very you know smaller flywheel rather mass of the flywheel will be less.

So, from this we can say that if the higher the number of cylinders these are lesser is the fluctuation of energy if you can arrange in this line such a way. So, with this I stop my discussion today and we will continue our discussion in the next class.

Thank you.