

Mining Machinery
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Module - 02
Lecture - 03
Prime Movers

Welcome back to our discussions on Mining Machinery. Today we are going to discuss one of the important aspects of machines is Prime Mover.

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Prime Movers

Prime Mover is defined as a machine or component that converts energy from an energy source into motive power. Thus it **imparts power or motion to another device**. For example a turbine that turns a generator, or an engine or motor that powers a drive train.

A tractor unit of an articulated truck or a trailer is a heavy-duty towing engine that provides motive power for hauling a towed or trailered load

Diagram: A blue box labeled 'Working Member' is connected to a grey box labeled 'Prime Mover' by a blue line. The 'Working Member' box contains a yellow circle with a blue arrow pointing clockwise, indicating motion or power transfer.

NPTEL

Now, you know that all these machinery mining machinery, they are basically; they have got a working member. As you can see in any machine, the working members are having some

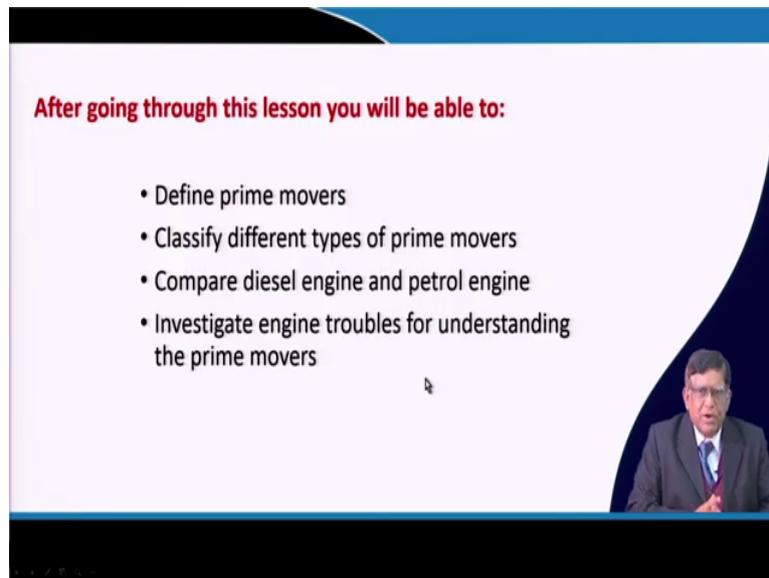
motions; that is it may be having a rotary motion or it may be having some translatory motion.

Now, to give that working member maybe a bucket, may be a cutting tool, maybe a hammer whatever it is that member will have to be powered and that energy it is coming from the prime mover. So, this prime mover it is defined as a machine or a component that converts energy from energy source into motive power. That is if this motion it can be, in some cases if it is in automobile or in cars and all; we are having the prime mover to drive this wheels, so that the our car can advance.

So, that basically the prime mover imparts power or motion to another device. So, for example, in a turbine that turns a generator or an engine or motor that powers a drive train. So, this is what exactly a prime mover. So, this explains that your in machinery or while working in the mines your that, if the prime mover is not properly selected, either you will be having a high of that energy bill or you will be finding difficulty in providing the necessary energy for the working components.

So, a tractor unit or any articulated dump truck or trailer, they have got a heavy duty towing engines that provides motive power for hauling a towed or trailered road. So, sometimes even in that on the road, you may see there are very multi axial trucks. So, those are they are hauling a huge loads on it; but there the basic thing, the prime mover is the first front portions where there is the whole energy for moving it, it is provided.

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After going through this lesson you will be able to:

- Define prime movers
- Classify different types of prime movers
- Compare diesel engine and petrol engine
- Investigate engine troubles for understanding the prime movers

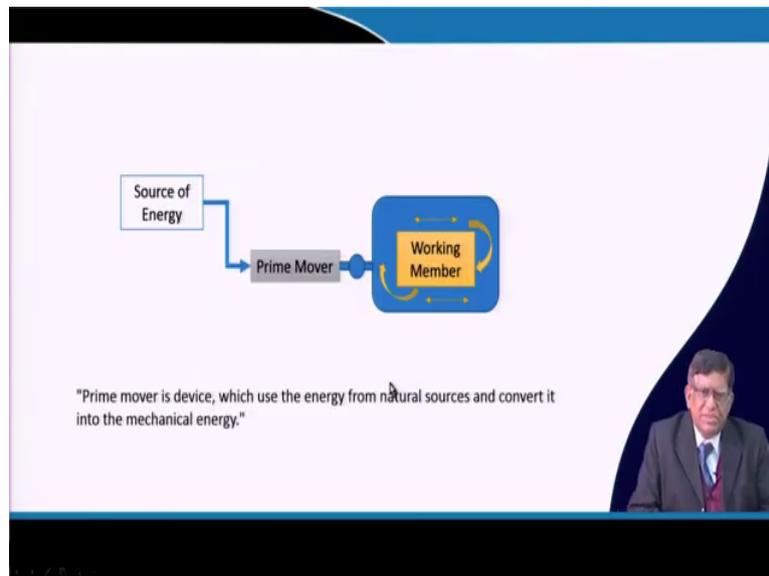
So, today's lesson our main objective is to define prime mover, which we have just already told. Then you should be able to classify different types of prime movers and then some of the things you may basic knowledge you are having. You might have seen diesel engine and petrol engine.

But do you know exactly what is there or if you after this class you will be able to answer, if someone ask you that what will happen if in my car, in if it is a petrol car, if I put in diesel here what will happen or in my diesel driven car if I put some petrol what will happen, this type of simple questions that we will be trying to discuss today.

And then after knowing these things, you will be able to do your own self studies; you will be able to investigate from the internet or other literary, literature of engineering, technical

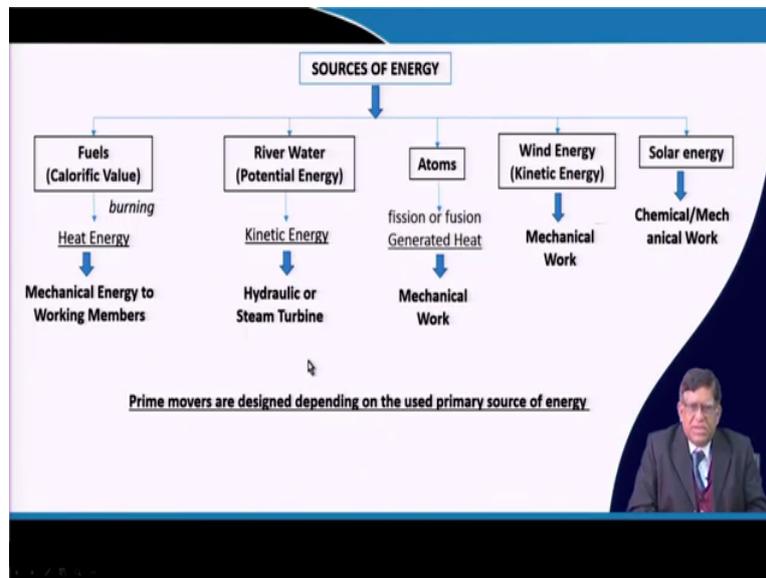
literature from there you will investigate,, what are the different type of troubles that a prime mover can give for the running of the machines.

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So, let us let us see here. So, what should be there at; to become a prime mover, it must have a source of energy, from where it is coming exactly there also a certain conversion taking place and some devices is there and from there the prime mover is going to the working member. So, how we can say define; it is a device which is uses the energy from the natural sources and convert it into a mechanical energy.

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So, here we are considering it is a just energy conversion. But thing is that ,what could be those sources of energy? You know that all whatever we are doing by our engineering, it is basically we are using the energy which are naturally available; from there by our ingenuity, we have engineered it to do our work.

As you see that basically all sources of energy are natural; if you say it is a fuel, it is a river water, it can be atom in nuclear or in a wind energy your wind, air, atmosphere or the solar. The thing is anthropogenic or human developed, it is all are natural.

Now, in the fuel you know that, this is a fossil fuel, maybe coal, may be your natural gas, it can be petrol; these have got certain calorific value and which is exactly when it is burnt, it

gives heat energy. So, once we get the heat energy that, you can convert to mechanical energy and which can be sent by the prime mover to the working member.

Similarly, you have got the river water, they have got basically a potential energy; where there is a river water, it can be used by two ways. One is because if the water in river is having a current; because of there is a current in river is basically a difference of the potential energy, water from high potential energy it will be flowing to the lower.

So, whenever there is a elevation level, it will flow and if you can make the water to flow; it will be having its kinetic energy, from the potential energy, it is getting that kinetic energy and that kinetic energy you will be driving the turbine, which will becoming a prime mover for driving a shaft for doing any operations.

Earlier there were many riverside that is say for irrigations and other things, they were running this water wheel for raising water and all that there are the main prime mover they used to use this water energy. Or you take the water from the river and that one you convert it to steam to run drive the steam turbine; that is also another way of using those water.

Other thing you know in a nuclear energy, it is basically the energy is there in the atom which is naturally available, which will be exactly the human ingenuity has come brought out the fusion and fission reactions to be taken place over there. And that ultimately it generates heat and from there as any other of the heat energy conversion processes, it heat can be given to mechanical work.

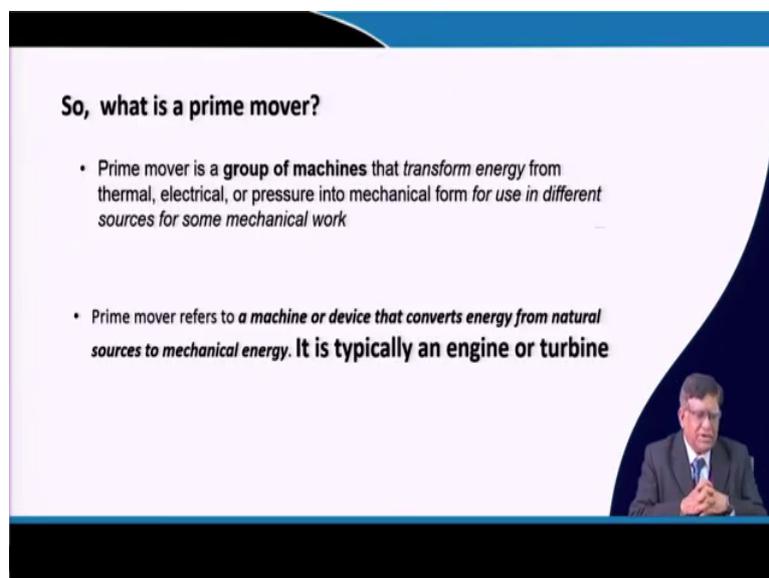
Similarly, we have got the wind energy; from the they have got the wind has got this kinetic energy; you know that natural wind energy is again coming; it is basically from the solar.

And that say from the heat energy, we are getting a motion in the wind and that wind velocity is converted to a mechanical work by some devices and then we are going to get the prime mover. Other thing is the solar energy, which can be used in the form of heat or sometimes it

is just to get certain chemical reactions from that we get a; so from there we can get by chemically converting to different form of energy.

So, I hope now you understand that, there are different natural sources of energy; from those sources of energy, we will have to make this prime mover. And there depending on this source of energy, there could be different type of prime mover. As an engineer your job is to design, your job is to design a prime mover depending on the type of work you want to do.

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So, what is a prime mover?

- Prime mover is a **group of machines** that *transform energy* from thermal, electrical, or pressure into mechanical form *for use in different sources for some mechanical work*
- Prime mover refers to *a machine or device that converts energy from natural sources to mechanical energy*. **It is typically an engine or turbine**

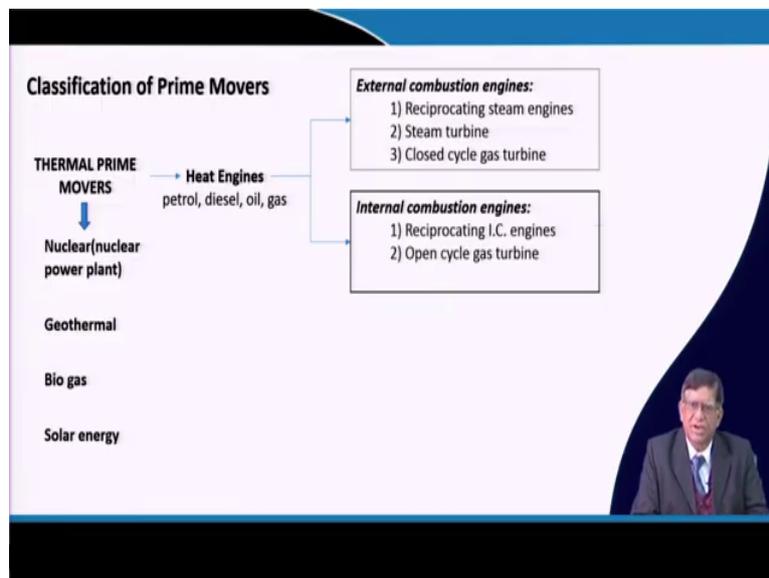
Video inset: A man in a suit and glasses speaking.

Now, in, so you can now tell, what is a prime mover? You can think you can note it down; prime mover is a group of machines that transform energy from thermal electrical or pressure into mechanical form for use in different sources for some mechanical work.

So, that is a prime mover. So, basically it refers to a machine or a device which is used only for energy conversion.

So, then it could be a typically we see in mechanically, it can be an engine or turbine or in some cases, we will be finding, we will in a different class we will talk about the other prime mover is your electric motors. Once you from the different source of energy, you get electrical energy; from there you can make electric motor, which will be also a prime mover. Today we will not be discussing about the electrical part of it.

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Now, that what, how will you classify this different type of our prime mover? So, basically what we see, we have seen already; then from the sources of energy, our we have the thermal prime movers and they are basically from the heat engine. And here you have already studied

in your earlier classes regarding your thermodynamics and the IC engines; you studied about this petrol, diesel and gas engines. And here basically it is a combustion engine.

So, as we said earlier, it is a fuel; you will be that burning either diesel, gas or petrol and they will be exactly generating this heat. Now, whether this combustion is taking place internally or externally depending on that. That earlier when the steam engines were developed in the 17th century, 18th century; there we were having external combustion engine.

There where you may see some of the old photographs over here that when; even this shovel for that a side by side a big steam engine you are running and from there for excavating this say coal, how a steam engine powered shovels were working at the end of the nineteenth century.

So, there are reciprocating steam engines were very common; this is one of the oldest or a that is say we must appreciate the engineering design that made about a centuries ago. And then there were steam turbine and then gas turbine, they were used; later on with the when that electricity were generated by using this turbines, that led to a whole developments..

And those of you who are nowadays studying the history of industrial revolutions; because everybody is talking about industry 4.0. And by telling industry 4.0, many of you might have studied the history of what is industry 1.0 revolution, what is industrial revolution 2, what is industrial revolution 3. In the industrial revolution 1, the steam engines were there as an external combustion engine.

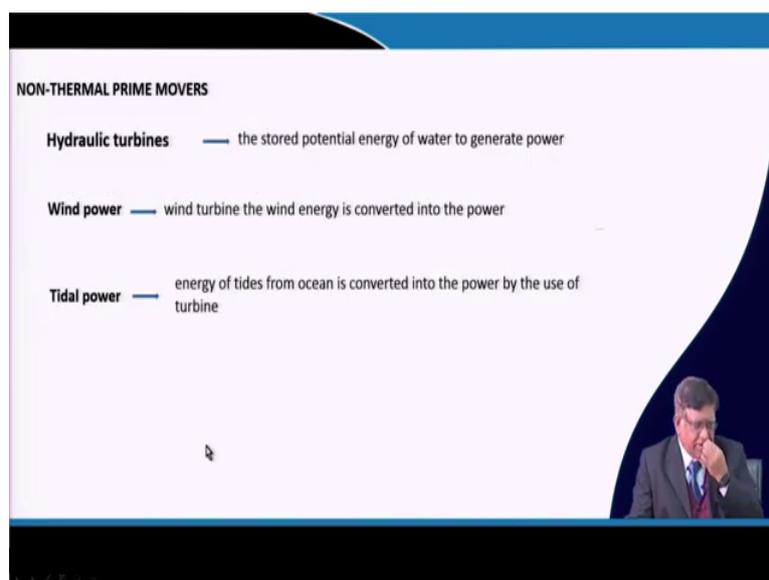
Now, after that we got this internal combustion engines, they brought a different type of revolutions in the nineteenth century. When exactly with the Ford company and all which came and brought on this your car and then the with the car and other industrial activities started doing it. So, here we have got this reciprocating IC engine, open cycle gas turbine engine, different type of engines are there; out of this, there are other type of thermal this prime movers which are converting from the nuclear energy.

We are not going to detail of it, this is for your general knowledge and information's, you should have that; that means this energy for doing work, it can come from the geothermal.

In the geothermal sector as a mining engineer, you may be little bit interested; because the geology it plays a big role and the geothermal energy, there exactly to exploit the geothermal energy, the mining engineers may do lot of geological knowledge to drill hole to go into the deeper things, to make the water to move and all that is there.

But the other form of energy biogas energy, solar energy those are also converted to get.

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But thing is that this conversion to as to become a prime mover, it basically requires this turbines.

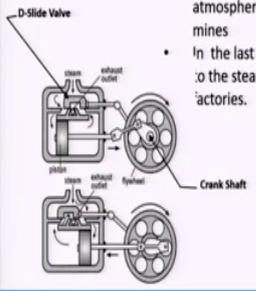
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Development of Prime Movers

Steam Engine:

- **Thomas Savery**, patented a means of pumping water out of coal mines by steam power in 1698. His device did not have a moving part and is not called steam engine
- In 1712, **Thomas Newcomen**, working with Thomas Savery, invented an atmospheric steam engine as an improved device for pumping water from coal mines
- In the last quarter of the 18th century, **James Watt** invented several improvements to the steam engine that made it into a device that could be used for power in factories.

When water is converted to steam volume increases. How much?



The diagram illustrates the basic components of a steam engine. It shows a horizontal cylinder with a piston inside. Above the cylinder is a D-slide valve mechanism that controls the flow of steam into and out of the cylinder. The piston is connected to a crank shaft, which is further connected to a flywheel. Labels indicate the 'D-Slide Valve', 'steam inlet', 'exhaust outlet', 'piston', 'exhaust outlet', 'flywheel', and 'Crank Shaft'.

The turbines you know exactly what a turbine is, the turbine will be basically sorry; that your turbines they will be having the, there will be number of things over there. Exactly in a turbine, we are having this non thermal prime movers that could be hydraulic turbine that wind power and tidal power.

In case of this stored potential energy of water that generate turbine; that means you might have heard that your tidal power stations, what they do exactly, high pressure water they are move into the turbine. In a turbine, basically we are having there is a your as an impeller form; that means when on a wheel, on the blades if the high pressure of fluid is flowing, at that time it will be rotating and with that when a shaft is connected, that will be taking out the things and we can make it move.

So, similarly in the wind power also, we have got in the windmill that blades which are exactly; because of the wind, they are getting a rotations, from that rotations exactly they are going to generate this electrical energy.

Similarly, we have got the tidal power. In the tidal power, energy of the tides from the ocean is converted to power by use of turbine. So, this basically you have now learned that the prime mover can be generated from different; that is it will be generated or it will be making to use this different form of energy to do a useful work.

Now, let us see that you as I told that, steam engine it is a in the 17th century it started and then in 18th century it exactly started growing and that this Thomas Newcomen, he developed a lot of things from the earlier crude mechanism. But the credit goes to the 18th century engineering work of James Watt, who made the steam engine. And this whole steam engine as a their uses initially it started in the coal mines; later on you know about that how the steam powered locomotives are working.

Now, basically in a steam engine, it is a reciprocating engine; if your steam is allowed to enter through a chamber, then it will be pushing it, then we have got this crankshaft by which this crank mechanism that translatory motion is converted to a rotary motion and that wheel rotates. So, this was exactly and then when in the next stroke that steam used one will be going out.

So, like that this your with a crank mechanism and reciprocating motion of the piston that steam engine used to work, and this type of engines were they are most feasible in our Indian railway still 20 years ago all, most all the long distance trains were having this coal power; but nowadays this has been taken by the diesel engines.

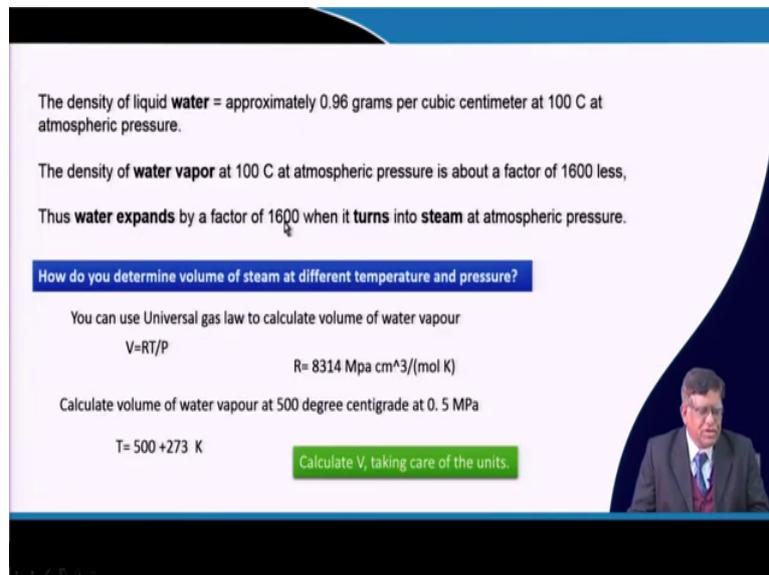
But here this steam engines were basically done during the early 20th century, almost everywhere this was the main prime mover. But the main thing is there that, steam is generated from burning of coal and then heating of water. The Basic importance over here that is what is that volume of that steam will be coming; now by burning the say coal you are

generating the heat, but the main uses is being done by the vaporizing that is your water vapor which is generated from water.

So, water is becoming steam and in that, exactly the volume is increasing; that because of that volume, you will have it will be able to, when your high volume is brought into a less volume less volume of space, it will be generating that pressure by which it will get the necessary energy to push this piston move.

So, that is why, then there is a exactly how much volume will be increased; when you convert water to steam exactly from one kg of water, how much volume of steam you will be getting, that will be depending on under how much pressures and that at what temperature you are following.

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The density of liquid **water** = approximately 0.96 grams per cubic centimeter at 100 C at atmospheric pressure.

The density of **water vapor** at 100 C at atmospheric pressure is about a factor of 1600 less,

Thus **water expands** by a factor of 1600 when it **turns** into **steam** at atmospheric pressure.

How do you determine volume of steam at different temperature and pressure?

You can use Universal gas law to calculate volume of water vapour

$$V=RT/P$$
$$R= 8314 \text{ Mpa cm}^3/(\text{mol K})$$

Calculate volume of water vapour at 500 degree centigrade at 0.5 MPa

$$T= 500 +273 \text{ K}$$

Calculate V, taking care of the units.

So, the basic principle, there exactly you will be using the universal gas law. So, if your that for a normally what happens; in a normal what at 100 degree 100 degree centigrade and at one atmospheric pressure that, if your water vapor is density is 1600 time less. So, that is why, as because the density is less, the volume will be more.

So, that is a very simple principle and that principle when you use it the universal gas law is applicable there and if the universal value R value is known that is 8314 Mega Pascal per centimeter cube per mol Kelvin.

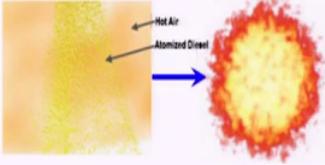
So, and if we want to find out say, at a particular at 500 degree and at say 0.5 Mega Pascal; what will be the volume of this your water? You can calculate it out, you can use this formula, use these values; then you can calculate it out. So, like that if you know; that means, if now you know that much of steam if you are putting into a small chamber, that exactly how much pressure it will give on to the piston and with which it will be moving?

So, there those mechanical engineering part comes over here, which becomes the main calculations in determining how it will become a prime mover.

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[Utube vedio on diesel engine](#)

Operation of a diesel engine is all about producing high temperature and high pressure air continuously.



When an atomized form of diesel is made to contact with high temperature and pressure air it leads to the release of chemical energy

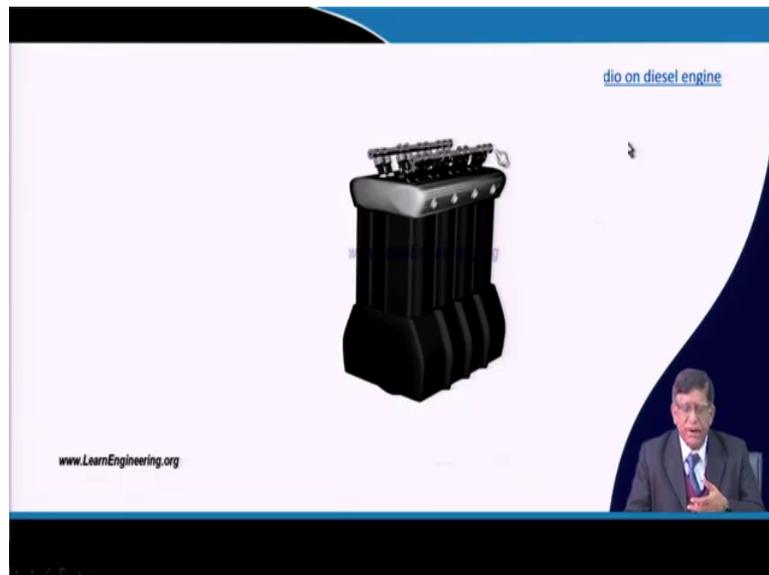


But the next thing is, you need to know that, there is a how we get this diesel engine and that your the petrol engine they work? Exactly there also we are not making, just like you had in the water and expanding into steam; here also with the burning of that your burning of fuel and that exactly that fuel is atomized and then a huge amount of a thrust, that is exactly this is a the sudden expansion in that your as a form of gas which is produced by burning of this fuel that gives the pressure.

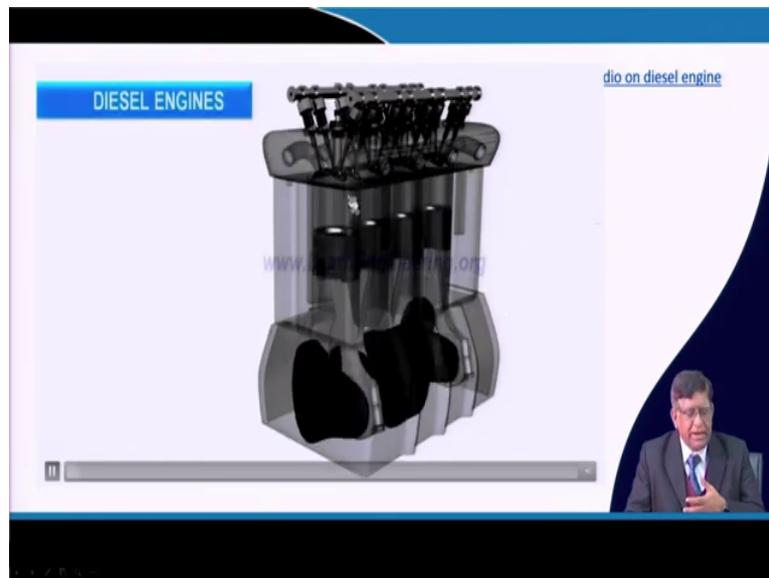
So, in your any IC engine, internal combustion engines you have already studied; that is your wind is atomized fuel and that air, they are going into a closed chamber. As soon as they burnt, then they create that volume expands and because of that, they give a pressure and the pistons they start reciprocating motion. And from that reciprocating motions exactly by the crankshaft, your it starts giving a rotary motions.

So, you can see there are it will be, you will have to go to different operating very good videos are there in YouTube; you please go over there and you can see that.

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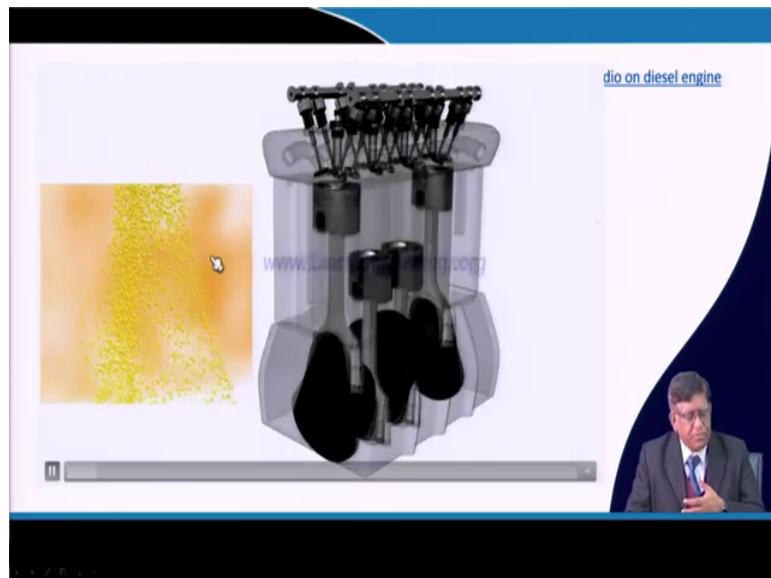


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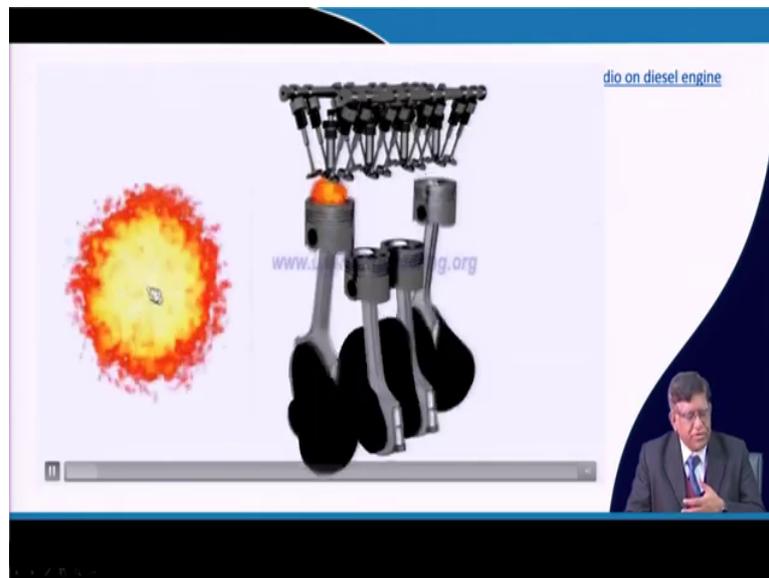


Then you will find, see this is if a how it works. If you go to see a in a diesel engine, exactly that when your fuel is burnt over here; that is we are going to get this piston is moving and that crankshaft is rotating.

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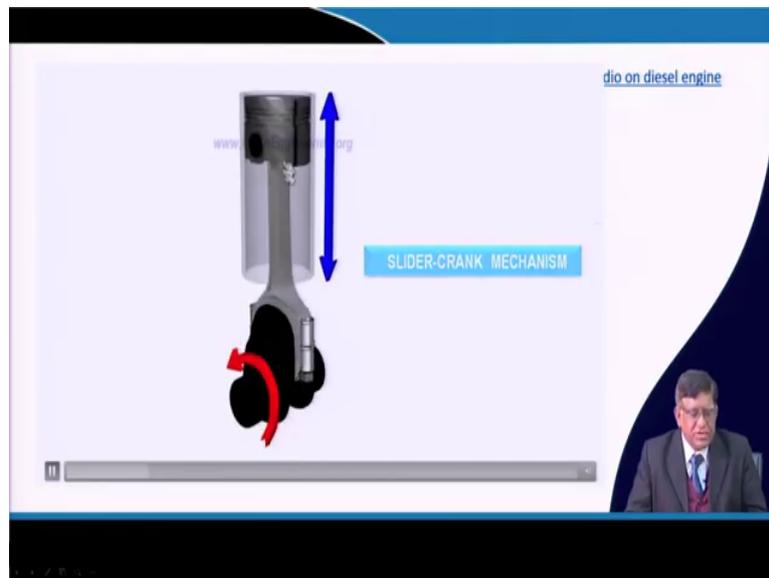


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So, this here we are having a force cylinder that in that above this wind is our fuel is being sent and then there is at a particular sequence, which is called your firing sequence, there they burn. Say first one this one, then three, then two, then four; so like that they are being burnt and that with that fuel, it will be that your engine is getting this motion and that becomes the prime mover.

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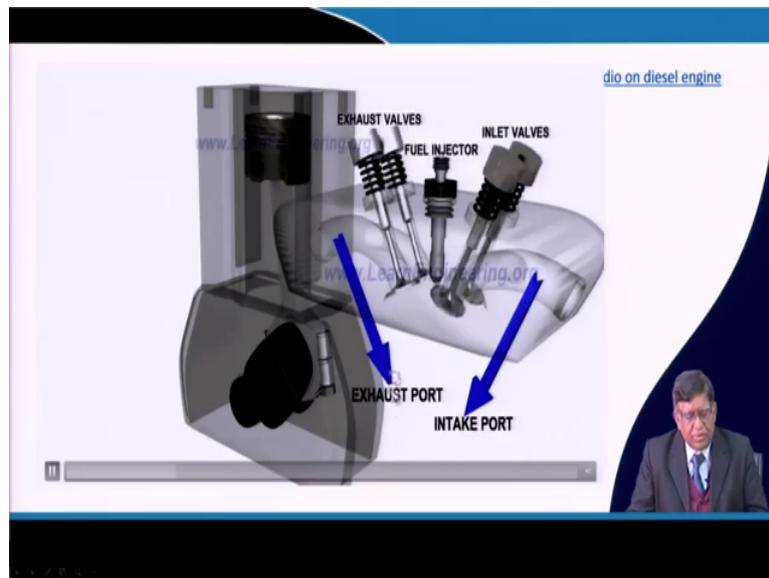


So, that is the main thing in that component is your this piston, which is having that your correcting dot and that is your crankshaft. So, this motions which is exactly the slider crank mechanism, this translatory motion is converted to this rotary motions and then it becomes the prime mover, which is connected to your any shaft for doing work.

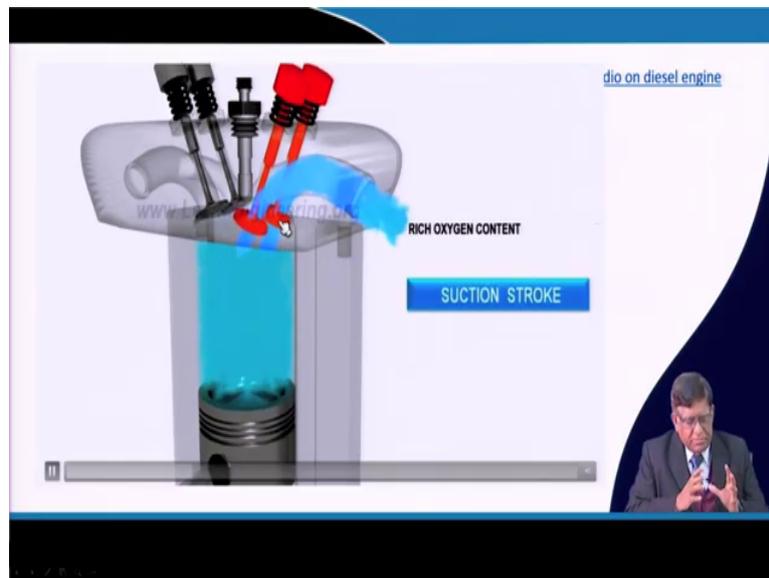
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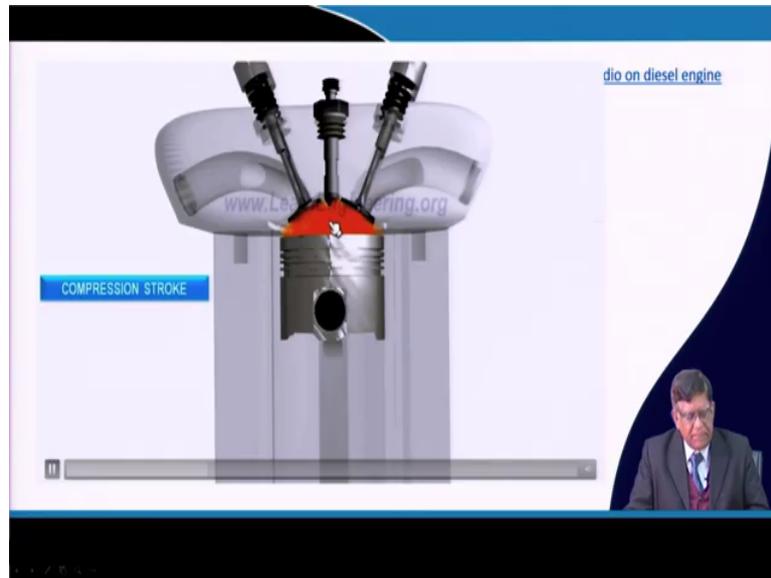


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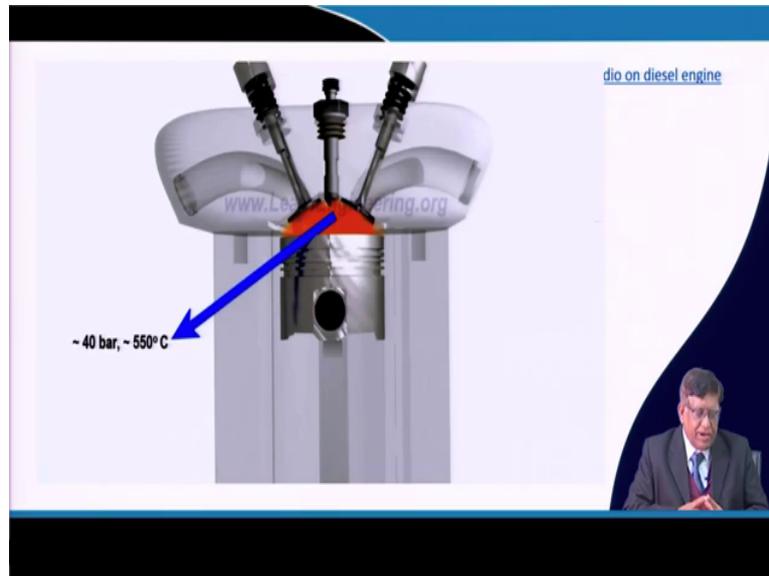


So, that all these things are brought into a engine block and then this is your how your; after burning your this say, there is a exhaust port. So, through that your exhaust will be going; so that means in case of your a engine internal combustion engine, your fuel and air is put over there.

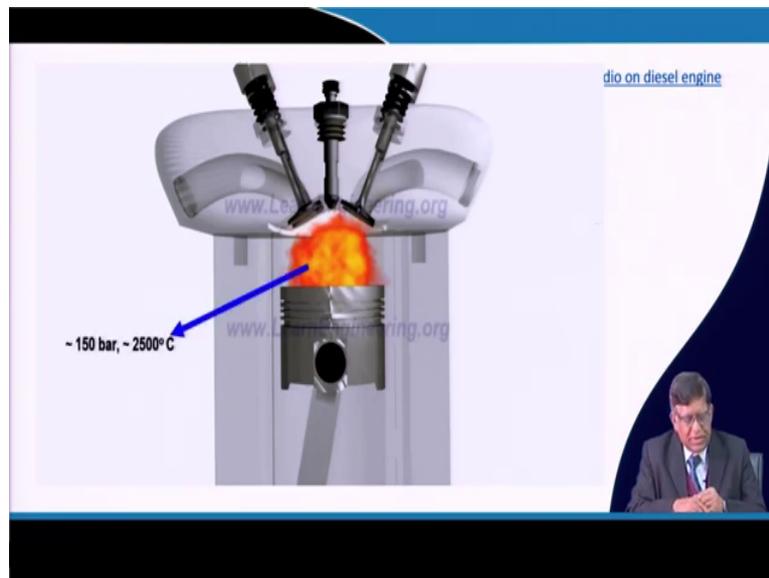
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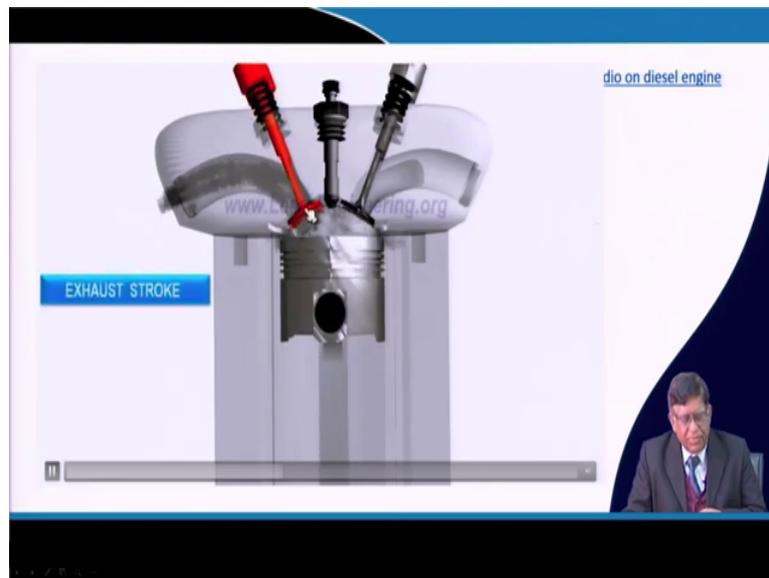
And within that chamber it get compressed and at that time it in the compression stroke, then there will be your; it will be it will be ignited there by. And under that high pressure and high temperatures this will when it will be expanding, it will be it is now getting fired.

And after getting fired, this will be pushing the piston down and this reciprocation motion which that piston is getting at that time, there will be; that is exactly then your the temperature reducing.

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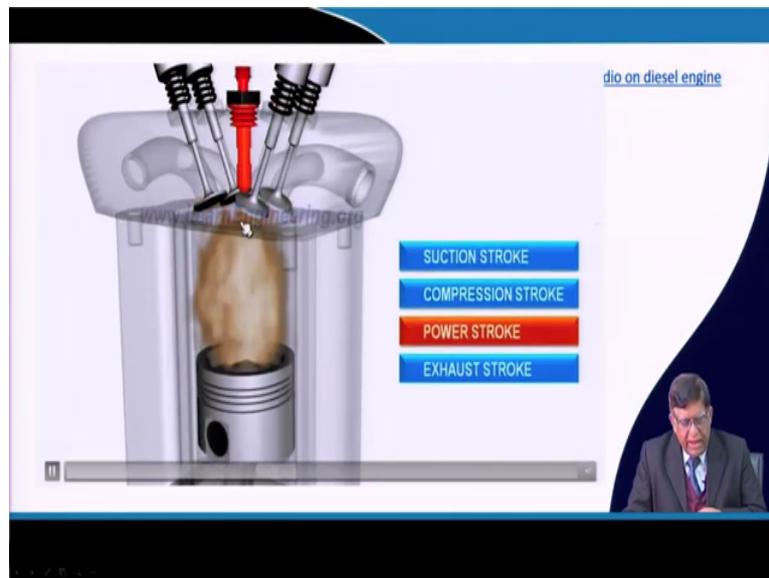


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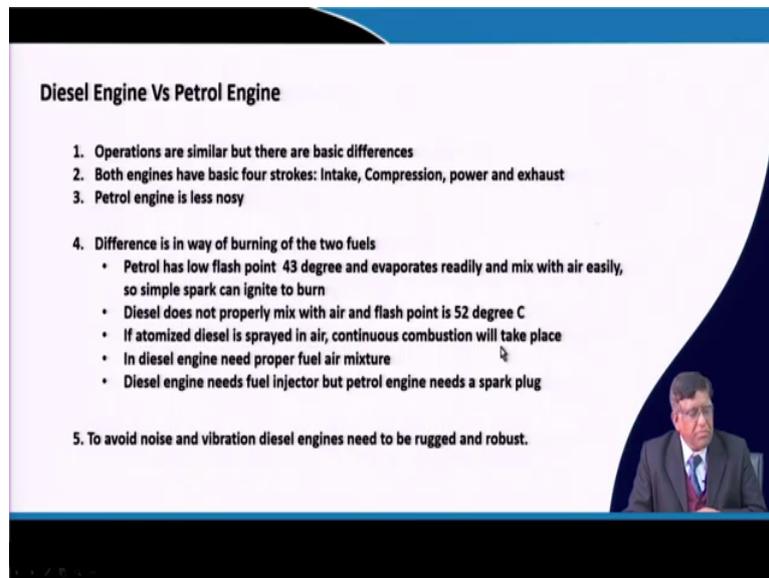
And then because of the crank rotations, this exhaust that is whatever the burnt out gases and all, it will be in the next stroke. When it is giving this your power stroke after that, it will be pushed up in the next compression thing this is; this is going out, your exhaust gases are going out and by opening up the this valve.

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And next one is again it will be going down, your this inlet that valve is opening and then the fuel and air is coming. And this is the system how in this four stroke, a four stroke IC engines will be keeping on working.

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Diesel Engine Vs Petrol Engine

1. Operations are similar but there are basic differences
2. Both engines have basic four strokes: Intake, Compression, power and exhaust
3. Petrol engine is less noisy
4. Difference is in way of burning of the two fuels
 - Petrol has low flash point 43 degree and evaporates readily and mix with air easily, so simple spark can ignite to burn
 - Diesel does not properly mix with air and flash point is 52 degree C
 - If atomized diesel is sprayed in air, continuous combustion will take place
 - In diesel engine need proper fuel air mixture
 - Diesel engine needs fuel injector but petrol engine needs a spark plug
5. To avoid noise and vibration diesel engines need to be rugged and robust.

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So, this you can find out such type of this videos are there in your YouTube, number of them are there please see. Now, the here a question come that is your, you have seen diesel engine, also you have seen your petrol engines.

Now, by they are all four stroke engines; if you see that they have got also this your 4 stages, four strokes, but the system is different. One thing is that is your, you might have observed that the costly new petrol cars and all they give the engine is very less noisy.

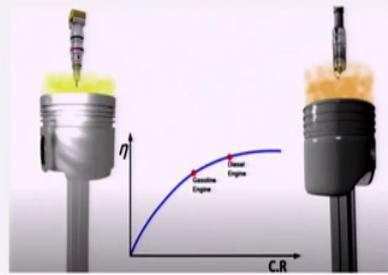
But here the main reason is they say, petrol has got low flash point and that is why they can be very easily ignited and then this say diesel engine has got a very high flash point and there, they you will have to give this atomized diesel and air will have to mix and that will have to be burnt.

So, that is why in a petrol engine only a spark plug is there by which it get ignited; but in case of diesel engine, you will have to get a fuel injector to atomize it and that is why there the fuel will be burned as a continuous burning flow.

But in case of this uninstantaneously it will do. Now, as because in a there will be a more thrust in case of your diesel engine, so it will have to be more robust; that is why you will find that the light vehicle weights are all having a petrol engine, but diesel engine equipments are normally heavier.

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- Diesel engine high compression rate (18-24 than petrol engine , which is 8-10. High compression ratio can give knocking or self ignition.
- Higher the compression ratio, better is the efficiency, thus diesel engine has fuel economic than petrol engine.



The slide contains a graph showing the relationship between efficiency (η) and compression ratio (C.R.). The curve shows that efficiency increases with compression ratio, and the diesel engine (represented by a blue dot) operates at a higher compression ratio and higher efficiency compared to the petrol engine (represented by a red dot).

Now, that is say you can see the efficiency; that is depending on your this compression ratio and the efficiency are related.

In case of your petrol engine; their efficiency is less, but because their compression ratio is less. But in case of your the diesel engine, the efficiency is better; because compression ratio is higher. You can see that in case of diesel engine, there will be fuel injector and here it is a spark plug.

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Can you put diesel in petrol engine?

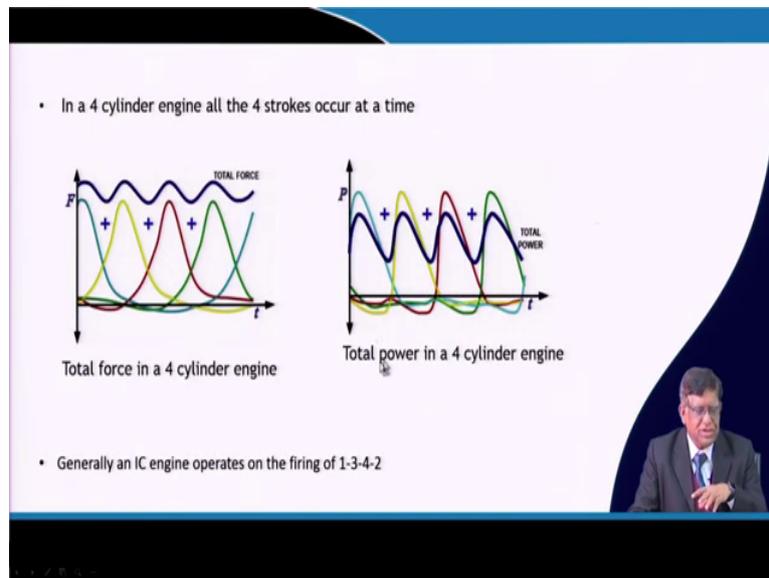
Diesel is less volatile and will not mix properly with air.
Petrol in diesel engine will be putting some eminence problems as extra energy will be available.

How the translator motion in the cylinder is converted to rotary motion?
(Using Slider-Crank mechanism linear motion of the piston is transformed into rotary motion at the crank

So, these are the some of the things. So, you cannot put a diesel engine into, diesel into a petrol engine or a petrol into a diesel engine; because diesel is less volatile and will not mix properly with air.

So, if you put in a petrol engine diesel, it will not get burned and you will not be able to drive; your energy that your it will stop, car will be knocking, giving heavy vibrations, you will be damaging the whole engine over there. So, never do this mixing.

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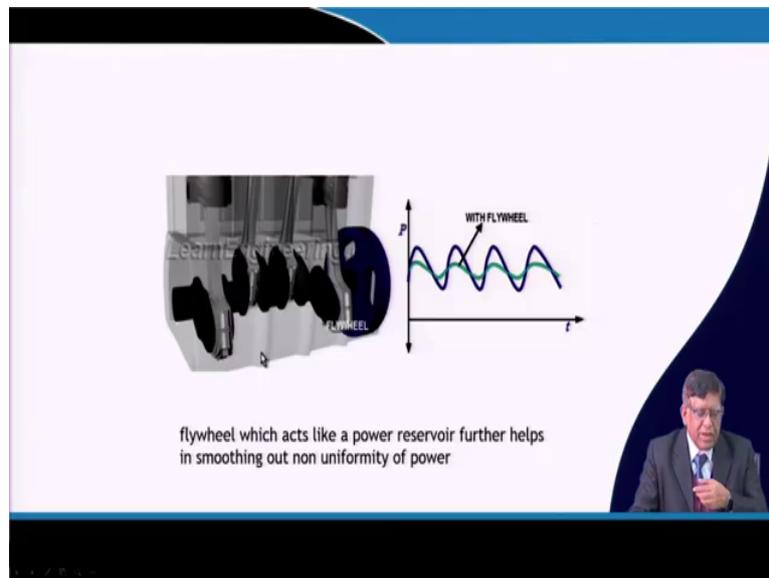


And that exactly the total this say, in a 4 cylinder engine, all the 4 strokes occur at a time. So, all the time this force are as you have seen in that, the animated video; that your that all the things are going together.

So, you are getting a total force which is in a uniform manner. So, this is a, you can see that their firing sequences were also the first cylinder, third cylinder, fourth cylinder, two cylinder, second cylinder.

Then in that firing sequence, it takes and then we get a uniform energy source.

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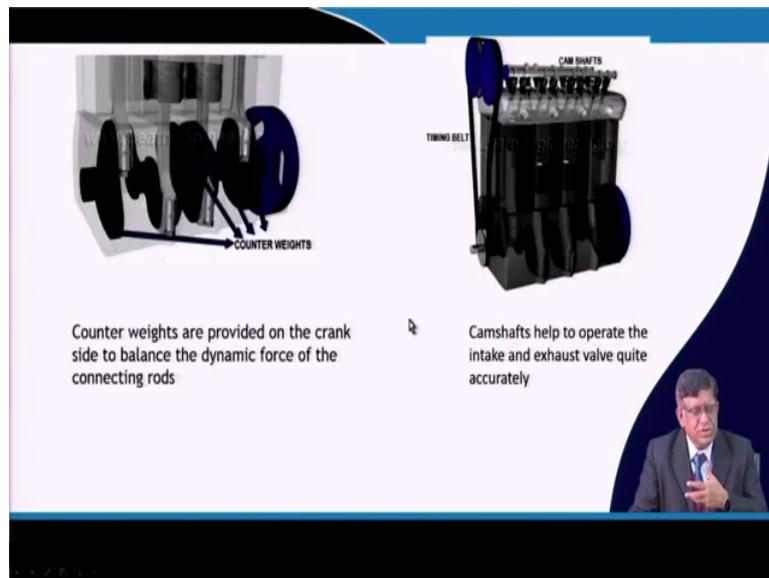


The slide features a 3D cutaway of an engine on the left, with a blue flywheel labeled 'FLYWHEEL' at the bottom right. To the right of the engine is a graph with a vertical axis labeled 'P' (Power) and a horizontal axis labeled 't' (Time). Two waveforms are shown: a blue line representing power without a flywheel, which has sharp peaks and troughs, and a green line representing power with a flywheel, which is significantly smoother. An arrow points from the text 'WITH FLYWHEEL' to the green waveform. Below the graph, the text reads: 'flywheel which acts like a power reservoir further helps in smoothing out non uniformity of power'. In the bottom right corner of the slide, there is a small video inset showing a man in a suit and glasses speaking.

So, this is exactly how a flywheel is an important part in an engine; because this flywheel is there, this will exactly smoothen. If you because at first, third, fourth and second; we are having this firing sequences, so that is a power available is that blue line.

But because of the flywheel, when there is a in between the firing date, it gives and it exactly smoothen the power outputs, the smoothening takes place.

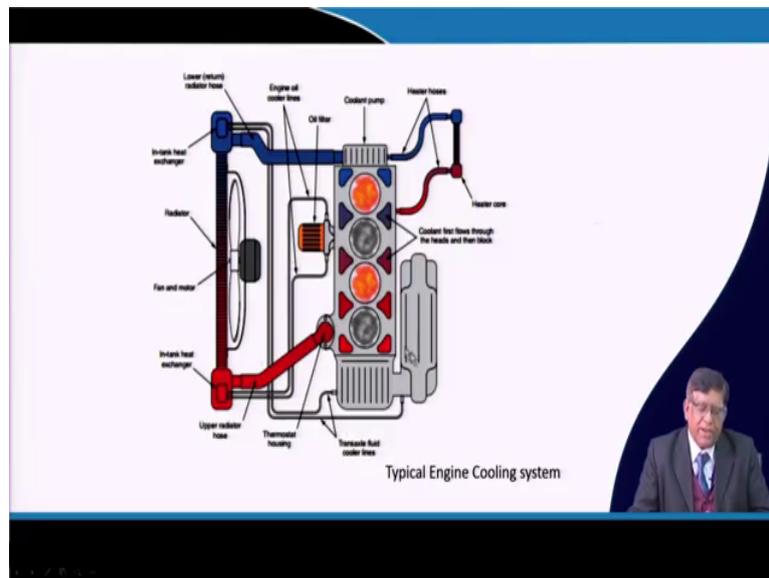
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So, that is your the, it everything, there is also a counter weight given. So, the, they are provided on the crank side to balance the dynamic force of the connecting rods; this connecting rod will be giving a dynamic force because of that.

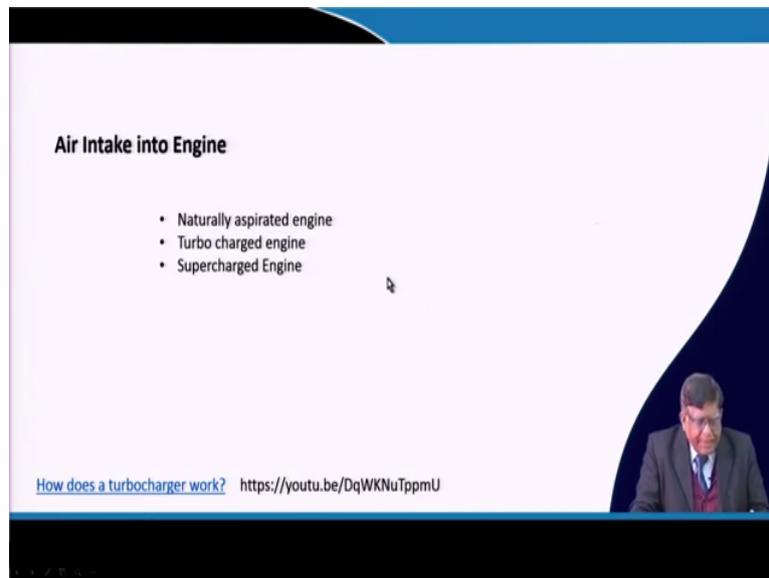
So, that nothing happens; that is why this you can see any crankshaft, there is this counter weights are provided. And then in an engine you will find from the main shaft, a chain drive or belt drive; belt drive is normally given and then for the injection of the fuel and there is a camshaft is there. So, this camshaft is driven in such a way that, that it is when it is coming, which valve will be opening and closing it will be done by taking power from here.

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So, these are the things there and that a engine cooling system is there; you will have to study how that engine heat is taken up, that for that exactly we have got a radiator, from that radiator that water is allowed to, that is there are fins through which this water will be moving also sometime this in coolant cooling oil is given, by which the heat is taken up and then the engine heat is controlled.

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Then also there are air can be taken into that, how will be putting out air there are three ways; naturally aspirated engine, turbo charged engine and super charged engine. That in a if there is a no forced pushing of air; then it is a naturally aspirated engine. In a turbo charged engine, exactly with your exhaust gas, there will be a blower will be run and then atmospheric air at a compressed rate it will be sent.

And there will be one intercooler in between by which exactly more oxygen is given to, so that the more amount of fuel can be burned. So, that is why in a heavy machines or in a machines which are working at higher altitudes, you will have to, engine will have to be turbo charged engine, where the air intake is taken out by means of a blower, which is run by the exhaust that is the turbocharged.

If that blower is driven by the engine power, that means from the engine shaft, just like we have the that your valve operation, cam follower and that cam operation is done; similarly if you take power from there and run the blower to give some extra additional air into the engine, that is called your supercharged.

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Turbine

- "turbo" or "turbines" is Latin in origin and implies that which spins or whirls around.
- Energy is transferred to or from a continuously flowing fluid by the dynamic action of moving blades or rotors
- **Turbines are defined as the hydraulic machines which convert hydraulic energy into mechanical energy**



GE90 series engine which helps power the Boeing 777 Airliner. With 22 blades the engine is over 120 inch (3 meters) tall producing over 115,000lb of thrust (over 127,000lb on a test) this engine is 10,000 more powerful than that used by the Wright brothers one century ago.

Pumps are defined as the hydraulic machines which convert mechanical energy into hydraulic energy



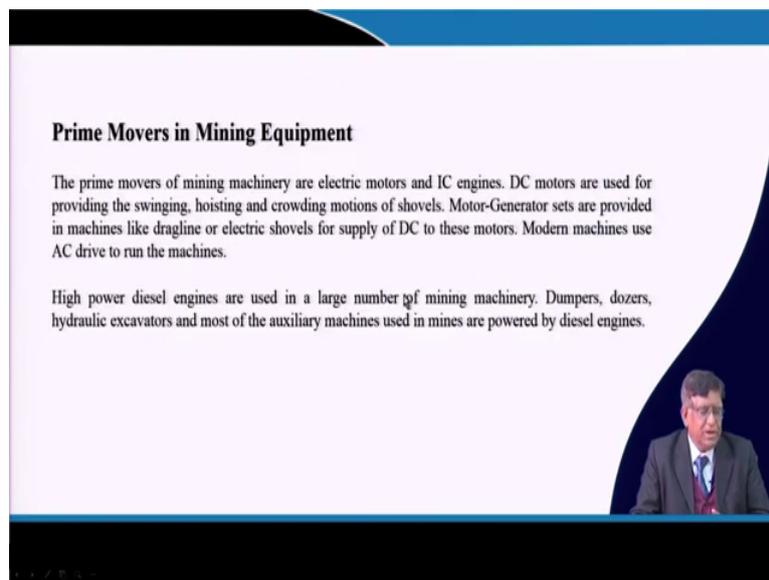
So, you will have to study about that and then the other prime mover as I said you can see a turbine here, the blades are there; when a fluid comes, they will start rotating and one from one rotations, the other can be done.

So, this is a turbines type of engines are there, there is a lot of things; you will be finding, how the turbo drills and drilling machines that your even down the down the hole hammer drill, there when they are working, there is a turbo machines are there. In the mining

machinery, lot of machines; then you can see also that your a turbine type of your impellers are there in case of your some of the pump and all, you can see that how it is exactly driving.

Though we are having a different type of prime mover, the operational member is driven by turbine, this also you will be finding.

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Prime Movers in Mining Equipment

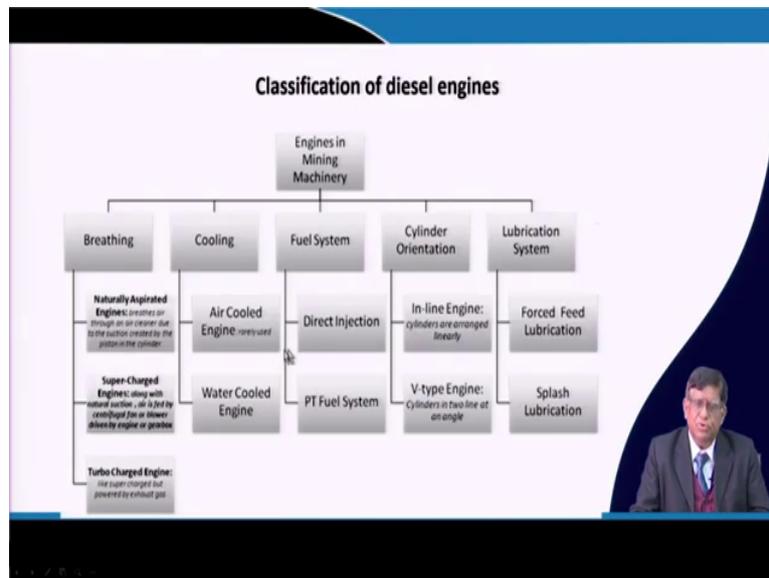
The prime movers of mining machinery are electric motors and IC engines. DC motors are used for providing the swinging, hoisting and crowding motions of shovels. Motor-Generator sets are provided in machines like dragline or electric shovels for supply of DC to these motors. Modern machines use AC drive to run the machines.

High power diesel engines are used in a large number of mining machinery. Dumpers, dozers, hydraulic excavators and most of the auxiliary machines used in mines are powered by diesel engines.

The slide features a white background with a blue header and footer. A small inset video in the bottom right corner shows a man in a suit and glasses speaking.

Then in a prime mover, in a mining equipment, there will be IC engines and AC and DC motors. So, you will nowadays many of the mining machinery, they are old versions, they used to use the DC motors.

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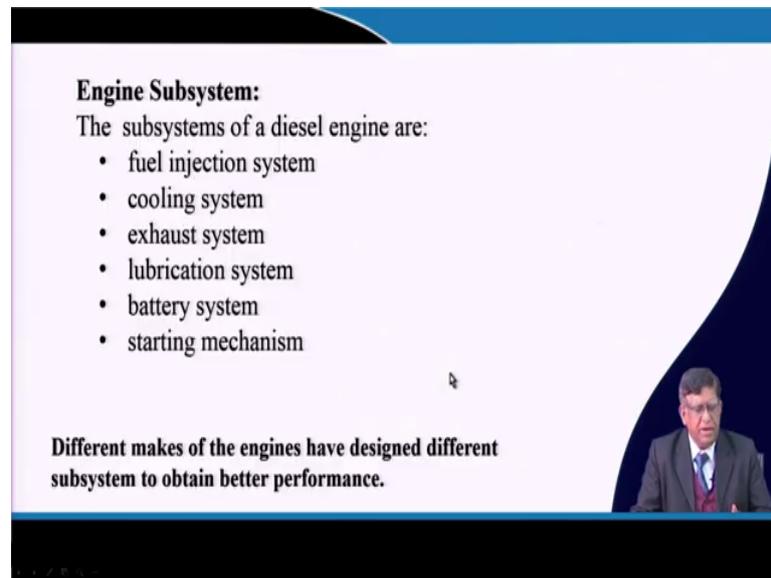


Now, because of the electronic control and all, AC motors are being used. And we have got a high power diesel engines are there; engines up to 16 cylinder engines are used. A different type of the engines used in mining machinery can be classified based on this aspiration air, air intake, cooling, fuel system, cylindrical orientations and lubrication system.

We have got that in line engine and V line engines, where your some of the dozers and dumpers you will finding the V line engines; because there are eight cylinder engine, twelve cylinder engines, to accommodate in that we can have a V line engines over there. So, there the fuel injections can be direct injections or the pressure timing fuel systems are there; similarly lubrications can be a forced lubrication and splash lubrications.

You will have to learn little bit about this by studying yourself and preparing new notes.

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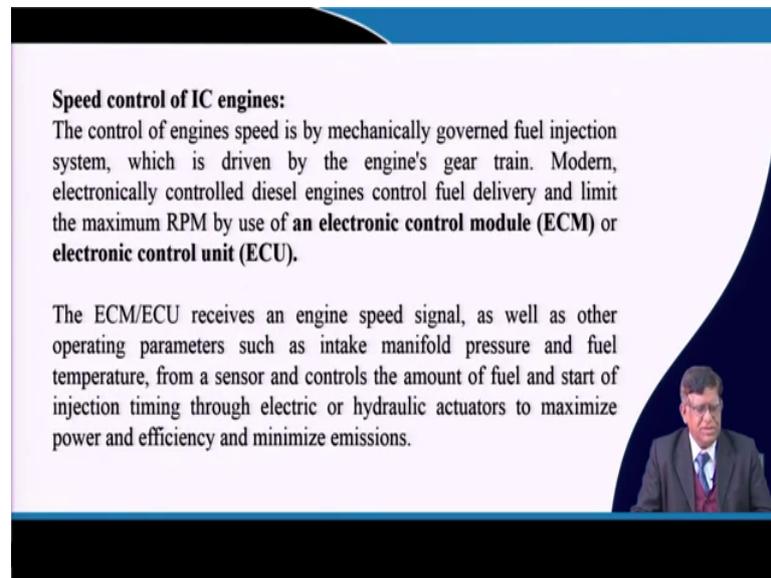
Engine Subsystem:
The subsystems of a diesel engine are:

- fuel injection system
- cooling system
- exhaust system
- lubrication system
- battery system
- starting mechanism

Different makes of the engines have designed different subsystem to obtain better performance.

So, that as a subsystems of your this prime mover, you will have to study fuel injection system, cooling system, exhaust system, lubrication system, battery system and starting mechanism. As an assignment, you please make a rough sketch of this system, and describe what are the components used in this particular systems.

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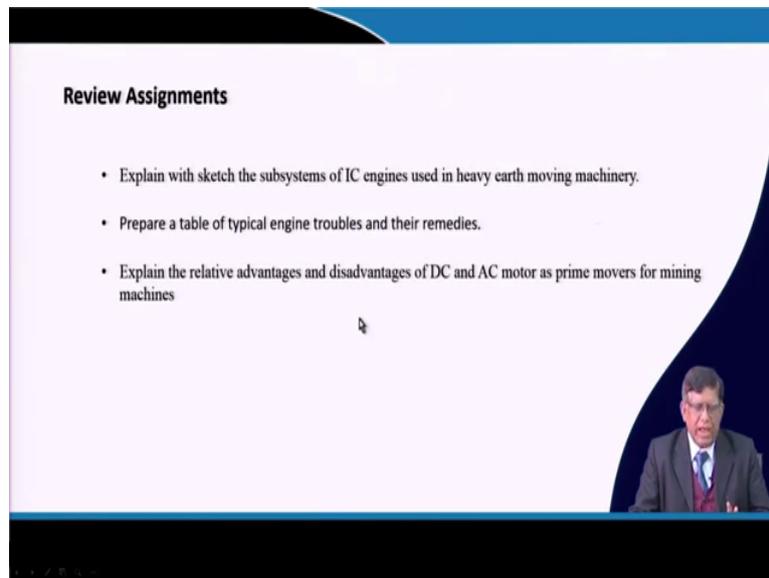


Speed control of IC engines:
The control of engines speed is by mechanically governed fuel injection system, which is driven by the engine's gear train. Modern, electronically controlled diesel engines control fuel delivery and limit the maximum RPM by use of an **electronic control module (ECM)** or **electronic control unit (ECU)**.

The ECM/ECU receives an engine speed signal, as well as other operating parameters such as intake manifold pressure and fuel temperature, from a sensor and controls the amount of fuel and start of injection timing through electric or hydraulic actuators to maximize power and efficiency and minimize emissions.

So, their control is done by, nowadays the modern electronic control modules are there in all modern machinery; either electronic control and electronic control module and control unit, this they are exactly taking the signals and accordingly this could be done. And this area lot of advances are taking place; when we will be discussing the individual machines, there we will be discussing this in detail.

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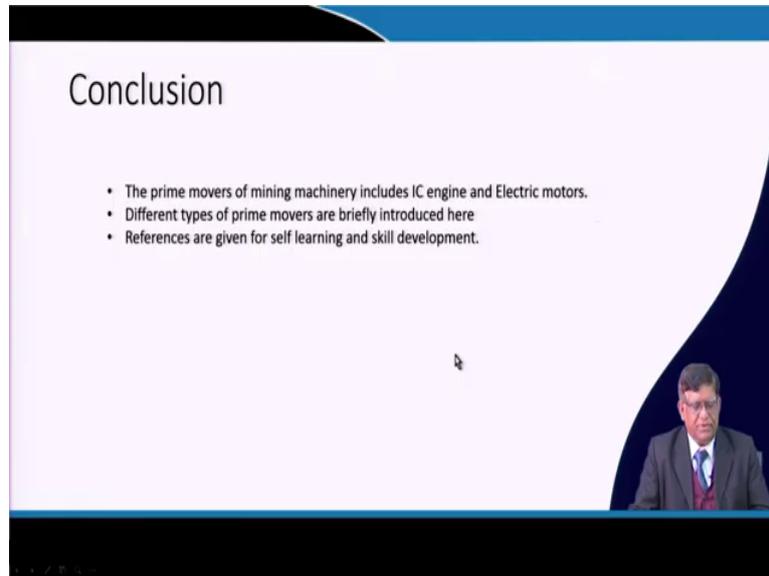


Review Assignments

- Explain with sketch the subsystems of IC engines used in heavy earth moving machinery.
- Prepare a table of typical engine troubles and their remedies.
- Explain the relative advantages and disadvantages of DC and AC motor as prime movers for mining machines

So, as a review assignments, please explain with sketch the different subsystems of IC engines and prepare a table of typical engine troubles and their remedies and explain the relative advantages and disadvantages of AC and DC motors of prime movers for mining machines. This is your self-study, investigative study you will have to make it.

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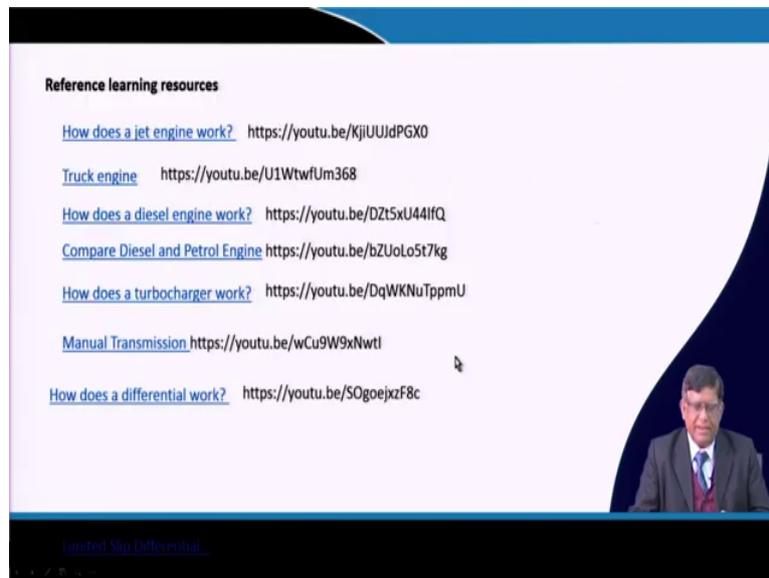


Conclusion

- The prime movers of mining machinery includes IC engine and Electric motors.
- Different types of prime movers are briefly introduced here
- References are given for self learning and skill development.

A small video inset in the bottom right corner shows a man in a suit and glasses, likely the presenter, looking towards the camera.

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Reference learning resources

- [How does a jet engine work?](https://youtu.be/KjiUUjdPGX0) <https://youtu.be/KjiUUjdPGX0>
- [Truck engine](https://youtu.be/U1WtwfUm368) <https://youtu.be/U1WtwfUm368>
- [How does a diesel engine work?](https://youtu.be/DZt5xU44IfQ) <https://youtu.be/DZt5xU44IfQ>
- [Compare Diesel and Petrol Engine](https://youtu.be/bZUoLo5t7kg) <https://youtu.be/bZUoLo5t7kg>
- [How does a turbocharger work?](https://youtu.be/DqWKNuTppmU) <https://youtu.be/DqWKNuTppmU>
- [Manual Transmission](https://youtu.be/wCu9W9xNwtI) <https://youtu.be/wCu9W9xNwtI>
- [How does a differential work?](https://youtu.be/SOgoejxzF8c) <https://youtu.be/SOgoejxzF8c>

Created by: Dr. Jyoti Chavhan

So, here today we have just introduced what are different type of prime movers.

So, that when will be starting the mining machinery; the main machines one by one about this, you will be having the little background information's. Please prepare your own portfolio and keep the informations there.

I have given some of the very useful link and references of videos; please watch that and make your own notes for learning it. So, the learning process will begin with this and we will be discussing the different mining machinery one by one in our subsequent classes.