Oil Hydraulics and Pneumatics
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Part 1: Introduction to actuators and Hydraulic motors
Lecture - 45
Hydraulic Motors

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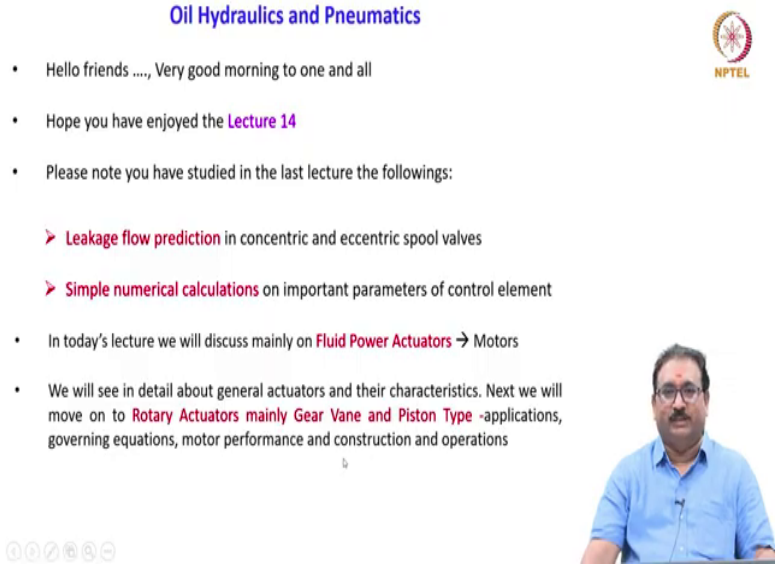

My name is Somashekhar, course faculty for this course. Hello friends, very good morning to one and all. Hope, you have enjoyed the lecture 14. Please note, you have studied in the last lecture the followings. We have derived simple equation for the leakage flow in concentric and eccentric spool valves and we have seen some numerical on important parameters of control parameters like a direction, pressure, and a flow.

In today's lecture friends, we will discuss mainly on Fluid Power Actuators. It is a new topic today. Please note friends, when I am talking about the motors it includes both hydraulic actuators and a pneumatic actuators, only difference is the working media. In oil hydraulics we are using the incompressible fluids, petroleum based fluids as I have told you. In case of pneumatics we are using the compressed gas mainly the air. Only this is a difference otherwise, the constructional details, operations, all remains the same.

Due to the pressure ratings, only the weight size will varies, because in hydraulics we are operating at the higher pressure the material to make the actuator is withstand these pressures, but in pneumatics very low pressures that is why all the bodies are made of very light materials like aluminium, ok. This is the only difference otherwise it remains same.

We will see in detail about the general actuators and their characteristics. Next, we will move on to rotary actuators mainly the gear, vane, and piston type. Here, we will discuss applications, governing equations, motor performance, and construction operation details of the motors.

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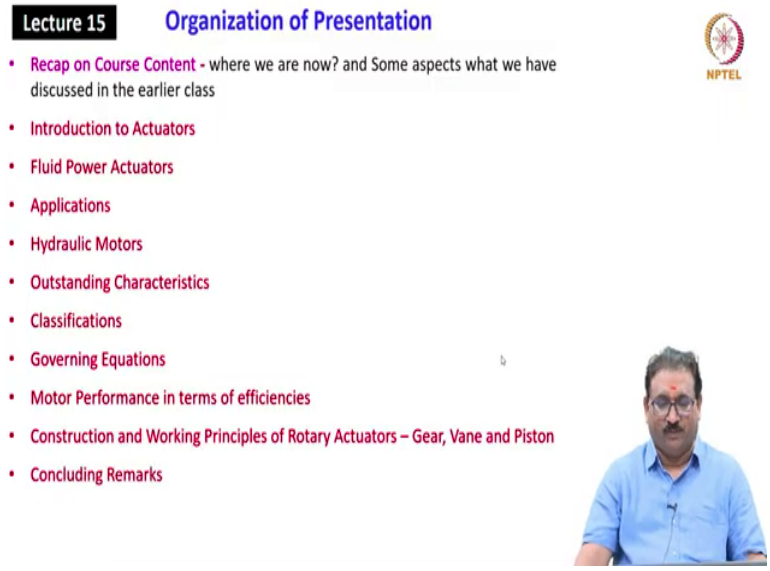

Quickly, I will tell you today's lecture includes the recap on course content. Here, we are now and some aspects what we have discussed in the earlier class very quickly. Move on to Introduction to actuators, fluid power actuators, applications, Hydraulic motors, outstanding characteristics, classifications, governing equations, motor performance, in terms of various efficiencies; like a volumetric efficiency, mechanical efficiency, and overall efficiency of the motors.

Also, we will see in today's lecture the construction and working principles of rotary actuators. Here, we will discuss the gear, vane, and a piston motors and variant available in these categories.

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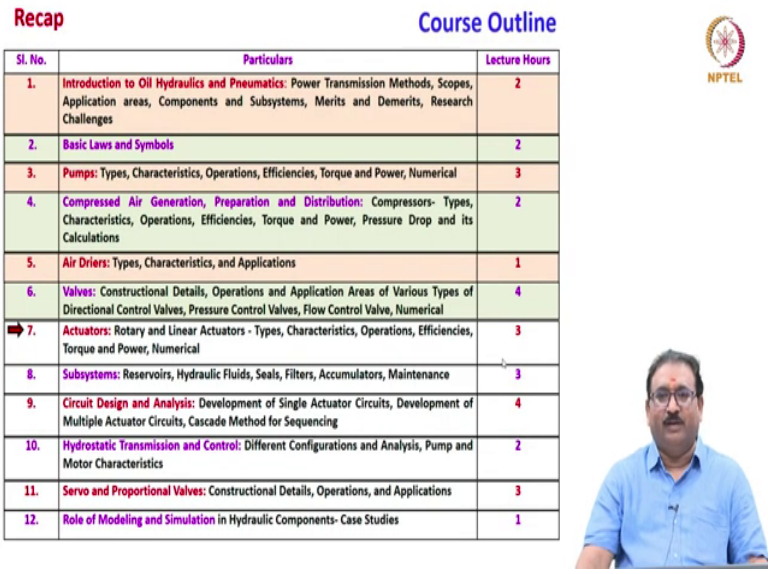

Finally, I will conclude today's lecture. Yes friends, already we have seen the 1 to serial number 6 which involves introduction to oil hydraulics and pneumatics, then basic laws and symbols, pumps, compressors air generation, preparation and distribution system, air dryers, and valves. It includes direction control valves, pressure control valves, flow control valves.

Now, today we are here, in the serial number 7 actuators. Here, we will spend around 3 lecture hours to discuss various rotary actuators and a linear actuators and also we will discuss some simple numericals to estimate some of the parameters.

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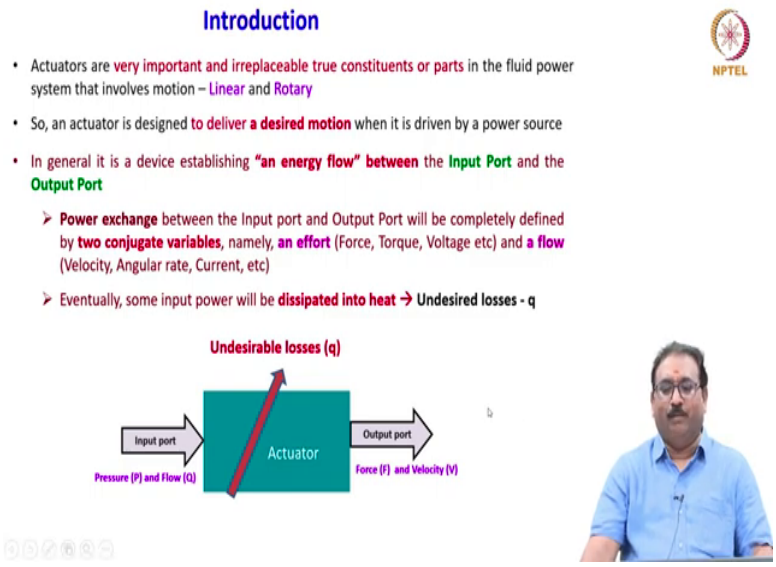

As we know friends, actuators are very important and irreplaceable true constituent parts in the fluid power system that involves the linear motion and a rotary motions. So, an actuator is designed to deliver a desired motion when it is driven by the power source. In general, it is a device establishing an energy flow between the input port and output port. Power exchange between the input port and output port will completely defined by two conjugate variables namely an effort.

Here, force, torque, voltage and a flow the velocity, angular rate, current, etcetera. Eventually, some input power will be dissipated into heat. What we can call it as a undesirable losses are there.

To represent this simple sketch is like this actuator will convert the one form of energy into the another form of energy generally, the mechanical energy. The input energy may be the

electrical energy, fluid energy, or heat energy, whatever it may be, but output energy is always a mechanical energy to do the useful work.

Here you will see friends, the input port is there output port is there to the actuator. The pressure P and a flow are the input here. The pressure P will decides the force. Similarly, the flow will decides the velocity in case of linear actuators. In case of rotary actuator the pressure will decides the torque and flow will decides the angular rotation. Then here, I am representing the undesirable losses during the conversion process from one to another.

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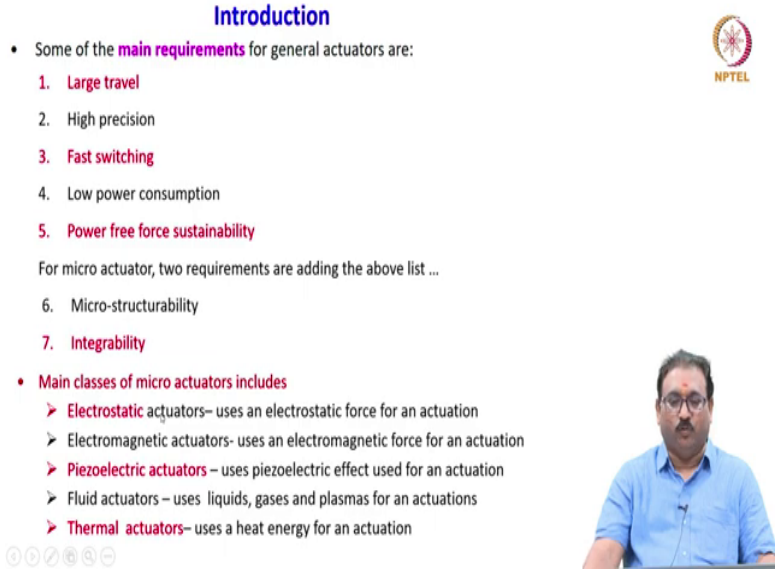

Now, we will see some of the main requirements in general actuator, irrespective of the food power actuators alone. You will see we required the large travel, high precision is required, fast switching either extension or retraction or a clockwise rotation or anti clockwise rotation fast switching is very-very important, then as usual the low power consumption.

Power free force sustainability, for micro actuators two requirements are added to the abolished; one is what you can call microstructurability and integrability. So, mainly these micro actuators are very essential nowadays to save the energy and also the size of the weight. A micro actuator category also we are getting the sum of the fluid power actuators. These micro actuators are classified generally based on the actuation methods.

First one is the electrostatic actuator. They uses the electrostatic force for an actuation. Electromagnetic actuator uses electromagnetic force for an actuation. Piezoelectric actuator uses the piezoelectric effect used for an actuation, fluid actuators uses the liquids, gases, and sometimes the plasma for an actuators, thermal actuators generally, uses the heat energy for an actuation.

Meaning your see here friends, there are macro actuators are there, micro actuators are there, micro actuators are playing a major role in the main supplications. Now, our concentration mainly on the macro actuators like what I am discussing today the hydraulic motors and hydraulic cylinders are the main concern today.

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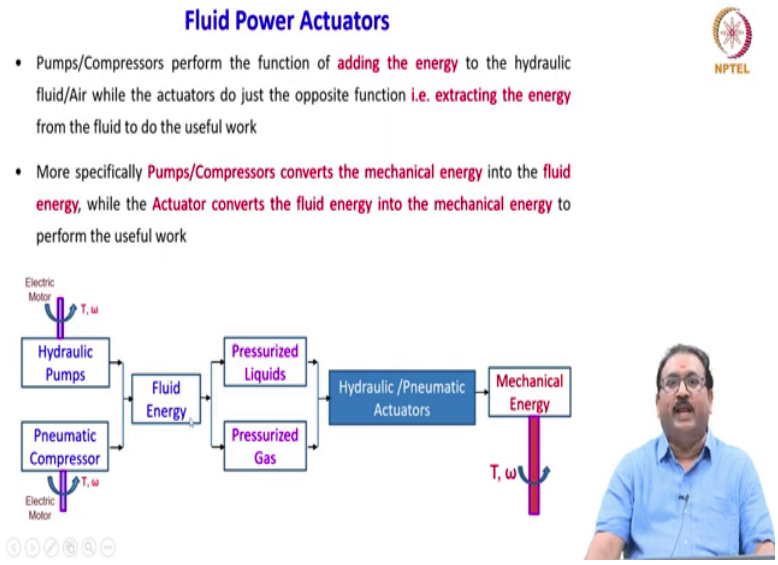

The fluid power actuators as we know friends already, the pumps and compressors perform the function of adding the energy to the hydraulic fluid or air, while the actuator do just the opposite function meaning, what they will do? They will extract the energy from the fluid to do the useful work.

More specifically, the pump or compressor converts the mechanical energy received from the electric motor into the fluid energy while, the actuator converts the fluid energy received from the pump or a compressor into mechanical energy to perform the useful task.

You will see friends here, in whole fluid power I am converting the mechanical energy into the fluid energy, fluid energy back into the mechanical energy to do the useful work with the

help of an actuators. Here, I am showing you a simple block diagram here friends. Here, you will see the hydraulic pumps and pneumatic compressors.

They will run through the electric motors meaning, they will receives both to run these pumps and compressor, we required the torque and angular velocity which will converse we are getting the fluid energy. Please remember, the pumps are whatever the compressor, the resistance to flow will create the fluid energy meaning; it is a pressure. This will come from the actuators.

Now, what happens, they will convert mechanical energy into the fluid energy through the pumps and compressor then this fluid energy either the pressurised liquid or a pressurised gas is an input to the hydraulic or pneumatic actuator which they will convert these things into the mechanical energy.

Meaning at the output and getting the torque or a angular velocity in case of motors. I am showing you here motors, but if you are using the cylinder here, you are getting the force and the velocity. Please remember friends, here what I am showing you here, it is a this is a hydraulic motors or a pneumatic motors.

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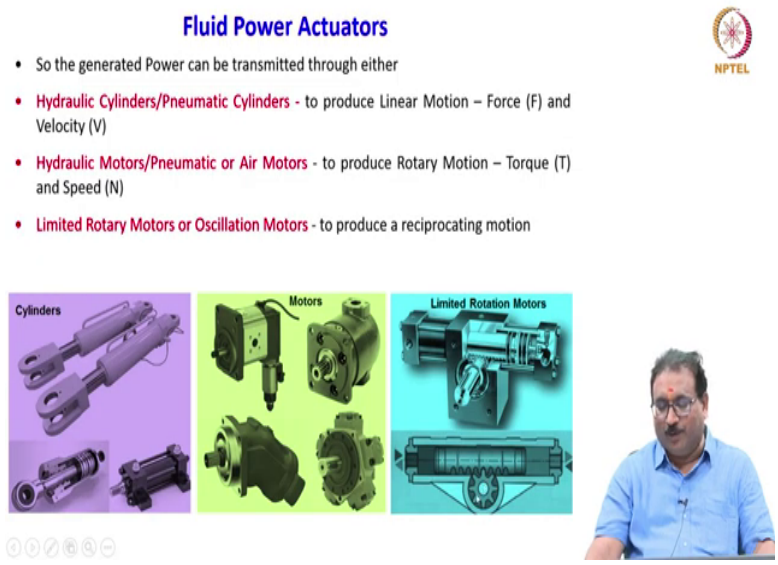

The generated power can be transmitted through either hydraulic cylinders or a pneumatic cylinders to produce a linear motion. Here, as I have told you a force and a velocity. Force is decided by the input pressure and velocity is decided by the input flow rate.

Similarly, hydraulic motors and a pneumatic motors are air motors to produce a rotary motion. Here, the torque T resided by the pressure energy of the fluid, speed or angular velocity whatever it is, for this the input parameter is a flow rate. Then one more category is there limited rotary motors are also known as oscillation motors. Here, to produce a reciprocating motion you will see here, I am showing you here some cylinders.

Cylinders are used to get the linear motion. The velocity and the force is an parameter here. In motors the torque and the angular velocity, omega is an output parameter. In linear rotary

motion also, the same it acts as a certain part. They will acts as a what we will call linear motion converted into the rotary motion in case of the limited rotation motors.

Here, I shown you here rack and pinion, you will see here rack and pinion. The linear motion of this converted into the rotary motion or rotary motion of this is converted into the linear motion, a limited rotation motors it is.

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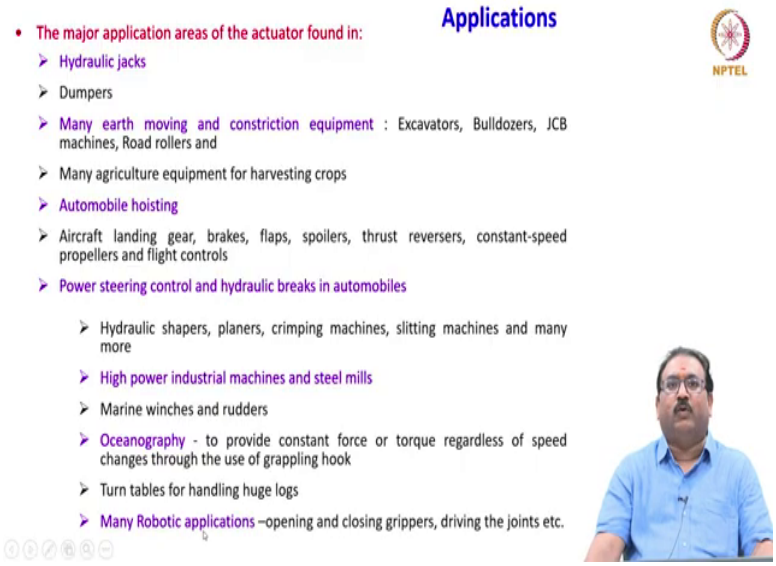

If you will see this friends, irrespective of the different types of actuator as we know the motors, cylinders, limited rotation motors, the major application includes the hydraulic jacks, dumpers. Many earthmoving and construction equipment, excavators, bulldozers, JCB machines, road rollers and many friends.

Many agricultural equipment for harvesting crops, auto mobile hosting, aircraft landing gear, brakes, flaps, spoilers, thrust reversers, constant speed propellers and a flight controls. Power steering control and hydraulic brakes in automobiles, hydraulic shapers, planners, crimping machines, slitting machines, and much more machine tools are drive through the fluid power.

High power industrial machines and steel mills marine winches and a rudders. In oceanography to provide a constant force or a torque, regardless of speed changes through the use of grappling hook, turn tables for handling the huge logs. Many robotic applications calls for the fluid power actuators mainly for opening and closing the grippers, driving the various types of joints. Meaning you will see here, the actuators are used each and every field currently to do the useful work.

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Now, today we will move on to the hydraulic motors along. I am showing you here the commercially available hydraulic motors, gear motors are there, vane motors are there ok, piston motors, axial piston design or a radial piston design, many things. Also, we are having the spatial addition to the gear motor, gerotor and a geroler motors. We will discuss one by one in today's lecture on hydraulic motors along.

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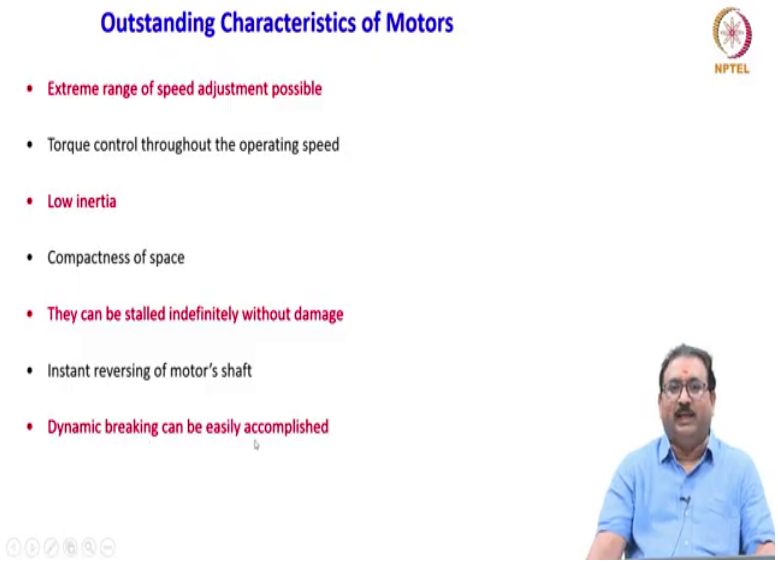

Question arises, what are the outstanding characteristics of the motors? Extreme range of speed adjustment is possible, torque control throughout the operating speed, low inertia, compactness of space. They can be stalled indefinitely without damage, instant reversing of motor shaft, dynamic braking can be easily accomplished. These are some of the important characteristics of the motors.

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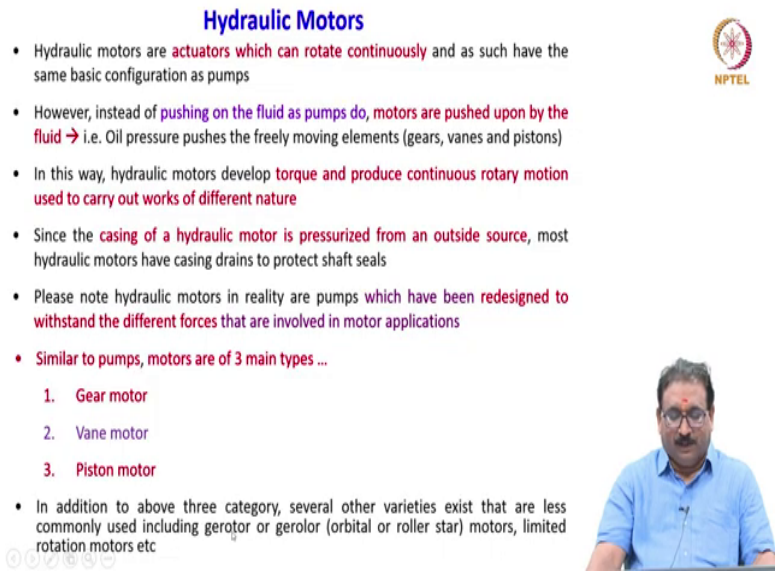

Hydraulic motors are actuators which can rotate continuously and as such are the same basic configurations as a pumps. However, instead of pushing on the fluid as pumps do, motors are pushed upon by the fluid. That is the oil pressure pushes the freely moving elements like a gears, vanes, and a pistons. In this way the hydraulic motors develops a torque and produce a continuous rotary motion used to carry out the works of different nature.

Since, the casing of hydraulic motor is pressurised from an outside source, most hydraulic motors have casing drains to protect shaft seals. Please note, hydraulic motors in reality are a pumps which have been designed to withstand the different forces that are involved in motor applications. As I have told you, the constructional details are similar to the pumps.

So, motors are also three main types; gear motor, vane motor, piston motor. In addition to the above three category, the several other varieties exist that are less commonly used including

the gerotor or a gerolor, orbital or a roller star, limited rotation motors, and many. We will discuss in today's lecture only on hydraulic motors.

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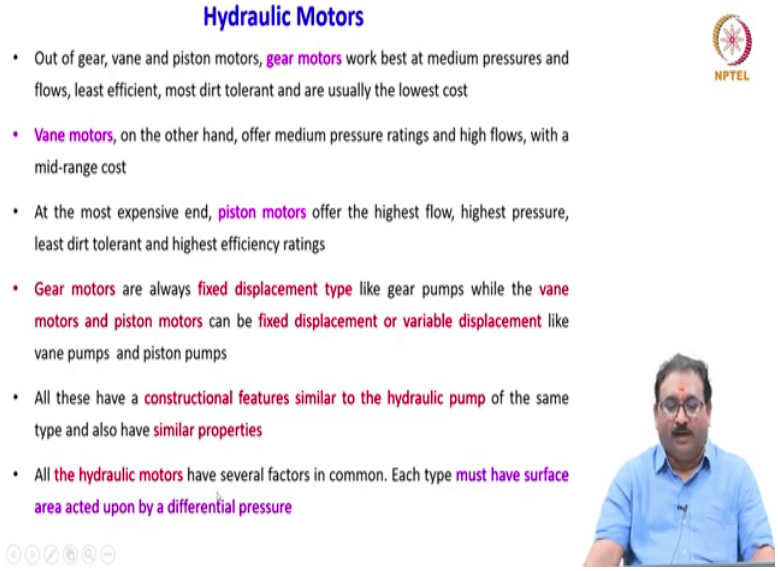

Out of gear vane and piston motors, gear motors work best in medium pressures and flows, least efficient, most dirt tolerant, and usually the low cost. Vane motors on the other hand offer a medium pressure ratings and high flows with a mid range cost. At the most expensive and piston motors offer the highest flow, highest pressure, least dirt tolerant, and highest efficiency ratings.

Gear motors are always a fixed type like a gear pumps while, the vane motors and a piston motors can be a fixed displacement or a variable displacement like our vane pumps and a piston pumps. All these have a constructional futures similar to the hydraulic pump of the same type and also have a similar properties. All the hydraulic motors have several factors in

common. Each type must have a surface area acted upon by the differential pressure very-very important, note down this.

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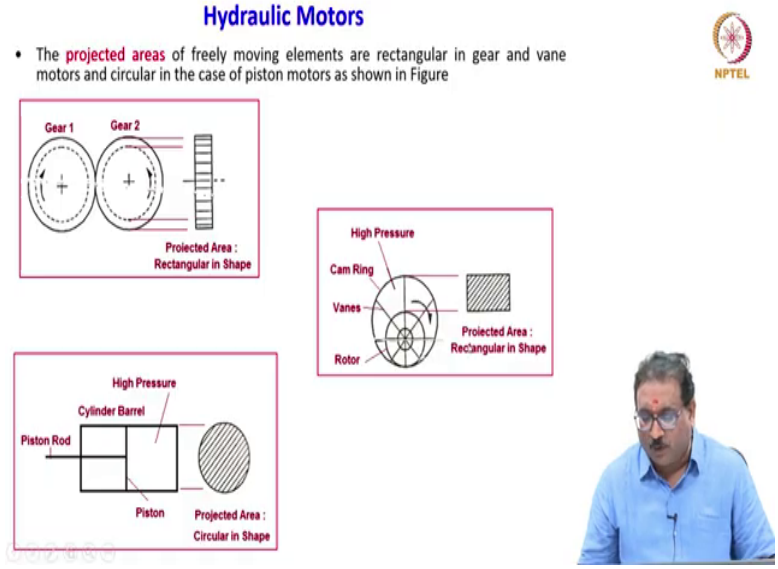

The projected areas of freely moving elements like a gears, vanes, and pistons. The projected areas are rectangular in case of the gear and a vane motors and it is a circular in case of the piston motors as shown in the figure below here. You will see here the two gears in the housing. The projected area here it is where the pressure is acting rectangular in shape to create the dock.

Similarly, in the vane pumps the projected area you will see. This unbalanced vane pump what I have drawn here, the projected area is a rectangular in shape. Here, you will see the projected area where high pressure is acting on the circular in shape.