Oil Hydraulics and Pneumatics
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Introduction to Oil Hydraulics and Pneumatics
Lecture – 02
Part 2: Merits and Demerits of Fluid Power, Power Transmission Method

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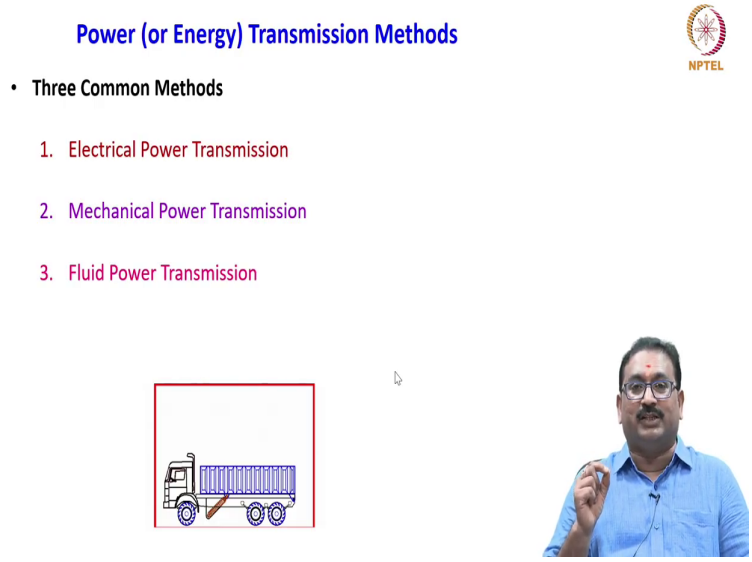

My name is Somashekhar, course faculty for this course. After knowing all the references, let us we will begin with today's lecture on Introduction to Fluid Power System. As I have told you oil hydraulics and a pneumatic systems are a part in the main fluid power system. Now we will discuss what are the power transmission methods are available for us.

As we know friends, there are three common methods; electrical power transmission, mechanical power transmission and fluid power transmission. Let us we will see very quickly the some of the features of these transmission methods to understand, to appreciate the fluid power technology in general.

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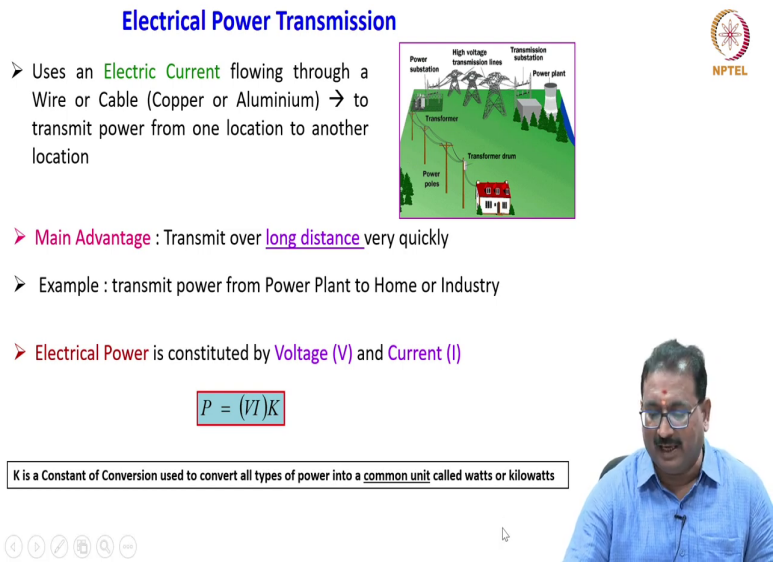

As we know that in electrical power transmission, we uses the electric current flowing through a wire or a cable to transmit power from one location to another location. The main advantage here is transmit over long distance very quickly.

Example transmit a power from the power plant to the destination where we are tapping the electric power in the houses and industry. Meaning you will see the very long distance is there to transmit the electrical power from the generating to the usable area.

Please understand friend, electric power is constituted by the voltage and current; there are the two variables. Now I am representing P equal to the function of VI K is used to convert all the powers into one unit like a watts or a kilowatt.

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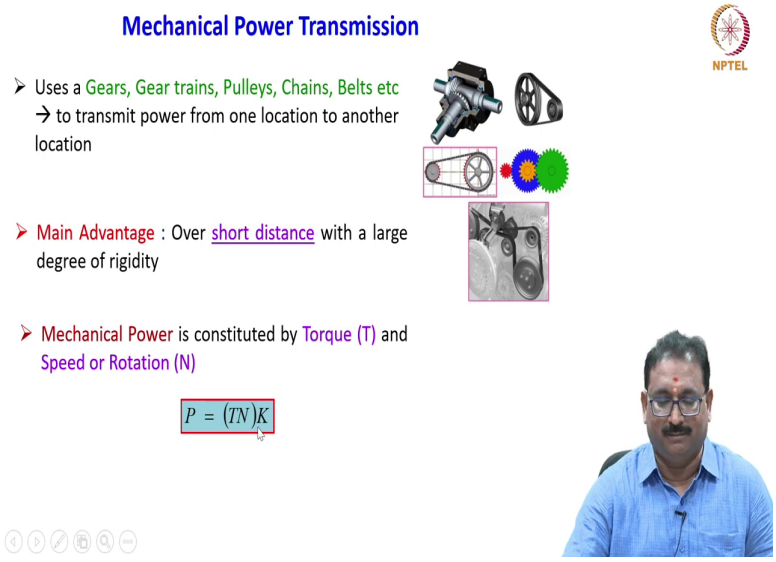

In mechanical power transmission all, we know that we uses gears, gear trains, pulleys, belts to transmit power from one location to another location. Main advantage here is over a short distance with a large degree of rigidity. Here mechanical power is constituted by torque and speed and P is a function of T and N.

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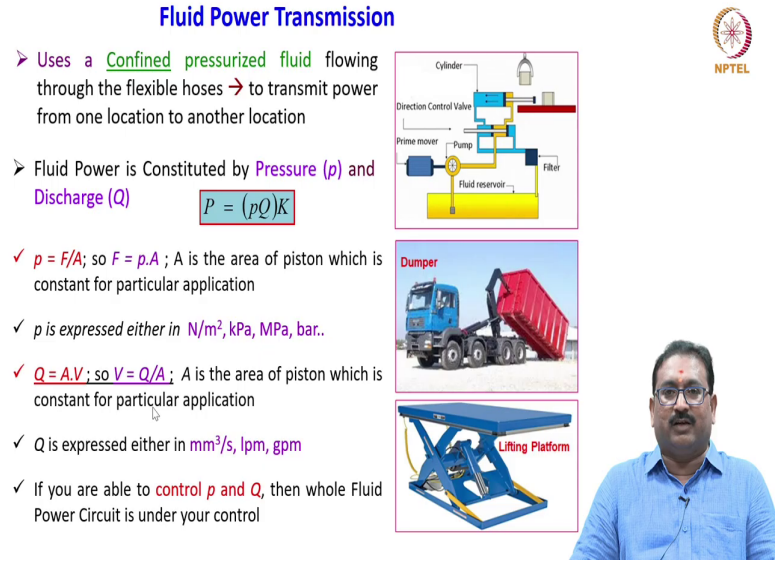

Now, third one is a fluid power transmission which uses the confined pressurized fluid flowing through the flexible hoses to transmit power from one location to another location. You will see here some of the figures have shown here in which the various components are there in the fluid power which includes the reservoir, pump drives through the prime mover generally electric motor or IC engine. Then here you will see friends, direction control valve is there to control the flow in and flow out of the actuator. Here it is linear actuator cylinder to do the particular task.

These types of circuits are built for various applications some of the things are what I have shown is dumper where the telescopic cylinders are used to do the oblique operations. Similarly you will see the lifting platform. Here also we are using the telescopic cylinders to

move the lifting platform up and down using the circuits. Please understand friends here fluid power is constituted by pressure and discharge; P is a function of p and Q.

Here you will see friends the pressure p is forced by an area. What is interested in the fluid power is I want to understand what is my the force output, how much load I moving with the help of the fluid pressure as because here a is the area of the piston which is a constant for a particular application. To control the load output for example, I want to move the 1 Newton to 1000 Newton with the help of varying the pressure because the pressure is one deciding your force outputs.

Similarly another parameter is there Q. What is the; also you will remember friends now; p is expressed in general Newton per meter, square kilo Pascal mega Pascal and bar.

The Q is what you will call discharge or a flow rate, Q is equal to A into V. In all the fluid power application what is very important is the velocity of the actuator. The velocity of the actuator is greatly depending on the discharge Q. Again A is constant correct.

Now if you will vary the flow rate very slowly or very fast, your actuator speed is controlled. Please understand there are two important variables in the power the pressure and Q. If you will control the pressure, you are able to control the load outputs. If you are able to control the Q, you are able to you are controlling the velocity of the actuator. Q is expressed in mm cube per second or liters per minute or gallons per minute.

As I have told you if you are able to control the p and Q, then the whole fluid power circuit is under your control. Only in the course the more emphasis on the how to control the pressure, how to control the flow and how to control the direction of the actuator.

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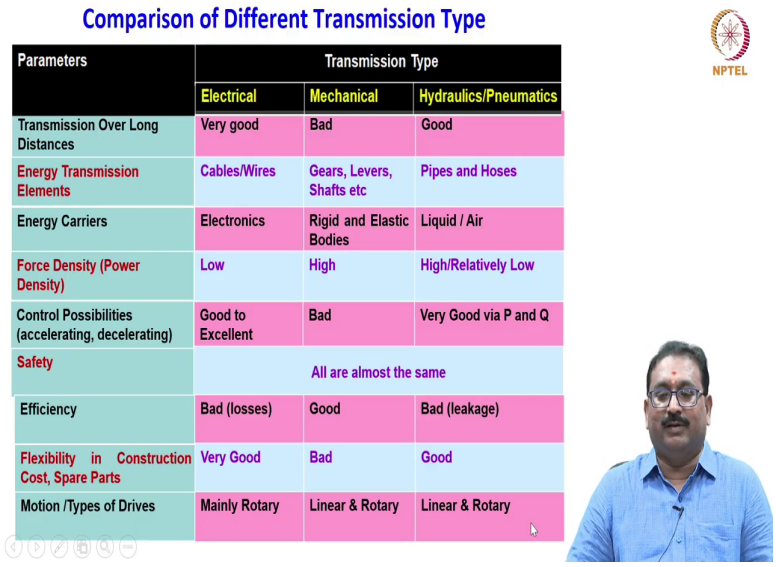

Parameters	Transmission Type		
	Electrical	Mechanical	Hydraulics/Pneumatics
Transmission Over Long Distances	Very good	Bad	Good
Energy Transmission Elements	Cables/Wires	Gears, Levers, Shafts etc	Pipes and Hoses
Energy Carriers	Electronics	Rigid and Elastic Bodies	Liquid / Air
Force Density (Power Density)	Low	High	High/Relatively Low
Control Possibilities (accelerating, decelerating)	Good to Excellent	Bad	Very Good via P and Q
Safety	All are almost the same		
Efficiency	Bad (losses)	Good	Bad (leakage)
Flexibility in Construction Cost, Spare Parts	Very Good	Bad	Good
Motion /Types of Drives	Mainly Rotary	Linear & Rotary	Linear & Rotary

Now, quickly I will show you the comparison of different transmission type like electrical, mechanical your fluid power hydraulics and pneumatics. Quickly you will see some of the parameter. Tell me friends transmission over long distance which is good, yes electrical is very good, mechanical is bad, hydraulics is good compared to mechanical

Energy transmission element, what elements we are using? In electrical cables and wires mechanical gears, levers, shafts, hydraulic pipes and hoses. Energy carriers, electronics rigid and elastic bodies; here liquid in hydraulics air in pneumatics. Force density here electrical is very low, mechanical is high, here hydraulics is very high and pneumatics is relatively low because the pneumatic pressure normal pneumatics we are using 8 to 10 bar.

The control possibilities here good to excellent because we are using the open loop to closed loop the bldc motors; the mechanical is bad here very good as I have told you to control the p and Q pressure and flow rate.

Safety wise all are almost same. Then efficiency wise if you will take, the bad in electrical because losses are more; mechanical good because mechanical elements are very rigid, hydraulics is bad due to the leakage.

Flexibility in construction cost and spare parts, you will see the electrical is very good because of the very cheaply available the like a switches you know so many things are available bulbs; whatever you will see cables very cheap, very good it is an electrical. Mechanical is bad because components are very expensive hydraulics good compared to mechanical.

Finally the motion types or a type of drives available in electrical is only generally it is a rotary. In mechanical, you may get linear and a rotary motions hydraulics is also linear and rotary motions. This table will give you the complete comparison between the different types of power transmission methods.

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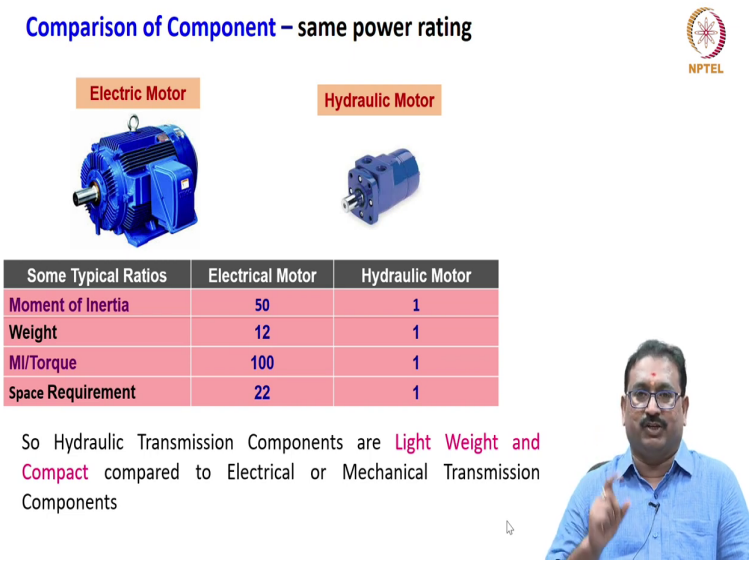

Just I will give you the some example how fluid power components are compact and lightweight. See now here I consider the electric motor and a hydraulic motor have the same power rating. You will see some of the typical ratios, the moment of inertia; electric motor to hydraulic motor is 50 is to 1, weight is 12 is to 1, moment of inertia to torque is 100 is to 1 and space requirement, you will see friends 22 is to 1.

So, the hydraulic transmission components are lightweight and compact compared to other transmission methods.

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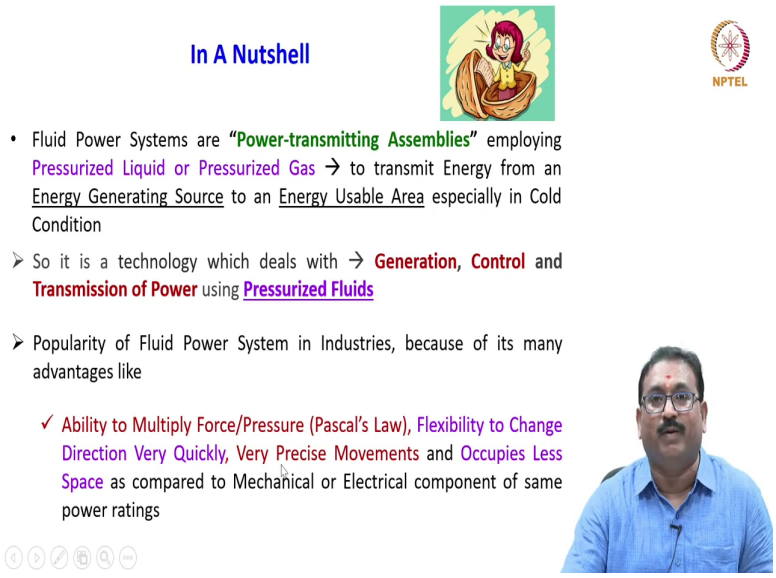

In a nutshell, the fluid power systems are power transmitting assemblies employing the pressurized liquid or a pressurized gas to transmit energy from an energy generating source to energy usable area especially in a cold condition. So, it is a technology which deals with generation, control and transmission of power using pressurized fluid.

Popularity of fluid power system in industries because of its many advantages, some of them are the ability to multiply the force or a pressure is possible because of the Pascal's Law. Flexibility to change the direction very quickly, very precise movements and occupies a less space as compared to other two power transmission elements.

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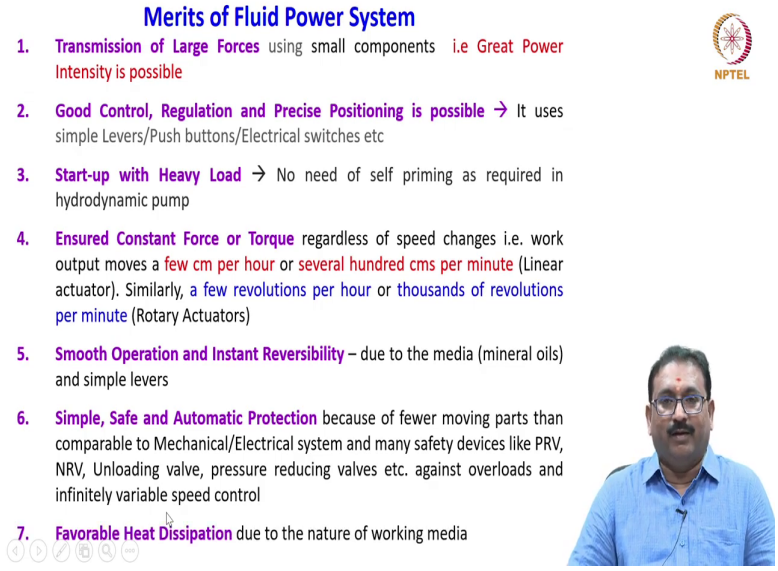

So, quickly we will see some of the merits of fluid power system. Transmission of large force forces using small components meaning you will get friends greater power intensity is possible, good control, regulation and precise positioning is possible because it uses the simple levers push buttons, electric switches in digital works.

Please note the any fluid power system components are startup with heavy loads. No need for self priming as required in hydrodynamic pump. In hydraulics, we are using the hydrostatic pumps which will start up with heavy load, no need to worry because they are designed like this. How it is, we will see later. Then ensured the constant force or a torque regardless of speed changes that is the work output moves few centimeter per hour or several 100 centimeters per minute if you will consider linear actuator.

Similarly, a few revolutions per hour or 1000 of revolutions per minute in case of rotary actuator. See here friends how I am controlling the actuator very minimal, medium, very fast possible in the fluid power system. Then please note smooth operation and instant reversibility is possible in the fluid power technology due to the media used and simple levers.

Also the fluid power components are simple safe and automatic production because of fewer moving parts than comparable to mechanical and electrical system and many safety devices like pressure relief valve, non return valve, unloading valve, pressure reducing valve etcetera against overloads and infinitable infinitely variable speed control is possible.

Also last, but not the least, the fluid power the main advantage is favorable heat dissipation due to the nature of working fluid what we are using.

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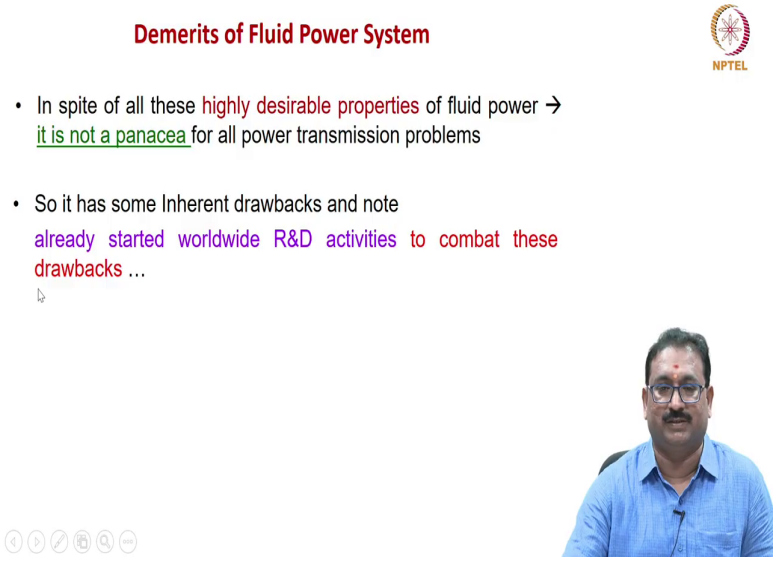

In spite of all these highly desirable properties of fluid power, it is not a panacea for all power transmission problems. So, it has some inherent drawbacks and note already started a worldwide R and D activities to combat these drawbacks.

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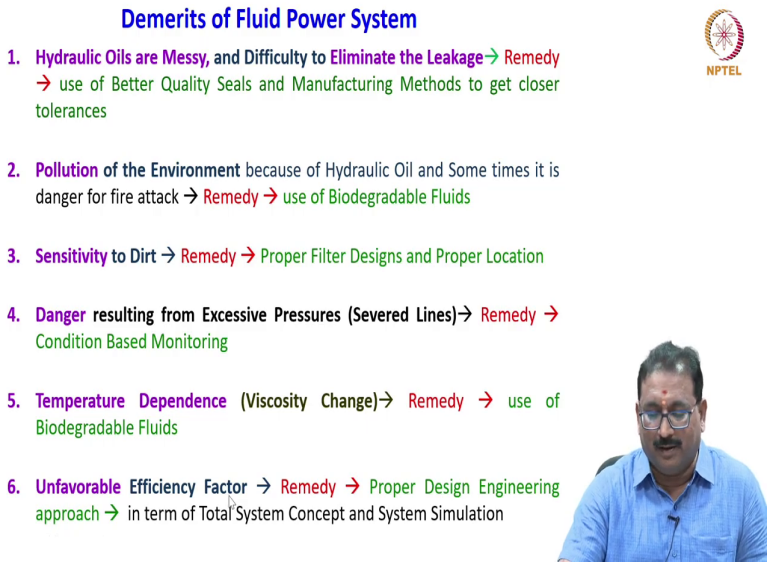

The some of the demerits of the fluid power system are hydraulic oils are messy and difficult to eliminate the leakage because the moving parts are there. Wherever moving parts are there, there is a chances of the leakage. The remedy is we have to use a better quality seals and manufacturing methods of the hydraulic or a pneumatic components to get a closer tolerances.

Second one is pollution of the environment because of the hydraulic oil and sometimes it is danger for fire attack as because most of the hydraulic fluids are petroleum based that is mineral based. The remedy is we have to use the biodegradable fluids to drive the hydraulic systems.

Sensitivity to dirt because as; I have told you the fluid power components are very precise in terms of tolerances. For example, in servo and proportional hydraulics, the clearance, the diametrical clearance what you will call the distance between the spool and sleeve is it is 2 to 4 micron.

Then you will see if dirt particles are entered, then there is a danger of wear and tear then system dynamics will get affected. So, what you will do? You have to use the proper filter design and proper location in the hydraulic circuits to overcome these problems.

Forth one is danger resulting from the excessive pressures meaning severe lines are there. So, remedy is we have to use a condition based monitoring to monitor the pressure in the various lines because you will remember friends, one power pack will supplies the energy 50 bar, 25 bar, 10 bar like this that time we have to monitor all the lines using the condition based monitoring system.

Then another drawback in the fluid power mainly in the hydraulics is temperature dependency, there is a viscosity changes. Remedy is use of biodegradable fluids.

Also unfavorable efficiency factors we are seen in the fluid power components, the remedy is the proper design engineering approach; what you will call it as a concurrent approach in design of various components is required rather than the sequential approach in terms of total system concept and systems simulation modeling is a essential before arriving the design parameters on the hydraulics and pneumatic systems.