Oil Hydraulics and Pneumatics
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Basic Components. Applications, Research Challenges, Status and Developments
Lecture – 06
Part 3: Typical Application of Fluid Power System, Status and Development

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My name is Somashekhar, course faculty for this course. Now, we will see some of the typical applications are discussed in the next slides.

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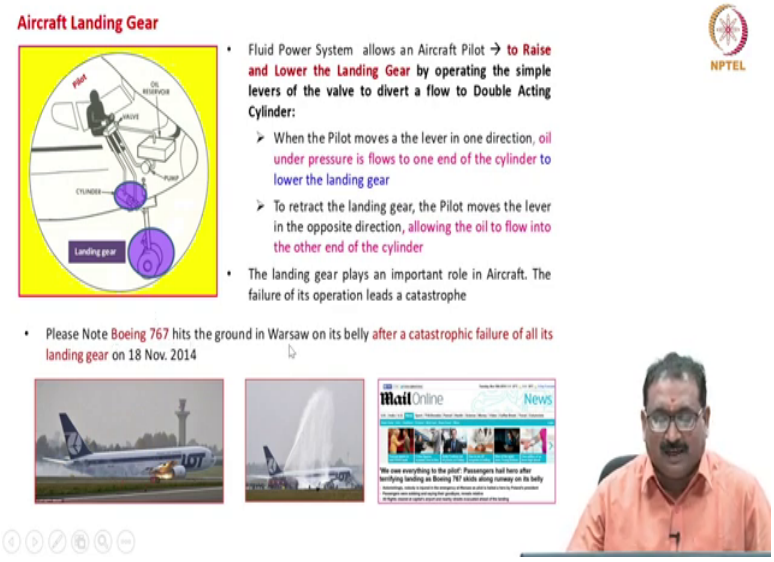

Aircraft landing gear, here you will see friends I am showing the pictorial views how the landing gear will work. Here pilot will moves the levers to divert the flow to the double acting cylinder, to raise the landing gear up and down based on the requirement. So, here fluid power system allows an aircraft in aircraft pilot to raise and lower the landing gear by operating the simple levers of the valve to divert a flow to a double acting cylinder.

When the pilot moves the lever in one direction, oil under pressure is flow to one end of the cylinder to lower the landing gear. To retract the landing gear, the pilot moves the lever in the opposite direction allowing the oil to flow into the other end of the cylinder. So, the landing gears are playing a major role to raise and lower the landing gears using the simple levers operated by the pilots. The failure of its operation leads to catastrophic failures.

You do not think all hydraulic systems are hundred percent safer. Now, one example I am giving here. Please note Boeing 767 hits the ground in Warsaw on its belly after a catastrophic failure of the landing gear in 18th November, 2014, meaning the operation of the all the components are very very essential when you are using the airworthy standards.

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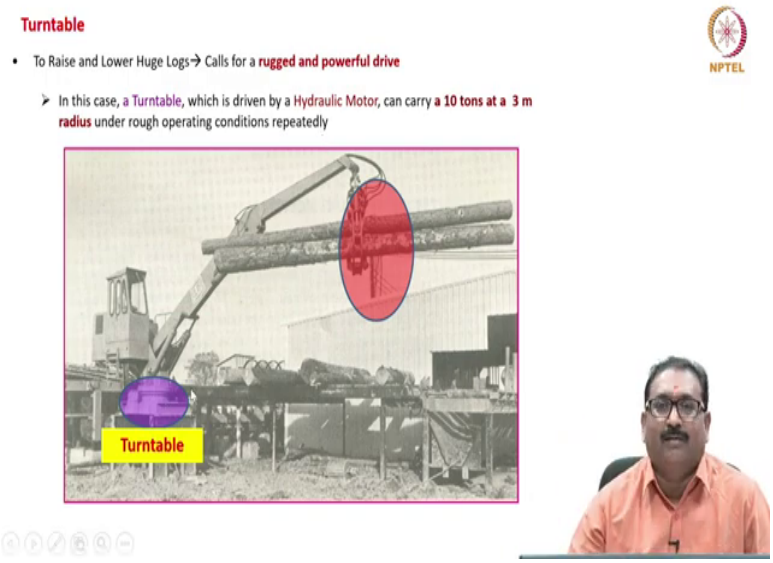

Next I will show you one more application turntable. This is a turntable, it is what are the figure will show the turntable. What for it is? To raise and lower the huge logs which calls for the rugged and powerful drive.

The very simple friends it is in this case a turntable, here you will see the turntable which is driven by the hydraulic motor can carry a 10 tons at a 3 meter radius under rough operating

condition repeatedly. It will lift the load 10 tons, and it move around 3 meter very easily, very quickly. This is a turntable application.

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Now, we will see overhead tram. You have traveled many times in the overhead trams in hilly stations. As we know that on steep inclines high driving torque is required for ascent and high breaking torque is required for descent. Most overhead trams in current use are having a haulage or a tow cable that is a moving cable to travel up or down.

But what I am showing here in this figure the 22 passenger 6 ton capacity hydraulically powered and controlled Skytram which is a unique in nature. It is self-propelled and travels on a stationary cable. Hence in this case the tram moves instead of the cable, the operator can Stop, Start, and Reverse any one car completely independent of any other car in the tram system that is a beauty of hydraulic system used in the overhead tram.

The main features of the hydraulic are here a pump driven by a standard eight-cylinder gasoline engine, supplies a pressurized fluid to four hydraulic motors. Each motor drives the two friction drive wheels. So, eight drive wheels on the top of the cables, supports and propel the tram car.

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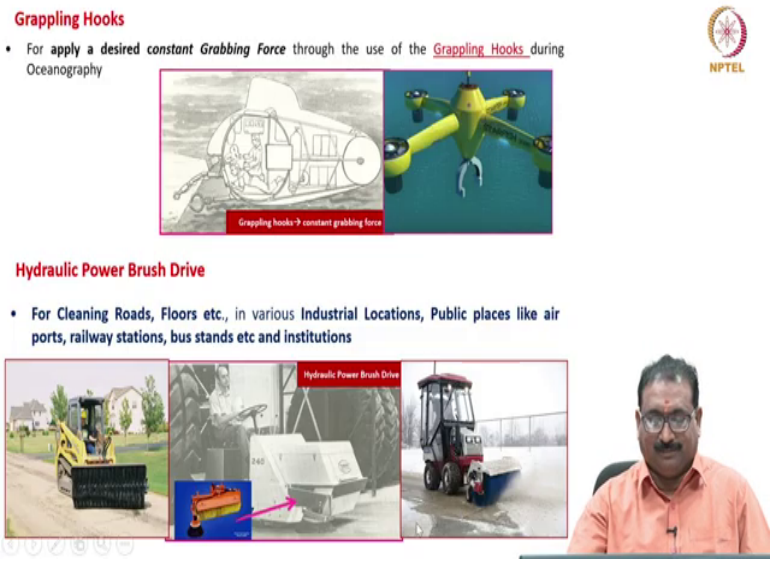

Move onto one more application Grappling Hook. For applying a desired constant grabbing force through the use of grappling hook during the oceanography; see the sketch here which will apply the constant grabbing force by the operator using the valves.

Already we are seen the hydraulic power brush used for cleaning the roads, floors, etcetera in various industrial locations public places like a airports, railway stations, bus stands etcetera

and also in institutions for cleaning the hydraulic power brush drives are used. These are the hydraulic brush drives operated by the fluid power system.

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Move on to another application hydraulically driven elevator conveyor system, basically used to send harvested husked ears of corn to a wagon trailer. In this type of system, hydraulic motor driven chain conveyor system is used. You will see the industrial hydraulic lift truck capacity to lift and transport a 2.5 tons capacity.

It consists of dual action tilting cylinders and a hoist cylinders and also the hydrostatic steering units. Tilt action is smooth and sure for better load stability and easier load placement. A lowering valve in the hoist cylinder controls the speed of descent even if the hydraulic circuit is broken that is a beauty in the industrial hydraulic lift truck.

They will move the load in the fork, and tilt it in any direction using the hydraulic cylinders. The operator only will what he will do? He will push the button to actuate the different actuator, to lower and lower the thing fork or raise the fork, or also possible to tilt to any angle using the simple levers.

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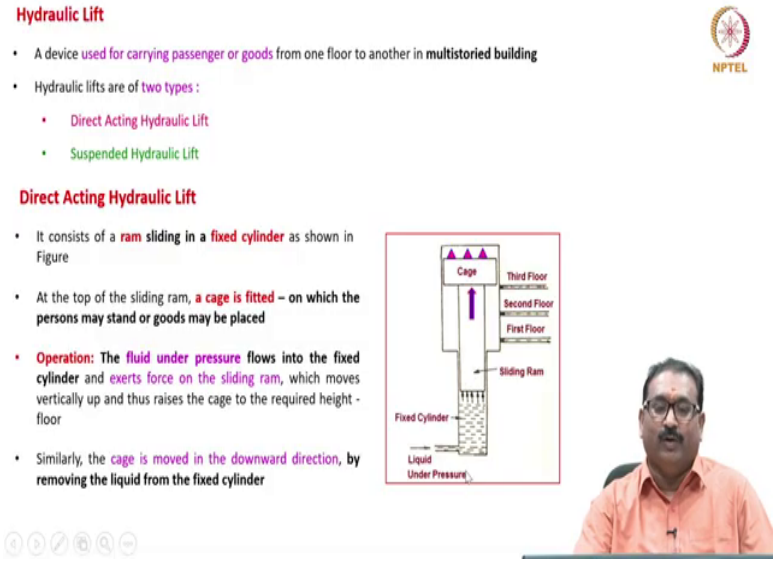

Now, we will see the one more application is hydraulic lift. A hydraulic lift is a device used for carrying the passenger or a goods from one floor to another floor in a multistoried buildings. It is purely hydraulic operated. Hydraulic lifts are of two types; one is direct acting hydraulic lift, low capacity; suspended hydraulic lift for high capacity.

Let us we will see direct acting hydraulic lift, what it is, how it operates. It consists of the ram. You will see here this is a ram, correct, this is hole is a cylinder. You will see this is a cylinder, and here is sliding ram. Top of the sliding ram is a cage which will carry the goods

or a any passenger. So, the direct acting hydraulic lift consists of a ram sliding in a fixed cylinder. At the top of the sliding ram, a cage is fitted - on which persons may stand or goods may be placed.

Operation is very simple friends here you will see here, the fluid under pressure flows into the fixed cylinder and exert a force on the sliding ram which moves vertically up. And thus raises the cage to the required height, first floor, or second floor, or third floor. Similarly, the cage is moved in the downward direction, how to move it?

Now, simply I will removes the oil present in the sliding ram side here, then automatically it will move. Due to the incompressibility of the fluid there is a cushioning is there for the sliding ram, no need to worry or sometimes the valves are used to control the downward motions.

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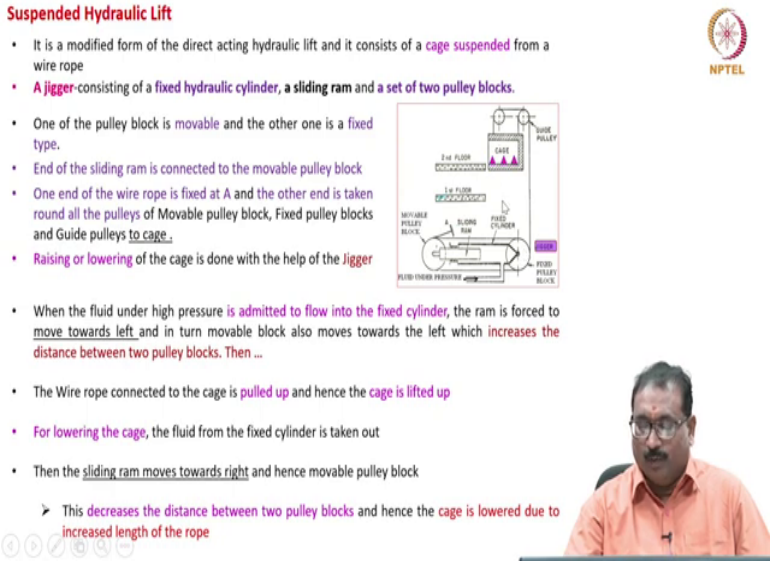

Then second category is suspended hydraulic lift for the heavy duty applications. What it consists? It is a modified form of the direct acting hydraulic lift. It consists of the cage, here cage, suspended from the wire rope, you will see here, suspended from the wire rope.

Here very important thing is a jigger is there, you will see here it is a jigger the whole unit is known as jigger consists of the fixed cylinder. See here, I am showing you here the fixed cylinder, a again a sliding ram inside the cylinder and a set of two pulleys, one is movable pulley and another one is a fixed pulley. One of the pulley as usual it is a movable and the other one is fixed pulley.

End of the sliding ram is connected to the movable pulley you will see. One end of the wire rope is fixed at A, and the other end of the wire rope is taken all around the all pulleys meaning the fixed pulley and the guiding pulleys then to the cage. Raising or lowering of the cage is done with the help of the jigger. Jigger is a device which can used to raise the load or lower the load. How it is we will see now.

When the fluid under the pressure is admitted to flow into the cylinder, the ram is forced to move towards the left; and in turn movable pulley also moves towards the left. What happens, which increases the distance between the movable pulley and the fixed pulley. Then the wire rope connected to the cage is pulled up when this distance between these two pulley increases, what happen?

The cage will be pulled up, and hence the cage is lifted. For lowering the fluid similar to previous the fluid inside the fixed cylinder is take out, then the sliding ram moves towards the right, and hence the movable pulley block also moves. This decreases the distance between the two pulley blocks and hence the cage is lowered to increase the length of the wire rope.

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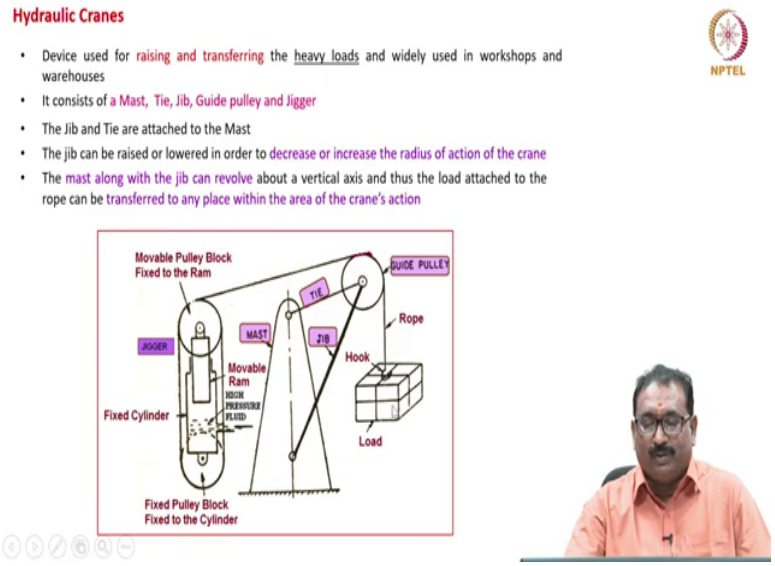

Then one more application is in the hydraulic cranes this is a hydraulic crane for heavy duty application is a device used for raising and transferring the heavy loads and wise widely used in workshops and warehouses. It consists of the mast, you see here it is a mast, and a tie, jib, guide pulley and as usual it is a jigger. The function of jigger is used to raise and lower the load and also to move to the required area.

The jib and tie are attached to the mast you will see here mast. The jib can be raised or lowered in order to decrease or increase the radius action of the crane. The mast along with the jib can revolve, the mast and jib can revolve about a vertical axis and thus the load attached to the rope can be transferred to any place within the area of the crane action.

Again here the jig jigger consists of the fixed pulley attached to the fixed cylinder. Movable block attached to the movable ram here. The ram will be move up and down with the help of pressurized fluids which in turn moves the load up and down and any radius it is.

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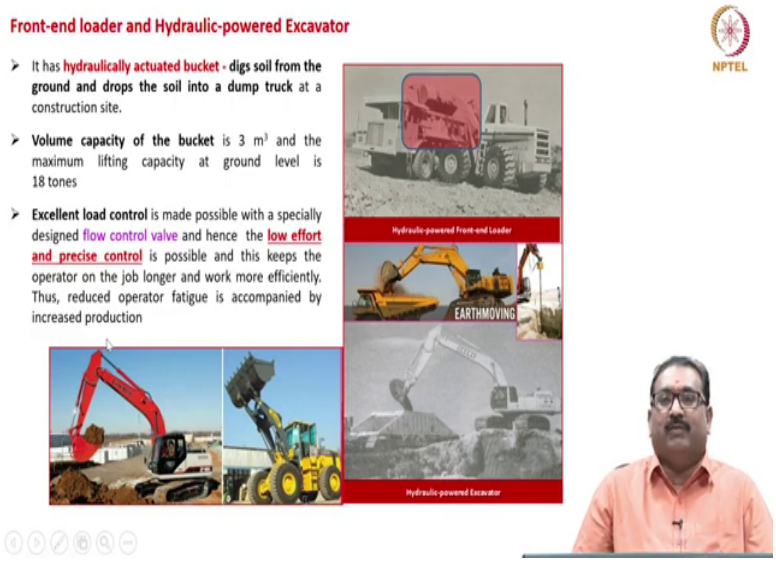

Now, move on to the next application, there are various things I have shown here. The front end loader and hydraulic powered excavator. It has a hydraulically actuated bucket. You will see here hydraulically actuated bucket using the hydraulic cylinders. See here many places hydraulic cylinders are there the hydraulically operated bucket, correct.

Here also you will see. The hydraulically actuated bucket digs the soil from the ground, and drops the soil into the dump truck you see dump truck at the construction site. Volume

capacity of the bucket, this bucket is 3 meter cube and the maximum lifting capacity at the ground level is 18 tones.

Here also you will remember the different categories are available, one what I am showing you here is the 3 meter cube volume capacity and the maximum lifting capacity is 18 tones.

Here excellent load control is made possible with the specially designed flow control valves, and hence the low effort and precise control is possible. And this keeps the operator on the job longer and work more efficiently and effectively. Thus reduced the operator fatigue is accompanied by increased production with the help of the front end loader and hydraulic powered excavators.

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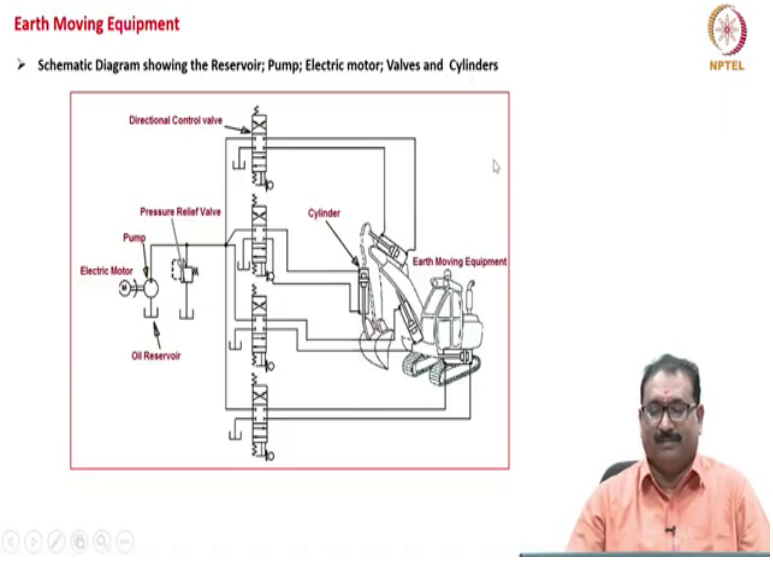

Then earth moving equipments. Just I am showing you here figure this is the earth moving equipment, we will do the purpose as I have told you in the previous slide. Here it is showing the various cylinders, you will see here the cylinders are used here, cylinders are used here double acting cylinder, here also cylinders are used, here also cylinders are used. The each cylinder is controlled through the direction control valve.

And again it is a power pack. Power pack is pump, tank, electric motor and pressure relief valve. Then you see here the two ends of the cylinders are connected to the each valves you know 1, 2, 3 and 4. All four cylinders are controlled with the help of the whole hydraulic circuits. The basic elements as I have told you reservoir, pump, electric motor valves and the cylinders. Here in this case it is a linear cylinders.

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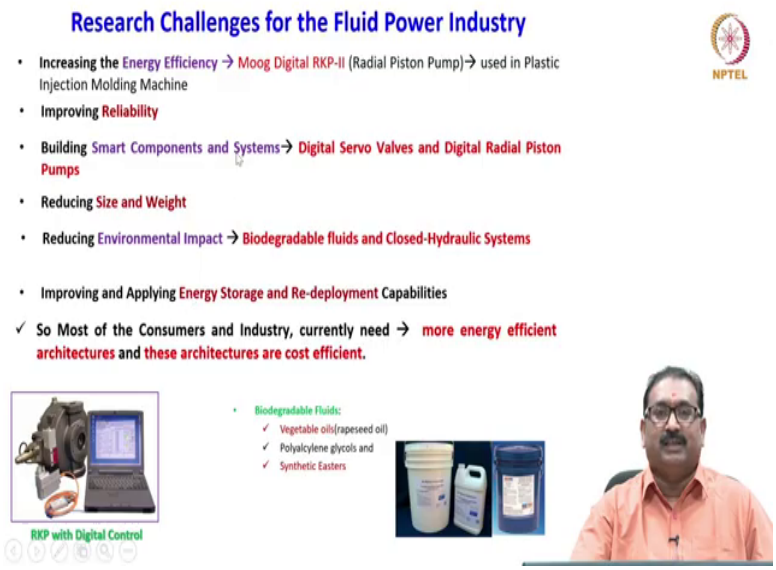

Application of fluid power continues no limit, sky is a limit. Now, we will quickly see the some of the research challenges for the fluid power industry. Increasing the energy efficiency is prime importance in all the hydraulic component. The one of the leaders in the hydraulic component is Moog working on this increasing the energy efficiency using the various softwares various experiments on the Moog Digital RKP valve.

It is a radial piston valve used in plastic molding, injection molding machine; subjecting this valve for the various operations, system simulation modeling, to enhance the energy efficiency. Now, people are trying to increase the energy efficiency of the individual component to the total system component.

Then improving the reliability of the component is one of the things researchers are working how to increase the reliability of the each and every component in the hydraulic circuit and

building the smart components and a systems. Already some of the valves are available in the category of digital servo valves and digital radial piston pumps. Here the various sensors are integrated; various actuators are integrated in the valve to enhance its performance.

Then another area is research challenges reducing the size and weight of the component. As I have told you the hydraulic components are heavy weight because of the power ratings, but now we have to think for how to reduce the size and weight. Next one is hydraulic oil or as I have told you the petroleum based fluids or a mineral oils which are dangerous when you are working in the closed environment. So, now is the environmental impact is playing a major role.

Now, the substitute for this is biodegradable fluids and a closed-hydraulic systems. Biodegradable fluids are vegetable oils, then synthetic easters and a glycols various types of glycols are developed. And now people are using biodegradable fluids to drive the hydraulic systems. The next one is improving and applying the energy storage and re-deployment capabilities in the hydraulic system.

Now, please understand friends these six areas where people working in the fluid power industry are rigorously working how to enhance these six important parameters. So, most of the consumers and industry currently need more energy efficient architectures and these architectures are cost efficient.

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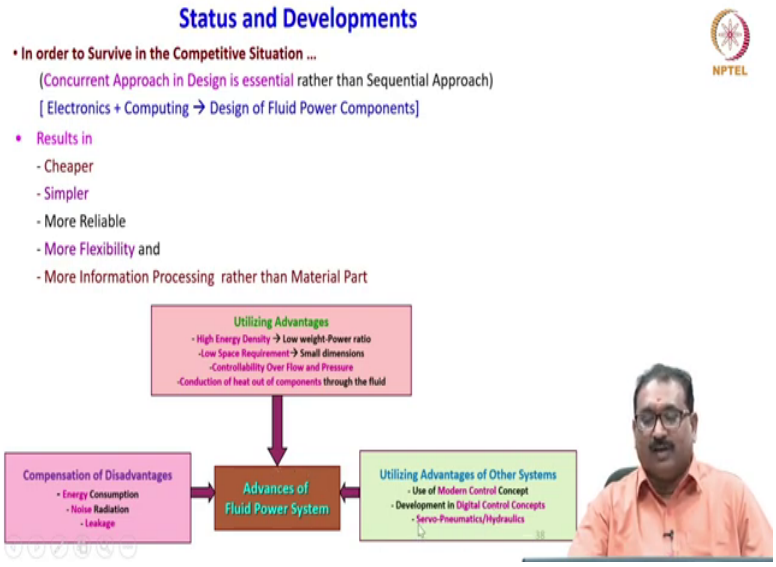

Now, we will see friends, status and development in the fluid power industry. Now, no other way for us in order to survive in the competitive market, the concurrent approach in design is essential rather than the sequential approach as because the digital valves are playing a complete role in the automation. So, the design of each and every component is on concurrent approach, not the sequential approach. Traditional approach is not useful now.

Now, all what we can call the mechatronic approach in the design of hydraulic component and pneumatic components is very important, meaning the more electronics and computing we are embedded in the fluid power components. What is the use for this? It results in cheaper, simpler, more reliable, more flexible and more information processing part rather than the material processing part.

So, what to do now, you may ask. Advances in fluid power calls for utilizing the advantages. What are the advantages? High energy density as because low weight power ratio, low space requirement small dimensions; controllability over flow and pressure is very easy; conduction of heat out of the component through the fluid is easy meaning what we will do to advance in the fluid power system, currently we have to use all the advantages available for the fluid power.

And try to compensate the disadvantages. What are the main disadvantages? Energy consumption, noise radiation, and leakage are the main disadvantages available in the fluid power system. People are trying to enhance these things by using the various control system concepts and a total system concept in the design of the parts.

Then what we will do? Utilize the advantages of other systems like a use of modern control concepts, development in control concepts and servo pneumatics and hydraulics, because these are the closed loop system for the various application, then only the fluid power industry will advances in the drastic growths. To do this, utilize advantages, eliminate disadvantages, and other advanced technologies are embedded in the fluid power components.

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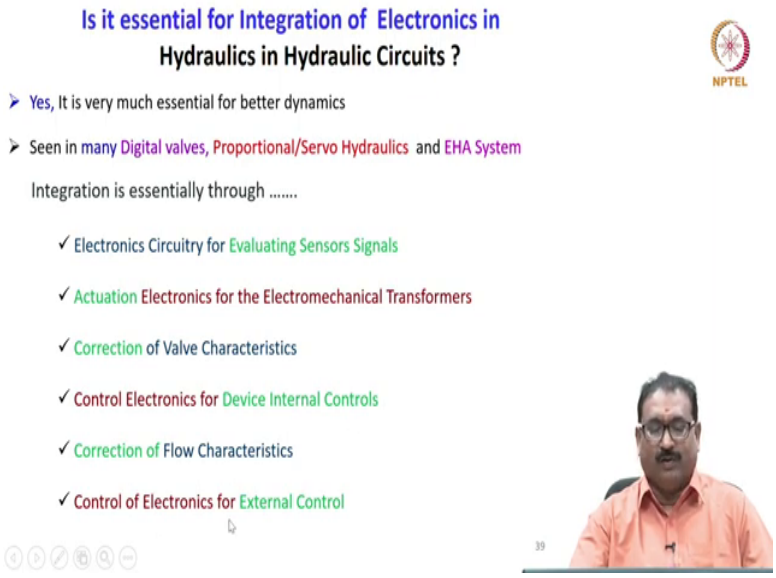

Then the question arises, is it essential for integration of electronics in hydraulic and pneumatic circuits? Yes, it is very much essential for better dynamics. Seen in many digital valves, proportional valves, servo valves and electro hydrostatic actuator systems. Integration of electronics into the fluid power component is very essential and is achieved through the electronic circuitry for evaluating the sensor signals.

Actuation electronics for the electromechanical transformers, correction of valve characteristics, control electronics for the device internal controls, correction of flow characteristics, control of electronics of external control.

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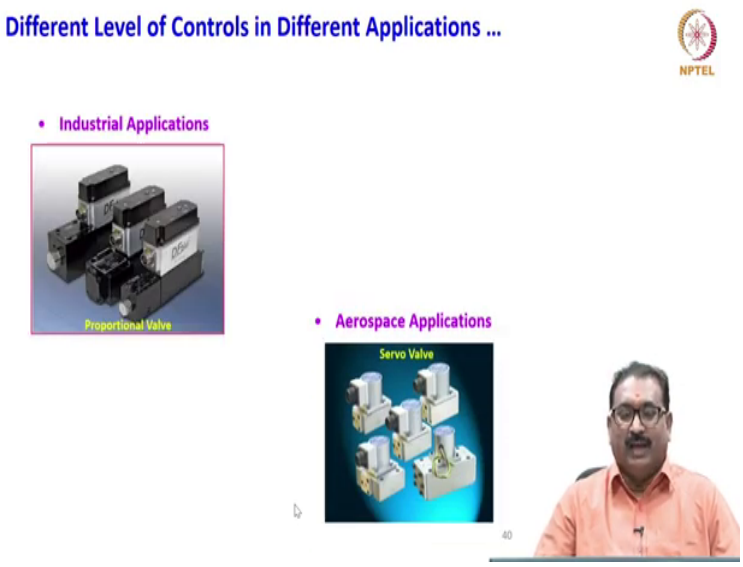

So, friends different level of controls are required in industry and as well as the space applications.

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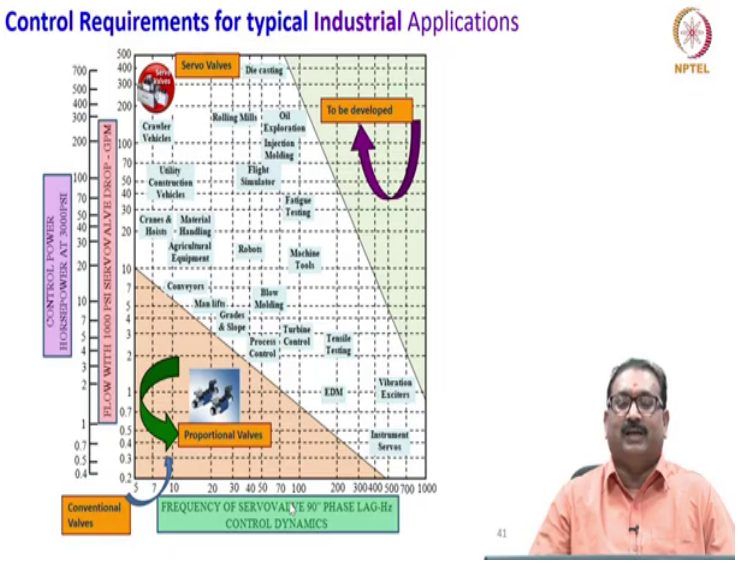

Let us quickly I will show you the control requirements for the industrial applications. You will see here friends, on the y-axis, I am showing the control power and the flow rate; and the x-axis, I am showing the frequency of the valves the many control dynamics I am showing.

Now, we will see here friends the various valves are used for various application based on the control power requirement, flow rate, and a frequency response, control dynamics requirement. We will see here the conventional valves what we are discussing now on off valves suit for the low power and low flow and the control dynamics are very limited.

The next level is the proportional valves, which will satisfy the high control power, flow and a control dynamics as compared to the conventional valves. Next a bigger bandwidth is for

the servo valves. Servo valves works on the speed back control system. And applications in industry is very wide.

You will see die casting machine rolling mills, correct, crawler vehicles, utility constructions, cranes and hoists, blow molding, robots, machine tools, turbine control, tensile testing machine, various EDM machines, vibration exciter, and many see. See servo valves are the closed loop system in which the electronics is integrated in the systems for the various purpose.

But in conventional valves no such things, mechanical things to control in one or the other way. But now people are thinking now these valves are available servo valves to suit for the higher control dynamics, higher control power, and a higher flow rate. But now people are thinking to develop further in this zone in which high control power, high flow rate with high control dynamics. Here valve to be developed now for the industrial application.

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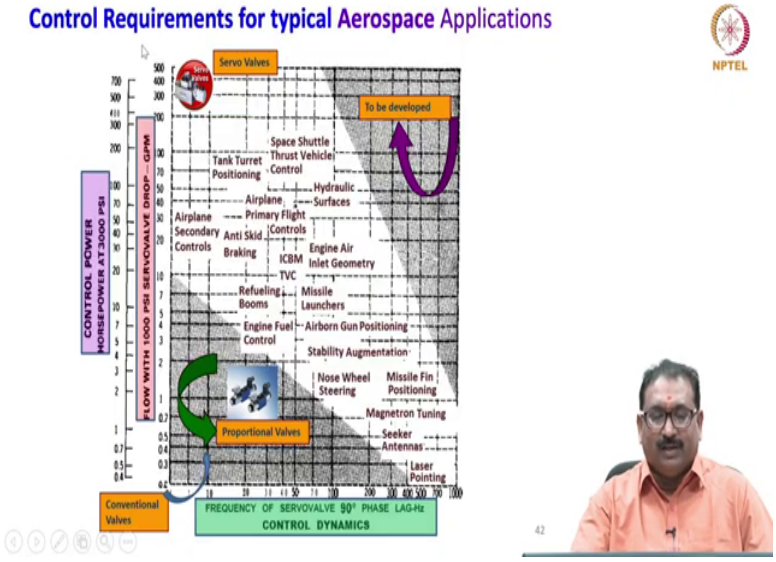

Similar to this control requirements for the space application it is space, here tank turret positioning, airplane, anti skid braking systems, refueling booms, engine control, airborn gun control system, missile launchers and many areas where the servo valves are suit in the defense.

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Now, quickly we will see friends fluid power industry growth and sales. In Indian scenario, the average growth is of 20 percent. The overall sales is 125 million US Dollar. USA, you will see 40 percent of the world share market; sales is 9400 Billion Dollar. Germany, we will see 20 percent of the world market share, and 5500 Million Dutch Mark. Japan, you will see over 20 percent of the world share market.

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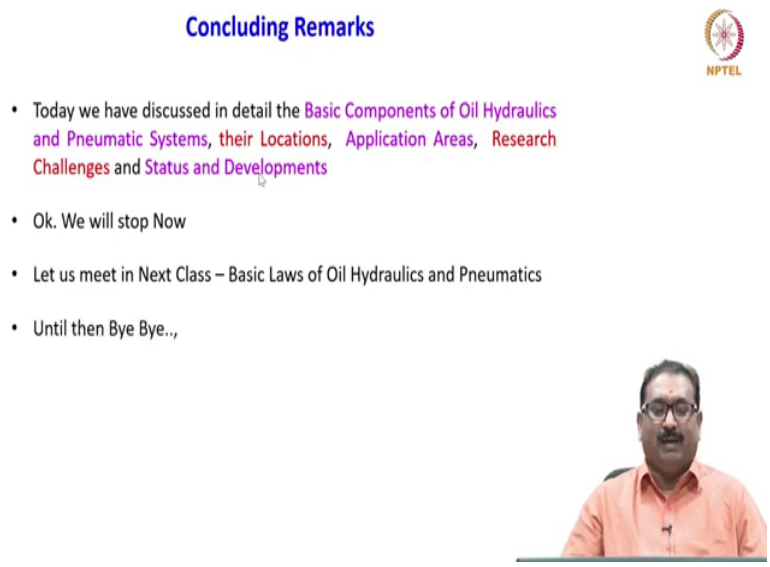

Now, quickly I will conclude this lecture-2. Today we have discussed in detail the basic components of oil hydraulics and pneumatic system, their locations, application areas, research challenges, status and developments ok. We will stop now. Let us meet in the next class. I will bring to you more on basic laws of oil hydraulics and a pneumatic system. Until then, bye bye.

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Thank you one and all for your kind attention. [FL]