Oil Hydraulics and Pneumatics
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Part 2: Hydraulic power pack, Typical customer's summary of requirements, Specifications of the hydraulic power unit
Lecture - 68
Oil Hydraulics Circuits: Design and Analysis

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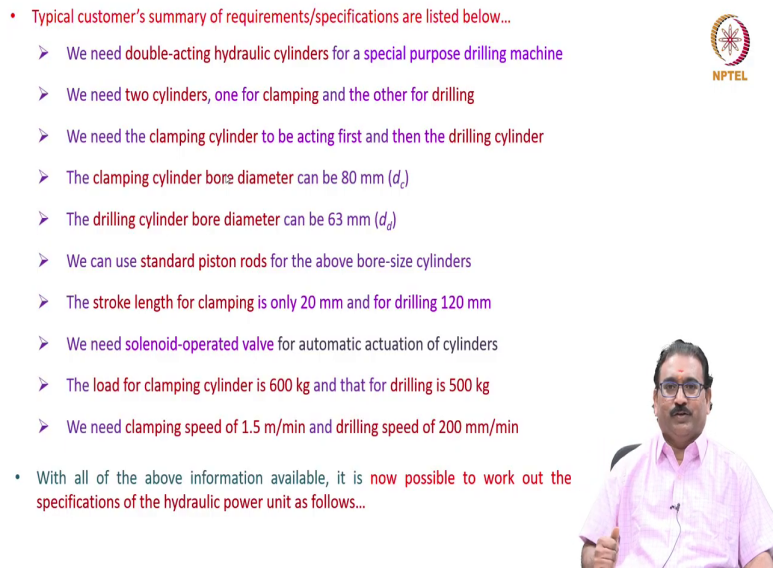

My name is Somashekhar, course faculty for this course. Typical customer summary of requirements or specifications are listed below. Customer's given the information's, I am listing here. We need double-acting hydraulic cylinders for a special purpose drilling machine. We need, we means customer is telling now; we need two cylinders, one for clamping and other for drilling. We need the clamping cylinder to be acting first and then the drilling cylinder.

The clamping cylinder bore diameter can be 80 mm. The drilling cylinder bore diameter ID, it is always be 63 mm. We can use a standard piston rods for the above bore size cylinders. The stroke length of the clamping cylinder is 20 mm and for the drilling cylinder is 120 mm. Then he is telling we need solenoid operated valve for automatic actuation of cylinders.

The load for clamping cylinder is 600 kg and that for the drilling is 500 kg. We need a clamping speed of 1.5 meters per minute and drilling speed of 200 mm per minute.

Please remember friends after collecting all information when he told only 3 ton capacity power pack, the design engineer or application engineer, meet the customer, he will collect all the information's. With all the above information available, it is now possible to work out the specifications of the hydraulic power unit as follows.

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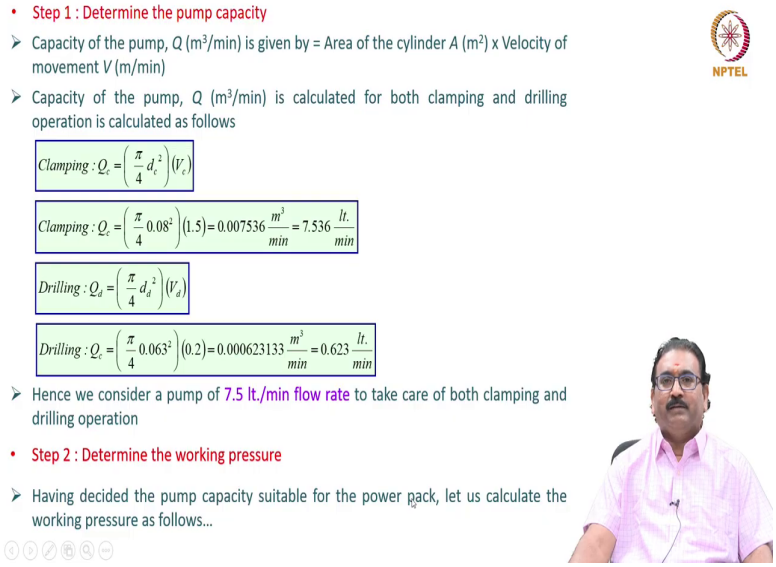

The step 1 is determine the pump capacity. Capacity of the pump what we can call Q meter cube per minute is given by area of the cylinder into velocity of movement, Q equal to A into V. Capacity of the pump Q is calculated for both clamping as well as drilling operation as follows. Clamping Q c equal to pi by 4 d c square into V c. Substitute the values.

Please take care all are in the same units. I may get clamping is 7.536 litres per minute. Similarly, we will calculate for the drilling operation same. Q d equal to pi by 4 d d square into V d. Substitute all the values, I may get here 0.623 litres per minute for drilling operation.

Then how to select the pump capacity? Bigger one, correct? Hence, we consider a pump of 7.5 litres per minute flow rate to take care for both clamping as well as a drilling operation. If 7.5 litres per minute pumps are not available, immediately, we will select next one is 8 litres per minute, allowed it is. Step-2, determine the working pressure. Having decided the pump capacity suitable for the power pack. Let us calculate the working pressure as follows.

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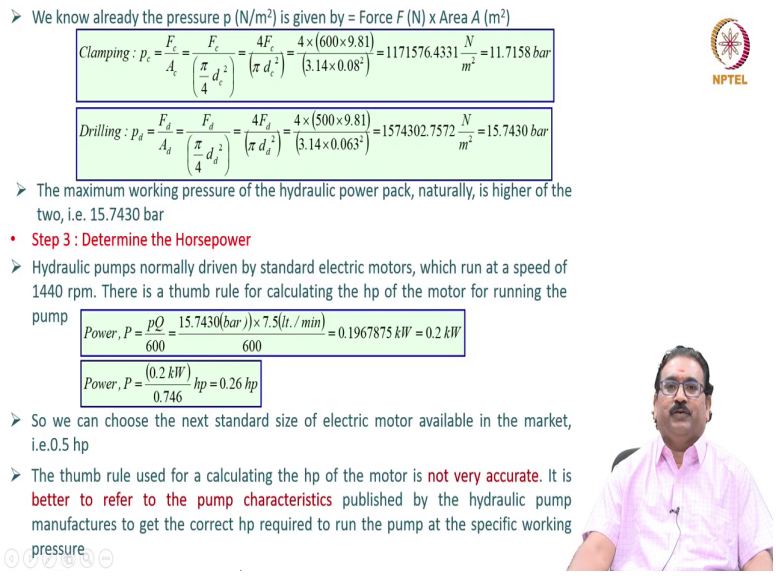

We already know that the pressure p is given by force into an area. For clamping p c equal to F c by A c. F c by A c is pi by 4 d c square already we are seen. This 4 will go up substitute all the values. For clamping p c, how much I am getting? 11.7158 bar. Similarly, you will calculate for the drilling, I may get 15.7430 bar. Then what is the pressure? Bigger one we have to take. The maximum working pressure of the hydraulic power pack naturally is higher of the two that is 15.7430.

Step 3, determine the horsepower. Hydraulic pumps normally driven by standard electric motors which run at a speed of 1440 rpm. There is a thumb rule for calculating the hp of the motor for running the pump. Power P equal to p Q by 600, this unit conversion only it is. Substitute p in the bar pressure in the bar; Q in the litres per minute; 600 unit conversion to get the power in the kilo watt. I may get here how much? 0.2 kilo watt power.

Then to know the in hp, 0.2 kilo watt divided by again unit conversion it is 0.746, it will give 0.26 hp. So, we can choose the next standard size of the electric motor available in the market that is 0.5 hp. The thumb rule for a calculating the hp of the motor is not very accurate. It is better to refer the pump characteristics published by the hydraulic pump manufacturers to get the correct hp required to run the pump at the specific working pressure.

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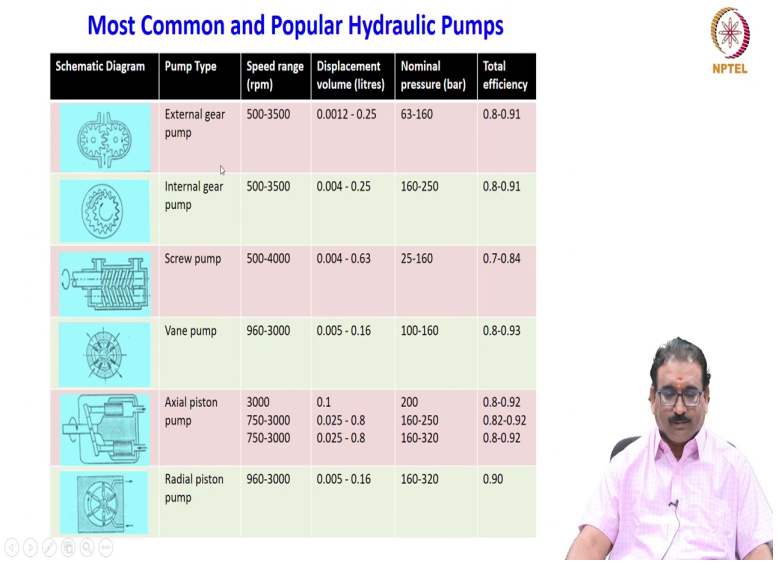

Already we have seen during the pump lecture hours, the various types of pumps are there. Here you will see this will give you the clear picture about the different types of pumps. The schematic diagram, pump type, speed range, displacement volume, nominal pressures each pump will withstand, and total efficiency.

Based on the requirement, you may select the external gear pump, internal gear pump, screw pump, vane pump, axial piston pump or a radial piston pump. If we will move from one to another, cost goes on increasing; also you will see the efficiencies.

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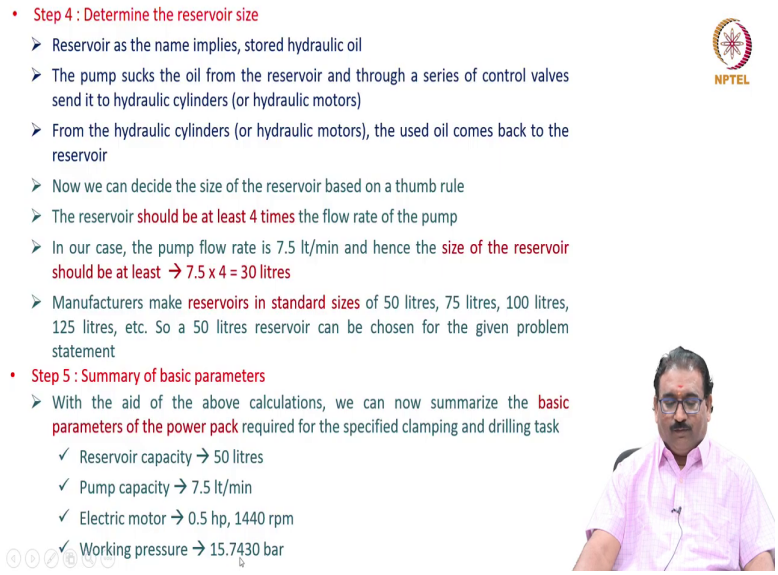

Step 4 is determine the reservoir size, tank size. Reservoir as the name implies stored hydraulic oil. The pump sucks the oil from the reservoir and through a series of control valves send it to the hydraulic cylinders or hydraulic motors. From the hydraulic cylinders or a hydraulic motors, the used oil comes back to the tank through the return line. Now, we can decide the size of the reservoir based on a thumb rule.

The reservoir should be at least 4 times the flow rate of the pump. In our case, the pump flow rate is 7.5 litres per minute and hence the size of the reservoir should be at least 4 times 7.5 meaning it is a 50 litres. Manufacturers make reservoirs in standard sizes of 50 litres, 75

litres, 100 litres, 125 litres, 150 litres, 200 litres but this 50 litres lies in the standard available in the market, then we will select the 50 litre reservoir.

Step 5, summary of basic parameters. With the aid of above calculations, we can now summarize the basic parameters of the power pack required for the specific task like a clamping and a drilling task. Reservoir capacity is 50 litres, pump capacity is 7.5 litres per minute, electric motor is 0.5 hp at a speed of 1440 rpm, working pressure is 15.7430 bar.

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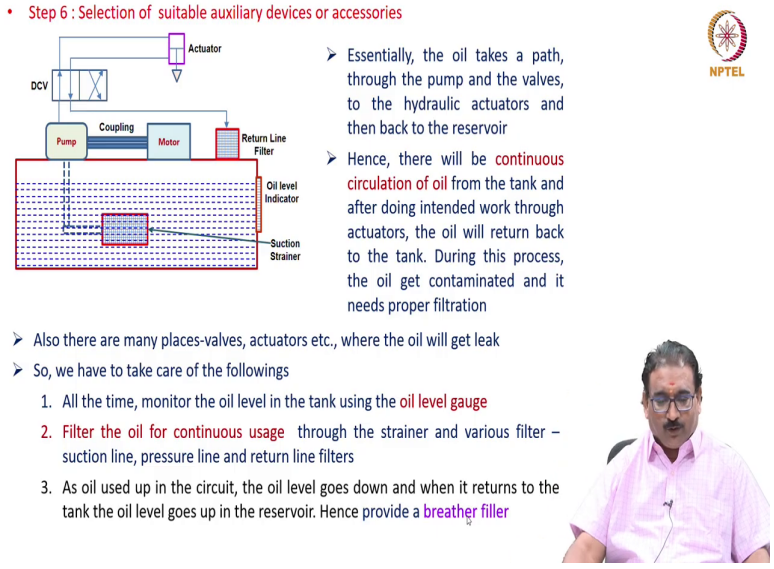

Next one is selection of suitable auxiliary devices or accessories. There are various accessories are there. Essentially, the oil takes a path, through the pump and the valves, to the hydraulic actuator and then back to the tank. You will see friends always the pump will sucks the oil from the tank, and sends to the directional control valve, then to the actuator. After doing the work, the oil will return back to the tank.

Hence, there will be a continuous circulation of oil from the tank and after doing intended work through the actuator, the oil will return back to the tank. During this process, the oil get contaminated and it needs efficient filtration before entering into the tank. And also from the tank, before entering to the pump element again filtration elements are required. These are called as accessory elements.

Also there are many places valves and actuators, where the oil will get leak meaning, oil level will goes on decreasing. So, we have to take care of the followings. What are those? All the time, monitor the oil level in the tank using the oil level gauge; you will see oil level gauge is there. You have to select the proper oil level gauge to mount over the tank to monitor the oil level.

As already we know that when the pump will sucks the fluid and sends the fluid, it level falls. After doing the work when the oil will enter the tank, it levels goes up; goes down, goes up. Every time, you have to monitor the oil level otherwise pump will run dry run, that is not good. It will destroy the pumps that is why always you have to monitor the oil level through the oil level indicator.

Then also I told you very very delicate parts are there, control valves are there, pumps are there, actuators are there, safety is very important. Wear and tear due to the foreign materials dust particles will enter. So, what we have to do? Efficient filtration is very important. So, filter the oil for continuous usage through the strainer and various filters, suction filters are there, pressure line filters are there, strainers the bigger way all are there.

As oil used up in the circuit, the oil level goes down and when it returns to the tank oil level goes up in the reservoir. Hence provide the breather filter or it is also known as breather filler use to air always exist over the tank, very important it is breather filler or a breather filter I will show you in the next line how it will come.

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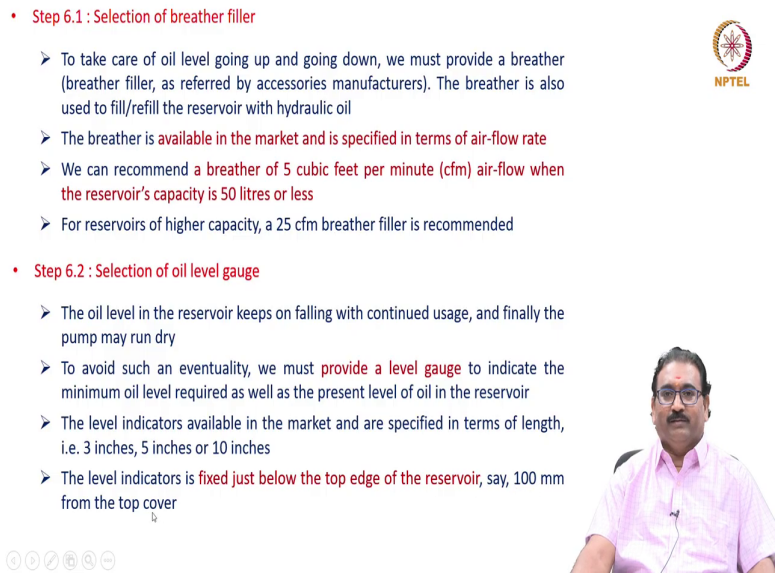

Then selection of the breather filler. To take care of the oil level going up and going down, we must provide a breather also known as it is an important accessory. The breather is also used to fill and refill the reservoir with a fresh hydraulic fluid. The breather is available in the market and a specified in terms of air-flow rate passing in and out.

We can recommend a breather of 5 cubic feet per minute cfm air-flow when the reservoir's capacity is 50 litres or less. For reservoirs of higher capacity a 25 cfm breather filler is recommended. Step 2 selection of oil level gauge. The oil level in the reservoir keeps on falling with the continued usage, and finally, the pump may run dry.

To avoid such an eventuality, we must provide a level gauge to indicate the minimum oil required as well as the present level of the oil in the reservoir. The level indicators available in the market and are specified in terms of the length.

You may get 3 inch, 5 inch, 10 inch, 20 inch. Based on your requirement, visibility, clarity, all you will mount over the tank where the level indicator is fixed just below the top edge of the reservoir say 100 mm from the top cover.

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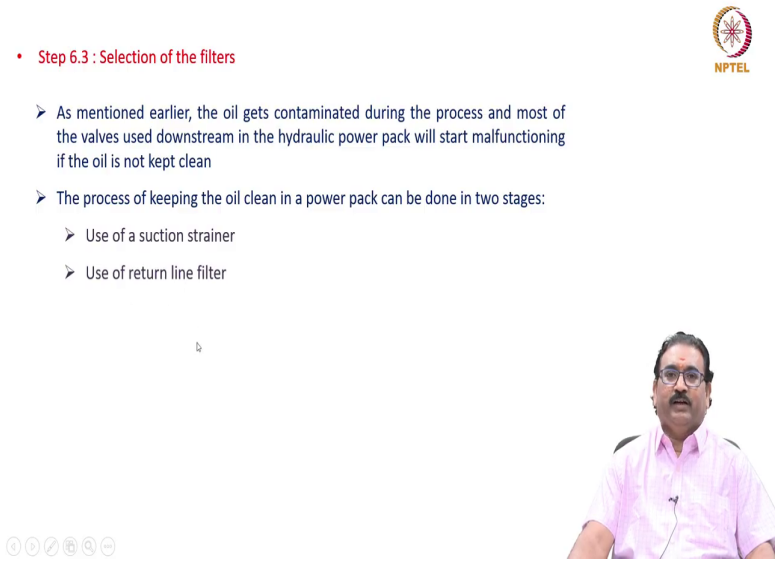

Next step 6.3 is selection of the filters. As mentioned earlier, the oil gets contaminated during the process and most of the valves used downstream in the hydraulic power pack will start malfunctioning if the oil is not kept clean. The process of keeping the oil clean in power pack can be done in two stages. First one is use of suction strainer, then use of return line filters.

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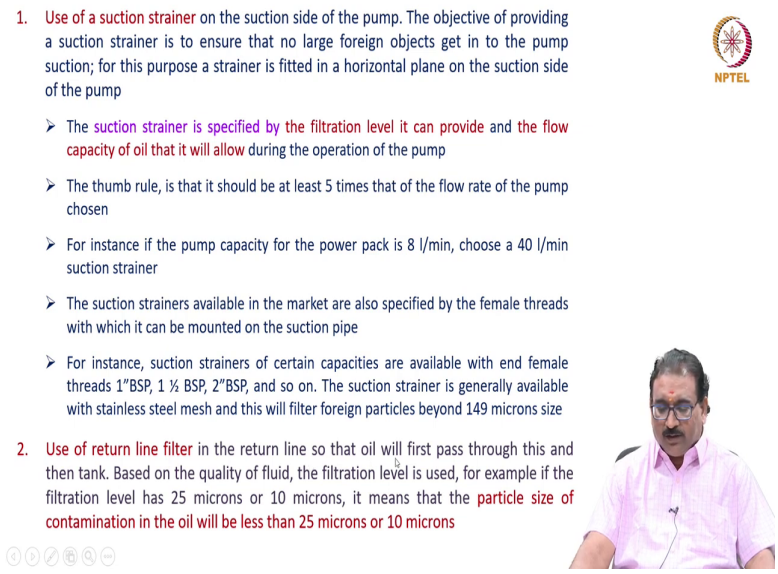

Use of suction strainer on the suction side of the pump. The objective of providing a suction strainer is to ensure that no larger foreign objects get into the pump suction; for this purpose a strainer is fitted in the horizontal plane on the suction side of the pump. The suction strainer is specified by the filtration level it can provide and the flow capacity of the oil that it will allow during the operation of the pump.

The thumb rule, is that it should be at least 5 times that of the oil flow rate of the pump whatever you are chosen. For instance if the pump capacity for the power pack is 8 litres per minute, now 7.5, 8 I am taking, choose 40 litres per minute suction strainer. The suction strainers are available in the market are also specified by the female threads with which it can be mounted on the suction pipe.

For instance, the suction strainers of certain capacities available with end female threads 1 inch BSP, 1 and half inch BSP, 2 inch BSP and so on. The suction strainer is generally available with stainless steel mesh and this will filter a foreign particles beyond 149 micron size.

Next use of return line filter in the return line so that the oil will first pass through this and then tank. Based on the quality of fluid, the filtration level is used. For example, if the filtration level has 25 microns or a 10 microns, it means that the particle size of contamination in the oil will be less than 25 microns or a 10 microns.

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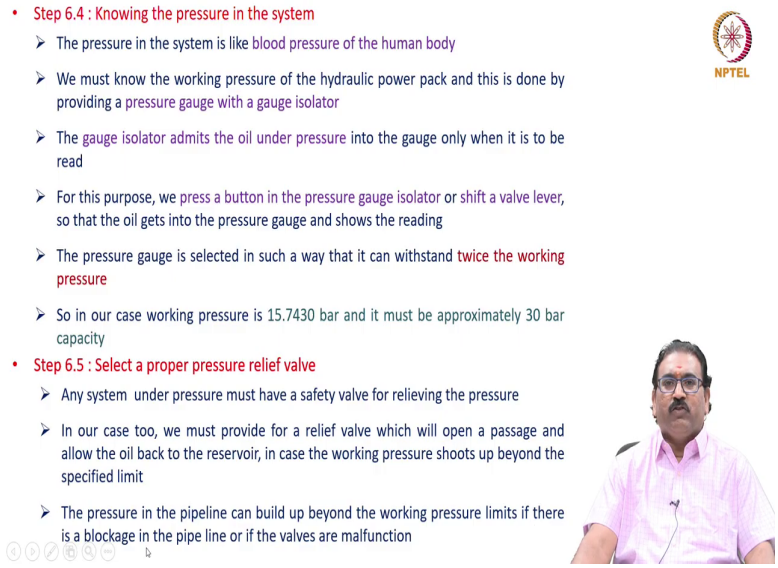

Step 4 is knowing the pressure in the system. The pressure in the system is like blood pressure of the human body. We must know the working pressure of the hydraulic power pack, and this is done by providing the pressure gauge with a gauge isolator. The gauge

isolator admits the oil under pressure into the gauge only when it is to be read. For this purpose, we press a button in the pressure gauge isolator or shift a valve lever, so that oil gets into the pressure gauge and shows the reading.

The pressure gauge is selected in such a way that it can withstand twice the working pressure. So, in our case working pressure is 15.73 bar and it must approximately 30 bar capacity meaning it will show the pressure gauge up to 30 bar. Step 6.5, select a proper pressure relief valve, to safeguard the whole system in turn the pump is very important.

Any system under pressure must have a safety valve for relieving the pressure. In our case too, we must provide a relief valve which will open a passage and allows the oil back to the reservoir, in case of working pressure shoots up beyond the specified limit. The pressure in the pipeline can build up beyond the working pressure limits if there is a blockage in the pipeline or if the valves are malfunction.

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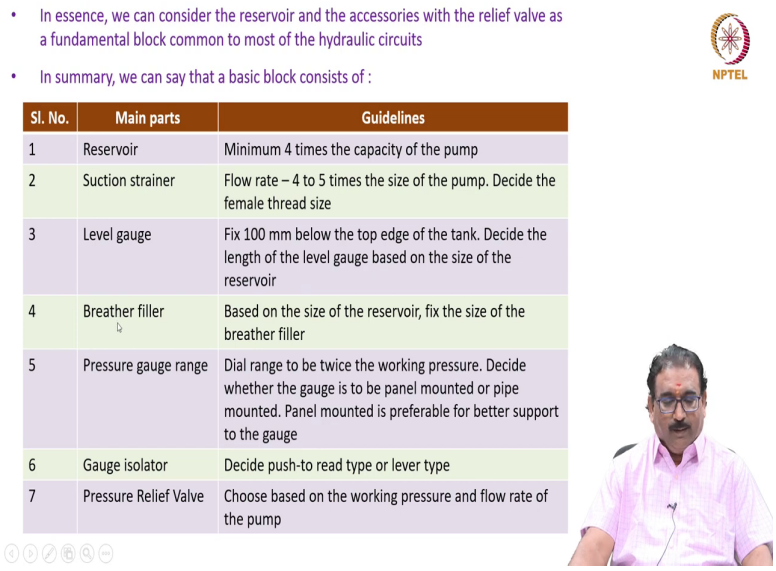

Sl. No.	Main parts	Guidelines
1	Reservoir	Minimum 4 times the capacity of the pump
2	Suction strainer	Flow rate – 4 to 5 times the size of the pump. Decide the female thread size
3	Level gauge	Fix 100 mm below the top edge of the tank. Decide the length of the level gauge based on the size of the reservoir
4	Breather filler	Based on the size of the reservoir, fix the size of the breather filler
5	Pressure gauge range	Dial range to be twice the working pressure. Decide whether the gauge is to be panel mounted or pipe mounted. Panel mounted is preferable for better support to the gauge
6	Gauge isolator	Decide push-to read type or lever type
7	Pressure Relief Valve	Choose based on the working pressure and flow rate of the pump

In essence, we can consider the reservoir and the accessories with a relief valve as a fundamental block common to most of the hydraulic circuits. In summary, we can say that the basic block consists of reservoir already I told you guideline maximum 4 times the capacity of the pump. Suction strainer, flow rate – 4 to 5 times the size of the pump; decide the female thread size. Level gauge, fix 100 mm below the top edge of the tank decide the length of the level gauge based on the size of the reservoir.

Breather filler, based on the size of the reservoir, fix the size of the breather filler. Pressure gauge range, dial range to be twice the working pressure; decide whether the gauge is to be panel mounted or a pipe mounted. Panel mounted is preferable for better support to the gauge.

Gauge isolator, decide a push-to read type or a lever type. Pressure relief valve, choose based on the working pressure and flow rate of the pump. These are all very very important in the power pack.