Oil Hydraulics and Pneumatics
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Part 3: Gear motors - external and internal, Direct-drive Gerotor motor and Orbital Gerotor motor
Lecture - 47
Hydraulic Motors

My name is Somashekhar; course faculty for this course.

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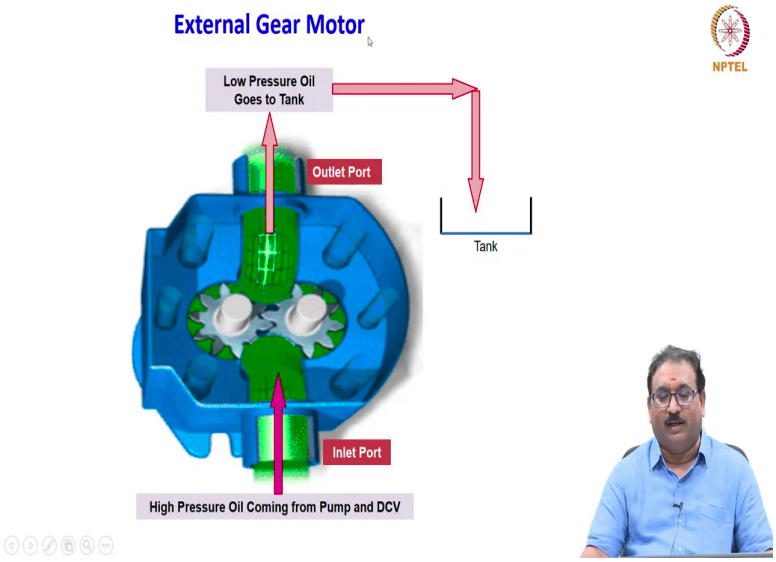

Here external gear motor what I have drawn here. The animation will show the high pressure oil coming from the pump and DCVs which will rotates the shaft here by rotating the gears. And fluid is carried around the periphery.

After rotating, after doing the work, it will leaves the low pressure oil which is directed to the tank. Please understand this friends. The inlet and outlet ports, and these are the two gears, and this is housing. Always the inlet side is a high pressure; outlet side is a low pressure.

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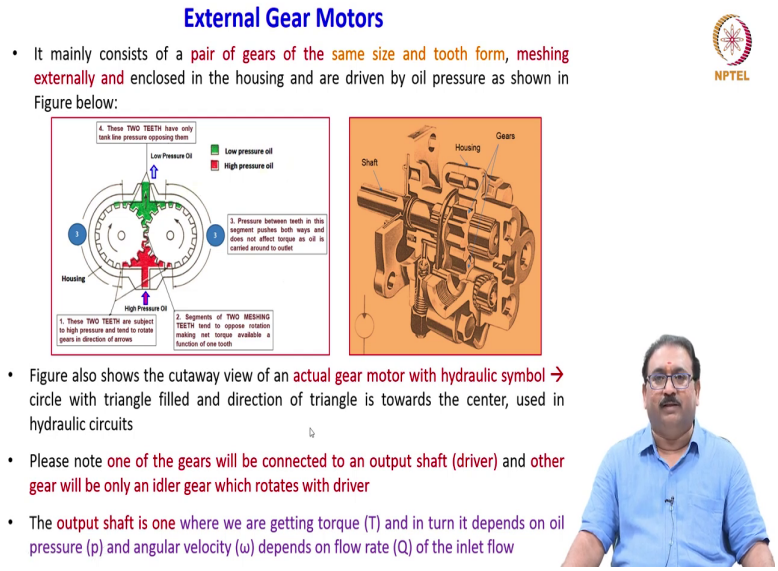

External gear motors – it consists mainly a pair of gears of the same size and a tooth form, meshing externally and enclosed in a housing and are driven by oil pressure as shown in the figure below. Here the figure shows here that two gears enclosed in the housing. It has two ports – inlet port and the outlet port.

Inlet port carries the high pressure oil from the tooth and control elements, which is used to rotate the shaft. Here one gear is a driver gear which is connected to the shaft. Here we want

the required torque with required speed. After rotating this, the fluid will exit from the outlet with a low pressure which is connected to the tank.

The very important things you will see here friends now the torque is generated with the high pressure fluid at the inlet how it is. Here I have marked four important points on the figure here. You will see here.

These two teeth here you will see the these two teeth are subjected to high pressure, and tend to rotate gears in the direction of arrows as I have shown you here. Here you will see a segment here what I have marked here, segment of two machine teeth tend to oppose a rotation making net torque available a function of one tooth here I have marked here.

Here pressure between teeth in this segment pushes both ways and does not affect a torque as oil is carried around the periphery. And here you will see friends another tooth these two teeth have only a tank line here opposing them ok. Always you will remember these are also unbalanced motors as because the inlet is high pressure, outlet is a low pressures. These external gear motors can also be used as a bi-directional by sending the fluid flow to the other side, then they will rotate in the other direction. This is also possible in the external gear motors.

Here you will see friends here a cutaway view of the actual gear motor with a hydraulic symbol is shown here means hydraulic symbol is used in the design of circuits. Please see here the triangle filled and direction is towards the center. Here this is an inlet; this is the outlet. Here also we will see in the cutaway view the two gears enclosed in the housing chamber, and this is a shaft which is rotated with the help of the fluid pressure and the fluid.

Please note as I have told you one of the gears will be connected to the output shaft driver and the other gear will be an idler gear which rotates with the driver. Here this is the driver, and idler gear. The output shaft is one where we are getting the torque and in turn it depends on the oil pressure more oil pressure more torque, and angular velocity depends on the flow rate

of the inlet flow. If more flow rate, shaft will rotate at a higher speed. The principle is very simple.

You will see here the operations are similar to the pumps, but in the pumps what we are doing we are sucking the fluid and we are expelling the fluid at the outlet. But in the external gear motor, we are using the pressurized fluid to rotate the shaft. After rotating, the outlet is a low pressure oil which is goes to the tank.

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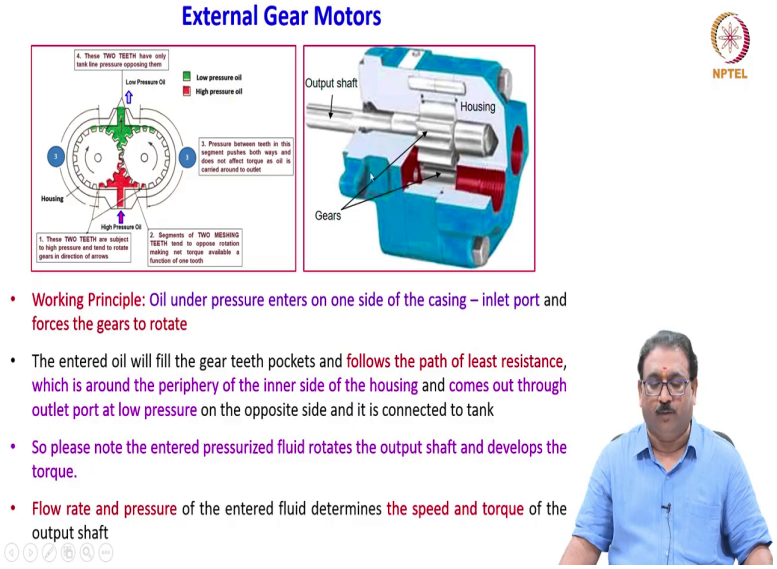

The working principle is very simple. As I have told you oil under pressure enters on one side of the casing that is the inlet port and forces the gears to rotate in the directions marked. The entered oil will fill the gear teeth pockets and follows the path of least resistance, which is around the periphery of the inner side of the housing and comes out through the outlet at a low pressure on the opposite side and it is connected to the tank.

So, please note the entered pressurized fluid rotates the output shaft and develops the torque. Flow rate and pressure of the entered fluid determines the speed and torque of the output shaft.

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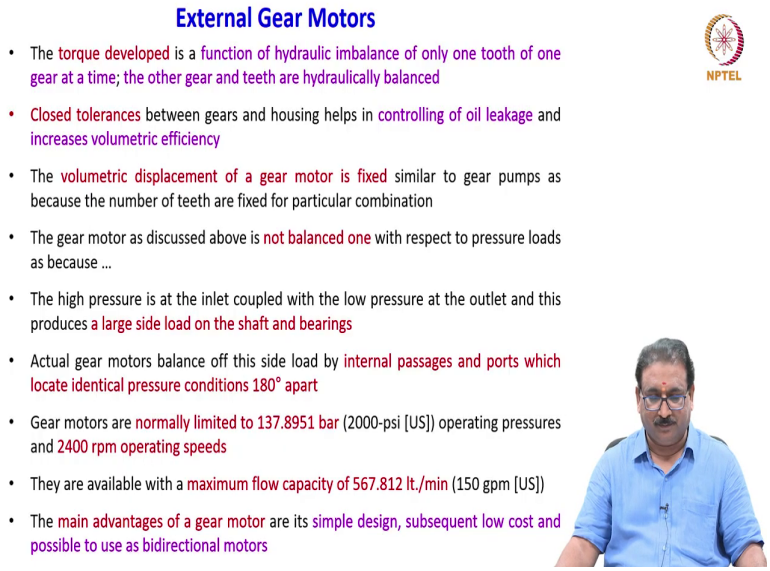

The torque developed is the function of hydraulic imbalance of only one tooth of one gear at a time; the other gear and teeth are hydraulically balanced. Closed tolerance between the gears and housing help in controlling the oil leakage and increases the volumetric efficiency.

The volumetric displacement of a gear motor is fixed as because the number of teeth on the gear is fixed at the particular combination. The gear motor as discussed above is not a balanced one with respect to the pressure loads as because the high pressure at the inlet

coupled with the low pressure at the outlet and this produces a large side load on the shaft and bearings, and hence the efficiency will go down.

Actual gear motors balance off this side load by internal passages and ports which locate identical pressure conditions 180 degree apart. Gear motors are normally limited to 137.89 bar in US they are mentioning psi pounds per square inch operating pressure – this is the operating pressure, and the operating speed is 2400 rpm.

They are available with maximum flow capacity of 567.81 liters per minute or in US customary unit 150 gallons per minute. The main advantages of the gear motor are its simple design, subsequent low cost and possible to use as a bidirectional based on the direction of flow in and out will decides the direction of the shaft rotations.

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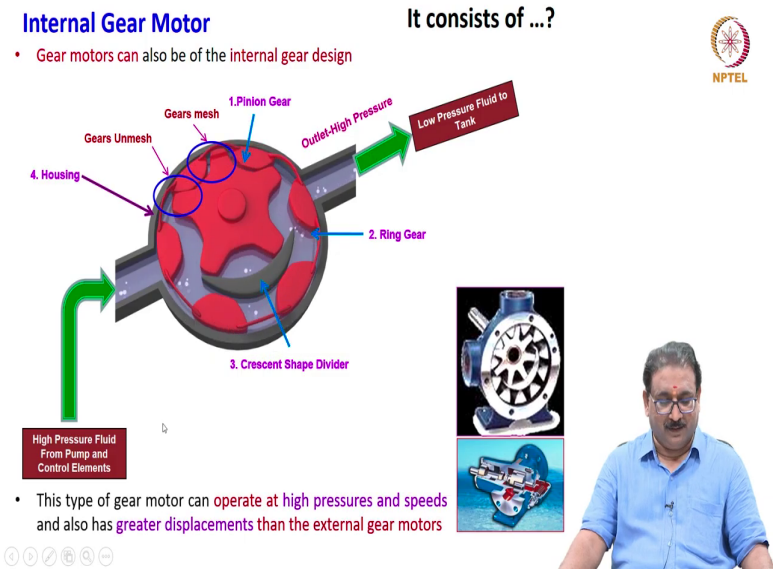

Now, we will move on to the internal gear motors. The gear motors can also be of the internal gear design, similar to your internal gear pumps. You already discussed in the previous classes the many details on the internal gear pumps.

Can you please tell me the finger what are the things I have shown here? Please not here the inlet is connected to the high pressure side from where the fluid will enters from the pump and control elements. And the outlet as I have told you connected to the low pressure fluid; please note these two important points.

Then can you please tell me what are the things are there here? As usual two gears are here; one external teeth another one is a internal teeth. Both axis are offset. The internal one is connected to the shaft where we required the torque and speed. Then you will see friends when they are located offset they have to make the seal positive seal that is a crescent shape divider, which will separates the outlet from the inlet. This is one of the important features in the gear motors.

Let us we will see what are the important component. Middle one is a pinion gear which has external tools. Then ring gear big one what I have shown here it is a internal tooth, then it is a crescent shape divider then mainly the whole housing. This type of gear motors can operate at a high pressures and a speeds. And also has a greater displacements than the external gear motors.

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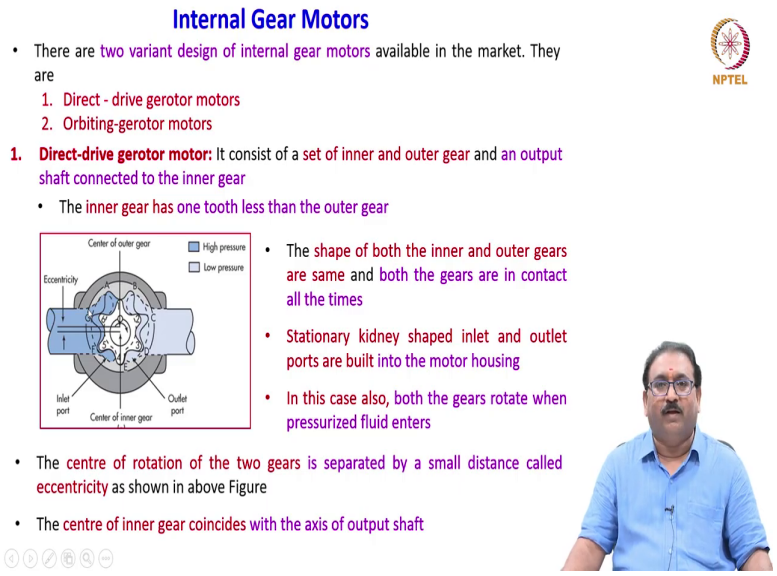

Here also there are two variant designs of internal gear motors are available commercially in the market. They are direct drive gerotor motors, and one more is orbiting gerotor motors. Let us we will see what is this gerotor. As I have told you in the gerotor pumps, the same principles here friends. The direct-drive gerotor motor consists of a set of inner and outer gear and an output shaft connected to the inner gear meaning inner gear is a driver.

See inner gear what I have shown here is a what is this it is a external teeth; and one more you will see the bigger one – here it is a same profile and size. But what you will see here the one tooth is less here and one tooth is more here, which will makes always they will contact at the down and up.

Here what is this? I will tell you now. Here the inner gear has one tooth less than the outer gear. The shape of both the inner and outer gears are same. And both the gears are in contact

all the times you will see how they are contact in all the times, and stationary you see here kidney shaped openings are there. Stationary kidney shaped inlet, and the outlet are built into the motor housing.

In this case also, both the gears rotate when the pressurized fluid enters. Then please note here the both the gears are offset. This is the center of rotation of the two gears separated by a small distance called an eccentricity. The center of the inner gear coincides with the axis of the motor shaft. Please also note here friends I have marked here for the inner gear 1, 2, 3, 4, 5, 6 for easy understanding. Similarly, for the outer gear I marked with capital A, B, C, D, E, F, G. Now, we will see how it will operate.

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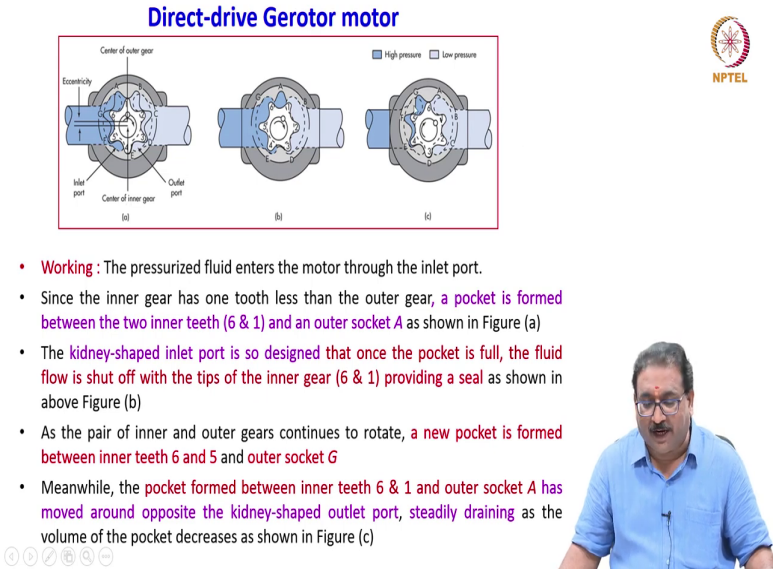

Working is the pressurized fluid enters the motor through the inlet port, this is the inlet port. Since the inner gear has one tooth less than the outer gear, pocket is formed you will see here

a pocket is formed between the two inner teeth, please see here two inner teeth 6 and 1 and outer pocket A here it is pocket is formed. The kidney shaped inlet port is so designed that once the pocket is full, the fluid is shut off with the tips of the inner gears 6 and 1 it is blocked – seals it.

As the pair of inner and outer gears continues to rotate, a new pocket is formed between the inner teeth 6 and 5. Now, we will see the 6 and 5 and the outer pocket you will see now, or else you will see here the new pocket is formed, then it will rotate to next.

Meanwhile, the pocket formed between the inner teeth 6 and 1, and outer socket A has moved around opposite the kidney shaped outlet port, steadily draining as the volume of the pocket decreases, correct. When it will move here, the oil will be drained discharged to the tank. During this moment, the pressurized fluid will rotate the shaft.

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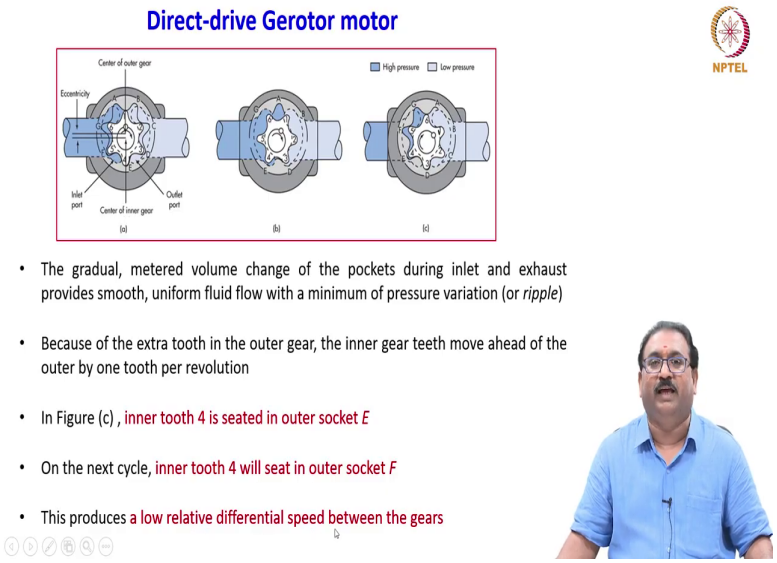

The gradual, metered volume change of the pockets during the inlet and exhaust provides a smooth, uniform fluid flow with a minimum pressure variation or a ripple. Because of the extra tooth in the outer gear, the inner gear teeth move ahead of outer by one tooth per revolution. In figure c, inner tooth 4, you will see here inner tooth 4 is seated in outer socket E right.

On the next cycle, when it will complete, then what happens the inner tooth 4 will sit in the outer socket F, it will go and sit here. This will continues. The next cycle, this will go and sit in the E like this it will do. This produces a low relative differential speed between the gears.

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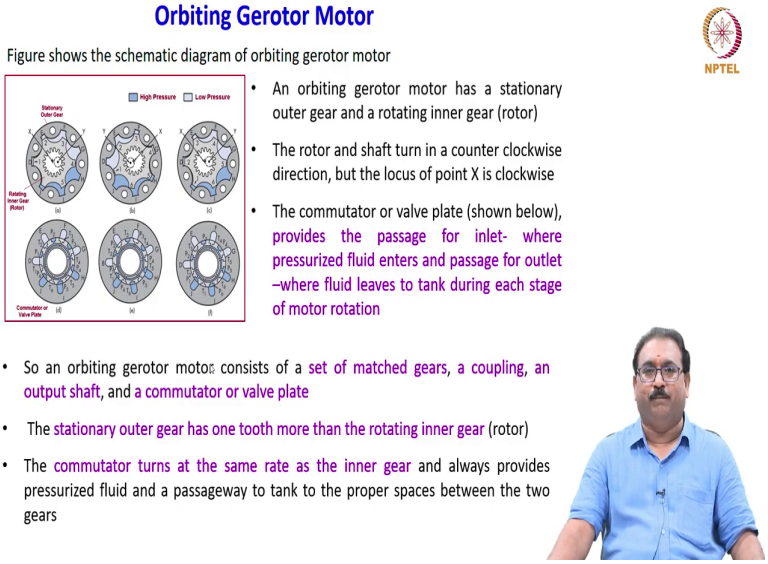

Similar to that, I will show you one more thing orbiting gerotor motor. It is slightly different in the operation. Because in the previous one the both the gears are rotating. Now, we will see the figure shows the schematic diagram of orbiting gerotor motor same here you will see

everything is same here. But you will see the outside one is a stationary outer gear, and inside one is a rotating inner gear. Where other constructional details are same friends here.

Here again you will see the center of the rotor and the stator x what I want locus of the point. This locus of the point x will move in the along with the circle. Now, we will see I have marked here one more down it is known as a commutator valve plate, which will shows the connection where the pressure high pressure oil will enter, and the low pressure oil will go to the tank. Here what I have marked here high pressure in the different color and low pressure in the different color.

Let us we will see now an orbiting gerotor motor has a stationary outer gear and a rotating inner gear. The inner gear is connected to the motor shaft that is rotor. The rotor and a shaft turn in a clockwise counter clockwise. Please note here friends the rotor and a shaft turn in counter clockwise direction, but the locus of point X is clock wise. This will rotate anti clockwise at time the locus will move in the clockwise.

The commutator or a valve plate provides the passages for inlet where the pressurized fluid will enters and passages for the outlet – where the fluid leaves to the tank bring the each motor rotation. So, an orbiting gerotor motor consists of a set of matched gears a coupling, an output shaft, and a commutator or a valve plate. The stationary outer gear has one tooth more than the rotating inner gear, similar to previous ones.

The commutator turns at the same rate as the inner gear and always provides a pressurized fluid and a passages to tank to the proper spaces between the two gears. You will see here these are all the pressurized when they will rotate. These are all connected to the tank. Gerotor motors are similar to your gerotor pump. Here while overcoming the crescent shaped divider by providing the one tooth less for the driver compared to the bigger gear.