MARINE ENGINEERING

By

Prof. Abdus Samad

IIT Madras

Lecture19

Positive displacement pump

Now we have discussed centrifugal pump positive displacement what is the difference now you see an example of positive this is now like a diaphragm pump it will be like this I have one diaphragm here okay using one rod okay I can have using rod this diaphragm so if the diaphragm is moving up and down Then fluid will be sucked or delivered. So you can make certain valve arrangements so they can deliver. In many cases, a diaphragm pump is also being used. Reciprocating pump.

The reciprocating pump will have like piston. And you can have one valve here. And fluid can be sucked. It can be delivered. This is called a reciprocating pump.

Continuously like cycle pumper. You are delivering continuously a certain amount of fluid. So this is called a reciprocating pump. This is a diaphragm pump. Progressive cavity pump, I have already shown.

Already shown in my bag. Screw pump. A screw pump is one type of progressive cavity pump. There is another vane pump is there. There will be a scroll pump.

Many types of positive decision pump pumps are there. And positive decision pump again, it can be like a simplex pump. Duplex pump, triplex, multi-cylinder, single acting, double acting, so many types of pumps will be there. So, reciprocating pump, whenever I say like cycle pumper, I already have shown one picture of this person like movie, hand pump, rural household people will be using. Reciprocating pump is you are giving reciprocating force to one piston.

Let us say I have one piston here and you are giving reciprocating force alternating. And there will be one certain valve arrangement. Using that valve arrangement, actually, you

suck fluid from one point and you deliver fluid to another point. When the piston is moving backward, maybe you are sucking. When piston pushing down, this is called piston.

This is piston rod. This is cylinder rod. this is suction pipe this is delivery pipe delivery pipe So, whenever we are moving up and down, suction pipe will be sucking fluid, delivery pipe will be delivering. And suction side one valve will be there, during upstroke only it will be opening, when downstroke suction valve will be closed, delivery valve will be open.

So, that way the reciprocating type pump will be working. This is called single acting reciprocating pump. okay and another pump can be possible like double acting pump how double acting pump will be working yes i'll be making horizontal one pump and i have one piston again piston will be very thin gap almost no gap actually okay and this is my piston rod and i have have one suction pipe I have a delivery pipe and this side also I will have similar arrangement okay like this okay so in single acting reciprocating pump you had only one time delivering one time sucking but in double acting pump you say a B you see a side actually single acting pump and when piston is moving backward when let us say a1 a2 a3 a4 when piston is moving backward let us say a a1 to a3 right side is moving so cavity a is getting filled but cavity b it will be delivering fluid okay

Again, when it is moving opposite direction, B will be sucking, A will be delivering. So, continuously one will be cylinder will be filled, another cylinder will be delivering fluid. So, that is called double acting. So, when piston moving left side or right side, both ways it is sucking or delivering. But in single acting case, it is delivering only during one stroke, other stroke it is sucking.

So, double acting cylinder, this is. double acting pump. Double acting I should write reciprocating. So, single acting pump if I have, how much fluid it can deliver? So, piston's diameter, let us say diameter D, cylinder diameter D. So, in that case, what is the area of the piston?

Area of piston, area of piston equals pi by 4 D square okay and how much stroke length how much from top to bottom it is going this for the stroke length is L okay in so volume A into L, total volume delivering is A area and total length, total volume delivering in one time. And what is the flow rate then? A L N, N means number of stroke, number of strokes.

How many number of stroke? 1, 2, 3, in 1 minute, let us say 60 is doing. So, 60 into total volume delivering. So, that is a flow rate. But for double acting, so Q will be doubled.

Q doubled, so it will be like Q will be 2ALN, but another issue is there. You see B side actually rod volume also there. Presently I am ignoring the rod volume. If I consider rod volume, if I piston rod volume, then rod volume we have to do minus.

So, Q will be like ALN plus area is reduced now, area minus area rod ln. So, this much of volume will be delivered in two double acting reciprocating pump. But if you have single acting, this is single acting. But if you assume that piston rod is very thin and it will not take lots of volume, so you can ignore.

So, you can see one problem, single acting formula Ln, double acting 2Ln, ignoring connecting rod diameter, discharge meter cube, so unit or SI unit, water deliver per stroke L is length. So, in a double acting, reciprocal acting pump, if the area of piston 200, so first you draw piston, it is like this, 200 centimeter area, 200 centimeter. length of stroke 15, crank rotation 60 rpm, n is given 60. So, for double acting, so 2 0.15 into 0.02 into 60.

So, it is going 0.35. If efficiency 98 percent, why efficiency coming up? Because piston and cylinder we are assuming ideally there is no gap, but there might be certain amount of gap like piston and cylinder, you see this one, small amount of gap may be possible. So, there may be certain amount of leakage. So, if there is any leakage, then

total volume whatever you are calculating it cannot deliver that much there will be a little bit lower volume okay so that is then your total efficiency will total volume flow rate will be like 0.343 okay so another problem is here a single electric receiving pump delivering water 0.012 8 meter cube, runs 60 rpm, stroke length 500, piston diameter 200, total piston diameter is given. Total lift is 15 meter, so total fluid lift. So, theoretical head, Q theoretical ALN by 60, so pi by 4 d square into NL by 60. So, it is coming pi by 4 into 0.22

square 0.5 into 60 by 60 so it is giving 0.019 meter cube per second so slip q theoretical minus q actual equals 0.019 minus 0.018 equals 0.001 meter cube per second so slip percentage 0.001 by 0.018 into 100 equals 5.26 percentage so c d uh okay slip formula actually i should write q theoretical minus q actual divided by q actual q theoretical so c d equals q actual by q theoretical equals 0.01 by 0.019 equals 947 so P theoretical theoretical power Rho Q theoretical into G HST neglect losses it is coming like 1000 into 0.019 into 9.81 into 15, it is giving 2796 watt equals 2.8 watt. motor efficiency, if motor efficiency is 95 percent,

Then electric input, electric input equals 2.8 divided by 95 equals 2.95 kilowatt. theoretical power output running the pump, electrical input also we got.