MARINE ENGINEERING

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Lecture20

Pumps in series/parallel

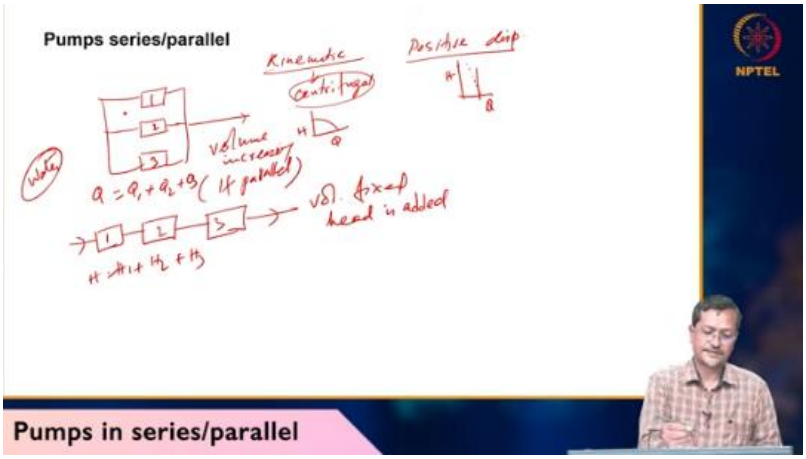
now i will start the pumps Pumps are parallel in series and compare that part so we have already learned that pumps can be two types one will be centrifugal or dynamic or kinematic pump and the other be positive displacement okay so they have their characteristics let's say kinematic or centrifugal centrifugal pump this pump is having limitation of head, you can see this Q and H curve and positive displacement curve you have seen vertical. in positive displacement pump actually you are developing infinity head ideally, but practically it may not be possible gradually this vertical line will be moving towards this H side or H axis and finally there will be some limitation of total amount of head. now in some cases you need very high amount of flow rate so in that case you actually you can connect pumps in parallel okay then you can collect the whole water here so total volume are increasing volume increasing if parallel if

But if you are connecting series, one pump, 1, 2, 3, like this, so in that case 1, 2, 3, so total volume fixed, volume fixed, but head fixed. the head is added or increased. But the parallel case, total volume increasing just every one pump is developing Q1, Q2, Q3. Q1 plus Q2 plus Q3. But in this case, the head is added up like say H1 plus H2 plus H3 total head.

But here Q equals Q1 plus Q2 plus Q3, okay? But in the first case,the head is not changing almost. The second case,the flow rate is not changing. The flow rate will never change because you cannot destroy mass, okay? because we are assuming this is incompressible flow, water is, although compressibility there, okay?

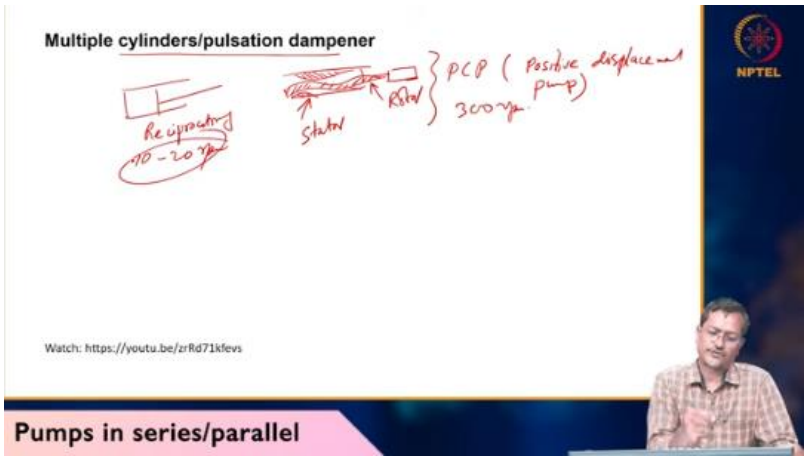
But what happens? We are not compressing at that level, so where significant compression can be observed. So, in practical application, we assume water is incompressible. it is incompressible, then head equals H1 plus H2 plus H3, Q equals Q1 plus Q2 plus Q3 for two different cases.

This is pump in series, pump in parallel. This is pump in parallel. pumps you can say pumps in series okay so both are having their advantages and disadvantages basically head and fluid multiplication okay basic difference okay pulsation dampener and multiple cylinders so what happens in reciprocating pump in centrifugal pump or a screw type pump or positive displacement like that pump i already explained what happens in positive displacement pump we have basically two types of positive displacement forms one will be reciprocating type another can be rotary type rotary type means like positive displacement form this is called I'll make this is rotor stator okay rotor stirrer, this is a PCP or positive displacement pump.



Displacement pump. normally PCP or positive displacement pump speed will be like 300 rpm. But in a centrifugal pump, the speed will be like 1400 to 3000 rpm. Reciprocating pump, when you are talking about reciprocating. because of speed, you cannot increase the

pump speed at a very high level. For example, if you have 10 strokes, 20 stroke, maybe 1 or 2 stroke per minute, 20 stroke, 100 stroke, 100 stroke also maybe sometimes it will be too high. 10, 20 strokes or 10, 20 times it is pushing and pulling, delivering fluid that can be okay for reciprocating pump, maybe 10, 20 rpm. it will be around this one. But for rotary type, this is reciprocating type, positive displacement pump.



And rotary type, this is rotary type, positive displacement pump. So, the reciprocating type pump is a very slow speed and the rotary type, its speed will be little bit higher. Another difference is that the reciprocating pump will give pressure pulses but positive displacement rotary type, screw type, that pump will give continuous pressure. How?

Let us say when piston is moving from A to B, fluid is getting sucked. So, that time you are not developing any pressure. Again when you are moving the piston from B to A, from B end to A end, you are increasing pressure, you are delivering that time. that time what is happening? one time you are getting very high pressure,

Again, when the piston is moving backward side, you are not getting any pressure,this time no pressure, again you are getting pressure. if you have one pressure measuring devices, let us say here, pressure, pressure gauge is there, so what will happen? When the piston is moving from B to A, your pressure is increasing, so it will be showing pressure like this. when piston is moving A to B, so B to A, A to B, sorry, A to B here, A to B, again this is B to A. B to A means you are getting pressure.

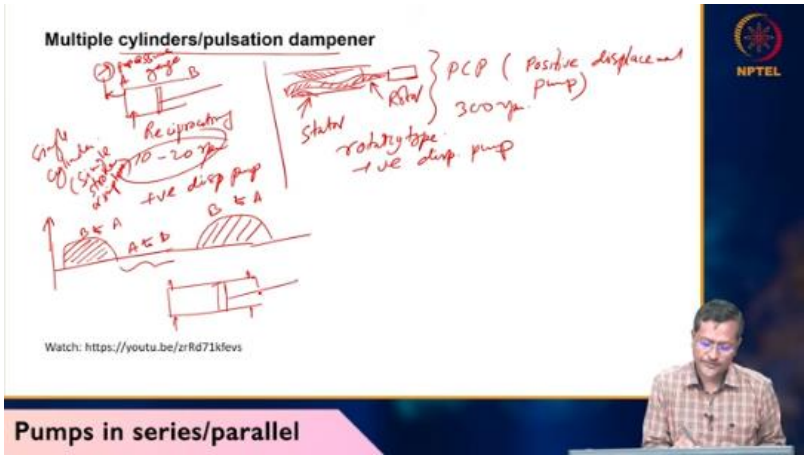
A to B means you are not getting any pressure. you are getting pulse. One-time pressure, no pressure. Pressure, no pressure. Pressure, no pressure.

pulse pressure we are getting. For example, your heart, human heart is working. It also gives a pulse. It is also giving a pulse like this. But your rotary-type system, is not giving that pulse.

Now, let us say in a certain situation, you are getting a pulse, but you do not want that pulse. You want smooth flow, but you want all the benefit of a positive displacement pump then what you do you put some pulsation dampener but in say in this case if you are creating multiple cylinder this is single cylinder right single cylinder pump and this single stroke is

also single stroke or simplex If you have a simplex pump, you are delivering one time, another time you are not delivering. you are getting passed flow.

Now, if you have double acting pump, double acting pump means like you have piston, you have one delivery valve, one suction valve and this side also there will be one delivery valve, suction valve. in that case actually your pulse profile will be like this. one time delivery, let us say A or maybe A1, B1 I can make. So, A1 delivery, but when piston is moving from A to B, B that time is not delivering, because you are getting pulse like this. Now, when piston moved at B, again moving in opposite direction, opposite direction that time B is delivering, B1.



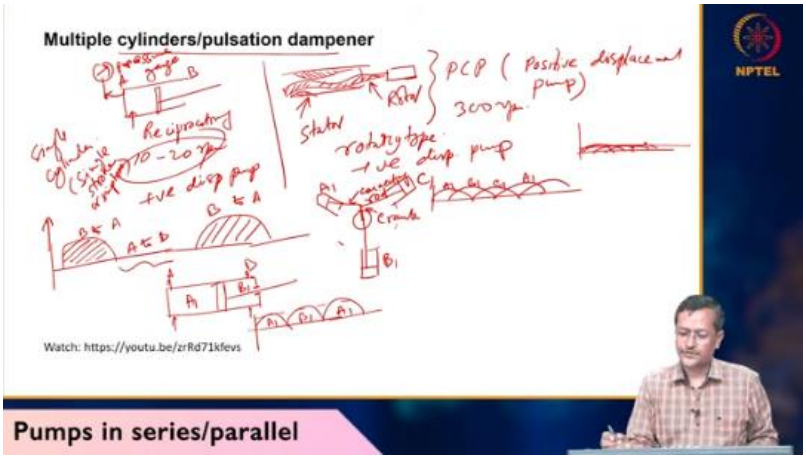
Then again A1 delivering. continuously A1 delivering one time, B1 one time delivering. now your pulse profile almost smooth, right? So first case, simplest case, you are getting only pulse, no pulse, pulse, no pulse. So now you are getting double stroke pump.

In that case, you are getting pulse, pulse, pulse. Still there is some variations. Now if I have multiple cylinders, let us say I create one system like this. i have one cylinder here okay i have another cylinder here and connected here i have another cylinder here connected here so what is happening when this crank connecting rod connecting rod, you can see this connecting rod are moving in different direction, right?

when crank is rotating, so one piston delivering, another piston sucking. in that case, pulse profile will be like this, let us say A1, B1, C1, I have three cylinder. So, A1 is delivering, now B1 will be delivering, now C1 will be delivering. So, A1, B1, C1, Now, again A1 will be delivering. Now, again B1 will be delivering.

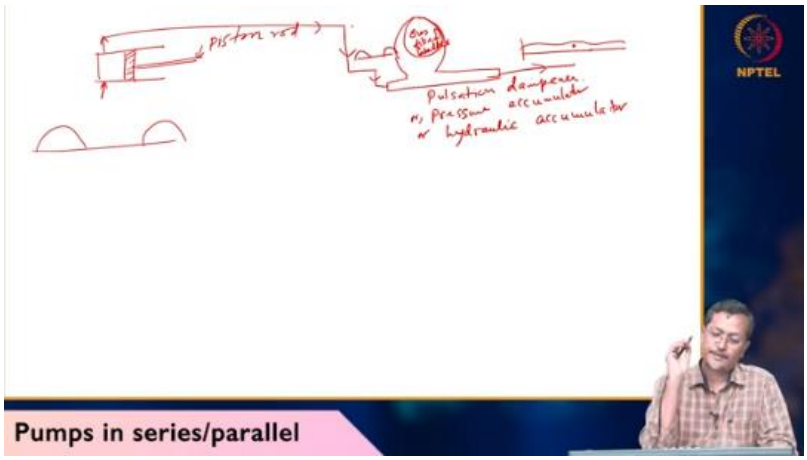
So, pulse profile again become much smoother. Now, if I have instead of three, I have many cylinders. So, in that case, what will happen? Pulse profile will be like this. you will get almost constant pulse.

if you have many cylinder, you are delivering total amount of fluid more and you are getting almost pulse free delivery. But in some cases, you are not having that much of benefit of having multiple cylinder. In this case, what you do, you use pulsation dampener. if it is only single cylinder, let us assume, okay, and you have piston here and piston rod here, piston rod or connecting rod and here delivery valve, entry valve. in that case you are getting pulse like this okay now if i have one delivery side i have one chamber with nitrogen field so chamber will be like this



okay chamber is like this and this is nitrogen filled area gas-filled balloon bladder gas filled bladder so what happens when delivery fluid will come so this delivery fluid will be compressing this bladder okay so this is called a pulsation dampener Or they say, pulsation accumulator, pressure accumulator or it is called pressure accumulator or hydraulic accumulator. what are the pressure pulses are there? It will be dampening or the pulses will be reduced. Because this gas field blower will be absorbing the pulses and it will be delivering smooth flow.

inlet pressure pulses is like this, then outlet pulses will be like this. it is smoothening. that is why it is called pulsation dampener. In many cases, this pulsation dampener is used for specific applications. Now, let us solve one problem.



Let us assume one radial flow impeller or centrifugal pump. We have a radial flow impeller, impeller A and impeller B. And impeller A is having diameter 1 feet. and impeller B has having 2 feet, efficiency 70, 65 and N is given 1500, 3000. calculation we have to do like this, head ratio HA by HB you have to calculate. So, head formula HA eta A UA square by 2G, you can remember the formula and HB also eta

B, similar formula, B to G, you means impeller speed. So, H A by H B equals eta A by eta B, U A square, U B square. 2g 2g vanished so eta a by eta b ua omega a square r a square omega b square r a square rb square this value will be like this eta a means 0.7 0.65 omega a 2 n pi by 60 2 n pi by 60 2 n pi by 60 n a n b square r a by r b square okay so r a by r b is given a is given 1 b is 2 so this will be giving like this 0.7 0.65 1 by 2 into 1 by 2 so finally we are getting square 0.067 this answer