Course on Momentum Transfer in Process Engineering
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Lecture 35
Module 7
Variable fluid flow-problems and solutions (Continued)

Okay, we have done variable flow, right? And we have done a problem also with that and let us do another problem because solving problem will give you confidence that yes you are proceeding in the right way. Whenever you do anything you try to make solutions of problems and numerical problems and the moment you that gives you two things, number 1 the idea of the numerals what is the pressure, what is the velocity all these you can come to know like coefficient of discharge unless you have some idea while doing the problems.

So suddenly you cannot tell that what is the coefficient of discharge values more or less what different of course it is company make so that depends on the nozzle or that can of instruments and this is a company make and company will tell you that what is the value of that Cd, but still while you are doing the solution of the problems you come across and you can definitely tell that the values are around 0.98, 0.95 it can also 0.85 depending on the design depending on the valve, depending on the (())(1:58), depending on the nozzles which you are getting from the supplier, right?

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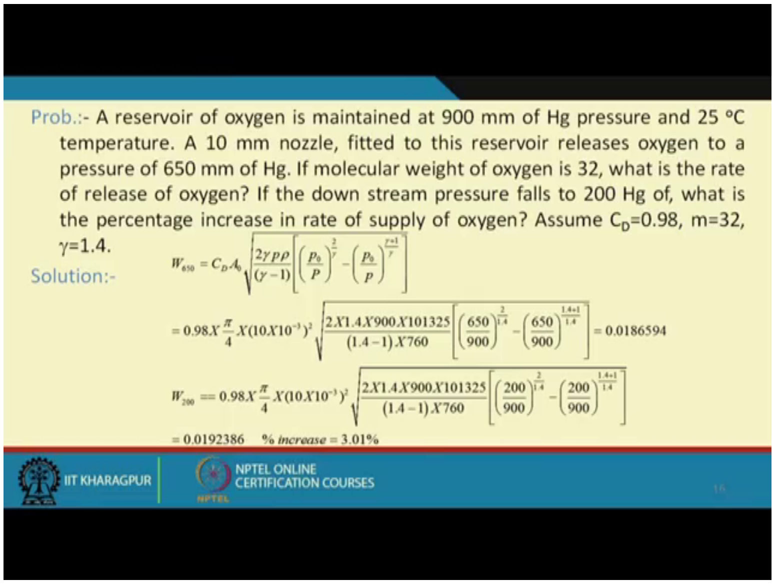

So let us do another problem and this problem tells that, A reservoir of oxygen is maintained at 900 millimeter of mercury pressure and 25 degree centigrade temperature. A 10 millimeter nozzle, fitted to this reservoir releases oxygen to a pressure of 650 millimeter of mercury. If molecular weight of oxygen is 32, what is the rate of release of oxygen? Further, if the downstream pressure falls to 200 millimeter of mercury, what is the percentage increase in the rate of supply of oxygen? You assume Cd value to be 0.98, molecular weight this I should change because small m is not molecular weight so it is capital M so molecular weight of oxygen is 32 and the given heat capacity ratio is 1.4, right?

I repeat, A reservoir of oxygen is maintained at 900 millimeter of mercury pressure and 25 degree centigrade temperature. A 10 millimeter nozzle, fitted to this reservoir releases oxygen to a pressure of 650 millimeter of mercury. If molecular weight of oxygen is 32, what is the rate of release of oxygen? If the downstream pressure falls to 200 millimeter of mercury, what is the percentage increase in the rate of supply of oxygen? Assume Cd 0.98, molecular weight already given 32 and gamma 1.4, right? Here also we should write, otherwise it is millimeter 200 millimeter of mercury that millimeter is coming capital so it should be small millimeter of mercury, right? Yeah, fine.

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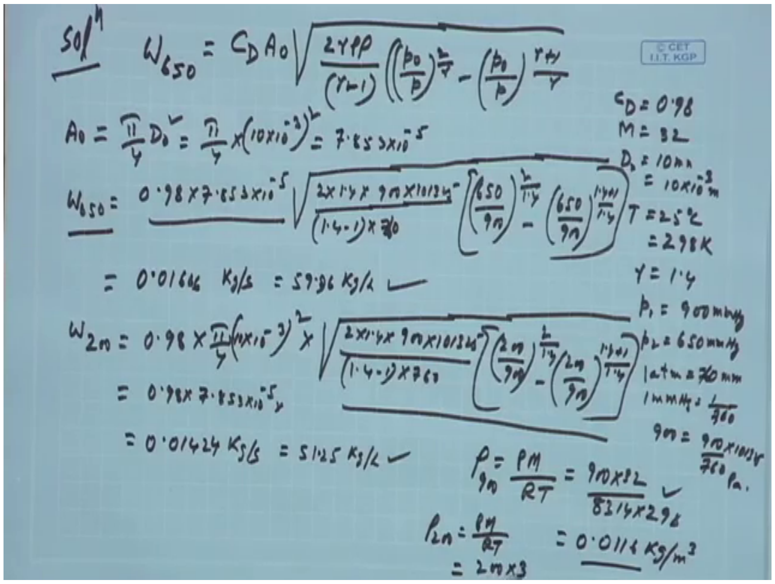

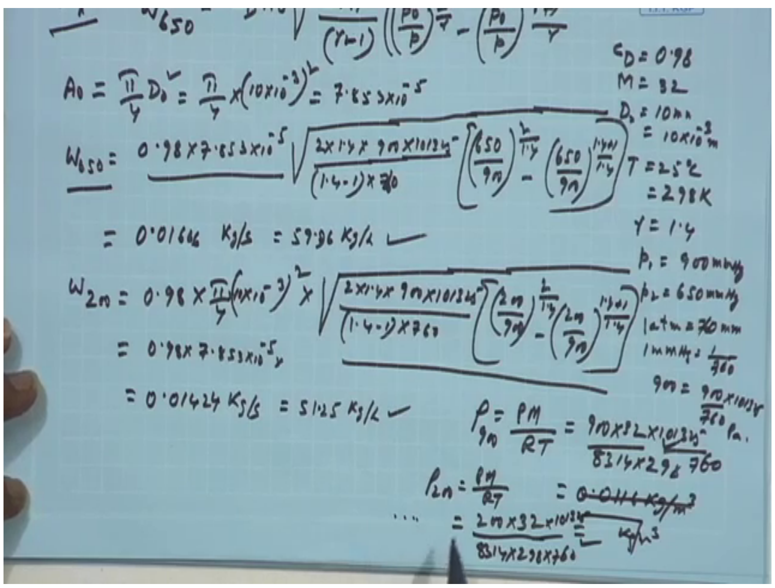

So then if we solve it, then we know W at 650 millimeter of mercury whatever has been said this is equals to Cd A0 under root 2 gamma p rho by gamma minus 1, right? Into p0 by p to the power point or rather 2 by gamma minus p0 by p to the power gamma plus 1 by gamma, right? So if that is true, then we can write given let us write that Cd is 0.98, then M is given 32, then D is given D of nozzle is given 10 millimeter, so it is equals to 10 10 to the power minus 3 meter then temperature given 25 degree centigrade is equals to 273 plus 25 that is 298 Kelvin, right? And gamma given 1.4, then p1 is given at 900 millimeter of mercury and p2 is given 650 millimeter of mercury, right?

So and also we have to find out that what is the value of A0, A0 is pi by 4 D0 square is equals to pi by 4 into 10 into 10 to the power minus 3 whole square, right? And this is equal to pi by 4 is equals to this into point 10 to the power minus 3 that is 1 into 10 to the power minus 2, so into 10 x to the power 2 plus minus is equals to 0.00 that is what so when you calculate you have to be very careful so pi by 4 into 10 into 10 to the power minus 3 whatever is written let us take that otherwise chances of mistakes are there and it is occurring.

So this square, right? So that means this 7.853 10 to the power minus 5, right? So we can write W650 this is equals to 0.98 into 7.853 10 to the power minus 5 under root 2 into 1.4 divided by 1.4 minus 1 into p, p given is your 900, right? p given is 900 millimeter of mercury, okay and millimeter of mercury 900 millimeter of mercury so it is 900 into 760 900 into 1760 atmosphere is equals to 760 millimeter of mercury, right? Or 1 millimeter of mercury is 1 by 760 atmosphere, right? So 900 millimeter of mercury is equals to 900 divided by 760 into 101325 Pascal, right?

So there should be written 900 into 101325 divided by 760, right? Into 760 so this is what this times we can write here since this are ratio so we can write this po 650 p is 900 to the power 2 by 1.4 minus 650 divided by 900 to the power 1.4 plus 1 by 1.4, right? So till now it is okay so this part is done let us do this part. So if we do 650 by 900 is equals to this to the power 2 by 1.4 is this so that is becoming this minus so let us take first this and second this that 650 divided by 900, right? So this is equals to this to the power 1.4 plus 1 that is 2.4 divided by 1.4, right? So this becomes that, then that becomes this then this is equals to this, fine.

This times 101325 times 900 times 1.4 times 2, right? Is equal to this divvied by 1.4 minus 1 that is 0.4 divided by 760 is equals to so much this is under root so much into 0.98 into 7.853 7.853 into 10 to the power minus 5 0.0166 is equals to 0.01666, right? This much of W that is kg per second, right? And this is divided by 3600 is equal to sorry into 3600 square is equal to 59.96 kg per hour, right? So if it is W650 so what about then W200. So W200 is 0.98, right? Into pi by 4 10 to 10 to the power minus 3 square, right? Into this remains under score 2 into 1.4 into this is from 900 to 200 so 900 into 101325 divided by 1.4 minus 1 into 760, right?

So this times this is 200 by 900 to the power 2 by 1.4 minus 200 by 900 to the power 1.4 plus 1 by 1.4, right? If this is true, then this we have already done this is equals to 7.853 10 to the power minus 5 times let us see how much is this, right? So that comes to be equal to 200 by 900 is equal to this to the power 2 by 1.4, right? So this is so, minus 1 then 2 (6) 200 by 900 to the power 2 by 1.4, right? So this is 1, 2 minus, right? Minus 1 200 by 900, right? To the power 1.4 2.4 by 1.4 so this becomes that becomes this becomes this, right?

So hopefully then I again some mistake has been done, some mistake again has been done. It is better do it carefully (())(20:59) 2 by 1.4 so that is this minus 1, 2 200 divided by 900 this goes x to the power y 2.4 divided by 1.4 is this and this is closed and finally is this, right? (())(21:59) that a we got it perhaps correctly into 2 into 1.4 into 900 into 101325 is equal to this divided by 0.4 divided by 760 is equal to this so this is under root this times 0.98 times 7.853 times 10 to the power minus 5 10 to the power 5 plus minus this is equals to this, right? So it is 0.0142, right? Kg per second 0.0142 say 4, right? This divided by not divided by this into 3600 is equals to 51.25 kg per hour, right? So it was 59.96 kg per hour, here it is 51.25 kg per hour hopefully they also got a similar number 0.0192 in our case 0.0142 in our earlier case 0.0166 in their case it was 0.0186.

However, then this means that this pressure that W200 was this 0.0192 0.0186 0.014 0.0166, so how much percentage increase in the rate? So it is coming to be decrease 59 to 51 so it is coming to be decreased but actually it is increased that was it is being shown that this is becoming an increase and this increase is W650 that we have found out in otherwise we have not done anything wrong that 0.985 there is Cd pi by 4 this is the diameter 10 to the power minus 3 whole square, so 2 that gamma 1.4 p 900, right? 101325 divided by 1.4 minus 1 into 760 what is not done is rho that is PM by RT that is not there should have been done.

So rho is equals to PM by RT where it is 900 into 32 by 8314 into 298, right? So that should have been there, right? So if that value comes to, then it is 900 into 32 is equals to this divided by R 8314 divided by 298 is equal to 0.0116 kg per meter cube. So that should have been there which here also it is missing that value of rho, right? Because this is 2 gamma p rho, so value of rho should have been there and that we can find out from rho is equals to PM by RT so much 0.0116 kg per meter cube.

However, if we put that then it is here into 650 by 900 p0 by p to the power 2 by gamma that is 2 by 1.4 minus 650 by 900 to the power 1.4 plus 1 by 1.4. So this is supposed to come a value which obviously is not also this one some other, please check and see how much actual it is coming and in a similar way W200 in this case W200 will be your this is rho 900 so W200 will be again PM by RT so we can write 200 into 32 here also some more thing had to be written 101325 by 760, so this may not be the right number some number in kg per meter cube will be there so here also 200 32 by 8314 into 298 into 760 into 101325 so this you put that becomes equals to some value.

So that rho value also has to come here, right? 0.985 by 4 into D square into 2 1.4 into 900 into 101325, fine but here rho value has to be there 1.4 minus 1 into 760 200 by 900 to the power 2 by 1.4 minus 200 by 900 to the power 1.4 plus 1 by 1.4. So this what will happen? This value will have lower value, whereas this value will have higher value and from there we can show that the increase is this much and we can find out the percentage this is what exactly the intention of the problem given is that you work with value and calculate and get really the (())(30:02) or get really the numbers which are associated, for example 5 percent, 3 percent increase or decrease whatever if depending on the cases it will be, right?

So when it is like that, then we can find out the real difference, okay so thank you for this class, thank you.