Surface Facilities for Oil and Gas Handling

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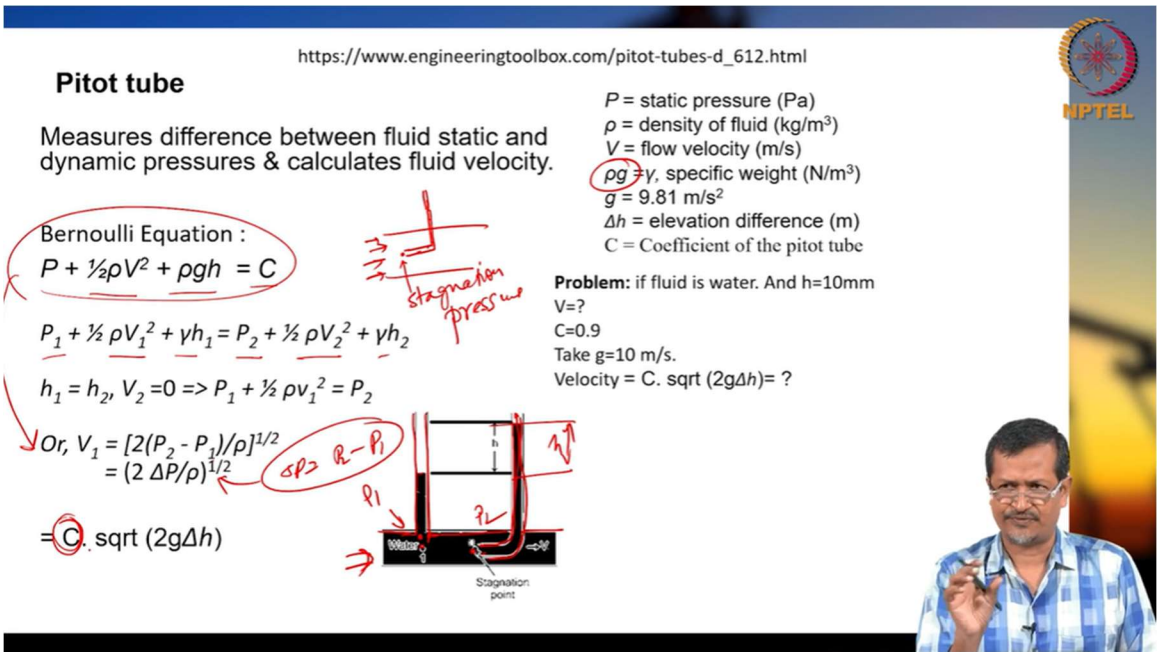
Flow Measurement Techniques-02

Water flows through orifice inserted in a steel pipe the orifice and the pipe internal diameter of 50 and 102 millimeter and data given 1000. So, sometime I do not give then water if I say then it is 1000 ok. Coefficient of discharge 0.6 is given pressure difference is given 2.

So, this is 1, this is 2 ok. So, del p is given 1 1 and 2 like if I make this U tube. So, pressure difference del p is given here instead of height directly pressure difference is given ok. So, d 1 d 2 by d 1 is equals 0.

or 50 direct I can write 50 by 102. So, it is going to be 0.49 ok. C d value is given 0.

6. So, C d you can get from the table if I give table ok if I do not give table then I will give the value or you can guess certain value if I ask you guess yourself ok. So, C v 0.6 C d 0.6 rho water is given 1000 kg per meter cube and del p given 20 kPa ok. So, m equals C d why I am directly coming? It should be q q equals C d A 2 rho del p by rho this is 1 minus A 2 by A 1 square.



So, this will be giving 0.6 into pi by 4 0.5 square 50 millimeter or if it is diameter 50 millimeter right. So, if I convert a meter it will be 0.

05 0.05 meter square 4 root over 1000 into 20000 kPa is there. So, into 2 and root over is there 1 minus 0.49 power 4. Why it is becoming like this? Like A 2 by A 1 equals pi by 4 d 2 d 2 square by pi by 4 d 1 square right. So, it is becoming like d 2 by d 1 square, but in actual term it is there A 2 by 1 square is there ok by A 1 whole square is there that means, d 2 by d 1 whole 4 ok.

So, that term is kept here delta p by 1000 ok, but why I am writing kg? It should be volume flow rate. . So, it is meter cube per second 7.7. Just check please this calculation is ok.

I think I have done some mistake here because I have written m it should not be m it will be q no no no no no no no no no no no no no I think last result is ok, but q is wrong. 7.7 is coming mass flow rate or flow volume flow rate? Volume flow rate. Volume or mass now my formula correct or not? 8.

5. 8. 5. 5. 8.

5. 8.55. 8.5. This is mass flow rate, but q value not required. . Meter cube per second. Meter cube per second ok. So, it will be you are saying like I did it this one.

0.0085. 0.0085. Like this? Yes. This is ok na. Yes. So, when I come mistake ok. So, I will I will record this one ok.

From this calculation we are getting value of flow rate volume flow rate is 0.0085 meter cube per second and mass flow rate will be multiplied by rho. So, q rho ah it is coming 8.55 kg per second fine ok. So, here another flow meter peter tube or piter tube many people say.

So, piter tube like it measures difference ah between fluid static and dynamic pressure ok. So, how it is measuring? I have one pipe if I put very narrow tube very narrow less 1 millimeter thickness or hole inside. So, what happen? All the fluid particle will be passing through this one, but some particle will not pass through this ok. It will get stagnated. So, if I have one measuring instrument here we will get stagnation pressure ok.

And let us see if I have different type of fluid inside. So, fluid level will be going up. So, that will be showing stagnation pressure stagnation pressure total pressure that area because high velocity fluid passing through this one. So, initially fluid pipe is having certain pressure again your high velocity fluid you are stopping ok. So, all velocity will be converted into pressure.

So, total pressure actually in measuring. So, that is called stagnation pressure ok. So, that is another fluid measuring fluid flow measuring instrument. So, again Bernoulli equation will be holding here ok. So, ah to calculate this one they have assumed like this I have one pipe ok I have two holes one hole is having just hole and one small narrow tube capillary tube sort of thing ok.

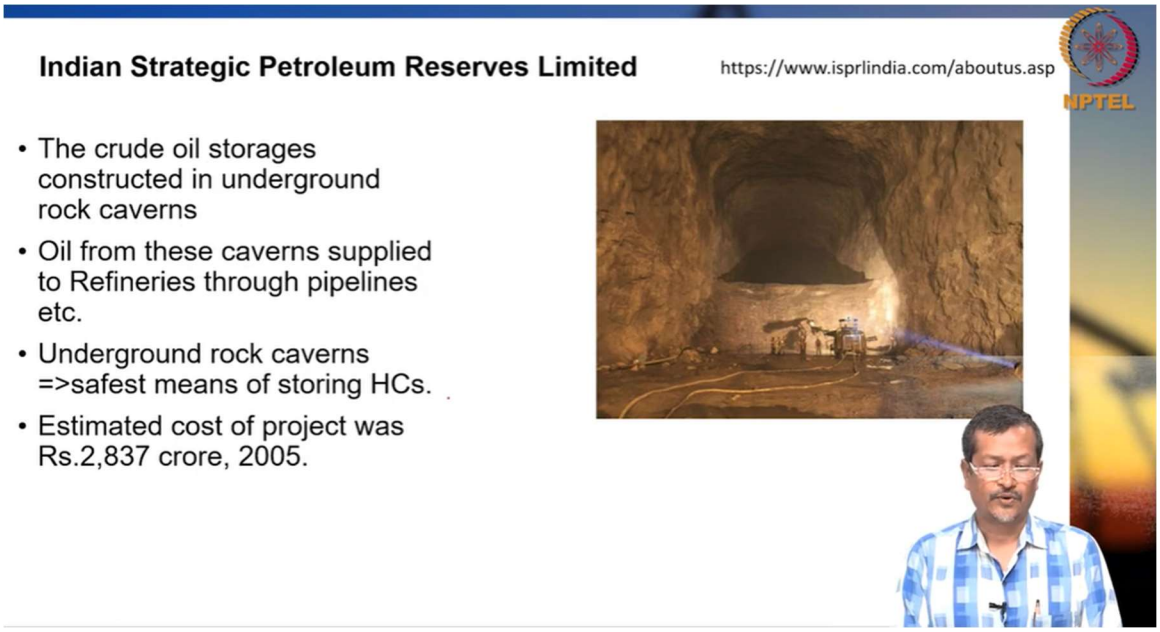
So, this pipe will be given certain pressure that will be called static pressure ok. And another I will put some pipe directing towards flow direction opposite to flow direction

ok. So, that fluid will get stagnated ok velocity fluid velocity particle will be stopping for certain moment and it should be increasing pressure ok. So, that pressure will be rising this fluid column level. So, this difference is h ok.

Now, if I use Bernoulli equation it will be like this p equals half rho v square plus rho gh equals c. Now, if same height is there then rho gh will be 0. So, p 1 plus half rho v square gamma, gamma means omega gamma value is actually rho g ok rho they have used the term. So, p 2 half rho v 2 square v 2. Now, what is p 1 p 2? I said this may be p 1 this may be p 2 this is maybe p 1 here p 2 here now v 2 is 0 ok.

So, v 2 is 0 means pressure will be higher there. Now, from there we are getting like if I use this Bernoulli equation finally, it will come like this. So, v 2 is 0 . So, you are getting v 1 equals to p 2 minus p 1 divided by rho per half and p 2 minus p 1 if I write del p del p equals p 2 minus p 1 then it is getting simplified like this and if there is certain loss in pitot tube then we have to put on constant also ok. So, 100 percent pressure will not be converted maybe there will be certain losses.

So, that term so, 0.95 0.98. So, that much of value they will be taking based on that they will calculate ok. So, del h means how much fluid is lifted one column is here another column is here. So, that difference del h ok. So, based on that you can do some calculation also to calculate flow rate. So, see if your fluid is water and h is 10.



So, this h is 10 ok, calculate velocity fluid velocity and C value like say I am giving 9 just assume take g value 10 meter. So, velocity C equals square T 2 gh. So, you can calculate also C square it 2 into 10 into del h del means 0.

01 right. So, 9 0.9 this is 0.9. So, you can get directly one value fine. So, this is left for your own calculation ok. So, U tube pressure measurement. So, vertical U tube possible ok, you get you sometime we give very heavier fluid like h g, sometime we give lighter fluid like annealing sort of thing. So, lighter fluid ok and we try to check what is the pressure difference like I have one pipe and I am putting tube like this.

So, if there is any obstruction or anything and it will be showing different pressure based on that we can get flow ah flow velocity measurement flow velocity flow rate flow rate to mass flow rate we can calculate ok. So, ah in some cases it can be inclined also based on your application area where maybe certain pipe they are not are not allowing to put vertical. So, there may be some inclined U tube also ok. You see my pipe is like this ok.

So, I will get inclined flow meter. So, in that case let us say my mercury level is going like this ok. And what is the angle ah? Angle can be like this theta ok and this level can be h. So, if I get h then you have to convert a vertical because h rho g related to your gravity ok. So, you have to convert you have to use sin theta function ok. So, del p will be gamma or h sin theta h means the distance gamma means or the g specific weight we can say ok rho g ok h that height and sin theta this theta angle.

So, then you can get del p ok you are not getting directly if I give inclined tube formula. Many time I give instead of saying h I will say ok pressure difference or ah vertical height is this one instead of h h means you have to calculate sin theta. If I see if I say vertical height that means you should not use your angle I am giving directly vertical height ok. Although angle will be there I will be showing everything, but just to confuse you I will write vertical height mercury is connected to between two points. If the manometer reading 26 millimeter ok, 26 is the difference ok, then calculate pressure difference between the points ok.

So, to pipe we have ok. So, you have to calculate pressure difference between two points 1 2 maybe ok ah. Then water is flowing through the pipe or air is flowing through the pipe. So, the data is given you can see this 20 degree centigrade temperature we are assuming

because air you need temperature r value, but water you do not need actually this is an incompressible ok. Water density given 30.

6, density water 1, molecular weight is 28.8, air molecular weight air temperature also given. So, you have to calculate in ah Kelvin. So, P 2 minus P 1 equals del P equals rho mercury minus rho water gh because if it is carrying water then this this column will be filled with water also, this portion will be filled with water ok. So, when you are calculating so, this portion also you have to calculate. So, mercury column difference and water column difference also you have to calculate ok.

So, 13600 minus 1000 mercury rho and g value 9.81 into 0.026. So, normally we give g value also because many times it is approximate with 10 g equals 10. So, then result will be different.

So, maximum time we give g value ok. So, it will be coming 3214.4 Newton per meter square ok ah for water. For air rho equals air density 28 point air molecular weight 28.8 into I will write the formula first PV equals nRT n by V equals P by RT ok.

From there you are getting rho equals 28.8 into 101 air at pressure 325 divided by 8314 into 293 because 1.2 kg per meter cube ok. So, you got density. So, del P equals rho m minus rho gh equals 13600 minus 1.

2 you got density air density 9.81 into 0.026 ok. So, this will be giving 34692 Newton per meter square ok. So, mass density actually mass mass density rho equals molecular weight into molecular density ok. So, let us see next problem one more problem this is last problem or then you have class ok. When you have class then I will 10 20 minutes I will take and finish .

. Sir can you show the . Any wrong? I will solve another problem a problem on Venturi meter a Venturi meter is fitted in a pipe or 30 centimeter diameter inclined tube. So, tube is inclined actually ok tube is inclined and we have one Venturi meter Venturi meter is actually narrow section you are creating ok. Now it is inclined at 40 degree. So, it should be 40 degree here ok to the horizontal to measure the flow rate petrol inside the petrol ok and specific gravity lower than water.

So, there is a 0.8 specific gravity ok. The ratio of area of main pipe main pipe this one and throat is 5 ok. So, main pipe area and throat. So, area throat by area main pipe is 5 and throat is throat is 1 meter from the inlet. So, it is showing 1 meter ok.

The difference in manometer head is 40. So, let us say liquid is filled like this only this section manometer is like this and liquid is filled here and draw properly ok. So, this section is filled with liquid ok and this difference of the difference is the two column is 40 millimeter.

Assume the coefficient of discharge 0.CD is given 0.96. Calculate discharge through the Venturi. So, we have to calculate flow rate flow rate and pressure difference del p between the throat and the entry point of the Venturi ok. Entry point means like here we can put one point and that point we have to calculate. Now, first we have to start with the formula Q equals C C CD A 1 I will write again Q Q equals C D A 1 A 2 A 1 square minus A 2 square into 2 g h.

So, A 1 is pi by 4 0.3 square equals 0.0707 meter square ok because 30 centimeter already given ok. Now, Q equals we put the values A 1 A 2 equals 0.

0707 divided by 5 equals 0.0141 meter square. Now, Q equals 0.96 the C D value given A 1 A 2 value we have to put A 1 A 2 and root over A 1 A 2 root over 2 into 9.81 into 0.04 sorry not square root it should be bracket 0.05 actually this diameter ok and this is mercury h g is given ok.

So, it is 13.6 divided by 0.8 this petrol specific gravity minus 1 ok. So, this would be giving 0.0486 meter cube per second. So, consider point A and B P A minus P B equals rho g rho g and let us say x plus 0.

04 g rho mercury minus rho rho petrol ok. So, this value will be coming like I will write from here 800 rho g is given sin theta plus 0.04 g 13600 minus 800. So, it will be giving 10067.32 newton per meter square or 10.

07 kilo newton per meter square instead of x I will write sin theta ok. Now, we will talk about strategic oil. Strategic oil is required when there is any global political conflict or any other issue which will be cutting our supply. For example, India importing 75 percent about 75 percent oil from outside country. Now, because of any political disturbance in oil producing country. So, it will be hampering our economy because we will not be able to import or maybe oil price will be increasing because of global crisis because of many reasons can be internal crisis or outside crisis because of that oil price can go up or supply can be cut.

So, for that to reduce disruption government many governments they have created a strategic oil reserve and how they have created. So, like for example, US, Israel, Japan, Korea they have already India also has created certain underwater reserve system. So, global petroleum reserve or GSPR crude oil inventories are stockpiled to safeguard the economy and help maintain national security during any energy crisis. So, energy crisis can be in many ways.

It is intended to be used to cover short term supply disruption. So, it cannot give for long term. So, maybe one day to let us say three months, two months, four months supply it can be given from the storage. India strategic oil, strategic petroleum reserve limited under Ministry of Petroleum Natural Gas they have created few reserves from their India government for military operations for emergency operations people can get fuel from there.

So, 36.92 million barrel of crude oil to provide 9.5 days consumption. So, very small amount of storage is there in it is already been created by India government. Refineries they maintain 64.5 days storage. So, total about 74 days storage is there in India. Three underground locations Bangalore, Visakhapatnam and Pudur in Karnataka already under operation and some other also under construction.

So, the crude oil storage constructed underground rock cabins. So, they will be cutting rock and they will be creating rock cabins and they will be storing there. So, oil from this cabins supplies to refineries through pipelines etcetera. So, this is actually crude oil not petrol or diesel. So, when you get oil from any oil field, so you store there as crude oil, crude form. Then after that you send to the reservoir, refineries and you separate diesel, petrol, naphtha, kerosene whatever you want to separate.

Underground rock cabins, safest means of storing hydrocarbon. Estimated cost of project it was in 2005 for India or about 3000 crore. So, it is huge cost also there, but it is also very much inevitable for country's safety and security in terms of military operations or economical issues. So, all government is trying to build their own storage systems for energy security only.

So, thank you very much for today lecture. We will start new topic on the next day. Thank you very much.