So that means I know the head losses that is what is computed here by substituting this value. There will be minor losses like bend losses, valve losses, the entry and exit losses all the components, this entry and exit loss we do not consider it here only the bend loss and valve loss we compute it which we have these values.

Major pipe head loss (due to friction):

$$(h_l)_p = f\frac{V^2}{2}\frac{L}{D}$$

$$(h_l)_p = 0.018\frac{1.58^2}{2}\frac{1922}{0.15}$$

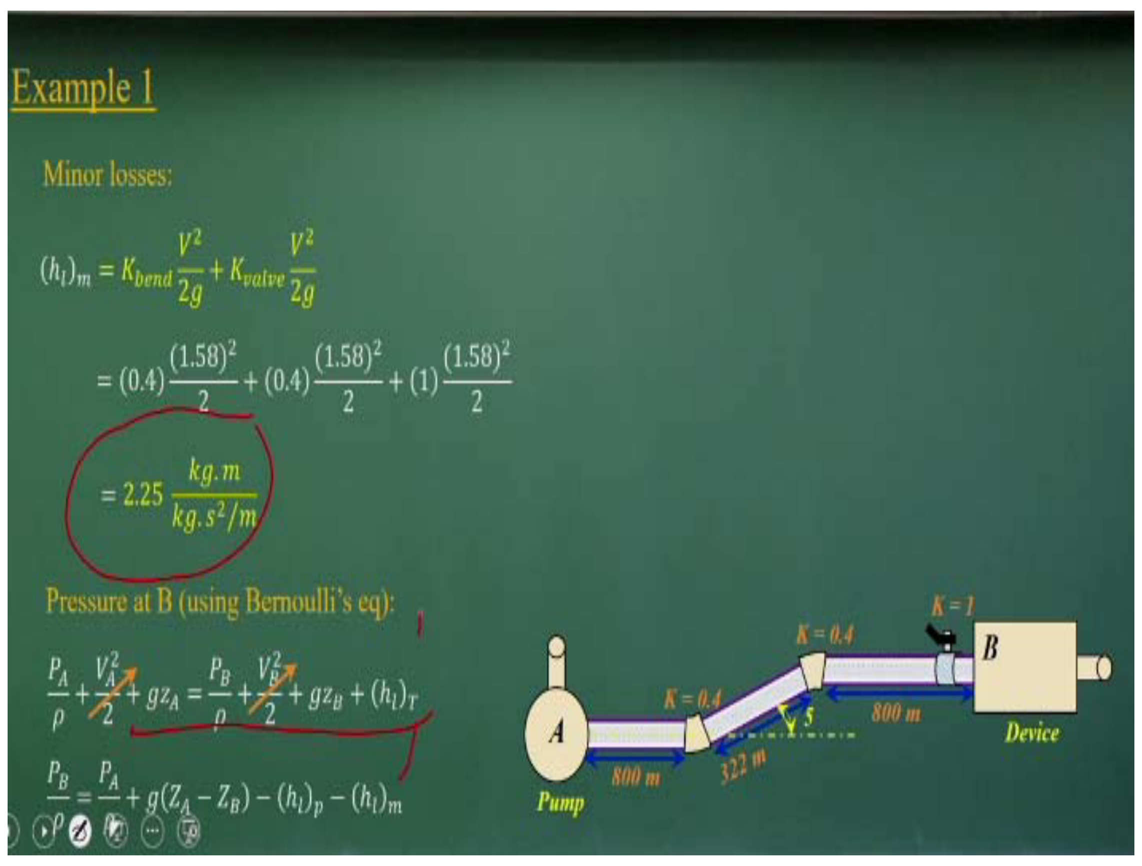
$$= 287.88\frac{kg.m}{kg.s^2/m}$$

Minor losses:

$$(h_l)_m = bend\ loss + valve\ loss + entry\ + exit$$

$$(h_l)_m = K_{bend}\frac{V^2}{2g} + K_{valve}\frac{V^2}{2g}$$

(Refer Slide Time: 50:39)



If are considering that the loss components will get it this much is the minor losses. Now we are substituting Bernoulli's equations, the modified Bernoulli's equations to compute what could be the pressure. So I am not going more detail as you can read this ppt to get these details.

Minor losses:

$$(h_l)_m = K_{bend}\frac{V^2}{2g} + K_{valve}\frac{V^2}{2g}$$

$$= (0.4)\frac{(1.58)^2}{2} + (0.4)\frac{(1.58)^2}{2} + (1)\frac{(1.58)^2}{2}$$

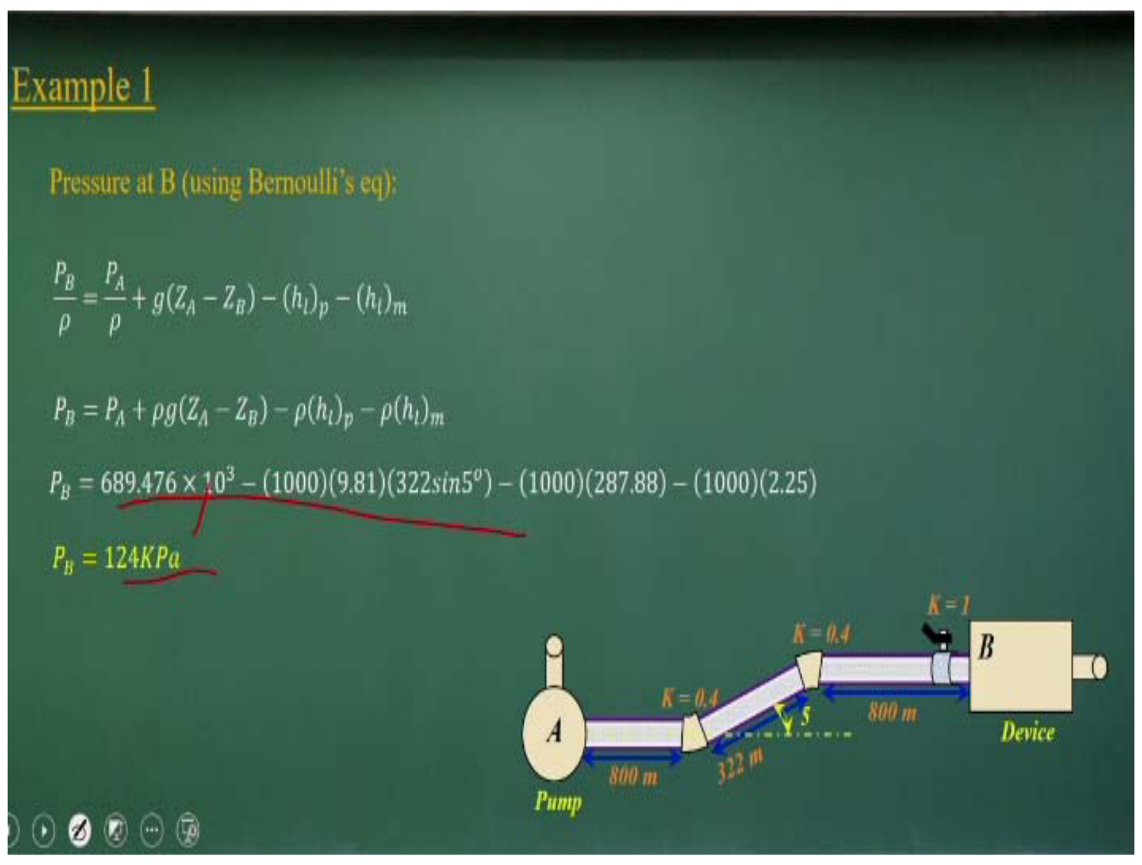
$$= 2.25\ \frac{kg.m}{kg.s^2/m}$$

Pressure at B (using Bernoulli's eq):

$$\frac{P_A}{\rho} + \frac{V_A^2}{2} + gz_A = \frac{P_B}{\rho} + \frac{V_B^2}{2} + gz_B + (h_l)_T$$

$$\frac{P_B}{\rho} = \frac{P_A}{\rho} + g(Z_A - Z_B) - (h_l)_p - (h_l)_m$$

(Refer Slide Time: 50:57)



So once know it then you can compute the pressure. Just substitute the value then compute the pressures. So it is quite easy job now once you know that.

Pressure at B (using Bernoulli's eq):

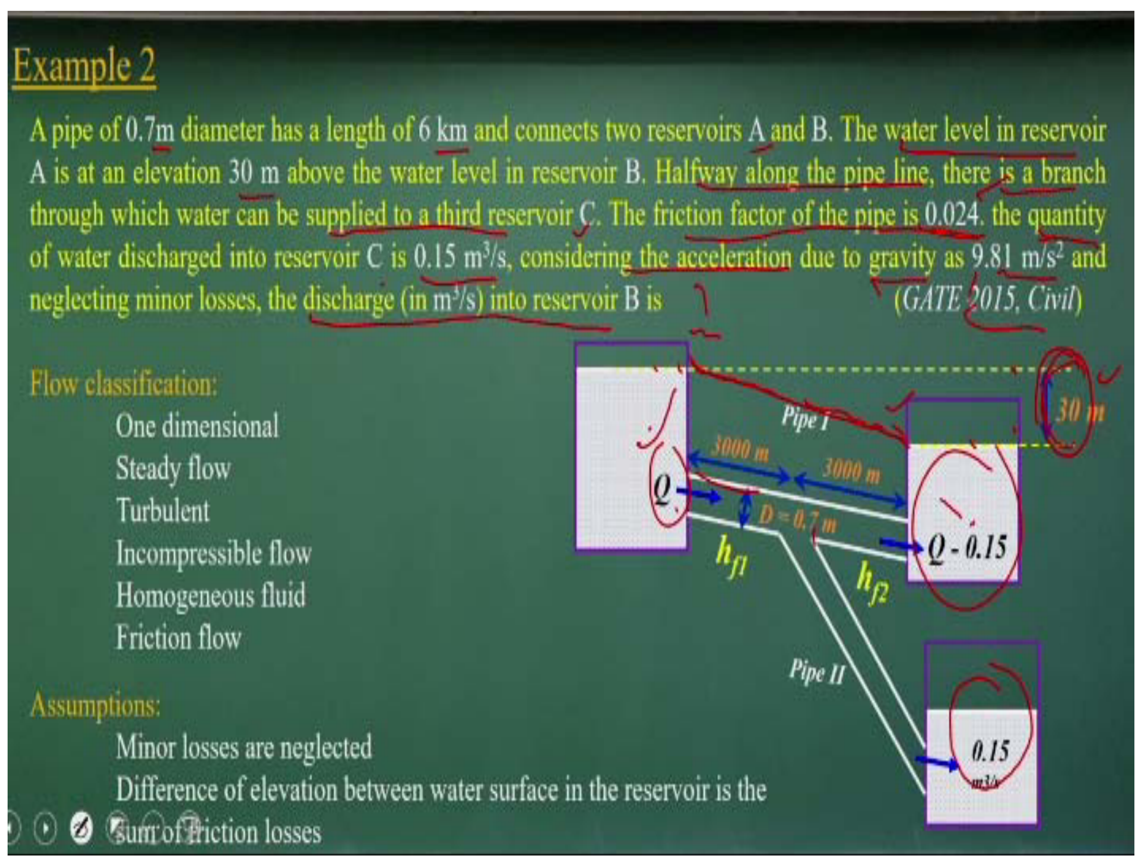
$$\frac{P_B}{\rho} = \frac{P_A}{\rho} + g(Z_A - Z_B) - (h_l)_p - (h_l)_m$$

$$P_B = P_A + \rho g(Z_A - Z_B) - \rho(h_l)_p - \rho(h_l)_m$$

$$P_B = 689.476 \times 10^3 - (1000)(9.81)(322sin5^o) - (1000)(287.88) - (1000)(2.25)$$

$$P_B = 124KPa$$

(Refer Slide Time: 51:09)



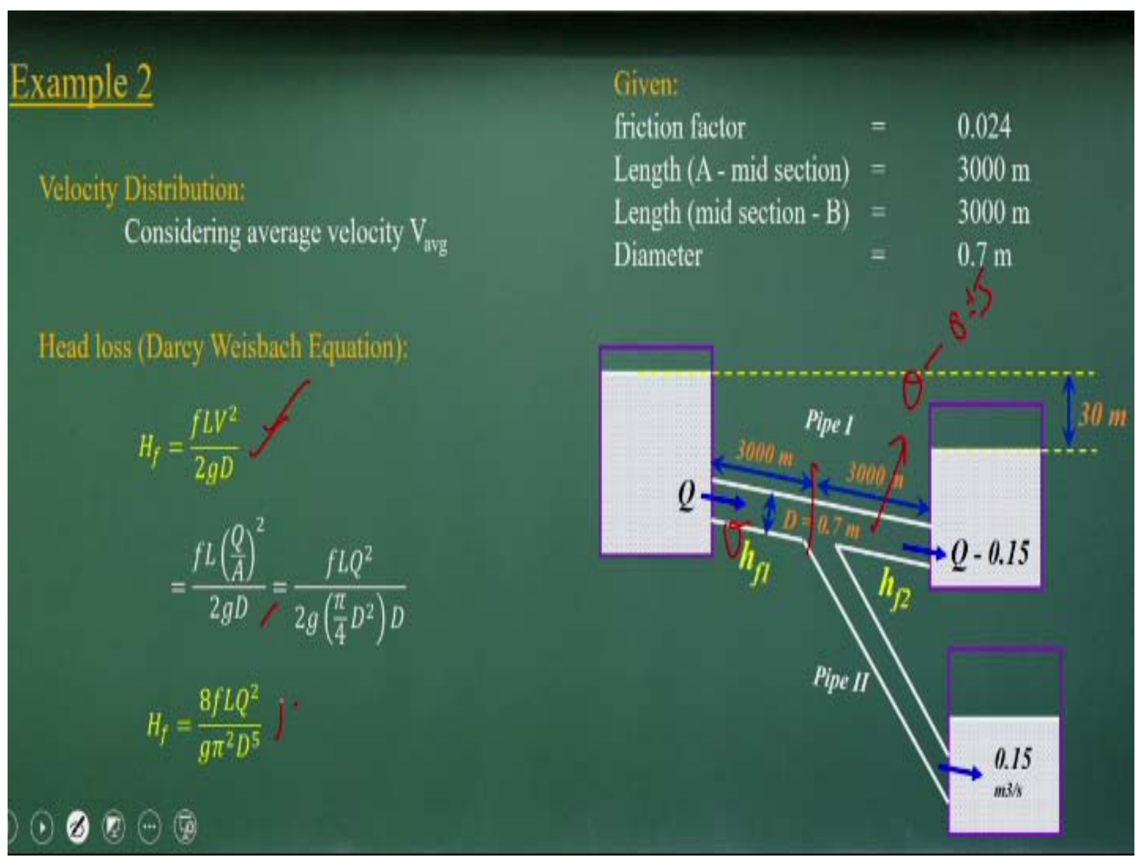
Now you take it the second problems which has the GATE 2015 problems is that the pipe of 0.7 meter diameter has a length of 6 kilometer connects the two reservoirs okay and the water level in the reservoirs is 30 meter above the water level of reservoir B okay. Halfway along this pipeline there is a branch. Water is supplied to the third reservoir C. Then friction factors of the pipe is given.

The quantity of the water discharged into reservoir C is given it. Considering this accelerations due to the gravity this value neglecting the minor loss the discharge into reservoir is what, okay? That is what is the questions. If you look it that you draw the sketches that is the 6 kilometer, this D is given and you have a 0.15 this the discharge what is coming.

If this is a Q amount of discharge this will be Q minus this point okay. So you know this part. You also know these two reservoirs having the elevation difference of 30 meters. That means, this much of energy loss has to be there. Otherwise, these two levels cannot be maintain it. So when flow comes from this pipe of a Q amount of the waters which is passing through this point one pipe on this, but total head losses, total energy losses from through these pipes would be the 30 meters.

Then this too have a 30 meters elevation difference will be there, because velocity at this point and this point will be the zero. So the total these values will be there or I can say it, it will have a some sort of the hydraulic gradient or energy gradient like this. So we need to try to know it that how what could be the Q value such way that we will have the energy losses of 30 meters when passing through these 6 kilometer long pipe. For that f is given to us okay. We know this the length, we know the f factors value is given.

(Refer Slide Time: 53:36)



So we just substitutes to compute head loss because this amount is a Q amount of waters and this pipe will be Q minus 0.15 okay. So you will compute the head loss. That is what we have derived it and you compute this head loss components. Sometimes we write in terms of Q or you can write in terms of V, that is not a big issue.

Given:

friction factor = 0.024

Length (A - mid section) = 3000 m

Length (mid section - B) = 3000 m

Diameter = 0.7 m

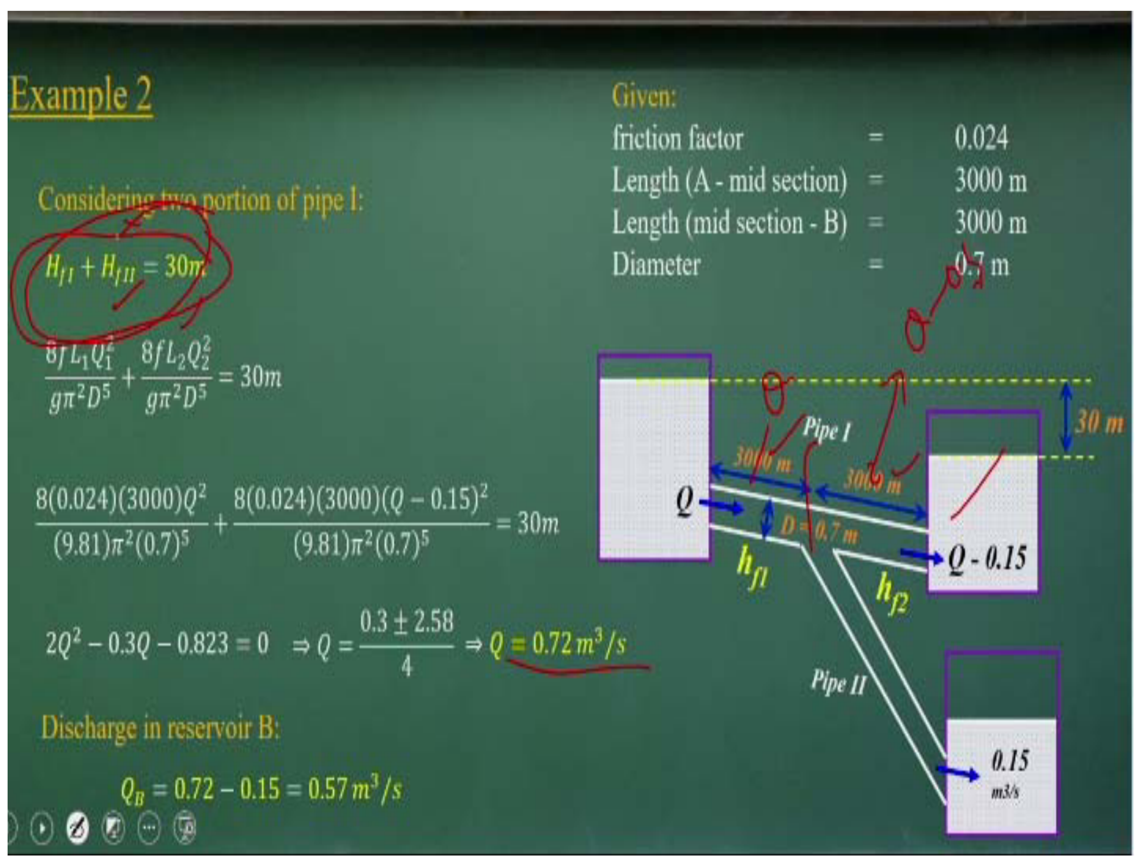
Head loss (Darcy Weisbach Equation):

$$H_f = \frac{fLV^2}{2gD}$$

$$= \frac{fL\left(\frac{Q}{A}\right)^2}{2gD} = \frac{fLQ^2}{2g\left(\frac{\pi}{4}D^2\right)D}$$

$$H_f = \frac{8fLQ^2}{g\pi^2 D^5}$$

(Refer Slide Time: 54:02)



Considering two portion of pipe I:

$$H_{fI} + H_{fII} = 30m$$

$$\frac{8fL_1Q_1^2}{g\pi^2D^5} + \frac{8fL_2Q_2^2}{g\pi^2D^5} = 30m$$

$$\frac{8(0.024)(3000)Q^2}{(9.81)\pi^2(0.7)^5} + \frac{8(0.024)(3000)(Q-0.15)^2}{(9.81)\pi^2(0.7)^5} = 30m$$

$$2Q^2 - 0.3Q - 0.823 = 0$$

$$\Rightarrow Q = \frac{0.3 \pm 2.58}{4}$$

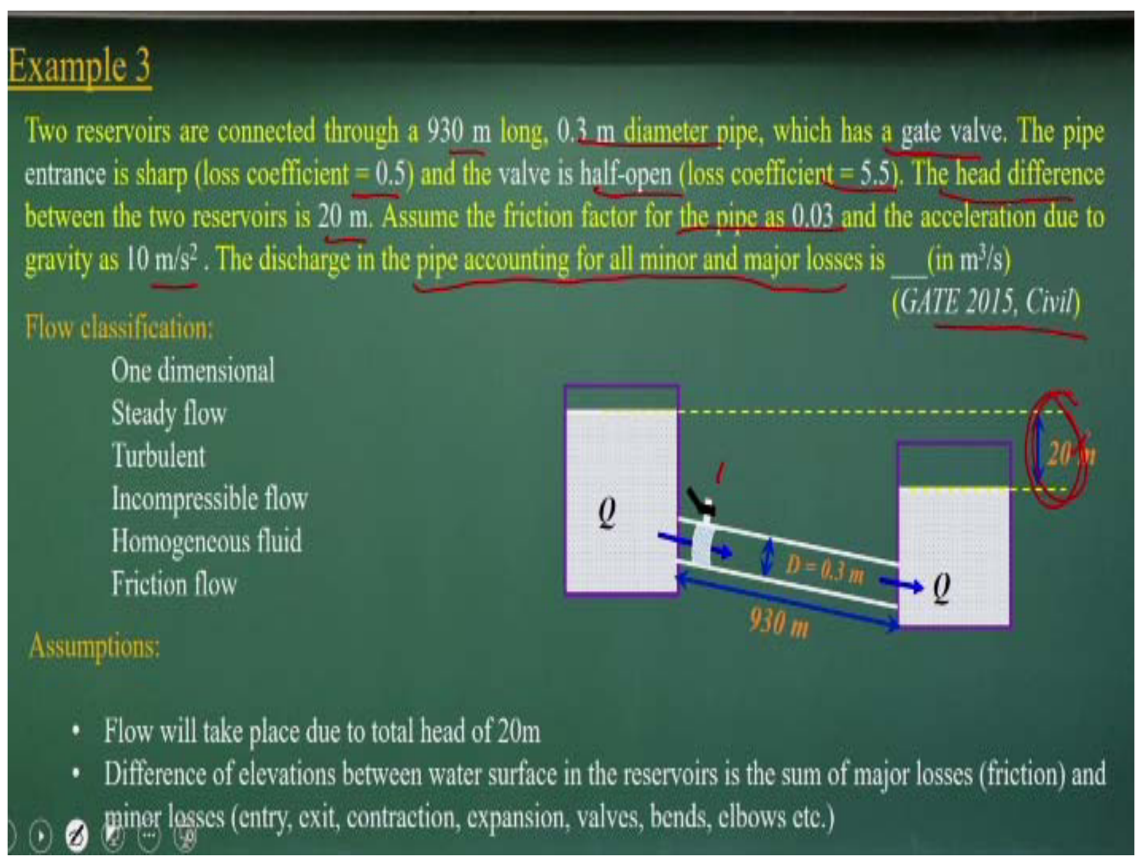
$$\Rightarrow Q = 0.72\, m^3/s$$

Discharge in reservoir B:

$$Q_B = 0.72 - 0.15 = 0.57\, m^3/s$$

And you can compute the energy losses and this should be equal to 30. That is what I was discussing. That is the key point of these problems, okay? The energy losses of this factor and this part should have. This is Q amount of discharge is going. This is Q minus 0.15. So you get this value. If you solve it, you will get the Q value and if know this Q value you can compute the Q. The tricky of these problems, the hints of the problems is only this ones nothing else.

(Refer Slide Time: 54:36)

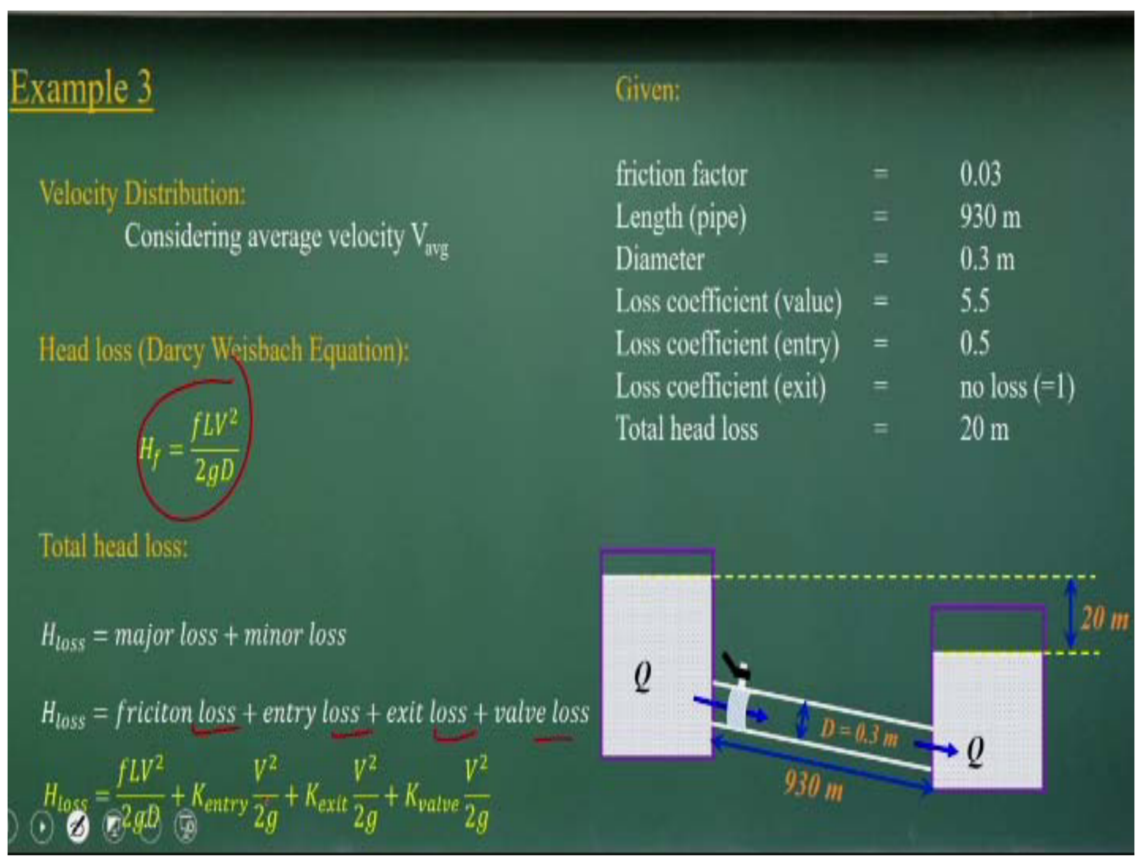


Another the third examples. Okay, two reservoirs are connected with a 930 meters. That is the GATE, again this 2015 paper. The diameter pipe which has a gate valve, okay it is having the valve here, okay. The pipe entrance is sharp. The loss coefficient is given it. The valve is half open. Loss coefficient also is given there. K is given here. Here also K is given. The head difference between two reservoirs is given it.

Again same problems, okay. Assuming the friction factor is given. Acceleration due to gravity is given. It is approximated here and you have to find the discharge accounting all the major and minor losses. If you look at these problems is exactly for the problems what we discussed it, nothing else, okay. Here we have a major losses and minor losses.

All these losses we will equate it to compute, find the total energy losses which will be the 20 meters, that is the problem. The f is given, the K values are given. So you will write in terms of this and compute it what will be the.

(Refer Slide Time: 55:48)



We will use this energy losses, frictions losses, entry losses, exit losses, valve losses, all components are there.

Given:

friction factor	=	0.03
Length (pipe)	=	930 m
Diameter	=	0.3 m
Loss coefficient (value)	=	5.5
Loss coefficient (entry)	=	0.5
Loss coefficient (exit)	=	no loss (=1)
Total head loss	=	20 m

Velocity Distribution:

Considering average velocity V_{avg}

Head loss (Darcy Weisbach Equation):

$$H_f = \frac{fLV^2}{2gD}$$

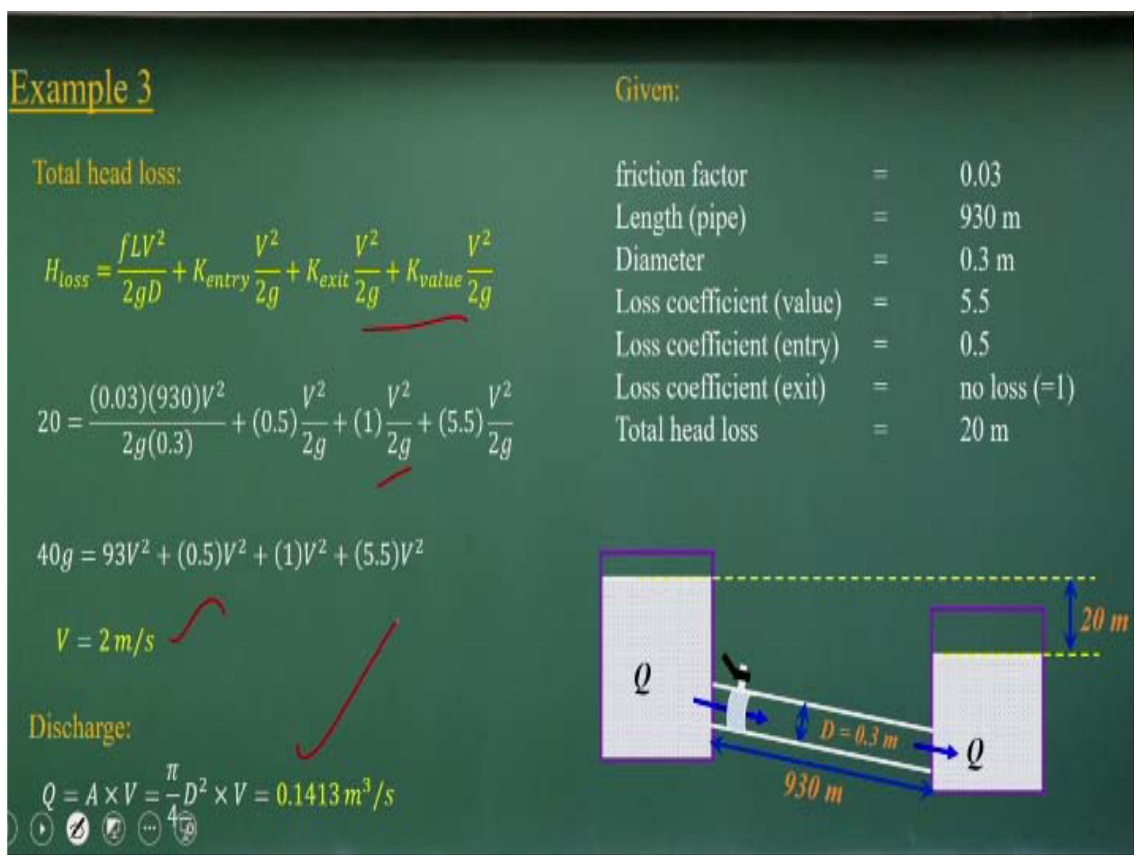
Total head loss:

$$H_{loss} = major\ loss + minor\ loss$$

$$H_{loss} = friciton\ loss + entry\ loss + exit\ loss + valve\ loss$$

$$H_{loss} = \frac{fLV^2}{2gD} + K_{entry}\frac{V^2}{2g} + K_{exit}\frac{V^2}{2g} + K_{valve}\frac{V^2}{2g}$$

(Refer Slide Time: 55:58)



And if you substitute it you will get the velocity and you will get the discharge. So the substituting this value and all you try to understand it. It is okay, it is not a very difficult task for you.

Given:

friction factor = 0.03

Length (pipe) = 930 m

Diameter = 0.3 m

Loss coefficient (value) = 5.5

Loss coefficient (entry) = 0.5

Loss coefficient (exit) = no loss (=1)

Total head loss = 20 m

Total head loss:

$$H_{loss} = \frac{fLV^2}{2gD} + K_{entry}\frac{V^2}{2g} + K_{exit}\frac{V^2}{2g} + K_{value}\frac{V^2}{2g}$$

$$20 = \frac{(0.03)(930)V^2}{2g(0.3)} + (0.5)\frac{V^2}{2g} + (1)\frac{V^2}{2g} + (5.5)\frac{V^2}{2g}$$

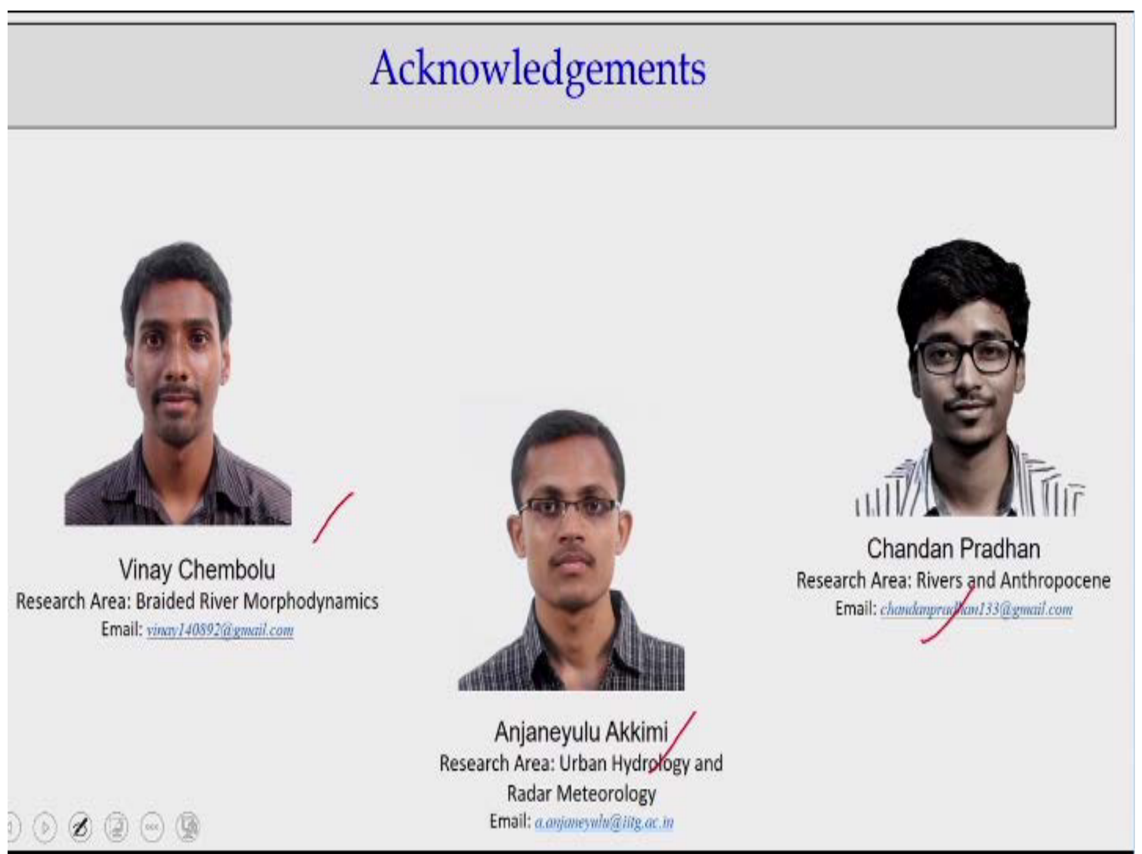
$$40g = 93V^2 + (0.5)V^2 + (1)V^2 + (5.5)V^2$$

$$V = 2\,m/s$$

Discharge:

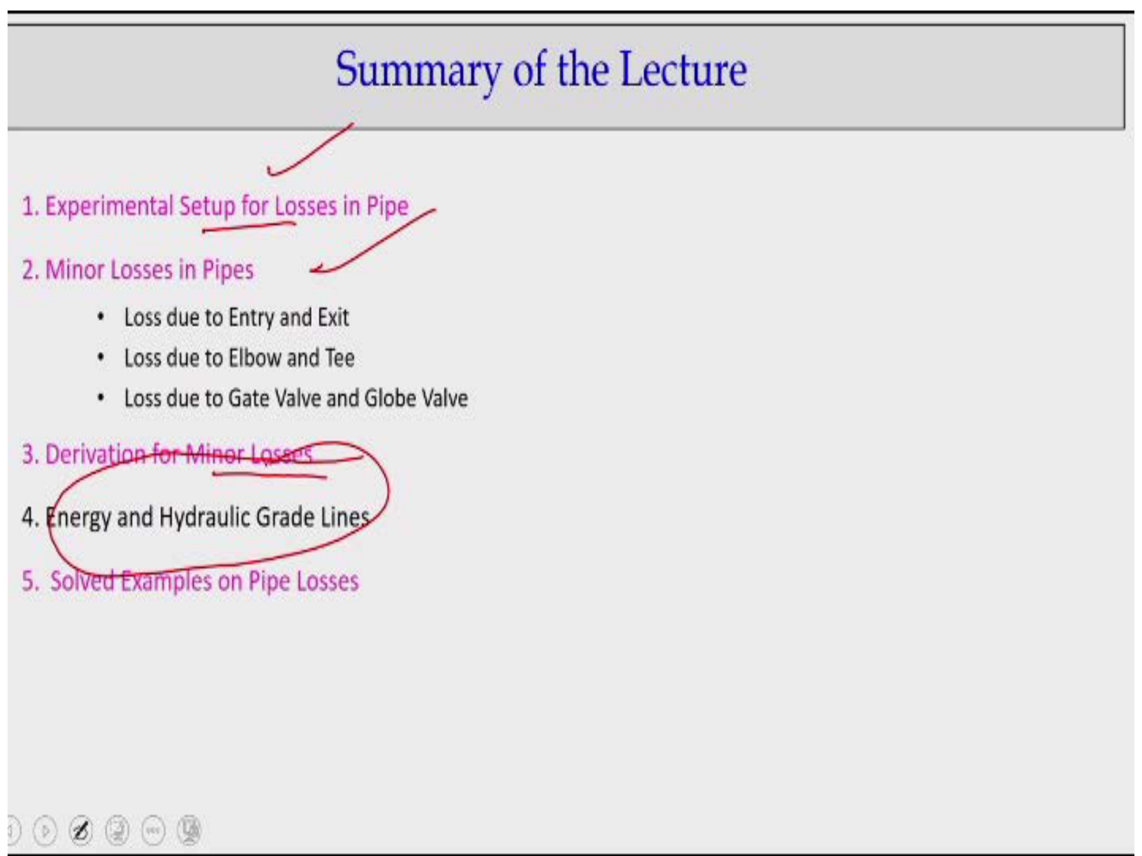
$$Q = A \times V = \frac{\pi}{4}D^2 \times V = 0.1413\,m^3/s$$

(Refer Slide Time: 56:11)



And with this let me finish this lectures with giving acknowledging their contributions having so beautiful ppt and illustrations for you delivering this lectures of fluid mechanics. Really I enjoyed lots delivering the lectures because it has a lot of illustrations, lot of examples and all. And then this there are the summary.

(Refer Slide Time: 56:42)



As you know it we discussed about the minor losses of the pipe. We also showed you the experimental setup. We also derived the minor losses how to these more importantly the energy and hydraulic gradient lines which need to be drawn it and also you can use the control volume concept and you try to understand the flow. It is not microscopically also the gross characteristics wise. With this let me thank all of you for this attention. Thank you.