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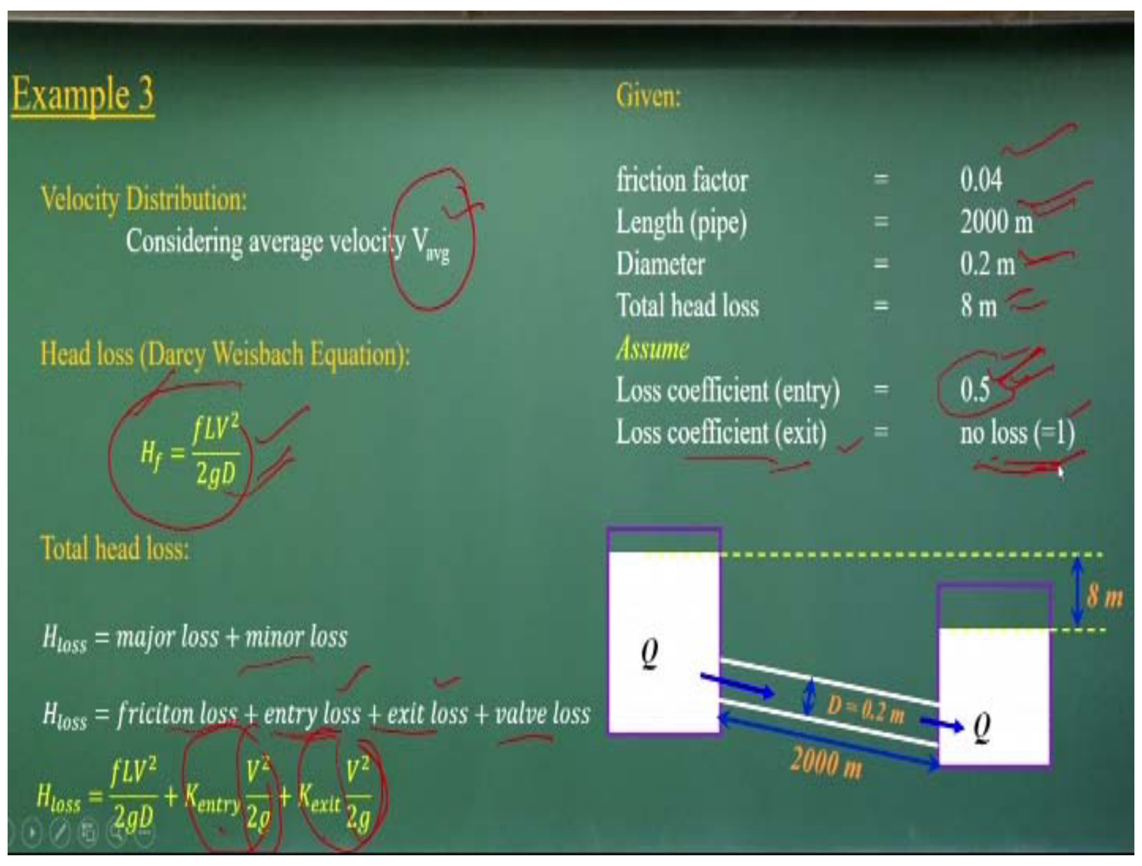

So the friction factors data what is given it length of the pipe the diameters and total head losses. The loss coefficient in terms of velocity head as you know it at the exit we consider as 1, at the entry we consider 0.5. The half of the velocity head losses at entry levels and at the exit level total velocity head what we lost it at the exit level. This is 1, this is 1.5.

Given:

friction factor	=	0.04
Length (pipe)	=	2000 m
Diameter	=	0.2 m
Total head loss	=	8 m
Assume		
Loss coefficient (entry)	=	0.5
Loss coefficient (exit)	=	no loss (=1)

Now we apply the Darcy Weisbach equations to compute what is energy losses for the major losses or the pipe flow because of the frictions components and the minor losses.

Head loss (Darcy Weisbach Equation

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

Total head loss:

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

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

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

That is what is a coefficients we use in terms of velocity head and here we have considered 0.5 and the 1.

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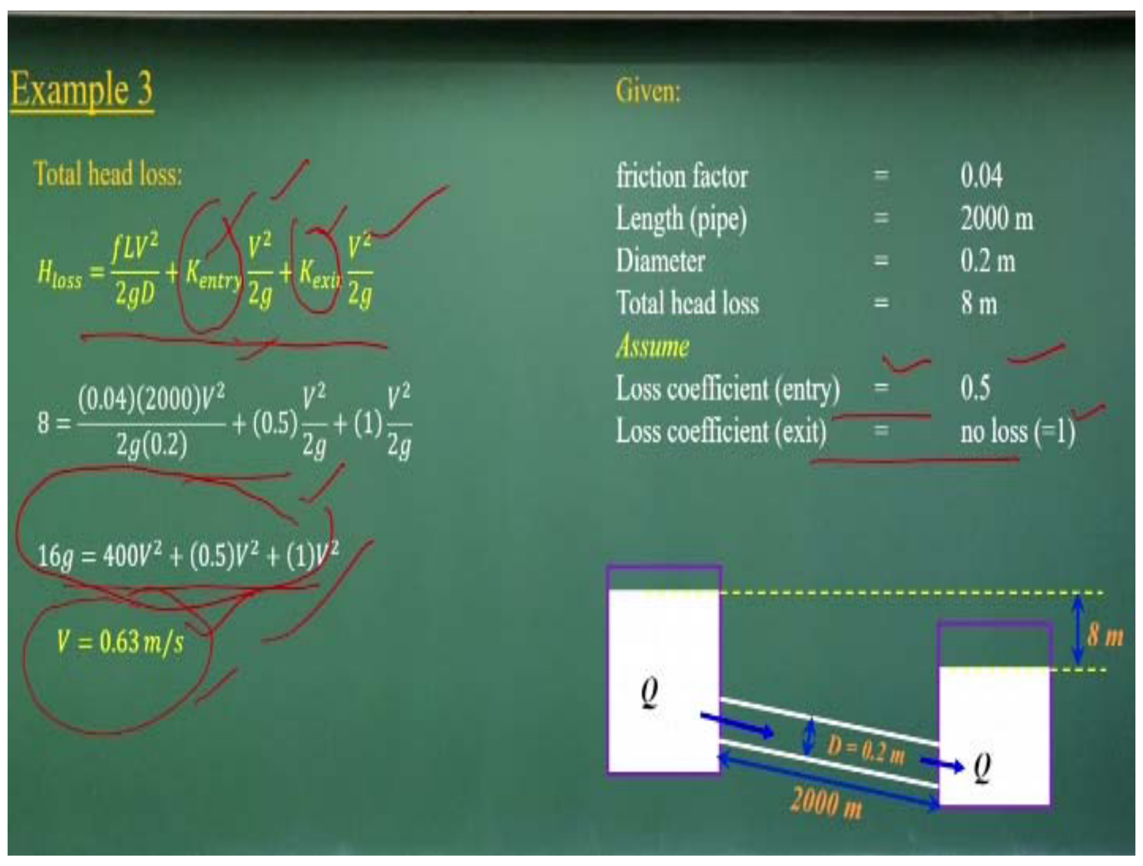

By substituting these and we can get it the series of equations like this and substituting the value you will get a quadratic functions and solving that you will get the velocity. So if you look at these problems is quite easy. Only you have to remember about the coefficients, the factors what we use it, the loss coefficient or factors what we use for computing the entry loss and the exit loss.

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

$$8 = \frac{(0.04)(2000)V^2}{2g(0.2)} + (0.5)\frac{V^2}{2g} + (1)\frac{V^2}{2g}$$

$$16g = 400V^2 + (0.5)V^2 + (1)V^2$$

$$V = 0.63\,m/s$$

The exit loss is total velocity head. Half of the velocity head we use it to as a loss at the entry level. That is the things, otherwise these problems quite a numerical problems to solve these ones.

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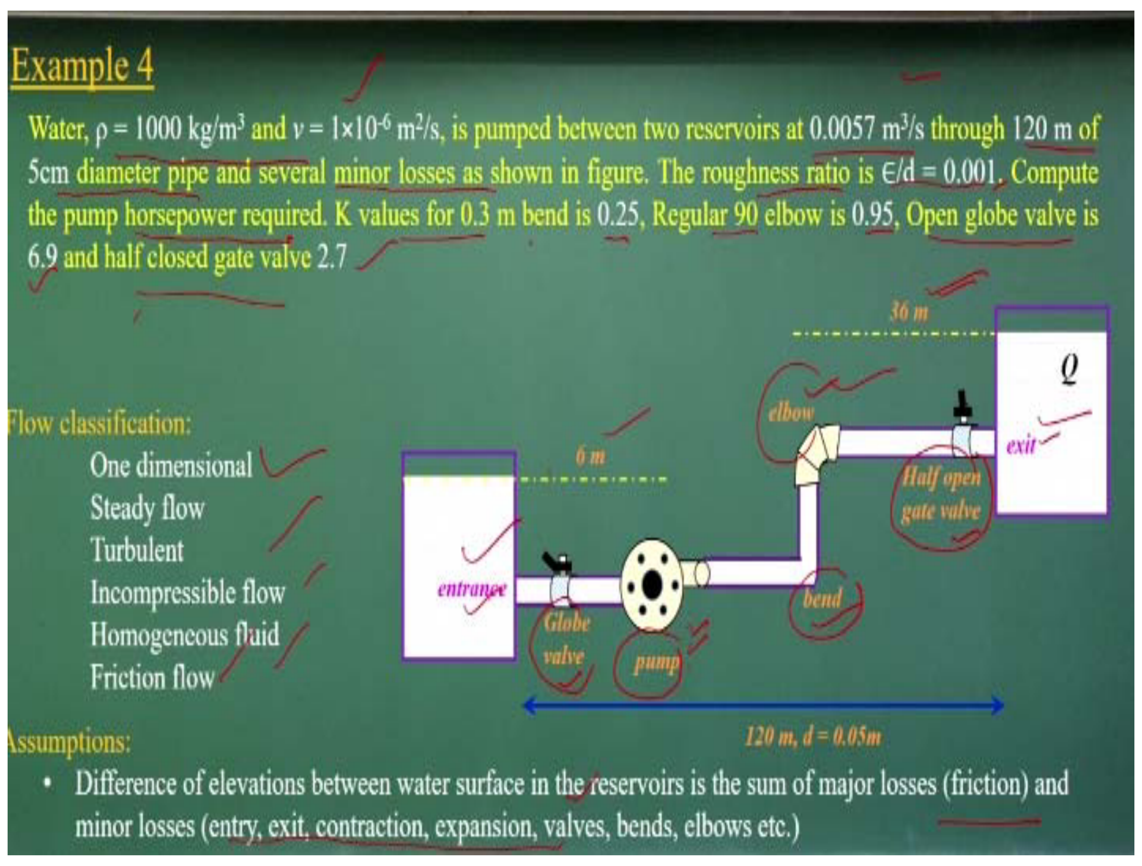

The last examples, let us have a it is slight bit a design problems could be consider it where you have the two reservoirs okay you have a entrance and exit. The water density and the kinematic viscosity is given to us. The two reservoirs having the discharge 120 meter long, 5 centimeter diameter pipe several minor losses can happen it like a valve losses.

There is a pumping systems here, there is a bend, there is a elbow, there is a half open valve gate, the exit and the entrance. All the losses can be there. If a roughness ratio of this pipe is given it is this part. Compute the pump horsepower required and the K value given for the bend is 0.25. Regular 90 degree elbow is 0.95. Open globe valve is 6.9. Half closed gate valve is 2.7.

Entry and exit already we discussed what could be the loss coefficients. So that way we need to compute how much of energy is required, the pumping at the pump so that we can have a these conditions which is a 6 meter, this is a 36 meters. The difference between them is 30 meters. So here we have a major losses, we have a minor losses. So as usual you will have a flow classifications.

In this case one dimensional flow and all and here you have a frictional losses and you have a losses what you have considered for the entrance valve, bend, elbow, half and exit valves. So these all the losses components are given it and we are looking it what could be the pumping requirement.

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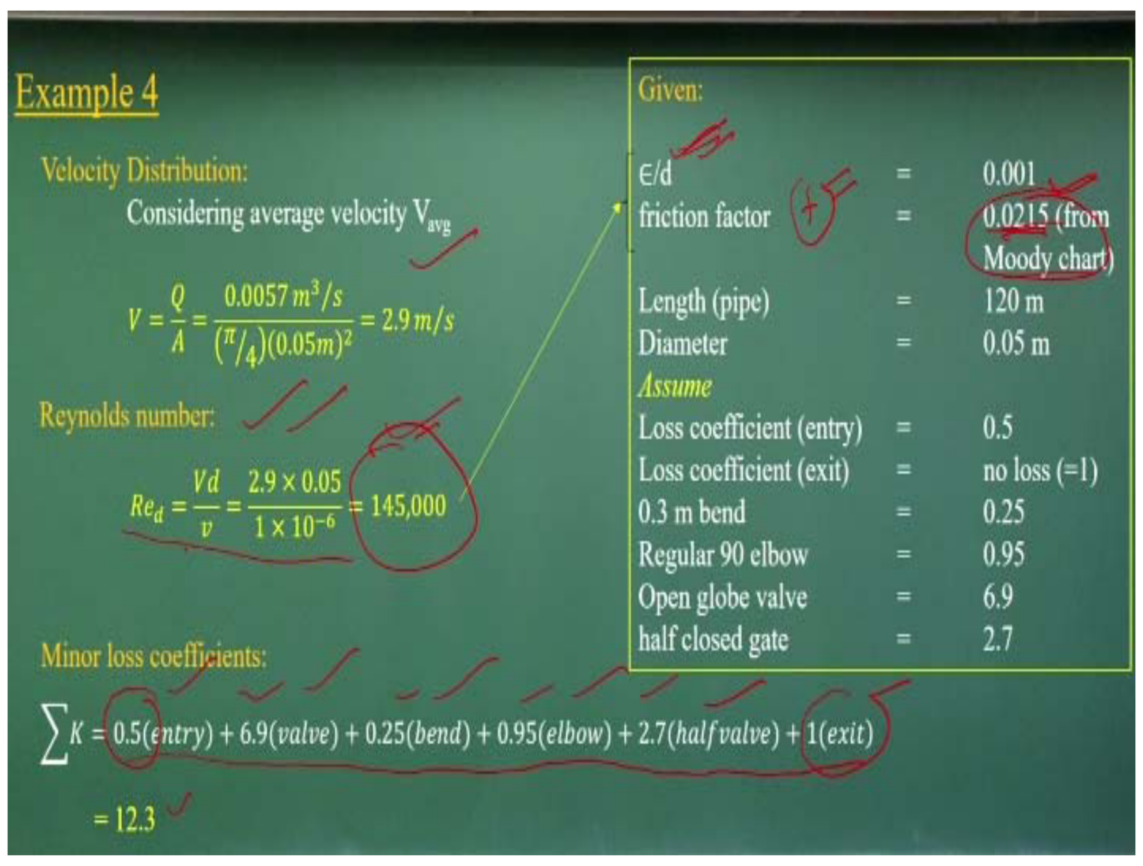

Since here the roughness factor is given to us, we need to compute the friction factors from Moody's chart which needs Reynolds numbers. So first let us compute what will be the average velocity and what could be the Reynolds numbers for this flow. Diameter is given, velocities, then we can get this. So these Reynolds numbers with these roughness factors we will get it from Moody's charts, the value of friction factor.

$$V = \frac{Q}{A} = \frac{0.0057\, m^3/s}{(\pi/4)(0.05m)^2} = 2.9\, m/s$$

$$Re_d = \frac{Vd}{v} = \frac{2.9 \times 0.05}{1 \times 10^{-6}} = 145{,}000$$

$$\sum K = 0.5(entry) + 6.9(valve) + 0.25(bend) + 0.95(elbow) + 2.7(halfvalve) + 1(exit)$$

= 12.3

This is what in general design we do it to compute the Reynolds numbers. Then we for a given roughness factors, we can compute it what will be the R. Get this from chart what will be the friction factors value. Then we can account for all the loss components in terms of velocity value. That entry, the valve, bend, elbow, half valve and exit which will be 12.3 in terms of velocity head.

This is the factors, the sum of the factors for the energy losses, factors we are adding it starting from entry is 0.5, exit is 1 and this value is given to us and mostly in a tabular forms are available to us. By conducting a series of experiment any of the industry they give these value what is the range of the energy loss coefficients for the bend, valve, elbow it is given generally in a any pipe manufacturing company.

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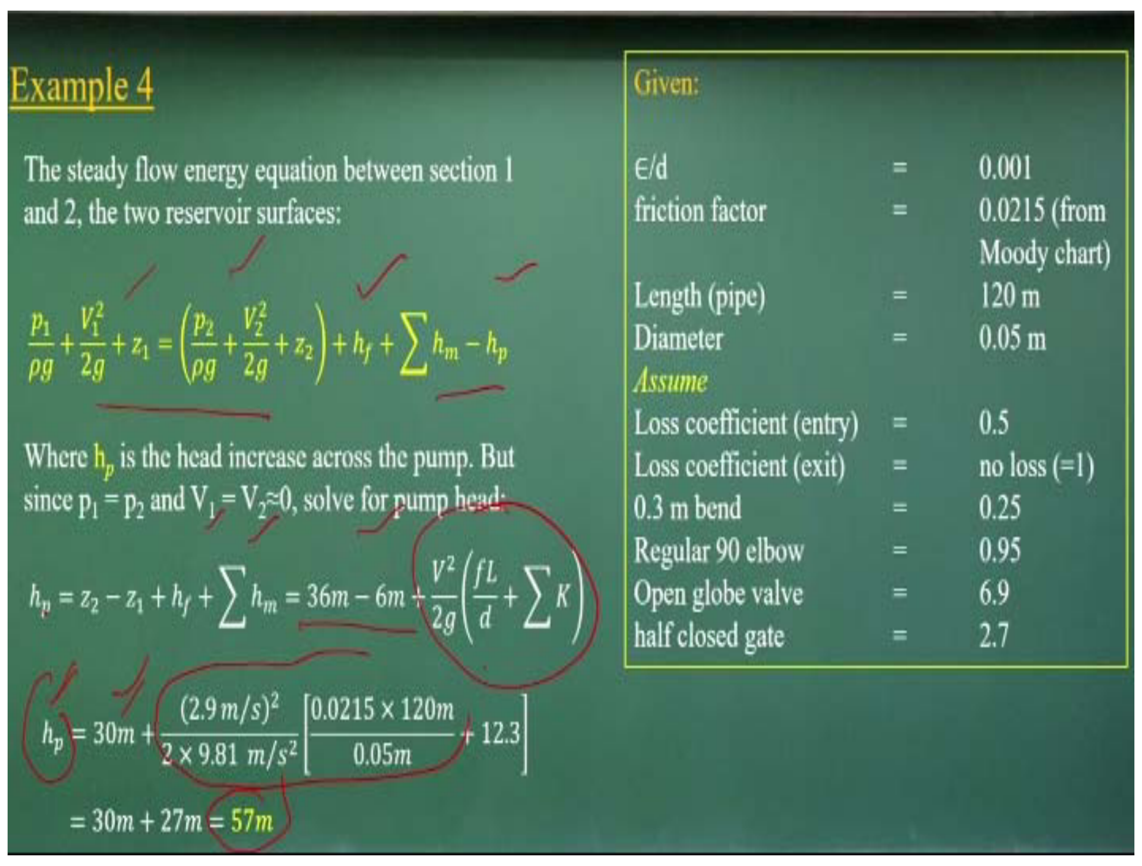

Now we will go to the next what we will do it is very simple things that we are applying this energy equations head loss and this part since two part V_1, V_2, if I put the energy losses V_1, V_2 is zero, and solving this pumping head, okay which is will give it the elevation difference and the major and the minor losses component. Then I will get it what is the head requirement at the pump which is coming out to be 57 meter, okay.

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \left(\frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2\right) + h_f + \sum h_m - h_p$$

Where h_p is the head increase across the pump. But since $p_1 = p_2$ and $V_1 = V_2 \approx 0$, solve for pump head:

$$h_p = z_2 - z_1 + h_f + \sum h_m = 36m - 6m + \frac{V^2}{2g}\left(\frac{fL}{d} + \sum K\right)$$

$$h_p = 30m + \frac{(2.9\, m/s)^2}{2 \times 9.81\ m/s^2}\left[\frac{0.0215 \times 120m}{0.05m} + 12.3\right]$$

$$= 30m + 27m = 57m$$

So this is the loss component and this is what the elevation, the potential head what we need it from 6 meter to 36 meters. That what is coming of. So for the for lifting 57 meters, how much of power we requirement.

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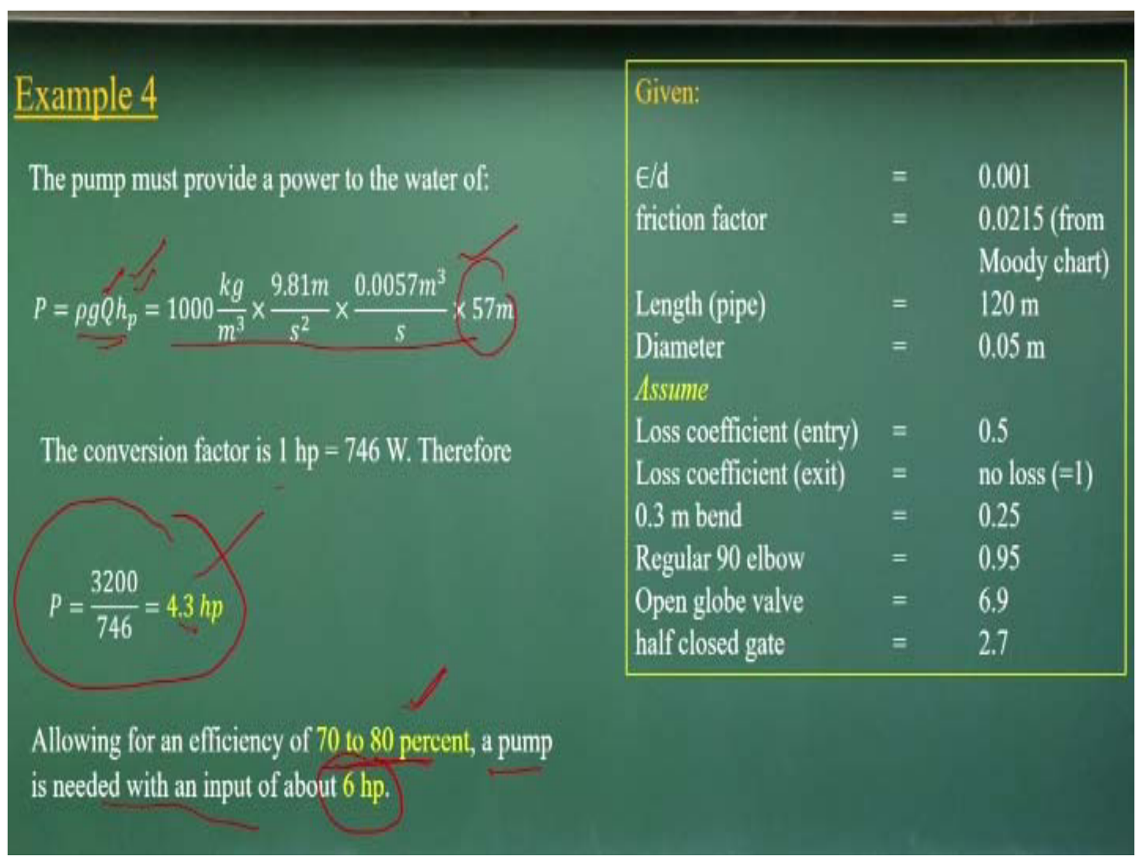

It is there which is very simple things for us to compete is that,

$$P = \rho g Q h_p = 1000\frac{kg}{m^3} \times \frac{9.81m}{s^2} \times \frac{0.0057m^3}{s} \times 57m$$

So you know it what is a power requirement to lift this much of mass of the flow. That is weight mass flux into the h_p. That what will give us the power.

The conversion factor is 1 hp = 746 W. Therefore

$$P = \frac{3200}{746} = 4.3\ hp$$

In terms of hp we will get it 4.3 hp power requirement is necessary to lift the water up 57 meters and if I consider any pumping centers we have this efficient with how much of efficiency 70 to 80. But you cannot have a 100% efficiency.

Considering that this 4.3 hp power and designing that we can consider the 6 hp pipe pump is enough this pipe flow, this system of two reservoir connecting with a 30 meter difference and energy losses what it will be accounted for. So this way, we generally use a design problem to solve the problem, do the designing of the piping system, additional energy like a pumping or in hydropower projects, we put it turbines and all.

The basic concept what you use is the energy gradient lines, the Moody's charts, and the Darcy Weisbach equations to solve this problem. With this, let me summarize this problems lectures what I discussed today.

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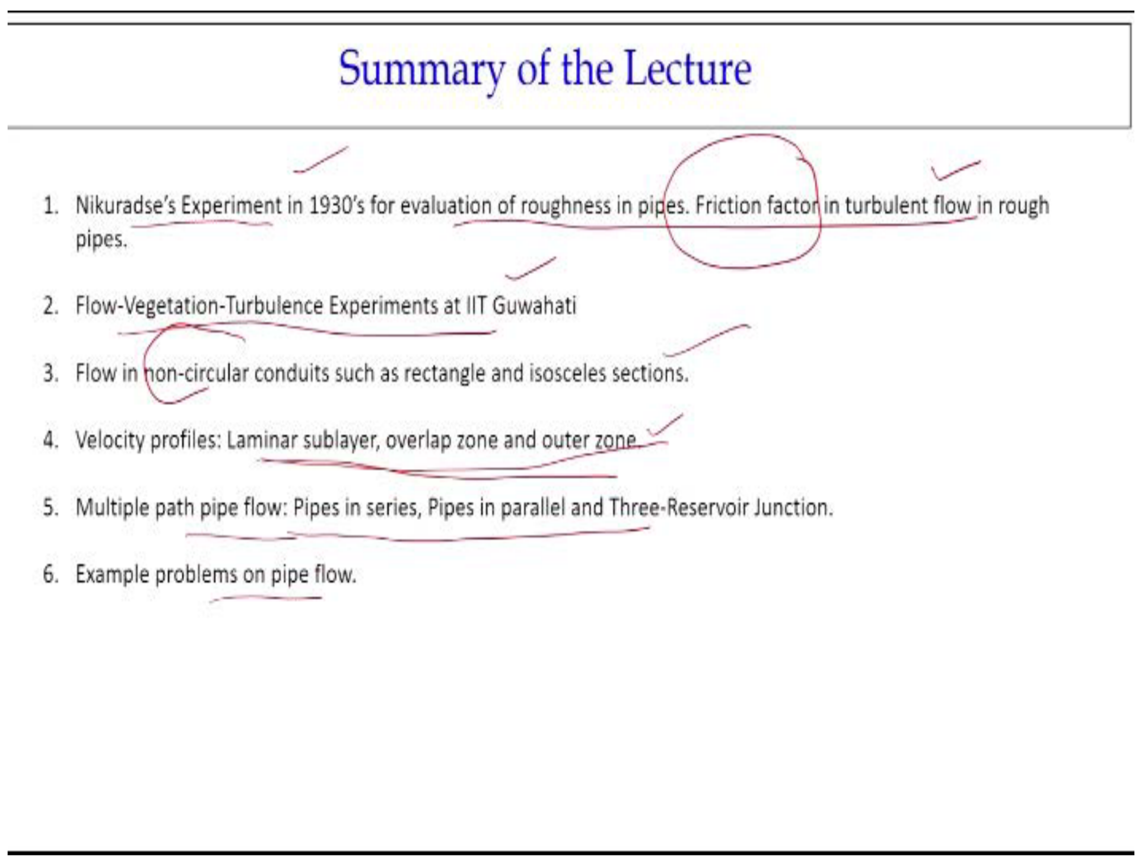

Starting from the 1930s Nikuradse's experiment is one of the finest experiments conducted way back in 1930s. And that was given us very complex problems like a turbulent flow in a rough pipes and as equivalent a energy losses in terms of friction factors and established the relations, which is quite interesting and quite inspiring to us to know that the series of experiment can help us to understand very complex flow turbulent flow in the pipes.

We also shown this just examples that similar type of experiment we have been conducting at IIT Guwahati. I discussed about noncircular pipes. We also discussed about very introductory levels because we did not discuss much about boundary layer concept or turbulent flow much details in these eight week classes.

So I just give you a introductory levels to know it, how the velocity profile is there and at the last we talked about the multipath pipe flow, pipe in series parallel and three junctions. And we solved the four examples. So with this I wish to concludes this 8 weeks and 20 hours lectures on the fluid mechanics. We cover all these topics and very beautiful illustrations, the ppt and all the blogs what you were doing it all they are helping by three PhD students, okay.

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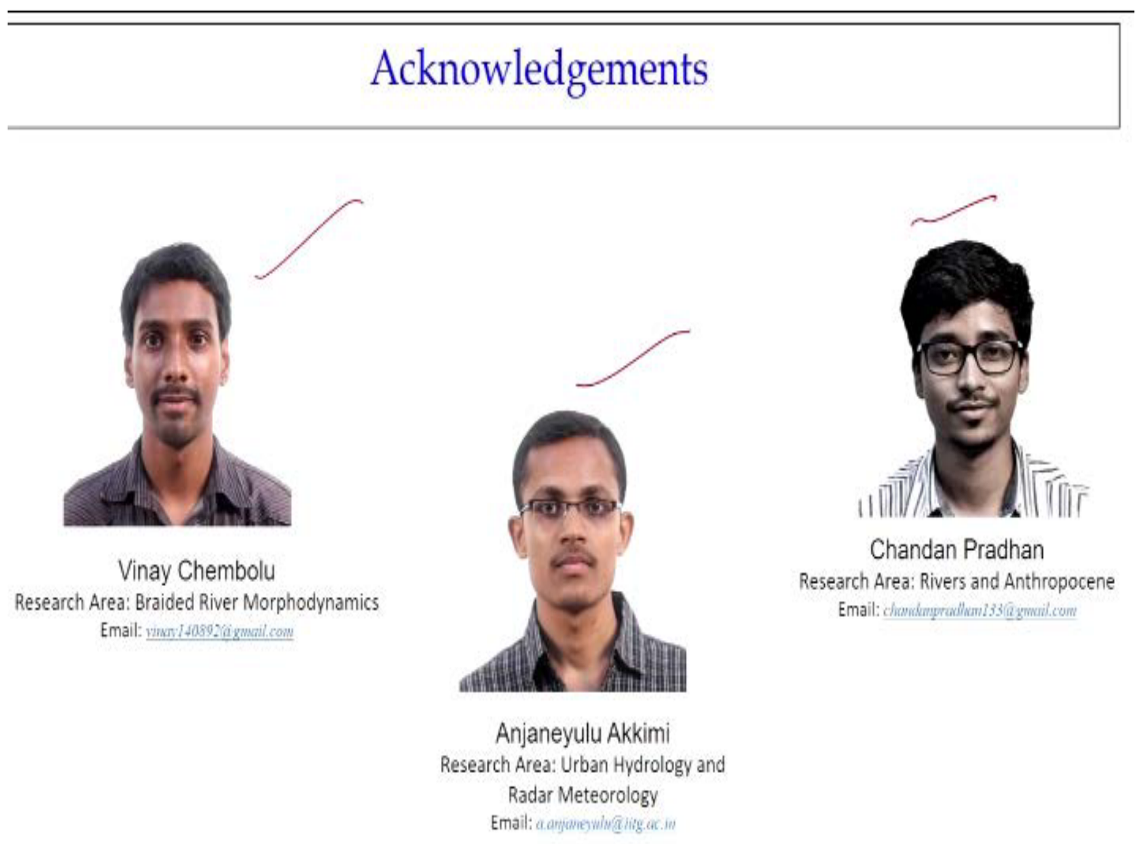

And I do acknowledge their effort for developing this course seamlessly, and ending this part let me conclude with this quote.

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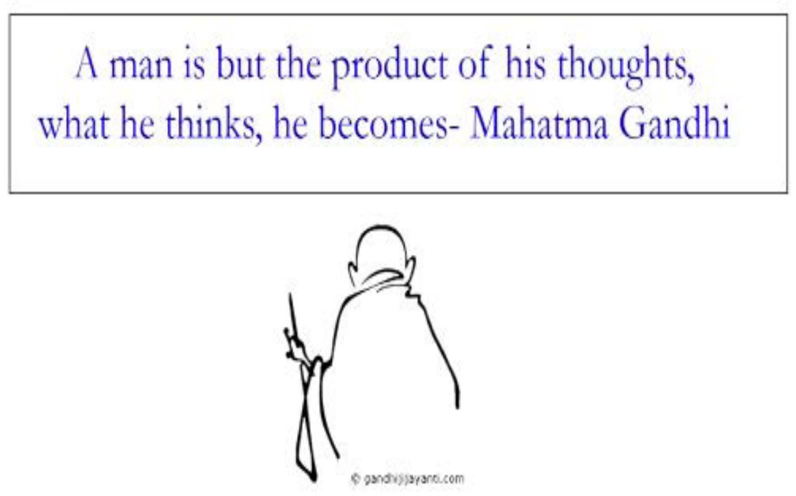

A man is but the product of his thoughts, what he thinks, he becomes. With this note, I can say that NPTEL course is given you opportunity to things beyond what you thought, okay? And that is what should look it that this quote will tell you, will inspire you to for the next level. With this, thank you lot to have this almost 23 hours lectures hearing from us. Thank you lot.