Upstream LNG Technology
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Lecture - 68
Tutorial on pumps – II

Welcome, we have solved some problems on the pump. And now what we shall do in this particular lecture we shall be looking into some more problems on the pumps.

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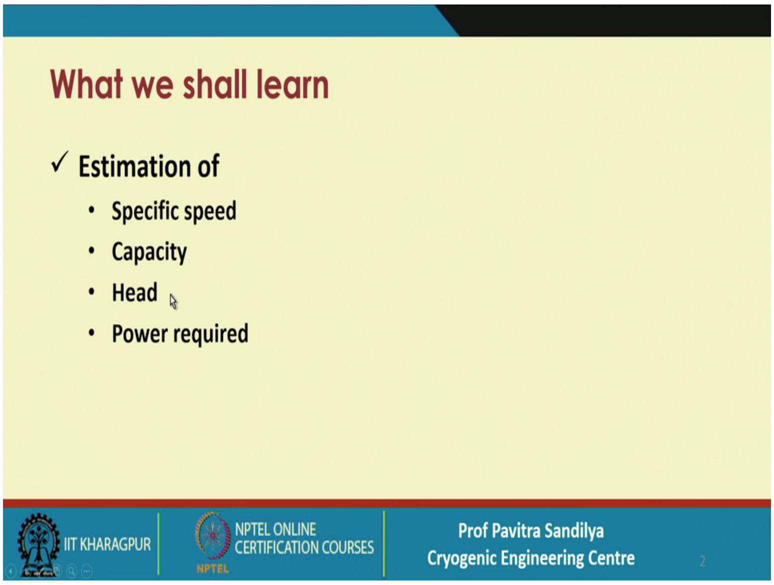

So, in this lecture we shall be learning about the estimations of the specific speed of a pump the capacity, then the head developed by the pump and the power required.

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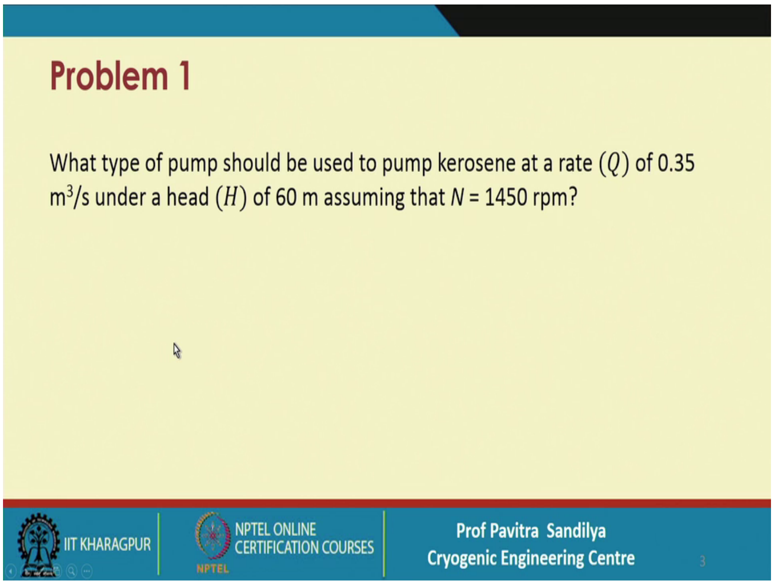

First we come to this problem that we have to decide what type of problem should be used to pump kerosene at a rate this and to produce a head of this much with a pumping speed of this. So, we have been given the capacity the head developed by the pump and the rotational speed. So, we have to decide that what type of pump is to be used.

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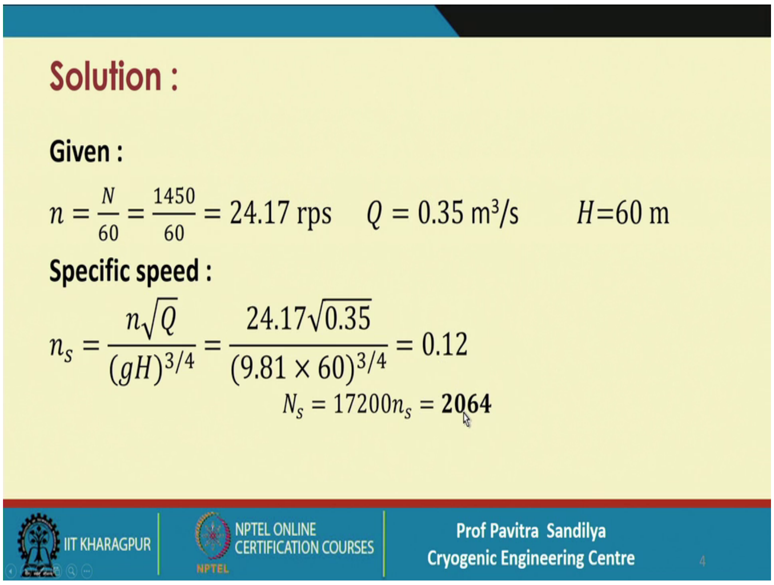

So, first what we do that we first find out the N that is in rps; that is rotation per second and we are given the rotation per minute from this we find an rps and then we find the out the value of Q and the H. And we use this specific speed equation this specific speed equation we put all the values of whatever we have put in this particular thing and we find this is the value of the small n s and this small n s is then converted to capital N s because in the manufacturers till data the generally the specific speed is given terms of the capital N s. So, we also learnt in our lecture that the how to convert the small n s in to the capital N s by multiplying by this particular factor and we get this value of the specific speed.

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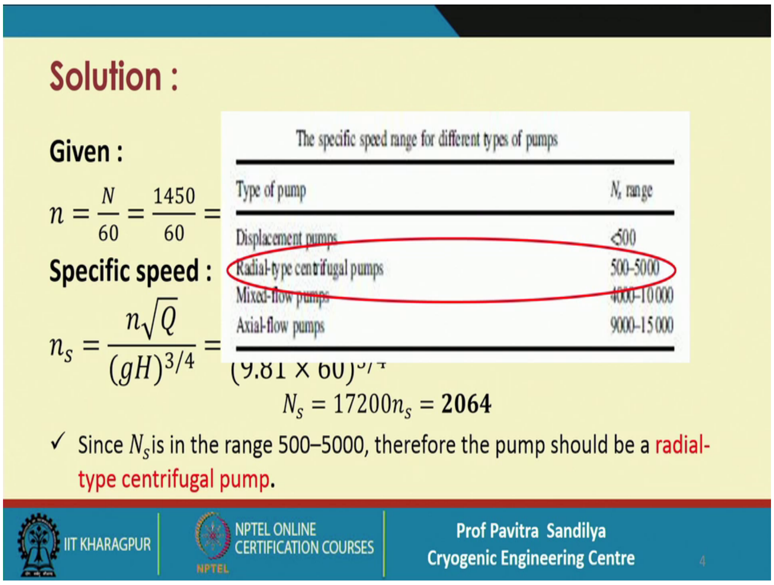

And now this particular table which is supplied by the manufacturer. We locate this particular value and we find these value is coming here between this 500 and 5,000, 2064 and for this we have the radial type of centrifugal pump. So, based on the value of the specific speed we recommend the radial type of centrifugal pump for this particular application. So, this is a very straightforward manner of utilizing the value of the specific heat specific speed and which we are finding from the given data to decide the type of the pump.

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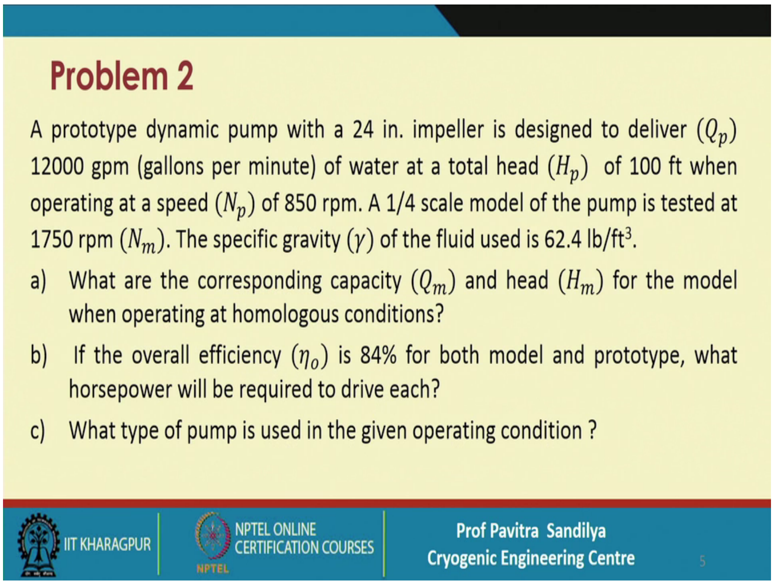

Next we come to another problem, in this we have a prototype dynamic pump with a in this impeller diameter 24 inches which is designed to deliver to 12,000 gallons per minute of water at a total head of 100 feet and the operating speed is 850 rpm and then we have to develop a one fourth; that means, a one fourth of the scale model is to be is tested at this particular rpm.

So, the rpm has now increased, the specific gravity of the fluid is taken to be this particular thing. And now we are been what are the corresponding capacities and the head for the model. That is a when we are making it one fourth the size of the prototype. And then the overall efficiency is 84 percent for both the model and prototype pumps. So, we have to find out the, what is the horse power required and what type of pump is to use in the operating conditions? So, we have to go for selection of the pump we have to find out the horsepower of the pump and we have to find out the capacity and the head developed by the model pump.

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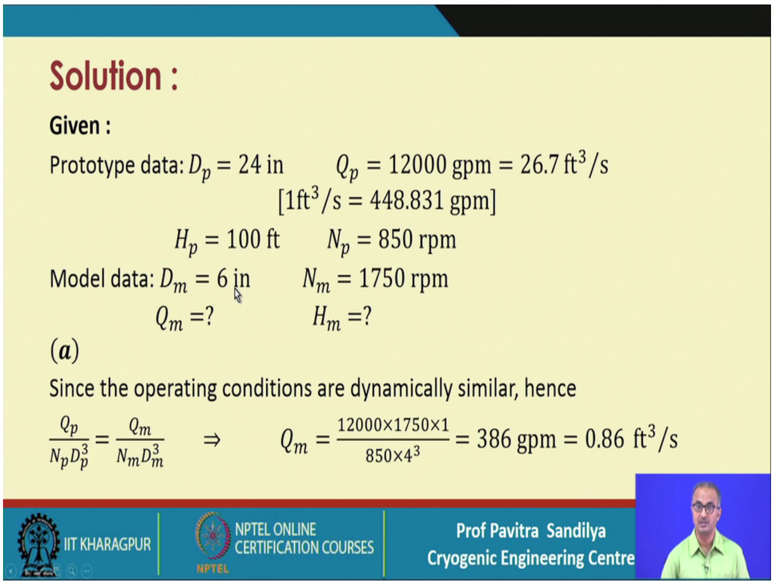

For solution of this first we write all the data that is given to us. And here we do what? It may convert this flow rate of the liquid from gallons per minute to cubic feet per second with this particular relationship between the cubic feet per second and the gallons per minute. And these are the various heads for the prototype this p here represents the prototype and m represents the model. For the model we have been given the diameter of the impeller and the rotational speed and we have to find out the capacity and the head.

Now, they are dynamically similar so we use this particular equation to find out the capacity of the model pump. Here we have been given plug in the values of the N p N m and the D p D m and the Q m we plug in the values. And we give this is as the gpm and this gpm is in converted using this particular relationship we convert it to the cubic feet per second. So, what we find that for the model pump the capacity has come down from 12,000 gpm to in a prototype to only 386 gpm and why because the speed has got increased and also the diameter impeller has got reduced.

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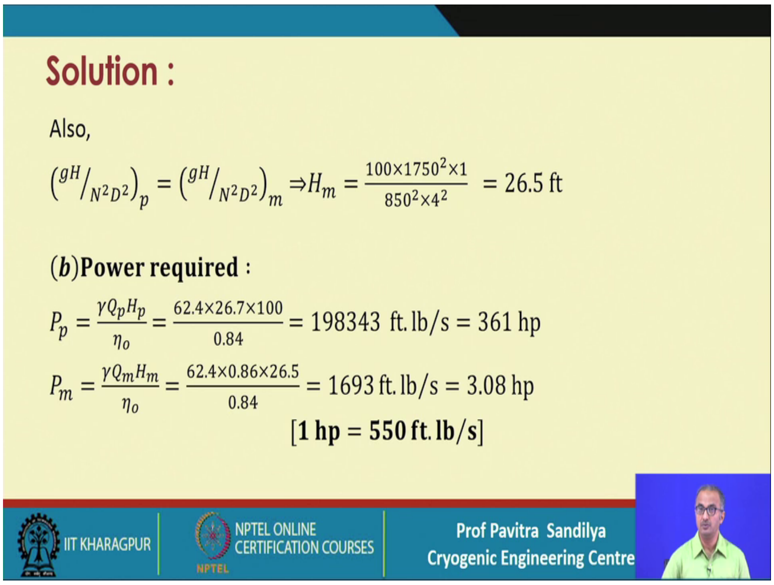

Next what we do we have to find out the head of the thing so again we go for the similarity analysis. So, this is the similarity equation we get for the prototype and the model. And now we plug in the values for each of these and we find this is the value of the head that is developed by the model pump. Now about a power requirement we what we do we use this particular equation for using the overall efficiency and we find this is the particular power required that is the 361 hp. And here we are using this conversion factor of 1 hp in terms of feet pound per second.

And for the model again we because we have found out the Q m H m value for the model from the earlier parts and you plug in the values here and we find this is the power consumption by the model. So, the power consumption has come down for the model from the value for the prototype pump.

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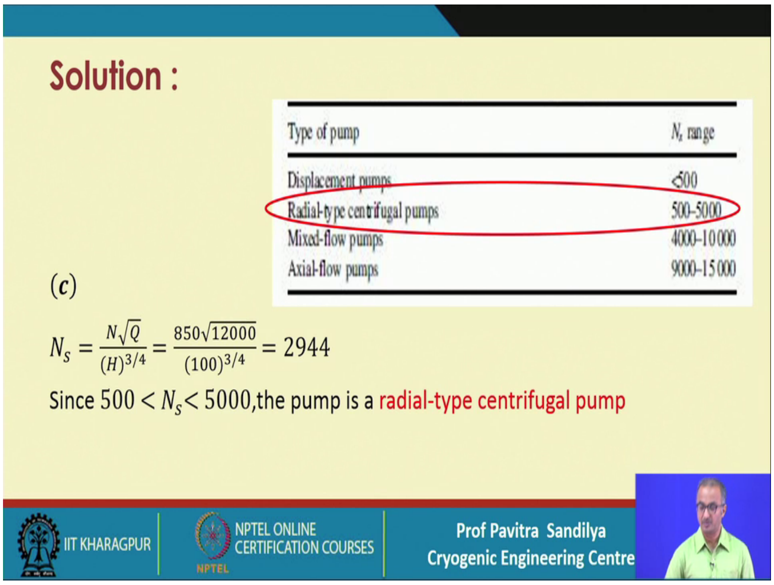

Now, to decide the pump what we do again we find the value of the N s the plug in the values of the N in terms of rpm Q in terms of the gpm H in terms of feet. We get this value and from this particular chart which we saw earlier we find out that this N s come in this range and for this we are recommending the radial type centrifugal pump. So, this is how we are able to select the pump for this particular application for the model pump.

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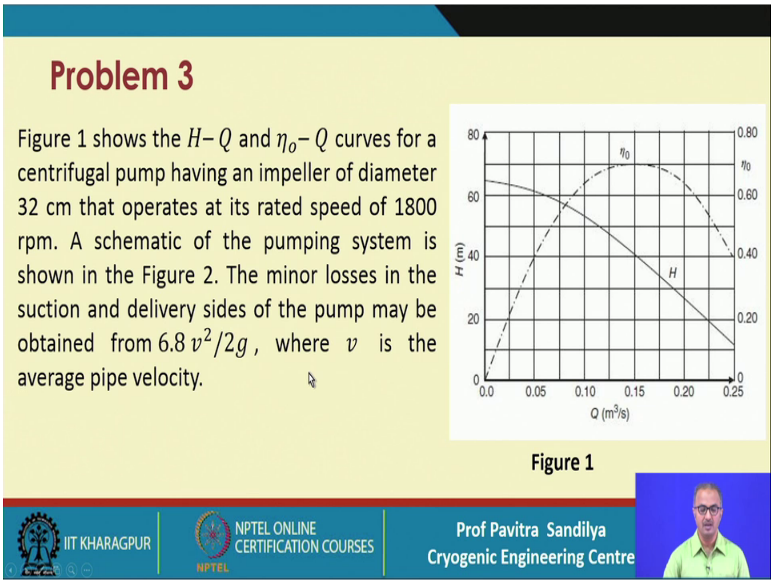

Now next question we have been given this performance curve ok. And this is the H-Q and the eta naught Q. That is the head verses capacity and the overall efficiency verses capacity. On this x axis we are plotting the capacity on this axis between the head now this axis we have the overall efficiency. And this is for a centrifugal pump having impeller diameter of 32 centimeter and it operates at a rated speed of 1800 rpm. And the system will the schematic of the pumping system is shown separately I will show you as it has been showed at the minor losses in the suction and delivery side of pump may be obtained from this particular equation where V is the average pipe velocity.

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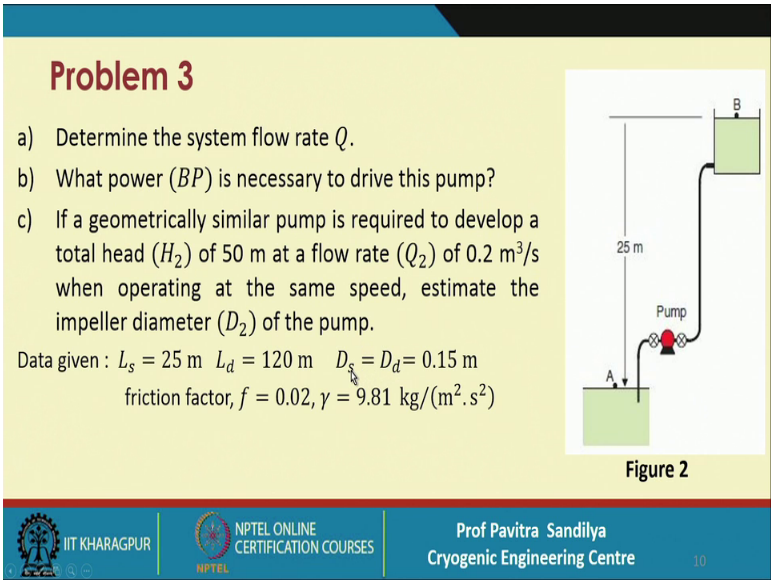

Now, here is the system particular system we find that the some liquid has to be pumped from this to this and this is a pump here and the difference between the levels is about 25 meter. So, we have to determine the system flow rate and what is the power necessary to drive this pump. And if here geometrically similar pump is required to develop some other head that is from 25 meter we want to increase the head to 50 meter. And the flow rate is point this particular thing, then we have to estimate the impeller diameter of the pump.

So, with this information what we put that the all these data which are given for our system we find that the length of the pipe place in the suction side is this on delivery side is this. And this is the diameter of the pipes on the suction side and the delivery side. So, this data is given to us the friction factor is given this friction factor we will used to find out the major losses of in the pipelines and this is the value of the gamma.

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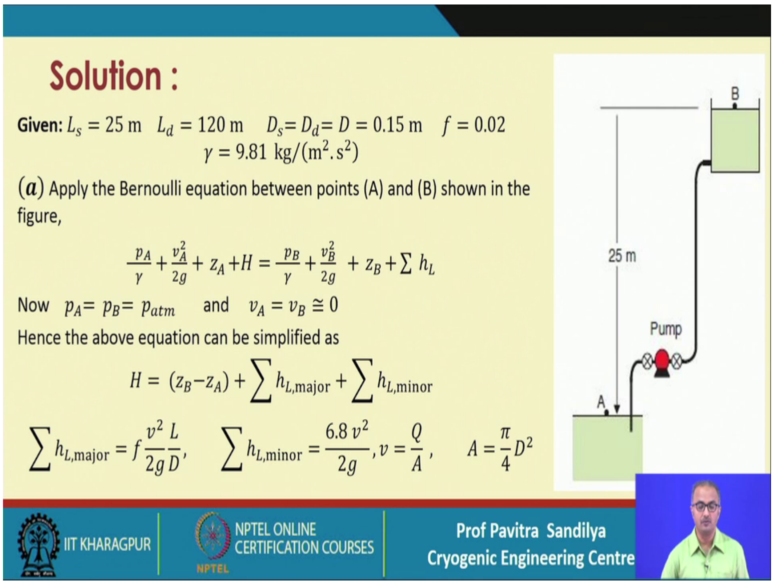

Now, what we do for solution we put all the data given to us and we now apply the first law of thermodynamics or the Bernoulli's equation. And here we find that both these surfaces are exposed to the atmosphere. So, that they experiencing the atmospheric pressure and again we are neglecting the rate of change of the levels in this two particular tanks.

So, that is how we are putting this V A and V B equal to 0 and then we find this is the expression for the head developed by the pump. And here we put the expression for the major losses to the total loss may be taken to be the summation of the major loss and the minor loss. So, major loss is formed from this expression using the friction factor and this is the expression given in the problem to find out the minor losses in these this velocity is the, this Q by A and A is the pi by 4 D square.

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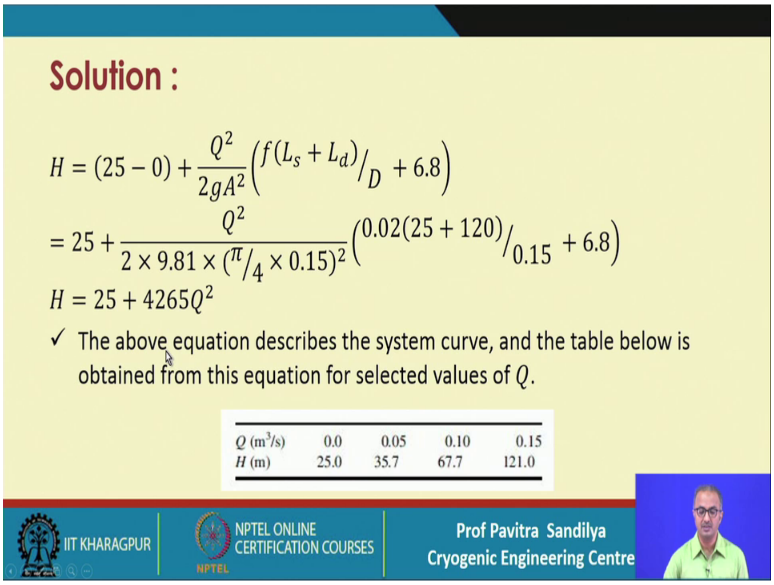

So, all these things we are knowing so what we do that we plug in the values of everything and we find this is how we are generating the expression for the system curve for the head versus the Q. And for this above equation we find that we put different values of Q and we find the different values of H.

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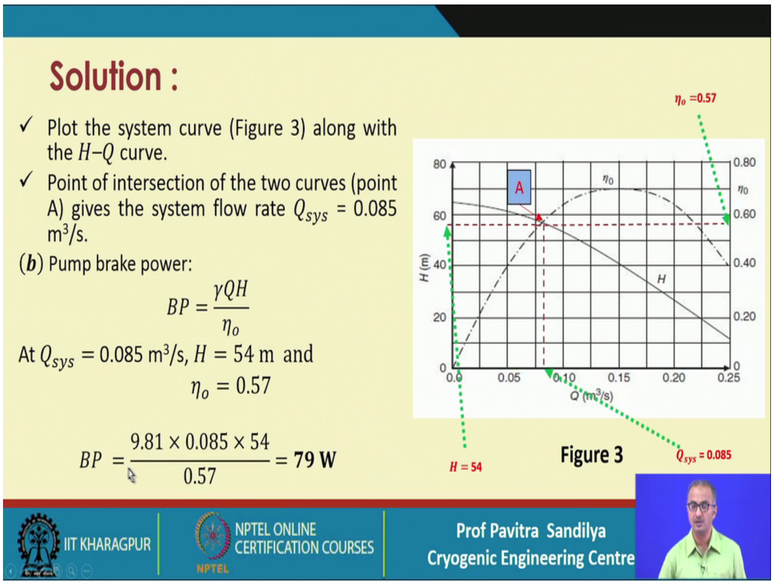

So, that if we plot this H versus Q on the this figure what is with we do that this is the here we are plotting this H was Q and once we plot it the point of intersection is giving us the particular system Q and the break horsepower can be once we have found out Q value then we can also find the value of the H which is here is 54 meter. And then we plug in the values over here to find out the power of the pump which is coming to about 79 watt.

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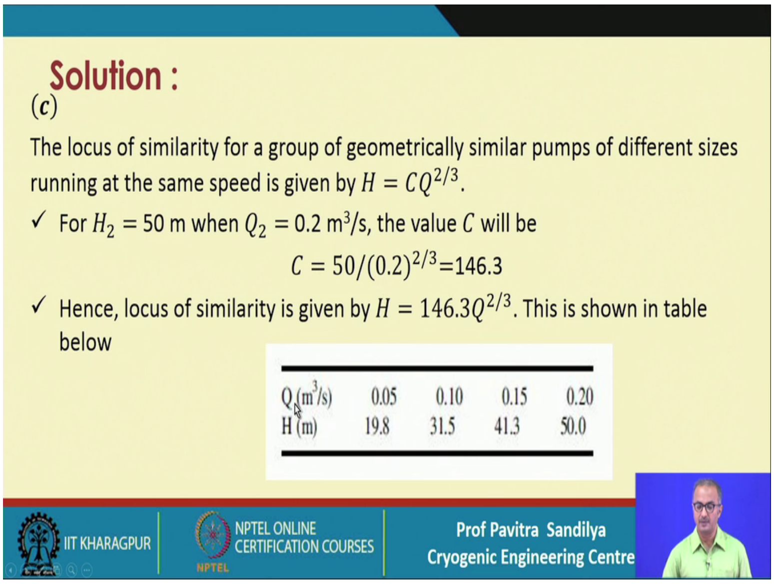

Now, what we do that locus of for a similarity pump because in a second part we have been given that we are going to change the pump. So, we have the we are putting this particular expression for the similar pumps. And this H equal to some C, Q to the power 2 by 3 and this C value we can be determined from the value of the H and the Q for the new pump. So, we plug in the values and we find this is the value of the c and now we can generate some value of the H and Q to plot.

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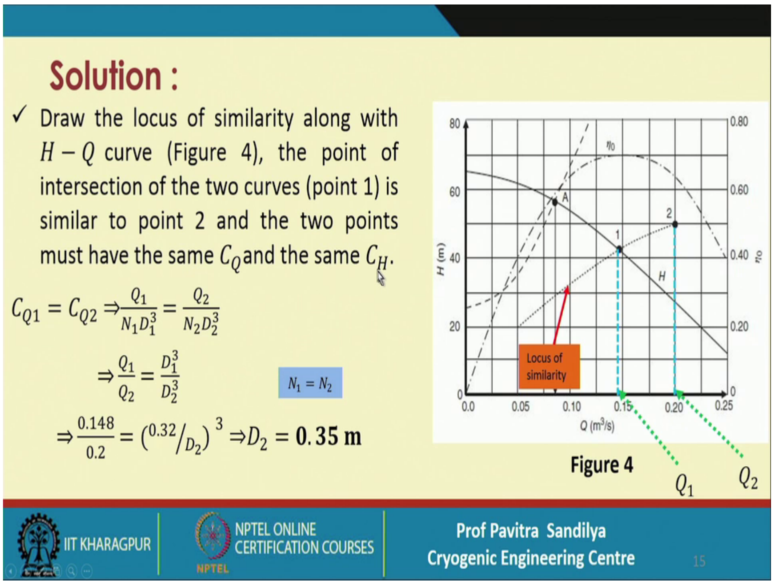

And again we plot these values and we find that this is the locus of similarity and we find that wherever we see plot the in the point of intersection of two curves. Point 1 is similar to point 2 and point 2 is not point 2 is a one which is for the original pump. So, this point this similarity is this mainly applicable for both the pumps. So, this will be or a new for the first part and this we find for this particular second part. And this particular Q1 and Q2 we can see that for when we at on similar pumps both the C Q and C H will be the same and C Q is given by this expression.

And we put them in this expression we find that N 1 and N 2 are the same, because in the problem they are saying that the pumps are running at the same speed once they run at same speed then this is the thing we find the how the capacity is related to the impeller diameter. And this Q1 Q2 are rate from this particular graph, we plug in the values of Q1 and Q2 and we find out the value of the impeller diameter for the second pump. Now you may either use this equality of C Q you may also use equality of C H both should read to the same answer.

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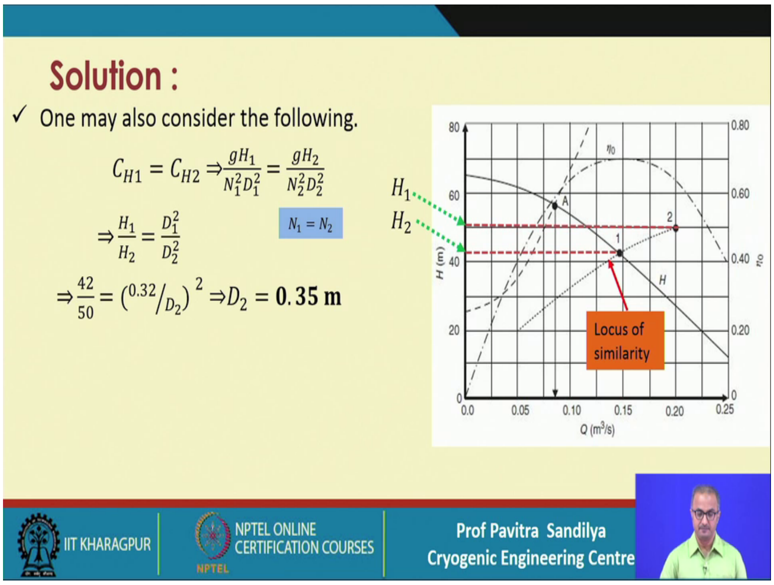

So we can check that also that we can do that we put this equality of C H and we get this expression. And from the expression again we find that because N 1 is equal to N 2. So, this head are related to the impeller diameters like this, and again we plot it now instead of reading the Q we are reading the H values. Once we read the H values from this graph and then we know the value of D 1 and again we find the value of D 2. And we find that D 2 is coming same as the one we just of obtained by equalizing the C Q.

So, as of the demonstrated that, both the ways one can find out the impeller diameter of the other pump. So, in any one of them will suffice.

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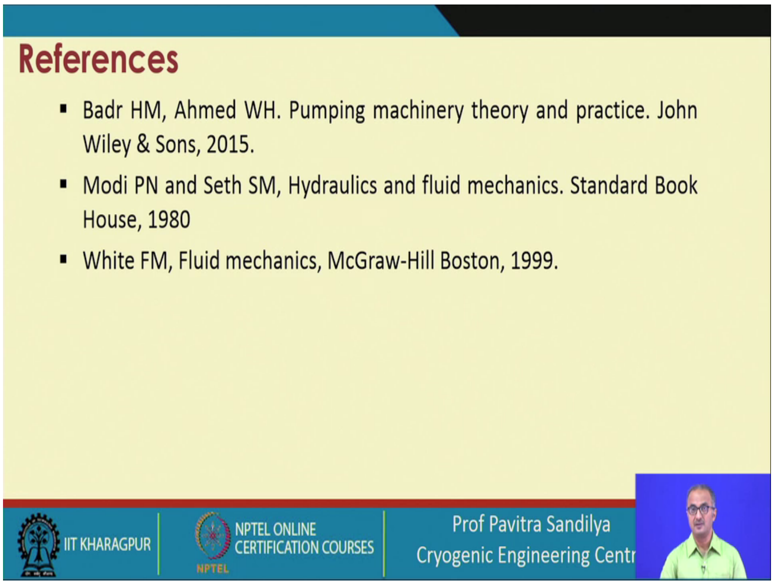

So, these are the various references, in which you can find more detail about these pumps.

Thank you.