Principles of Casting Technology
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Lecture - 20
Gating System Design
Problem solving

Welcome to the lecture on Gating System Design. In this lecture we will go on solving certain problems based on gating system design.

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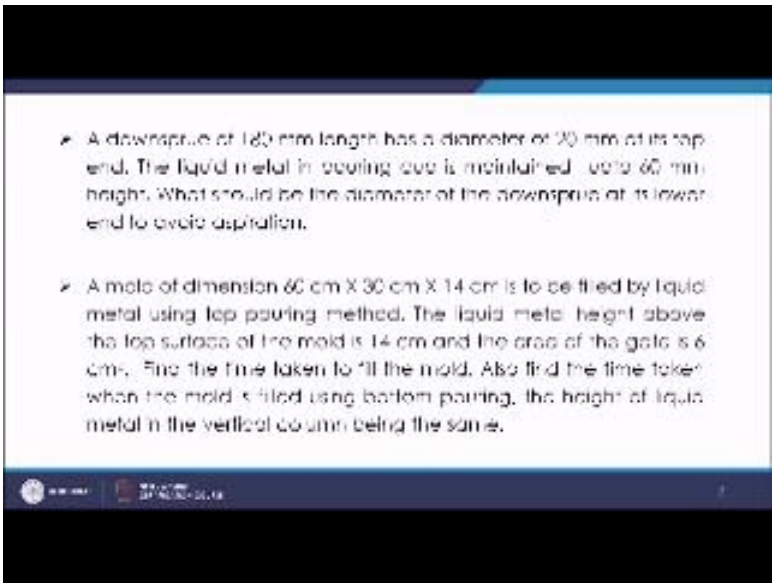

Let us start with the first question that is a downsprue of 180 mm length, has a diameter of 20 mm at its top end. The liquid metal in pouring cup is maintained up to 60 mm height, what should be the diameter of the downsprue at its lower end to avoid aspiration?

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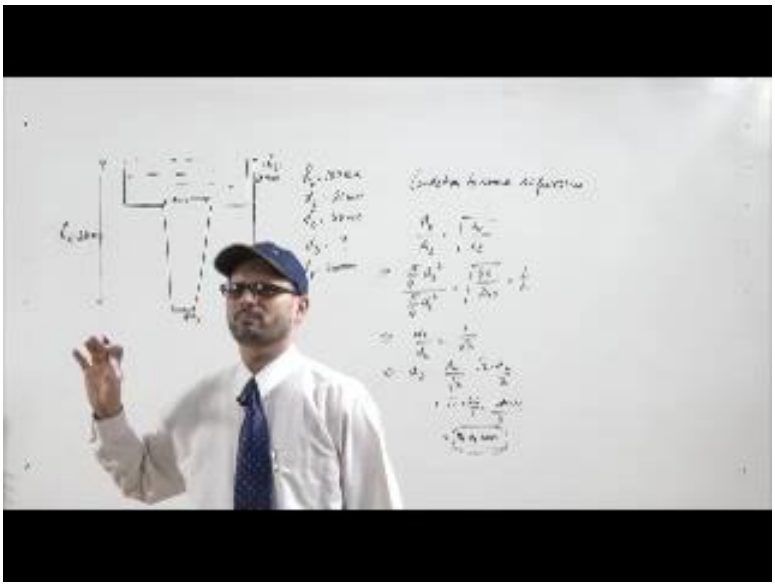

So, in this question, you have been given a pouring cup and a downsprue, then the downsprue length 180 mm. So, this length is 180 mm which is normally we take as h 2, then diameter of 20 mm at its top end. So, this point is point 2. So, here the diameter d 2, at this point you have d 2. So, h 2 is given as 180 mm, and d 2 is given as a diameter of 20 mm.

The liquid metal in the pouring cup is maintained up to 60 mm height. So, the liquid metal is maintained up to this height, and this height is given as 60 mm, and we by convention we write as height of the pouring cup. So, height of the pouring cup is given as 60 mm. So, basically we write h t that is total height, and total height becomes h c plus h 2, and that becomes h t equal to 240 mm.

Now, what they want is at this point so this is the point 3, and here the diameter is d 3. So, what should be the diameter of the downsprue at its lower end here, you need to find d 3 so that there is no aspiration. So, the condition to avoid aspiration is, it has already be derived in the previous lecture, the condition to avoid aspiration is, if this is A 3 and if this is A 2. So, A 3 upon A 2 is nothing, but under root h c upon h t. So, this is the condition of avoiding aspiration.

So, A 3 will be pi by 4 and d 3 square divided by pi by 4 d 2 square, this will be under root h c. So, h c is given as 60 divided by h t is given as 240. So, we have to calculate h t is given as 240 mm. So, it will be 240, and this comes out to be 1 by 2. So, what we

found here we get d 3 upon d 2 equal to 1 by root 2. And from there are we had to find d 3. So, d 3 will be d 2 upon root 2, and it is nothing but root 2 times d 2 upon 2 and d 2 is given as 20. So, root 2 into 20 upon 2, 1.414 into 20 upon 2. So, this is nothing but 14.14. So, this is the diameter at the bottom end of its 2, which will avoid the aspiration in this problem and that is why 14.14 mm is the answer.

Now, to will deal with the next question. The next question is given as like this. A mold of dimension 60 centimeter, by 30 centimeter, by 14 centimeter is to be filled by liquid metal using top pouring method. So, we are been given a mold, whose dimension is given, 14 centimeter is the height of the mold. The liquid metal height above the top surface of the mold is 14 centimeter. So, height of the metal head which is we are doing the top pouring. So, the height of the metal head over the top surface is given as 14 centimeter.

And the area of the gate is 6 centimeters, point from where the metal enters into the casting cavity, that cross sectional area is 6 centimeter square, find the time taken to fill the mold. So, we have to find the pouring time, when we do the top pouring of the casting; also find the time taken when the mold is filled using bottom pouring, the height of liquid metal in the vertical column being the same. So, it is seems the height of the liquid column was earlier 14 centimeter, and also the height of the cavity is or mold is 14 centimeter. So, in the second case, when we do a bottom pouring, the top portion or the liquid metal in the vertical column or in the pouring cup will be same as the top surface of the casting cavity. So, what will be the time taken to fill the liquid metal?

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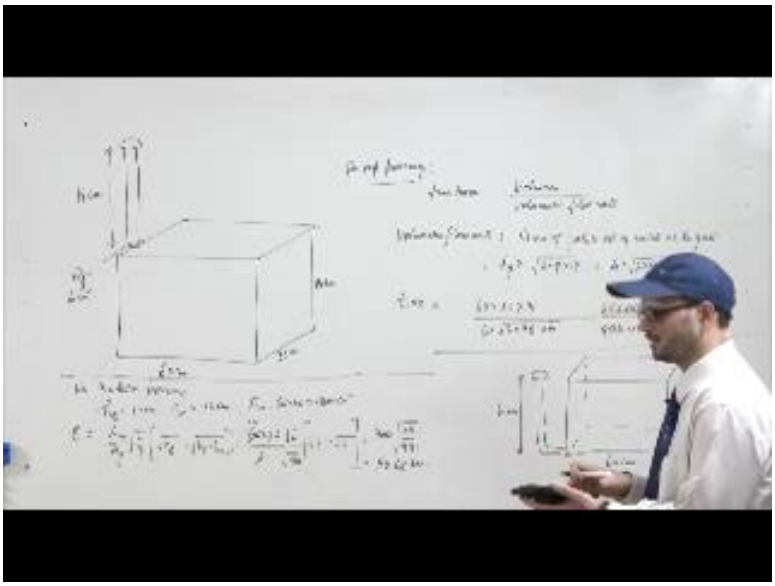

Now in this case let us see we have a cavity. So, this height is 14 centimeter, width is 30 centimeter and length is 60 centimeter. And we are basically pouring from here, and this is the pouring cup, and this height also is given as 14 centimeter. So, this is the case of top pouring, and in that case the area of the gate A g, this area is A g and A g is given as 6 centimeter square. So, for top pouring, we have to find the time taken. So, time taken will be volume upon volumetric flow rate, volumetric flow rate will be area of the gate multiplied by velocity of the fluid at the gate. So, volumetric flow rate, this is the flow rate of the metal, which is entering into the cavity. So, it will be area of gate multiplied by velocity of metal at the gate.

Now velocity of the metal, so this is nothing but A g, and velocity of metal at the gate sees being the top pouring this case your velocity will be under root 2 g h. So, it will be under root 2 g into h 14 centimeter. So, A g is given as 6, to 6 times under root 2 into 981 into 14 volume is. So, time will be volume, volume is 60 by 30 by 14, we are taken g as 981 gram per centimeter square. So, it is in that case, 981 centimeter per Second Square sorry. So, that is the value of g in that unit. So, it will be divided by this volumetric flow rate, 6 into under root 2 into 981 into 14. So, we have to find it. So, it will be 981 multiplied by 14, multiplied by 2 under root is 165.73 into 6. So, it is 994.4. So, 2 5 2 0 0 upon 994.41, and. So, it will be 2 5, 25.34 seconds. So, this is the time taken to fill the cavity, when the cavity is being poured using the top gating or using top pouring.

Now, let us see how much time it will be taken, when we are going to do it using bottom pouring. So, in the case of bottom pouring what will happen, you have the cavity. So, in this case your pouring top will be here, and it will be entering at this point. So, this is your 14 centimeter, and you have the dimensions like the earlier one 60 centimeter, 30 centimeter, and 14 centimeter. So, in this case this is your pouring top, and this height is same.

Now, if you go for bottom pouring. So, up to this stays we have done it for top pouring, now will calculate for bottom pouring when the liquid metal is supplied at this point. Now for the bottom pouring, as we see in this case the total height is 14 centimeter, and height of the mold is 14 centimeter. So, using the bottom pouring, we know that for bottom pouring time taken is A m upon A g under root 2, upon g under root h t minus under root h t minus h m. So, this is the formula which we have derived for finding the pouring time for bottom pouring. Now in this case we will have all these values, A m is nothing, but the cross sectional area of this mold. So, a b is given as 60 multiplied by 30. So, 60 multiplied by 30, you have A m as 60 multiplied by 30 that is 1800 centimeter square. Then A g is given a 6, then under root 2 upon under root 981 that is under root 2 by g, then root h t. So, root 14 minus root h t minus h m. So, h t and h m are same. So, it will be 0. So, you have to calculate these values.

So, if you calculate the values, it will be 300 into 1.414, that is 4 2 4 2 or we can do under root 28. So, we can have 300 under root 28 upon 981. So, that will be point 1 6 8 9 so into 300. So, it is 50.68. Now this is the time taken to fill the mold using this bottom gating, when we do with top gating the time taken is 25.34 second whereas, when we do the bottom gating, the liquid metal head is the same, in that case the time taken is 50.68. What we see incidentally is that, the time taken is basically 2 times this. So, we have also earlier same that in those cases, when we replace this height with this, then this time using the bottom pouring is 2 times in the time taken by the top pouring and that is what we have got this time.

The next question what we are going to solve is, based on this figure.

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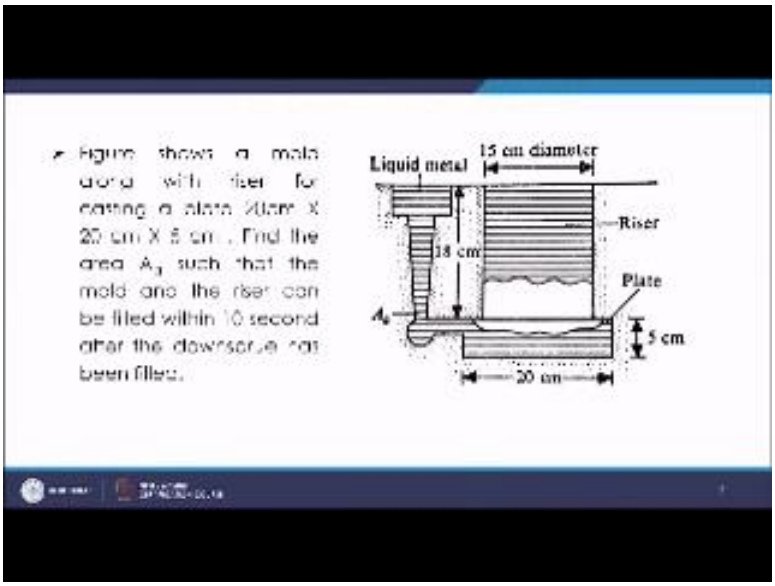

In the figure shows a mold along with riser for casting a plate 20 centimeter by 20 centimeter by 5 centimeter. So, there is a plate, of dimension 20 centimeter by 20 centimeter by 5 centimeter 5 centimeters is the height. So, this is a rectangular type of cross section plate with 5 centimeter of height, find the area a g such that, the mold and the riser can be filled within 10 second, after the downsprue has been filled. So, this is a problem which tells that, there has to be 2 types of filling: one is the filling of this plate, which is we will be done using the top pouring for this using this height of the liquid metal. And with the similar height of liquid metal, you have to fill this height of the riser which is cylindrical in say the diameter is 15 centimeter, and the height is 18 centimeter. So, the 2 portions had to be filled up, one by top pouring method, another by bottom pouring method. And the condition is given that this should be done within 10 seconds of the time.

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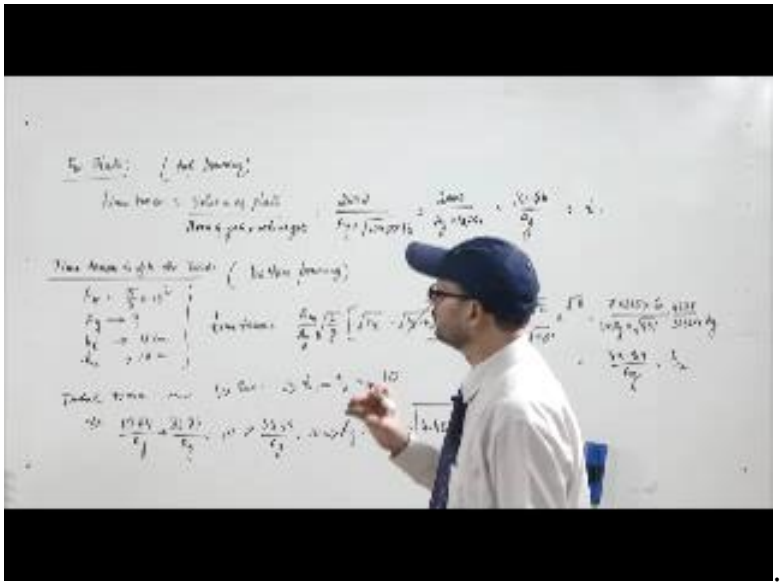 .

So, let us see what will be the time taken. So, in this case what given let us first write, for the mold when we take about the plate for plate, if gets the time taken since it is a case of top pouring. So, time taken will be volume of the plate, divided by the volumetric flow rate of the plate that is area of the plate into. So, this is the area of gate into velocity at grid. So, this is the basically time taken, when we taken the time taken for the plate portion. So, the volume is 20 by 20 by 5. So, it is 2000 then area of the gate which is to be found, multiplied by under root 2 g h.

So, it is since it is a case of top pouring, so for this you have the case of top pouring. So, under root 2 g h and h is in this case is 18 centimeter, g is 981 centimeter per Second Square. So, if you find this value it will be. So, 2000 divided by A g into 174.52, that is 11.46 upon A g, sorry there was a mistake here this value will be 187.92. So, this value will be 2000 upon 187.92 that is 10 .64 upon A g. So, this is the time taken to filled up plate person.

Now time taken to fill the riser; so in this case you have bottom pouring, because the riser is at a level above then this level of the gate. So, this is the case of bottom pouring, in this case you have A m as pi by 4, this is a cylindrical casting cylindrical riser. So, pi by 4 into 15 square, A g has been given already area of the gate is given. So, area g is to be found out, and we need h t. So, h t is given as 18 centimeter that is height, and h m that is height of the mold that is also 18 centimeter.

So if we take the bottom pouring, the time taken will be A m upon A g under root 2 by g, under root h t minus under root h t minus h m. So, since h t and h m are same. So, this term will value is to 0. So, we are left with this term this will be equal to A m is pi by 4 into 15 square upon A g that is you have to calculate, into root 2 upon root 981 multiplied by under root h t. So, that h t is given as 18. So, it will be under root 18. So, what we have to do is, we have to have pi into 225, into under root 2, under root 18. So, basically that will be 6, divided by A g into under root 981, and there will be 4 here. So, let us have its value, it will be 225 into 3.14 into 6. So, that is 4 2 3 9 upon nine eighty one under root. So, it will be 31.32 into 4 A g. So, it will be 4 2 3 9 divided by 125.28. So, it is 33.84 upon A g.

So, what we see is, one case we are getting 10.64 upon A g using the top pouring, and when we go for bottom pouring, we are getting the value 33.84 upon A g. Now these 2 timings together they should not exceed 10 of seconds. So, if we take the limiting time, we need to have total time you can take the limiting case as 10 seconds. So, this is your t 1 and this is your t 2. So, that is t 1 plus t 2 you have to equate as 10. So, you can it like this, 10.64 upon A g, plus at 3.84 upon A g will be 10. So, it will be 44.48 upon A g will be 10, or A g will be 4.448 or 4.45 seconds. So, this is a time which we will require. So, this is the total time. So, this is 4.4 not seconds, it is the centimeters square. 4.45 centimeter square is the area of the gate, which will be able to complete the filling of this cavity in 10 seconds.

So, this is all about the solving of such problems, whenever we encounter such problems we can see that you have a case of something like a parting line type of gate, where we have something poured at the down level and something poured at the top level. So, you have to find the time taken for both the parts and then you have to add them, and the conditions are met. So, you are getting some value. So, this is how you can solve the problems.

Thank you.