Principles of Casting Technology
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Lecture – 17
Gating System Design
Types of Gates

Welcome to the lecture on Gating System Design. In this lecture we will discuss about the types of gates and further we will also discuss about the gating ratios.

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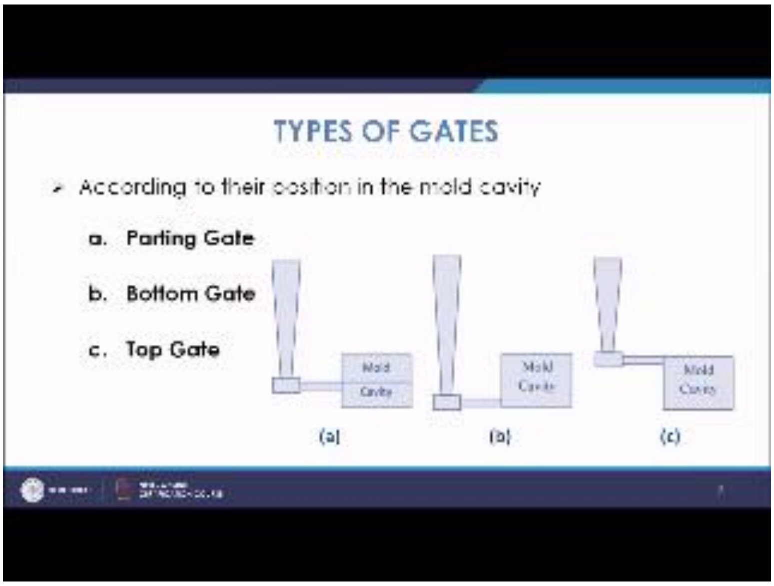

We have studied about the gating system and there the main purpose is to ensure that metal is fed to the cavity and the metal traversing the path by following the route from pouring basin from there it comes through the sprue goes to the runner and finally, to the gates and then it enters into the cavity.

Now the question is that how to enter into the cavity, whether it should enter from the top portion of the casting or at the parting line of the casting or air from the bottom of the casting and based on that according to its position in the mold cavity the gates are classified as of these 3 types parting gate bottom gate and top gate. The parting gate is the one where the metal entry into the cavity will be at the parting line. So, this is the parting gate, so here you have the entry of the molten metal would that as the parting plane similarly in this case the metal is seeing to enter at the bottom of the mold cavity it is known as bottom gate and if the metal is entering from the top portion of the mold cavity then it is known as the top gate.

The most simple normally is that when you are using the sprue cup or from the riser it comes and vertically you are filling the cavity from the top that basically is a part of cavity I mean typing gate that is the top gate, but then you have the limitations many a times you cannot afford to directly feed the molten metal from the top of the cavity because of many resource. So, you may need to feed the molten metal either at the parting line or at the mold at the bottom of the cavity.

Let us see the parting gates, the parting gates basically these gates enter the mold cavity along mold parting line. So, we know that the parting line is the line or it is basically a plane which separates the 2 halves of the mold that is cope and drag. So, basically it passes along that line which separates the 2 types of molding boxes that is cope and drag.

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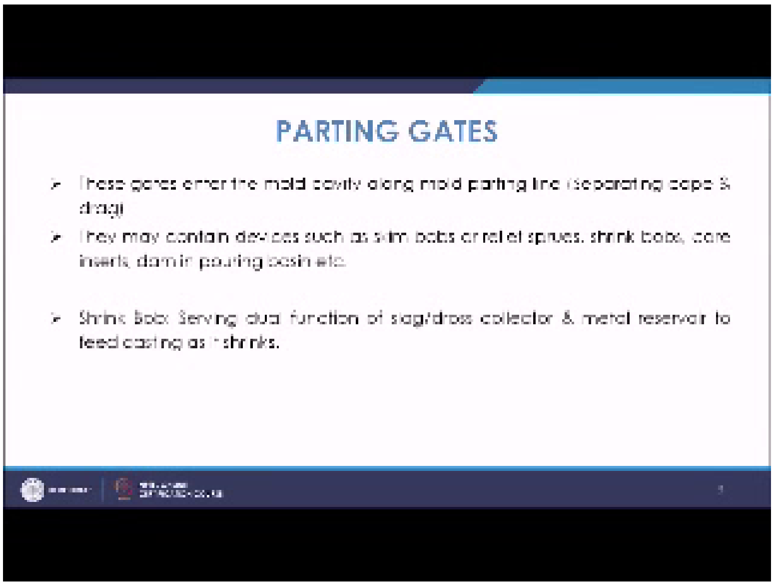

Now, in this type of gates, you may have to give the devices like shrink bobs or relief sprues shrink bobs core inserts dam in pouring basin it is seen. So, all these points or all these relief sprues or shrink bobs they have some specific functions what is the function that we can see further like there is shrink bob. So, we can see the different types of gates.

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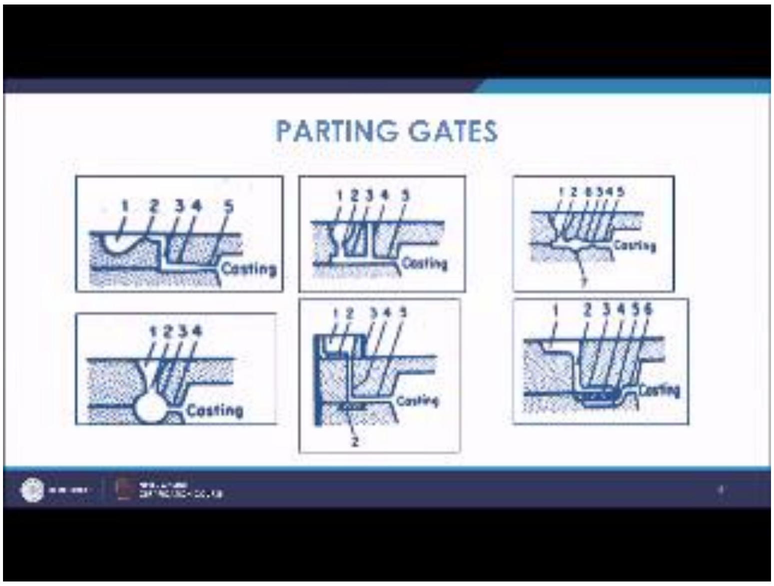

Now, if you look at this portion, in this case what we see here is this is the pouring basin, 1 is the pouring basin and in the 2, 2 it is basically a dam is made here so that all the heavier inclusions.

In this portion does not enter in to this portion through the sprue and further to the runner and the gates. So, in this portion this per portion 2 the point 2 is the presence of a dam which basically restricts the entry of any kind of dirt or foreign particle from entering and going into the metal stream which will go and enter the cavity 3 is the sprue and 4 is the runner and 5 is the gate and from here it is entering into the casting. So, as we see you have a casting this is the parting line of the casting and you have the top portion of this is the top portion box that is cope and this is the drag portion. This is how you have the mechanism to filter out the dirt and inclusions, in such cases.

Coming to this point let us see here in this case, you have again a pouring basin, it is going from here through the sprue number 2 and from there, it is this is a runner and this number 4 in this case this is known as relief sprue. So, this relief sprue basically is meant to get the pressure relieved if there is undo pressure increased in this zone this pressure is relieved at this point as well as it will also try to float out the inclusions of lighter masses then the metal.

When the molten metal stream will be flowing like this then in that case the lighter inclusions like oxides or so, they will come and they will get trapped here and they will go inside. So, they will be collected in this portion. So, they, this relief sprues, they are 2 functions one is to relieve the pressure if there is pressure increase at some point and another is that it will try to collect or separate the dirt or any for an impurity which is flowing in the stream and then you have the gates and further it goes into the casting.

Another variety of parting gate this is these are all parting gates where we use the different kinds of design. Now in this case one is the pouring cup for the 2 is the sprue then in this case the 3 here what is done is you have the use of this shrink bobs. So, here in this case we are using the shrink bob and this portion this that is 4 he choke. So, you have choke in this portion.

Now, in this case, the use of these shrink bobs are done the shrink bobs purpose is to basically both the purpose they can take these. So, if you have lighter impurities they can go there is skin bob in the cope portion. So, it has basically projection in the cope portion as well as in the drag portion if there is lighter impurity it will go and get trapped in this cope portion of these shrink bob and if there is a heavier impurity it will go and get trapped in this bottom portion of there is shrink bob. Then you have the choke and further it goes. So, basically we use the shrink bobs, in this case.

You can come here and this is known as shrink bob. So, in this case basically we are using the shrink bob. So, shrink bob basically it serves the dual purpose. First of all it collects and the impurities and it can attain it, heavier impurities can be placed here and then the second person purpose is that it will supply the liquid metal in case of shrinkage. So, if there is shrinkage in the cavity this shrink bob basically serves the purpose of feeding the liquid metal in that case these 2 figures they have shown the use of the core inserts.

Now, in this case, this core insert is used to filter the liquid metal from here. So, it will come from the pouring cup and then this is the strainer core basically and these are these are the cores or splash cores. So, in this case you have the strainer core which is used this strainer core basically it will filter all the metal which is coming from here to pass through that and then it will be fed to the casting. So, this is strainer core we will try to filter out the inclusions or the refractive particles which is coming along the main stream and then you can get the clean metal going into the cavity. So, these strainer cores are used in those cases.

You can also use these core inserts. So, basically these are inserts which are used they are made of dry sent cores. So, they are stronger and they are basically to withstand the impact of the liquid metal. So, the liquid metal because the liquid metal this being of larger height, so liquid metal may impact here and they can erode the surface of the sand here. So, you have a core insert here as well as when it falls from the sprue then the chances of erosion even in this portion is higher. So, in that case these core inserts try to prevent the damage of the mold when the molten metal strikes from a height at certain level. These are the different uses of the parting gate in the parting gate basically metal is flowing and entering in to the cavity at departing line as we see in all these cases.

Next is bottom gate now the bottom gate is the one where the metal is entering from the bottom half of the mold that is drag portion.

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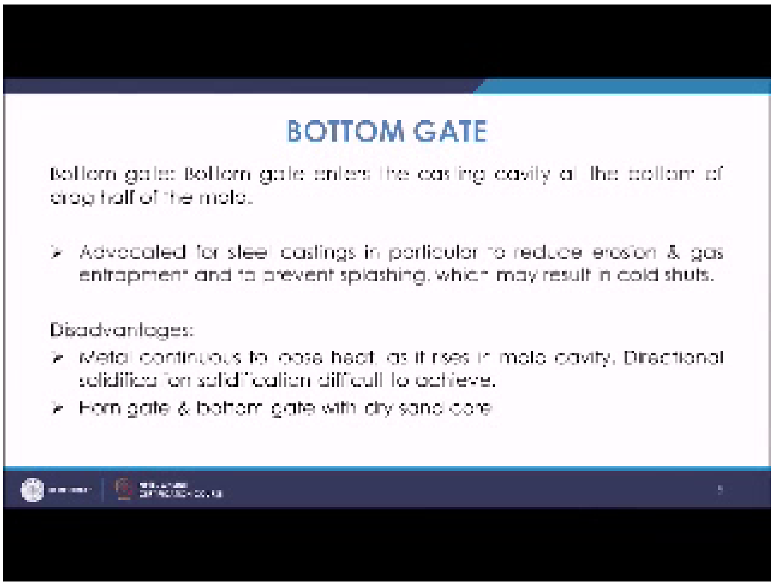

Here the metal enters the cavity at the bottom drag halve of the mold. So, it is basically advocated for a steel castings in particular because once you have a heavy metal with large density then there is chances of erosion when it falls from certain height and goes into the cavity.

In that case, it is tried that it goes through the bottom of the mold and that will also prevents the splashing because once it falls from certain height it may splash and that may result into cold shuts also once it is plash and the extremes are going like this then there may be formation of cold shuts. So, cold shuts basically it is now the disadvantage is metal is continuously loosing heat as it rises in the mold cavity. So, the external certification is difficult to achieve and it has 2 varieties basically you have one is horn gate. So, what happens in the bottom gate as you see in the bottom gate?

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In the bottom gate basically your entry of metal is from here. So, what happens? The hot metal, metal level will go on increasing now the first metal which has come the first metal goes at the top. So, they become colder and the last metal which enters here that is hotter. So, basically achieving a directional certification is somewhat difficult in the case of these bottom gatings, but; however, this is another advantage as we have discussed earlier.

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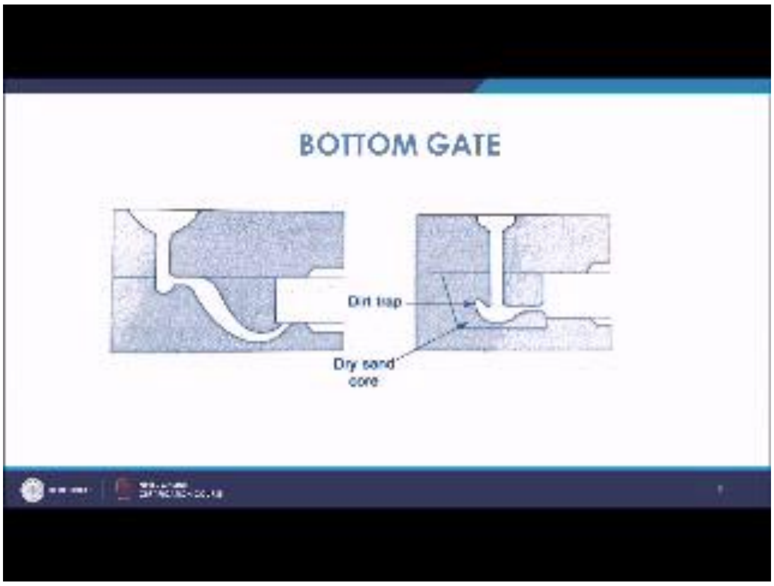

The thing is that they have you have 2 varieties of this bottom gating this type of gating which is shown here this is a variety known as horn gate. So, this horn gate is basically in the form of a horn. So, that is why it is known as a horn gate. So, it is giving the entry like this. So, it is a quite entry and that is why it is known as a horn gate, but it has certain disadvantage there is disadvantage is that in the horn gate the disadvantage is it produces spontane effects. So, when the liquid metal will enter from this point being the shape of horn. So, it will try to go in terms of a fountain. So, that is why there will be fountain effect in the cases of horn gates then there is also certain mechanism you have the dry sand core is used in the case of bottom gatings.

Because the metal is following from this height, effective head of the metal is increased in that case the impact of the liquid metal is higher. So, you need to have a very strong base and you must have this area very strong to withstand that force which is generated because of the fall of the liquid metal from the top. So, in that case you have this dry sand core practices putting this area with dry sand core. So, that it absorbs the impact the forces and it basically prevents the damage of the molding material. So, this is how this bottom gating is done.

Then you have top gate as the name indicates in the case of top gate the metal is entering from the top portion of the mold.

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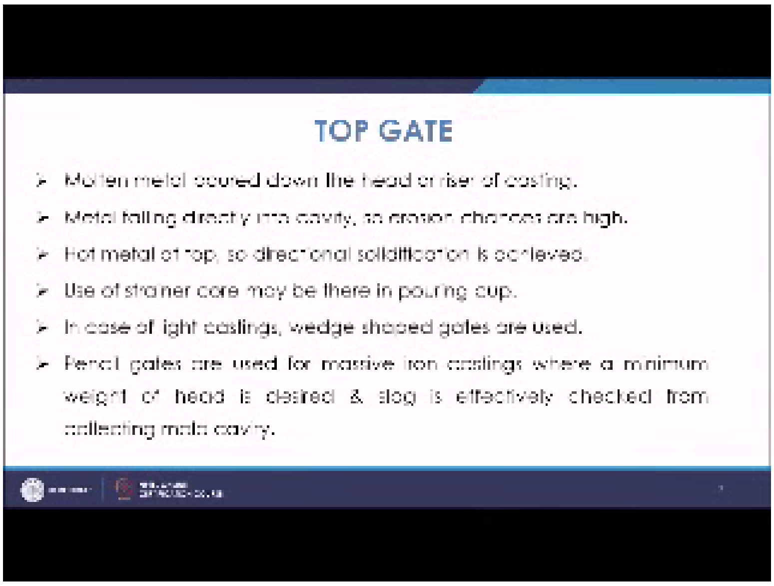

Basically you have the metal molten metal poured down the head or riser of the casting. So, what may happen that from the top itself, it has come and here from itself you can directly poured and you can directly pour and it may go into the casting. So, this is known as top gating. So, this may serve as a reservoir or a riser which can feed the metal in case of shrinkage.

Now, in this case metal is falling directly into cavity. So, a chance of erosion is high because the metal will be directly falling and it will be falling at this point. So, the chances of erosion is quite high in the cases of top gating now the advantage of top gating is that in this case as we have seen in the bottom gating you have colder metal at the top and hotter metal at the bottom, but in this case you have the colder metal will be at the bottom and hotter metal will be at the top. So, this way you have colder metal and you have hotter metal.

What happens that this basically helps in achieving a directional certification the metal will be start solidifying from this side and ultimately it will finish here this will be a hot. So, this will be freezing it and the shrinkage will be taken care of by the riser which is connected to this portion. So, this is the advantage of using these types of top gates.

Now, in these cases you may use the strainer core. So, what may happen you may think of using certain type of cores that is a strainer core. So, that you can think of taking the impurities out and you can and not allow the impurities you come through it and you can allow the only the clean metal to pass through it in case of light castings you can have wedge shaped gates and you have different types of gates.

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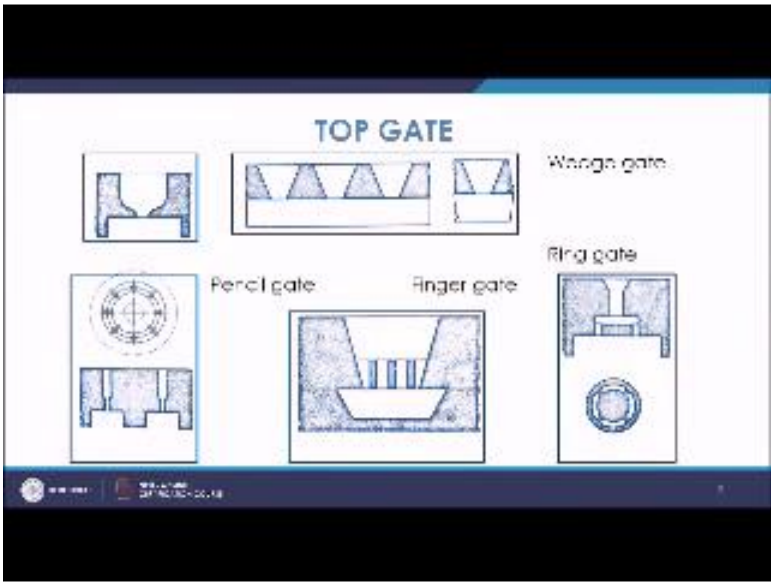

Let us see this is a typical top gate which shows that from the gate it works as a header or riser and from here it you can directly pour into the cavity and you can also put the core inserts as we have put here. So, you can have the core insert at this point. So, that the clean metal enters into the cavity.

Now, in the cases, where to what we have seen that when we have a light casting you can use this wedge shaped castings. So, wedge shaped casting you have the wedge shaped this gates. So, they are used when you have the light castings then you go for the wedge shaped castings then you have the pencil gates pencil gates are used for massive iron castings where a minimum weight of head is desired and slag effect is effectively change from collecting in to the mold cavity. So, if you look at this pencil gate here you can see that you have if you have a very large casting then either you have to maintain a very large head or you will have if you have this smaller head in that case you have to basically show the see that the metal enters through a very small opening.

That is known as this is the pencil gate. So, this is for those castings where you need to have a very small opening very small head is to be needs to be maintained and also there will be blockage of the entry of foreign impurities.

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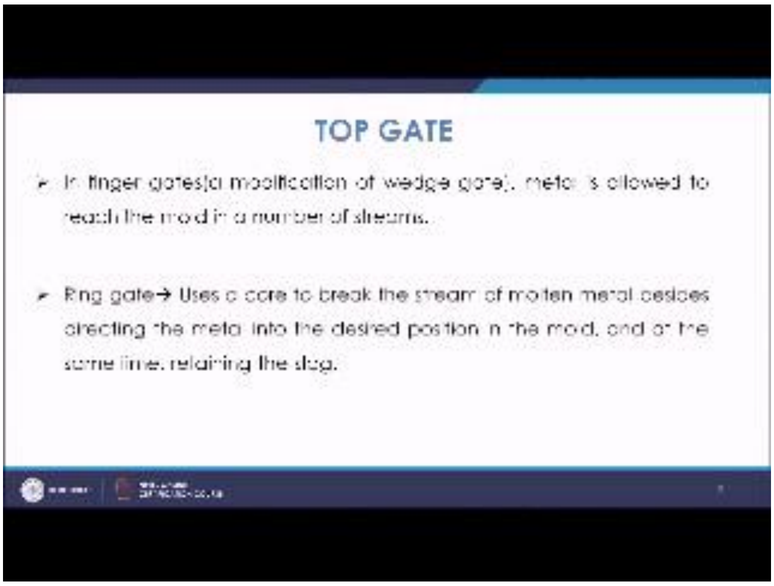

Then you have finger gate which is nothing, but a modification of the wedge gate and what metal is allowed to reach the mold in a number of streams. So, if you look at this finger gate. So, it is just like a will wedge gate, but you are allowing it to pass through a number of streams.

Then you have a ring gate. So, it is in the form of a ring and you have the core at the center. So, it a core is used to break the stream of molten metal besides directing the metal into desired position in the mold and retained the slag. So, as you see you have in the form of in the portion the center portion the core which is we stopping in the form of a ring the liquid metal will be allowed to go into the cavity.

That is why it is known as a ring gate. So, these are the different types of top bottom and parting line gates now we will move to another important parameter another important element of a gating system that is choke. So, we have anyway by the studying the gating system we have seen that this sprue is normally tapered while we move from top to bottom and at the bottom it has the minimum cross section. So, that is generally called a choke, but not necessarily that is choke you can have any portion which is can be termed as choke.

Now, what is choke the smallest area in the feeding channel that controls flow rate in to mold cavity and controls the pouring time. So, in that gating system wherever you have the smallest cross sectional area because that is known as a choke

Normally it is at the bottom of the sprue. So, that is why, but it is not always necessarily there it has not to be at that place only it can be somewhere in the gate also. So, it normally occurs at the bottom of sprue for early establishment of proper flow characteristics. So, what happens in the case of choke the choke basically if it is at the bottom of the sprue.

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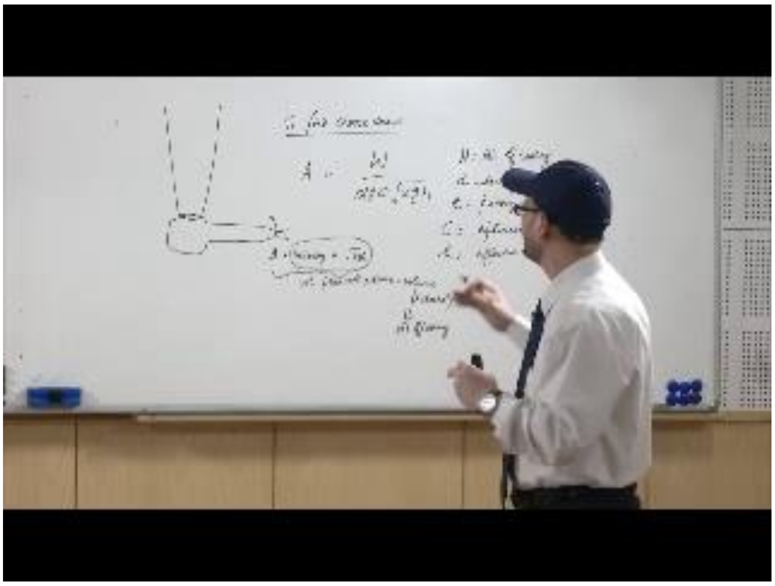

So, you may have here the minimum cross section area and from here, basically you have the pouring cup and then it goes. So, it may be here or it may be somewhere in the downstream.

Now, what happens because the pouring rate will be controlled or if may be dependent upon this choke area itself. So to find the choke area, what happens the choke area is calculated as W upon dtc root 2gh how it comes this w is rate of the casting, d is density of molten metal, t is the pouring time, c is the factor efficiency factor which is known as nozzle efficiency it depends upon the gating system type of gating system used, h is the effective metal head.

What happens? That from the area of the choke once you have the area and you know the velocity, so this velocity will be basically nothing, but under root 2gh. So, this area into velocity that will be giving you the volumetric flow rate and. So, area into velocity, velocity is nothing but root 2gh and this will give you the volumetric flow rate. Volumetric flow rate and then this is multiplied with the time. So, multiplied by time, that will give you the volume. So, that will give you the volume of the liquid metal and once this volume it is multiplied with the density then that gives you the mass. So, weight of casting.

Using this expression basically that is why area into velocity into time into density multiplied by the efficiency factor that gives you the weight of the cast. So, this way you can get the choke area dimension. So, choke area can be calculated using that.

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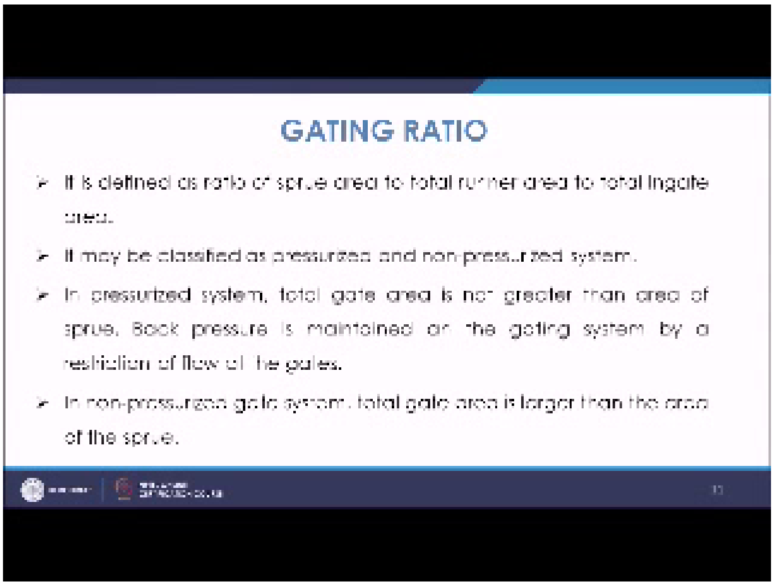

Gating ratio is another important term that is gating ratio now it is defined as the ratio of sprue area to total runner area to total in gate area. So, it is a ratio basically when as we have understood that when you will have the choke at this point at the bottom of the sprue after this point the flow is established. So, all the dimensions of the runners and gates they are expressed as the ratio of this dimension. So, that is your choke dimension primary choke it is known as that. So, based on that assuming that your choke is, at this point, the sprue area; then ratio further divided by total runner area divided by total in gate area that is known as the gating ratio.

Now, why the need of gating ratio is required? This is because of the requirement for different types of metals in some cases you need to see that metal flows full the main requirement is that there should be quite entry of the molten metal into the stream there should not be much of the turbulence as I have there may be chances of oxidation of the metal. In some cases you feel that your metal should go into the cavity as early as possible because in that case if it does not go early in the cavity it will lose it is super heat and it may lead to another kind of defects temperature related defects or cold shuts or misrun.

Basically you need to ensure that how your metal goes into the cavity. Now if your area is minimum here and further the area is increased in that case, you can expect that there will be a quite movement of the liquid metal further downstream where as you can have a case, where in the later reason you may have a portion where you have minimum cross section. So, in that case this portion may also be this is the portion which has the minimum area. So, that is basically working as a choke. So, basically that controls the flow rate now.

What happens because of this whole system is full it is running full. So, back pressure is maintained. So, in that case, on the basis of that you have 2 types of gating ratios and that is one is pressurized gating system another is non pressurized gating system. So, what happens? It is defined as that in pressurized gating system total gate area is not greater then area of the sprue. So, in this case this total gate area will be smaller than the area of this sprue. So, in that case your back pressure is maintained and because there is restriction of flow at the gates fluid filmy fill fluid film is there. So, because of that there is restriction at the gates and behind the gate all the portion is running full. So, a back pressure is maintained that is a pressurized system.

In non pressurized gate system total gate area will be larger than the area of the sprue. So, this is the minimum area and this gate area has to be larger than this area. So, that is known as a non pressurized gating system. So, like 1 is to 3 is to 3 is a case of non-pressurized gating system, simply 1 is 2 is to 1 is a case of pressurized gating system. So, this is how this gating ratio is defined and it is seen that for certain cases or suppose for liquid metals lie liquid metal casting for cast iron or steel or if you take aluminum the requirement of gating is different in case of aluminum you feel that there should not be the cases when there should be dross formation. Similarly in case of steels or cast iron we feel that you should not face a case when there should be much of the loss in its super heats.

According to that, you go for pressurized or non pressurized type of system also because in case of non pressurized system, this portion is becoming larger so your runner area and in gate area is larger. So, there will be more loss of metals in the area of runner and gates, so your yield will be less. Whereas in the case pressurized gating you have the smaller area, so yield will be somewhat better. So, this is how the difference is there in between the pressurized and non pressurized gating system.

Thank you.