Metal Casting
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Module – 02
Sand Casting Process
Lecture – 16
Sand Casting Defects-I

Good Morning Friends. In the previous lectures we have learnt about the risering system and the gating system. Now in this lecture let us learn about the casting defects.

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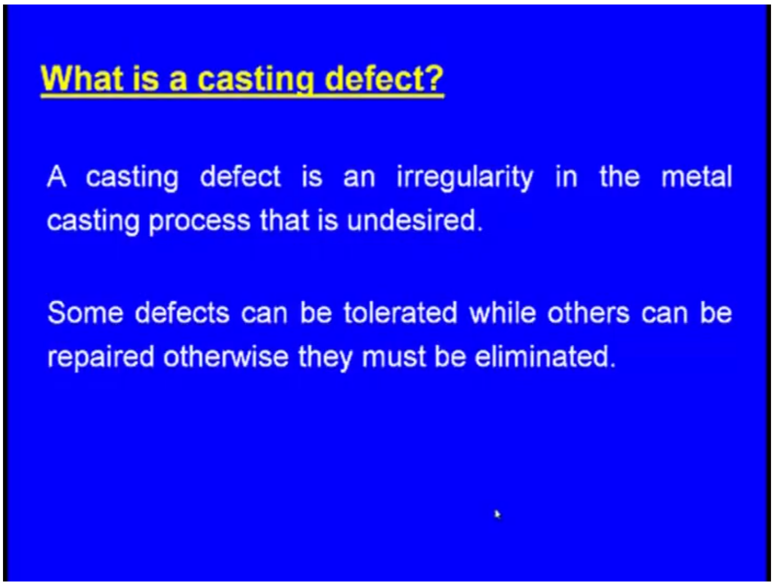

Now, what is a casting defect, a casting defect is an irregularity in the metal casting process that is undesired, some defect or an irregularity on the surface of the casting or inside the casting, which is not desirable this is a casting defect some defects can be ignored or they can be tolerated or some defects can be repaired by some welding and so on.

Whereas some defects because of their severity the casting has to be rejected. So, these are the what say broad classification of the casting defects. So, we can say that the casting defects can be what say minute defects and what say medium scale defects and the large scale defects that is the one classification now there is another broad classification.

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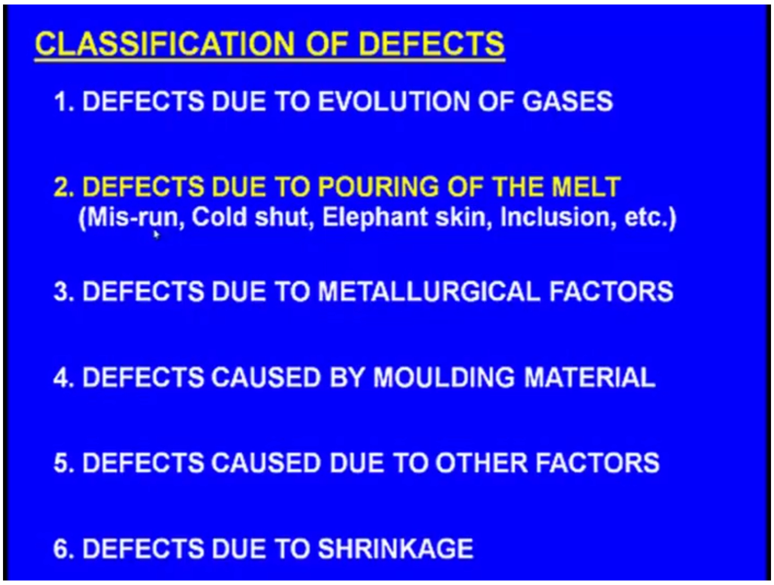

This is the broad classification of the defects; defects due to evolution of the gases means a gases used to arise from different sources because of these gases some defects arise.

So, this is the first classification of the casting defects. Next one defects due to pouring of the melt, melting means the molten metal or the molten alloy, now something is wrong with the melt that is why some other defects are arising. So, these are the defects due to pouring of the melt, now the third type is defects due to metallurgical factors, next one defects caused by the moulding material moulding material means the moulding sand or the moulding medium. So, in this moulding medium there is some defect that is why we are getting these defects.

Next one defects caused due to other factors, next one defects due to the shrinkage. So, the casting defects broadly can be classified into 6 types and among them the first one is the defects due to the evolution of the gases, now let us see what are the defects falling under this category let us study one by one then we will go on to the other categories. First let us see the defects due to the evolution of gases under this category we have blowholes pinhole porosity rat tail dispersed shrinkage blister and so on.

So, these are the defects that arise due to the evolution of gases first let us see the blowholes now this is the typical appearance of blowholes.

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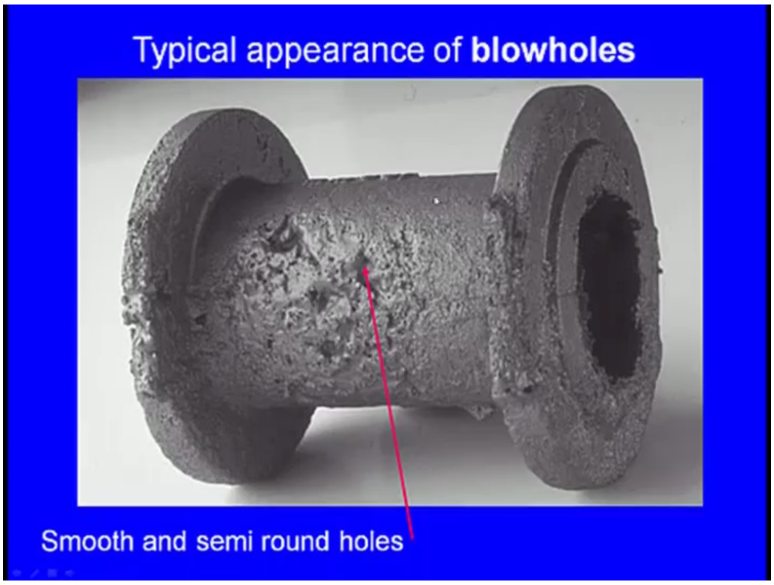

You can see smooth and semi round holes on the surface of the casting. So, this is a casting you can see these are all the what say a smooth and semi round holes on the surface of the casting. So, certainly this cannot be tolerated and ultimately the casting has to be rejected. So, this is one of the severe defects that arise among the castings now why this blowholes is arising causes.

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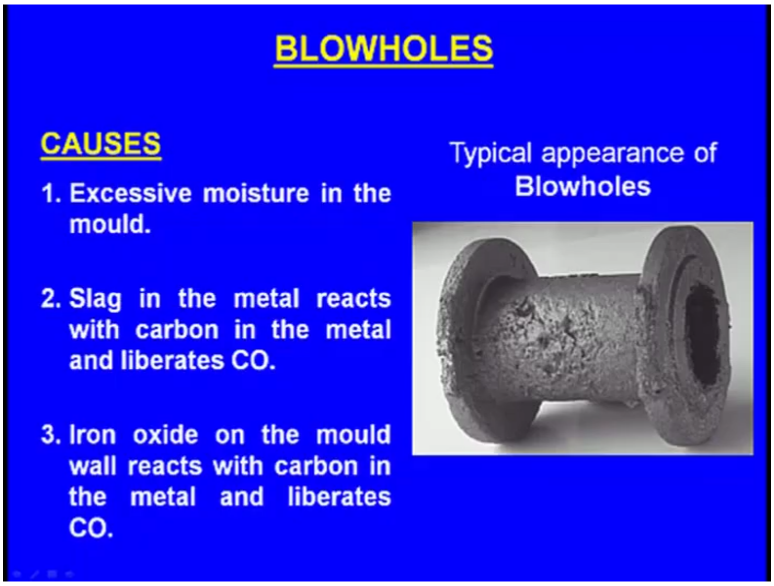

Excessive moisture in the mould we know that the moulding sand comprises of the base sand next one it comprises of the clay next additive and the moisture.

When the moisture content is more than required then what happens excessive steam will be produced and because of the excessive steam these blow holes can form. So, that is the first reason responsible for the blowholes. Second one is the slag in the metal reacts with carbon in the metal and liberates carbon monoxide, now when we are preparing the molten metal inside the furnace the slag will be collected, now what is this slag composed of slag is the main ingredient of the slag is the silicon oxide or the silicon dioxide.

Now, the slag contains oxygen, now it react this oxygen in the slag reacts with the metal right it reacts with the carbon in the metal first of all does the metal contains contain carbon yes cast iron contains carbon, steel contains carbon, cast iron contains carbon from 2.1 percent to 4 percent whereas, steel it contains carbon less than 2.1 percent. In all the cast irons and in all the steels carbon is present, now the oxygen in the slag reacts with the carbon in the molten metal and forms carbon monoxide and this carbon monoxide comes outside and it stays on the surface of the casting that is how the blowholes will arise.

Now, there is another reason iron oxide on the mould wall reacts with carbon in the metal and liberates carbon monoxide. Now iron oxide on the mould wall from where this iron oxide is coming, we use the chills for what say directional solidification, or we use the chaplet us for supporting the cores, now what are these chills and chaplet us made up of these are the metallic elements most of the times these are the chills are made up of what say steel components.

Now, again if these are what say a rusted for a long time what happens there is iron oxide on the surface of the chills, now this iron oxide comes and reacts with the carbon in the molten metal then what happens the oxygen from the iron oxide comes and reacts with the carbon in the molten metal and forms the carbon monoxide. This carbon monoxide yes it comes outside and it stays on the surface of the casting finally, we get the blowholes. So, these are the main causes of the blowholes.

Now, let us see what are the remedial measures.

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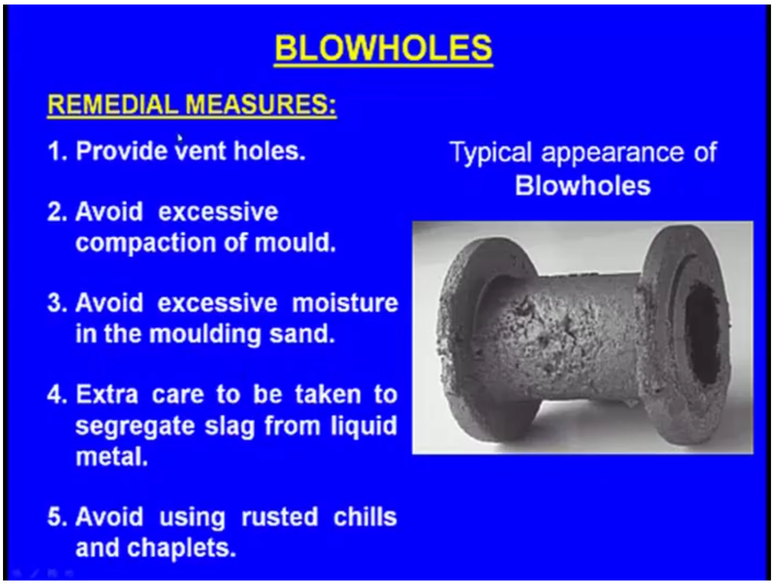

Provide vent holes yes no doubt there are gases arising gases are the steam, but provide the vent holes when we make sufficient vent holes all the gases that arise will be escaping through the vent holes. Next one avoid excessive compaction of the mould, the moulding sand should not be compacted then what is required, then what happens there is a term we have learnt about one permeability, what is this permeability? Permeability is the ability of the moulding sand to allow hot gases through it.

Now, that is why if the moulding sand is compacted very tightly the permeability of the moulding sand drastically comes down then the steam and the hot gases cannot pass through the what say neighboring grains of the moulding sand. Then what happens the gas will be accumulated inside the mould that is why we have to avoid the excessive compaction of the mould. Next one avoid excessive moisture in the moulding sand we should not cross the required proportion of the moisture in the moulding sand.

Next one extra care has to be taken to segregate slag from the liquid metal this slag has to be removed from the liquid metal, there will be a process called centrifuging by centrifuging the slag can be collected and it can be segregated, then the molten metal is free from the slag, then only the molten metal should be poured inside the moulding mould cavity. Next one we use the chills and chaplet us chills are meant for directional solidification or rapid cooling of the casting at the required locations whereas, chaplet us are meant for supporting the cores.

Now, we have to check before placing the chills, before placing the chaplet us inside the mould cavity we have to check what is their condition are they in good condition or are they rusted if they are rusted they must be cleaned. So, if we take that much care then we can minimize the blowholes, now we have seen completed the blowholes, now under the defects due to the evolution of the gases we have the pinhole porosity that is the second defect, now let us see the pinhole porosity.

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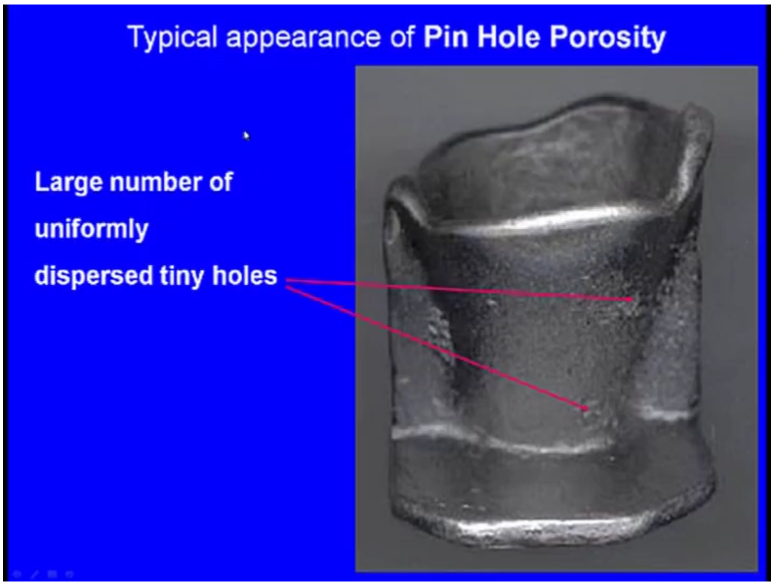

Now, this is the typical appearance of pinhole porosity, now this is a casting you can see here small what say holes are there on the surface of the casting and the size of this holes are as a small as the what say a pinhead, you can see a large number of uniformly dispersed tiny holes on the surface of the casting. So, this is the pinhole porosity whereas, in the blowholes they were what say big holes on the surface of the casting whereas, pinhole porosity is a small holes as a small as the head of a pin they will be dispersed everywhere on the surface of the casting.

So, this is the typical appearance of pinhole porosity now why this pinhole porosity is arising inside a casting.

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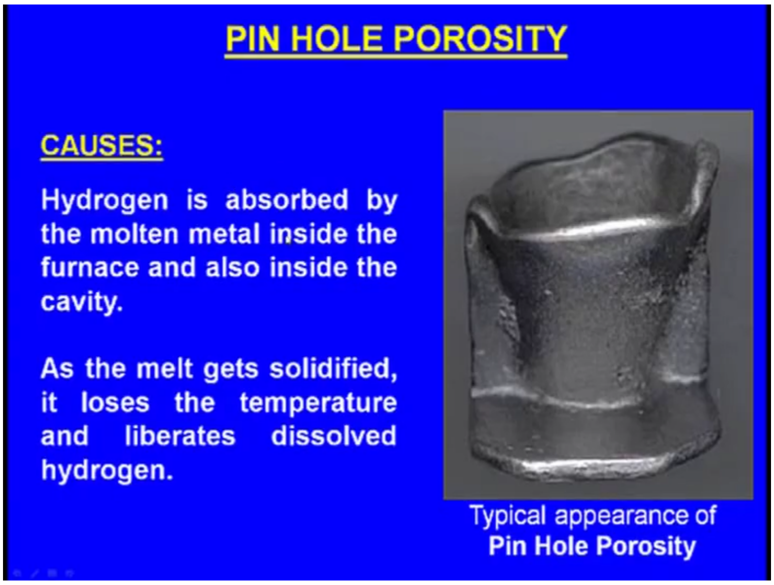

Hydrogen is absorbed by the molten metal inside the furnace and also inside the cavity. So, this is the main reason for the what say evolution of the pinhole porosity the main factor that influences the formation of the pinhole porosity is the hydrogen. This hydrogen is absorbed by the molten metal inside the furnace what is happening when we are melting the metal, inside in the open atmosphere the at hydrogen is present in the atmosphere.

The hydrogen present in the atmosphere readily comes and reacts with the molten metal. Now the molten metal rapidly absorbs the hydrogen, now when we pour it inside the cavity that time also it can absorb the hydrogen, now as the melt gets solidified as the molten material gets solidified then what happens whatever hydrogen it has absorbed it slowly liberates outside it sends outside then what happens it they dissolved hydrogen will be liberated outside, then it comes on the surface of the casting.

Now, small holes are created because of the presence of the hydrogen. So, this is the a cause of the pinhole porosity now how to prevent this what are the remedial measures to prevent the pinhole porosity.

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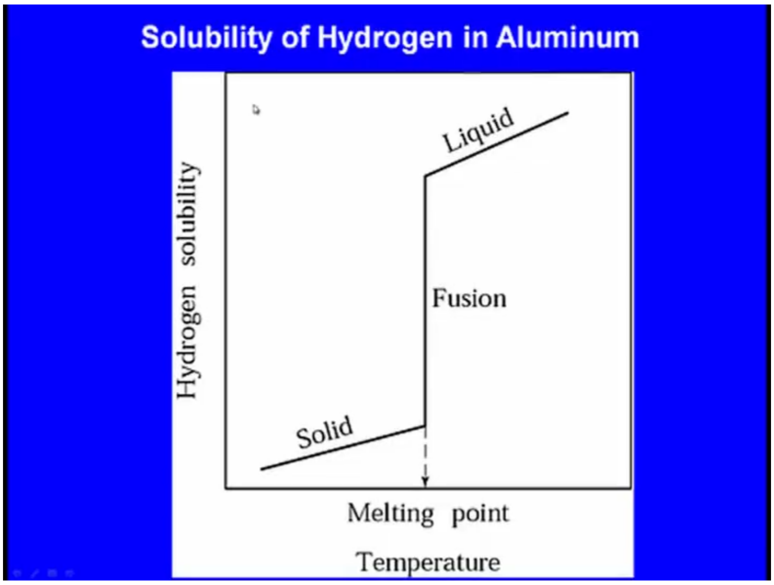

Before that let us see the solubility of hydrogen in aluminum, now if you see here this is the x axis indicates the melt what say temperature whereas, y axis indicates the hydrogen solubility now in the solid state you can see this is the solubility this much is the solubility.

Now, at the melting point you can see here the solubility is almost 4 times than it is solubility in the what say solid state. So, in the liquid state it is what say hydrogen solubility is drastically increasing, now these are the remedial measures. One is the vacuum melting instead of a melting the metal in the open atmosphere, if we melt it in the vacuum then no what say atmospheric hydrogen will come and interact with the molten metal, but this vacuum melting is quite expensive.

Next one vacuum degassing.

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Of course it may not be possible for us to melt the metal in the vacuum, but after melting before pouring it inside the moulding cavity we can do the vacuum degassing, whatever gases and whatever hydrogen is absorbed by the molten metal it will be removed by vacuum. So, this is another remedial measure next one avoid very high pouring temperatures, now what happens is there are 2 temperatures; one is the melting temperature is the temperature where the metal starts melting, but that is not enough for pouring right at that temperature if we try to tap the metal and try to pour before we pour it may solidified.

So, if we have to pour then the temperature of the metal should be more than the melting temperature this is known as the pouring temperature and so the pouring temperature for ferrous components is at least 100 degrees above the melting temperature, but if someone keeps on melting to a very high pouring temperature then what happens more hydrogen is absorbed by the metal, that is why avoid very high pouring temperature. Next one let us see the third defect under this first category defects due to the evolution of the gases under that the third category is the rat tail.

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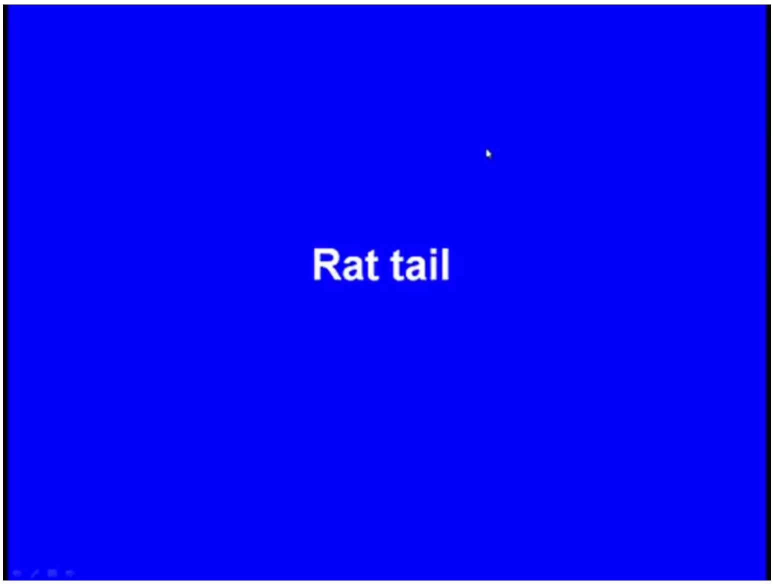

What is this rat tail it is in irregular depression on the surface of the casting similar to a rat tail impression.

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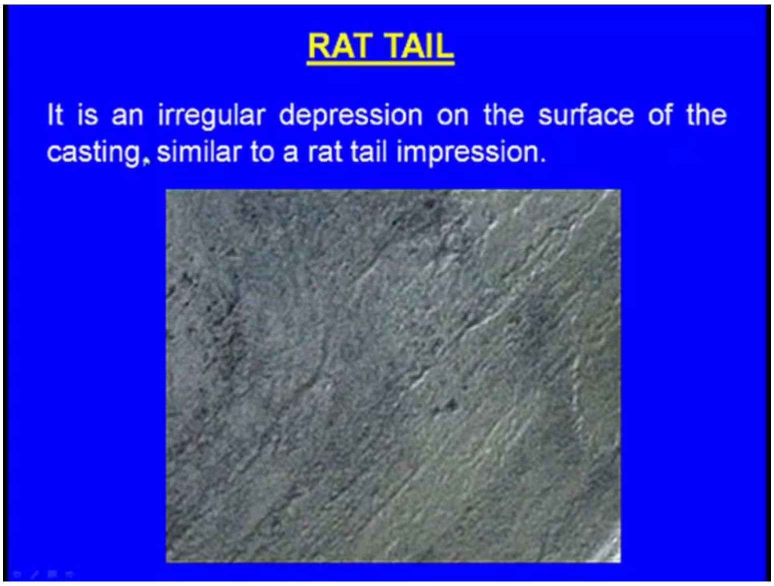

So, this is the surface of the casting and here we can see something like the tail of a rat what say tail impression if a rat is crawling on some surface, then we can detect some impression of it is tail and here we can see a similar impression on the surface of the casting this is known as the rat tail. Now what are the factors influencing rat tail.

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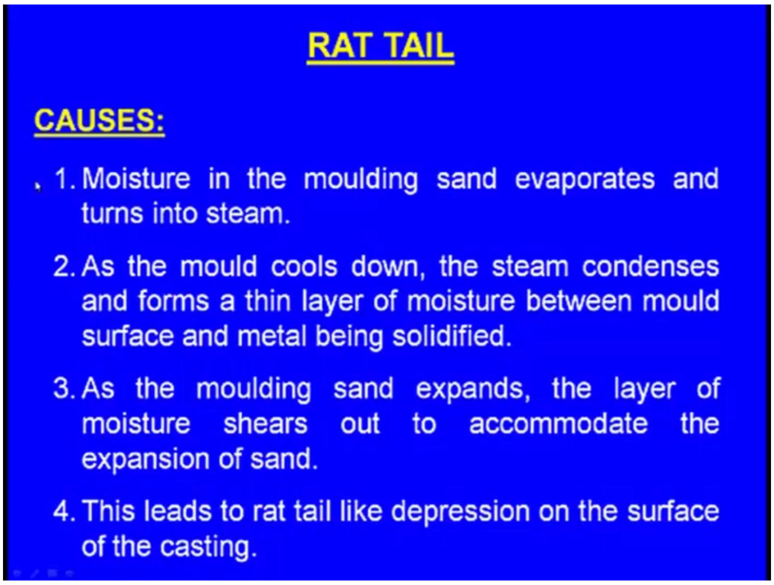

One is the moisture in the moulding sand evaporates and turns into sand yes this is well known to us.

Now, as the what say a mould cools down the steam condenses and forms a thin layer of moisture between the mould surface and the metal being solidified between mould surface and the metal being solidified a thin layer of steam is condensed. Now as the moulding sand expands now what happens after sometime the moulding sand can expand then the layer of the moisture shears out to accommodate the expansion of the sand. Now what happens the thin layer of the moisture is sheared due to the expansion of the sand, now the expanded sand comes here and because of that it leads to a rat tail depression on the surface of the casting.

So, that is how the rat tail generates the rat tail impression on the casting generates now what are the remedial measures.

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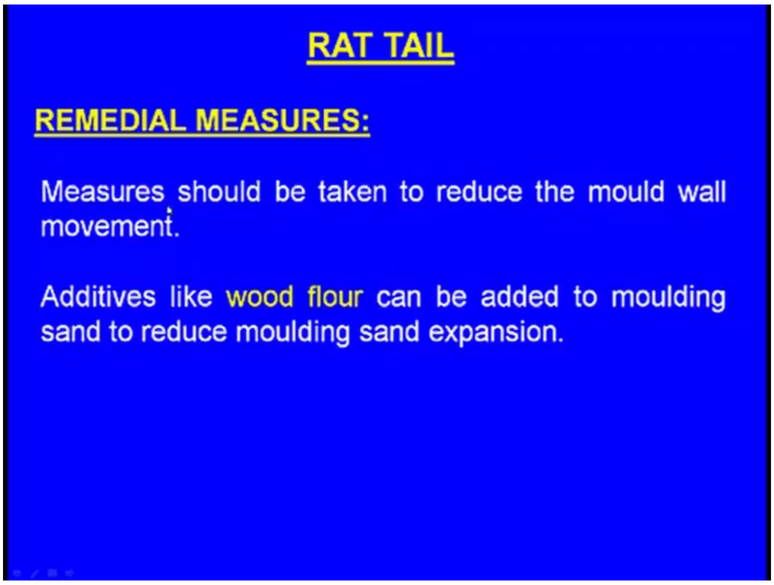

Measures should be taken to reduce the mould wall movement, first of all why this is happening because of the mould wall movement if there is no mould wall movement if there is no mould wall expansion this rat tail would not occur. So, we have to take measures to reduce the mould wall movement and also the mould expansion, for that in the what say ingredients of the moulding sand design are the in the moulding sand design we have seen the role of the additives like wood flour what it does it what say comes between the neighboring sand grains.

Once this wood flour comes and occupies between the neighboring sand grains even if these 2 sand grains are what say expanding the wood flour comes between the 2 neighboring sand grains and it accommodates the expansion of the sand grains the what is the net effect the mould wall moment will be minimized. So, additives like wood flour can be added to the moulding sand to reduce the moulding sand expansion, now we have completed a blowholes pinhole porosity and rat tail.

Now, under the first category let us see the dispersed shrinkage what is this dispersed shrinkage.

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So, now this is the typical appearance of the dispersed shrinkage now this is the casting you can see here there are small shrinkage cavities dispersed throughout the casting, these are all the small small cavities here you can see this is one casting, this is one what say a small what say cavity shrinkage cavity this is one small shrinkage cavity these are all dispersed all over the surface of the casting that is why it is known as the dispersed shrinkage why this is happening one is.

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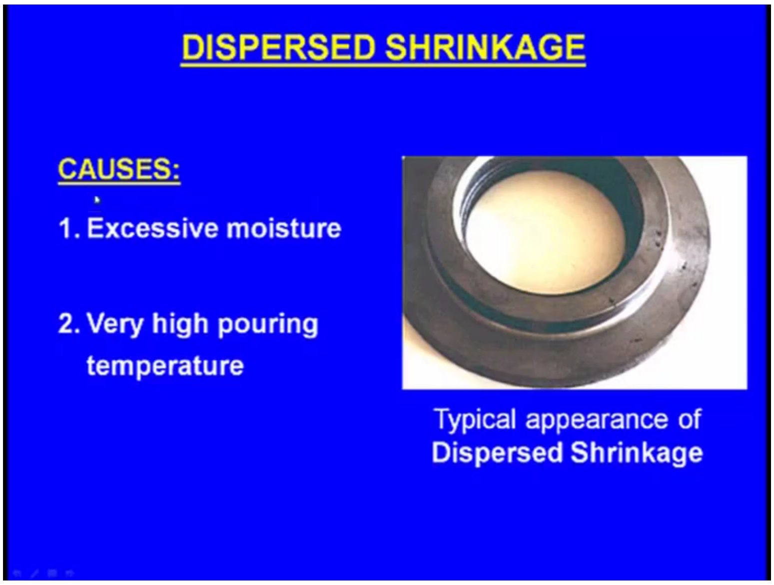

Excessive moisture second one very high pouring temperature.

Now, these are the remedial measures.

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Appropriate moisture and pouring temperature are to be taken next one let us see the blister.

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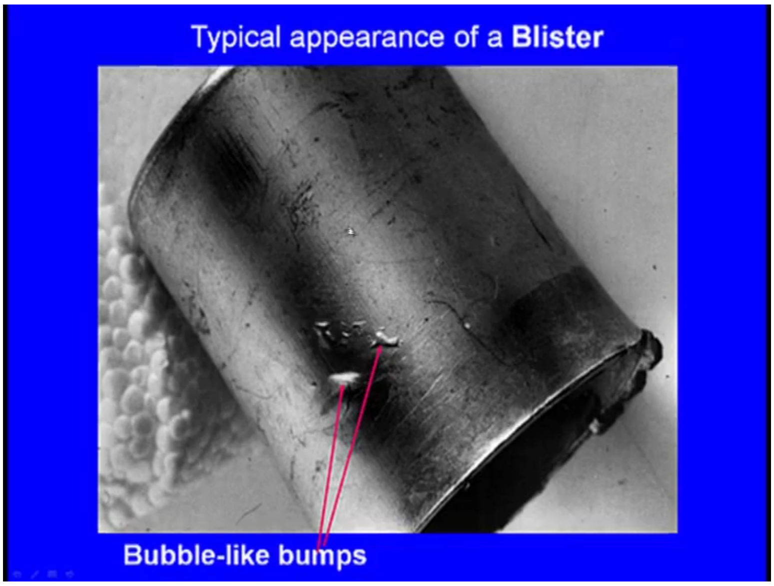

You can see this is the typical appearance of a blister now you this is the casting and here we can see a bubble like bumps are there. So, you can see here one kind of bubble like bumps is here and here we can see another bubble like bump and here also. So, we can see these what say a bubble like bumps are known as the blisters causes why these blisters are arising one is the gases trapped in the cavity cause depressions on the moulding surface.

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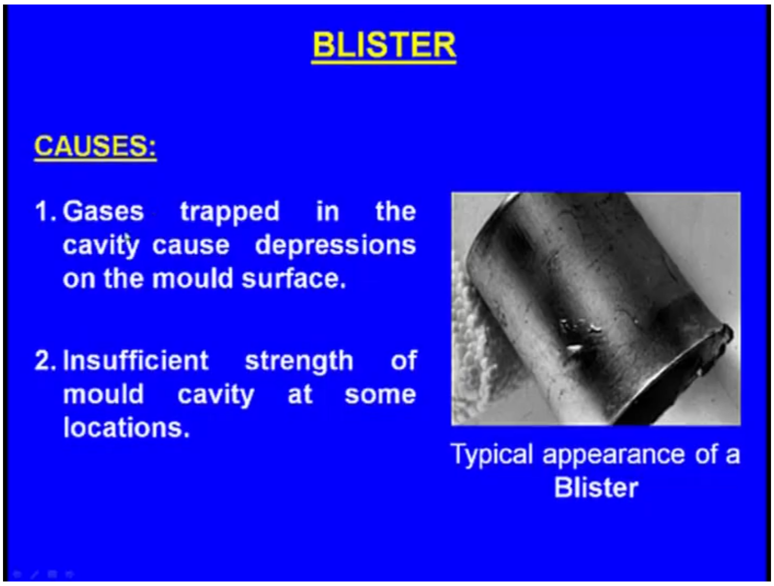

Now the gases will generate from different sources due to different reasons, now if these gases are not escaping outside what will happen they will be causing some depression to the moulding what say surface. Now what will happen a depression will be created because of the pressure applied by the gases that are produced, then what will happen in the depression the moulding what say a molten metal comes and occupies then what will happen yes we can see a projection on the surface of the casting.

Now, finally, the insufficient strength of the moulding cavity at some locations because of that this depression takes place and molten metal comes and occupies here. So, this is the blister now how to prevent this blister remedial measures ensure sufficient.

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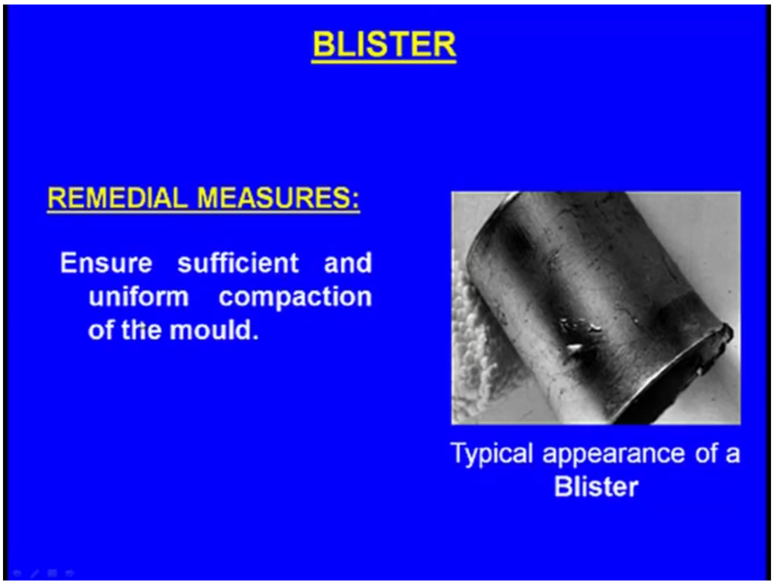

And uniform compaction of the mould if the compaction of the mould is not sufficient then this kind of problems arise and also the compaction should be uniform now with this we are completing the a first category that is the defects due to the evolution of the gases.

Now, let us see the defects due to the pouring of the melt under this category we have Mis-run cold shut elephant skin inclusion and so on. First let us see the Mis-run.

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Now, this is the typical appearance of a Mis-run defect, now you can see here this is a casting and it has got the ribs 5 ribs are there, now you can see this rib is perfectly cast, this rib is perfectly cast this rib is perfectly cast and this rib is also perfectly cast. Now if you see this rib and we can see some kind of imperfection we can see here and here it is not perfectly cast means the molten metal has not occupied exactly in the narrow surface or on the narrow cross section of the rib, this is the Mis-run means molten metal could not fill the thin section of the mould cavity here.

The cross section of this rib is very narrow because of that the molten metal could not occupy successfully this is a Mis-run you can see here this is another example.

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This is the casting and here the molten metal could not occupy properly this is a Mis-run this is another example.

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This is the casting and here the molten metal could not occupy in this region now this is another example.

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You can see here this is a turbine blade the turbine blade actually if had it been successfully cast it should come like this or it should come like this it should come like this.

But because the cross section of the blade is very narrow the molten metal could not occupy that narrow region that is how there is a discontinuity this is the Mis-run now what are the causes of the Mis-run defect.

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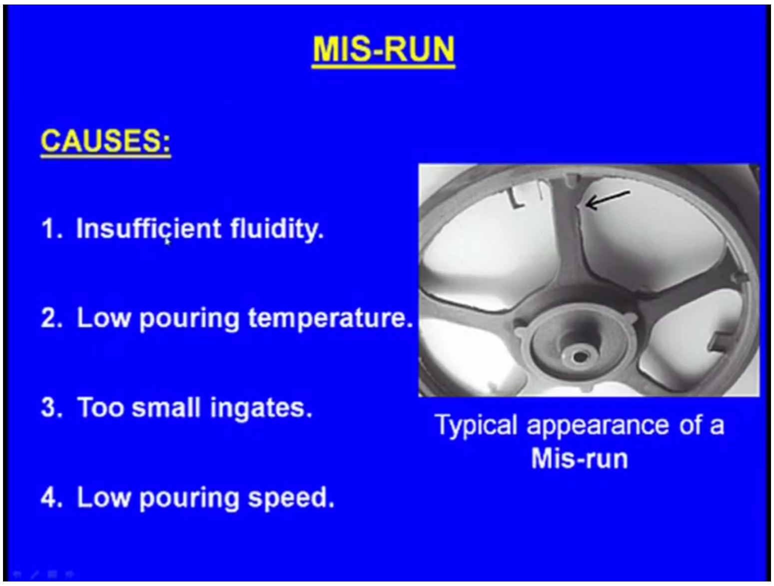

One is the insufficient fluidity the fluidity is not sufficient that is why the molten metal is not able to pass into that narrow region of the casting; next one low pouring temperature if the pouring temperature is low then what happens the viscosity will be more.

Once the viscosity is more it cannot penetrate into narrow sections that is why we should not go for the very low pouring temperature, next one too small ingates the ingates are too small too narrow that is how the molten metal is not able to pass through the small ingates, next one low pouring speed. So, these are the 4 causes that influences the Mis-run now let us see the remedial measures.

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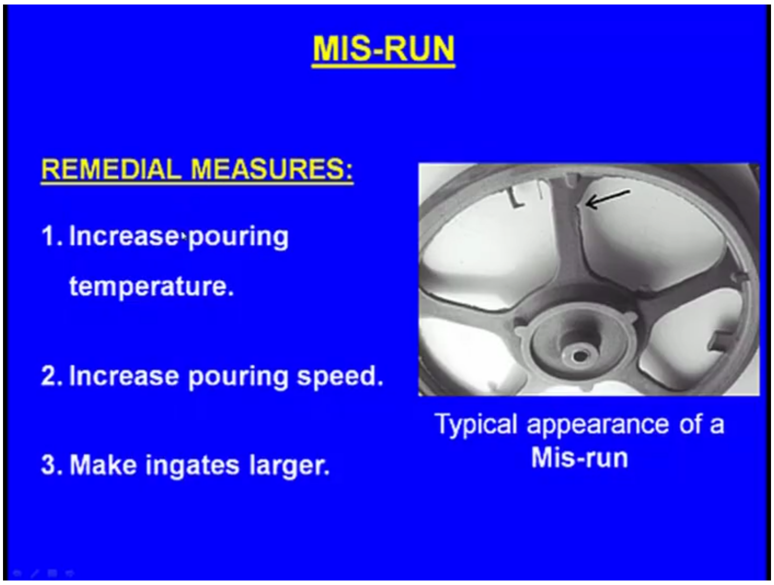

First one increase the pouring temperature this is the main reason which influences the Mis-run defect increase the pouring temperature always the pouring temperature must be at least 100 degrees above the melting temperature, then only the fluidity will be sufficient to flow into the even into the narrow regions.

Next one increase pouring speed next one make ingates larger. So, these are the remedial measures to prevent the Mis-run defect now under the second category we have the cold shut.

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What is this cold shut now here we can see this is a casting.

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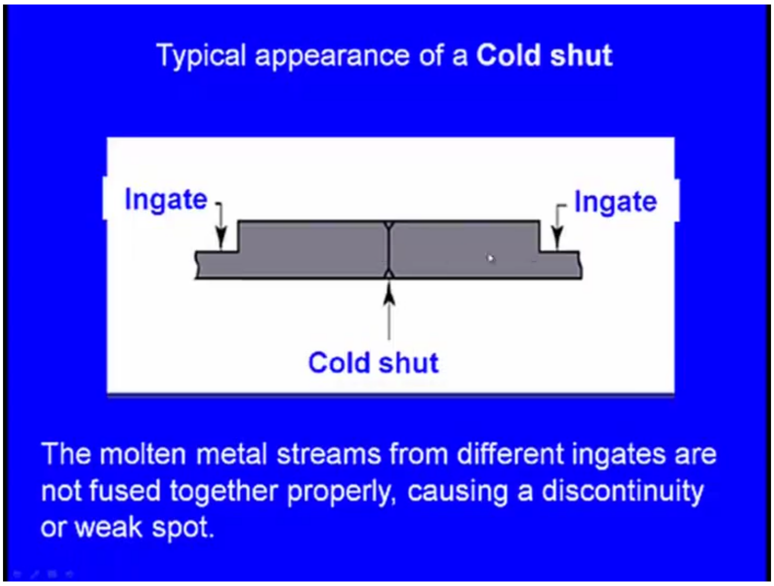

And here there is an ingate and here there is an ingate and what say 2 streams are flowing through these 2 ingates, one stream is coming like this and another stream is coming through this ingate these 2 streams are coming and they are supposed to meet here and they are supposed to fuse together perfectly and become one casting one component.

Now, what happens these 2 molten streams from different ingates are not fused together properly causing a discontinuity or a weak spot at the center or it at some other position they were not able to fuse together though apparently, it look after solidification it looks to be a single casting inside there is a in a in unseen discontinuity or a weak spot here there is a discontinuity these 2 streams could not fuse together this is the cold shut now what are the factors influencing the cold shut defect.

Now, before that let us see one more example.

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This is a cold shut defect in a bronze screw nut this is the bronze screw nut now right. So, here the one stream is coming like this and another stream is coming like this, but they are not fused together properly, then what will happen after solidification after solidification also it looks like a one casting only, but if you try to what say strike it these 2 will be separated into 2 halves here at the center there was a discontinuity that is how it got separated into 2 parts. So, this is the cold shut defect.

Now, what are the causes longer distance between the ingates.

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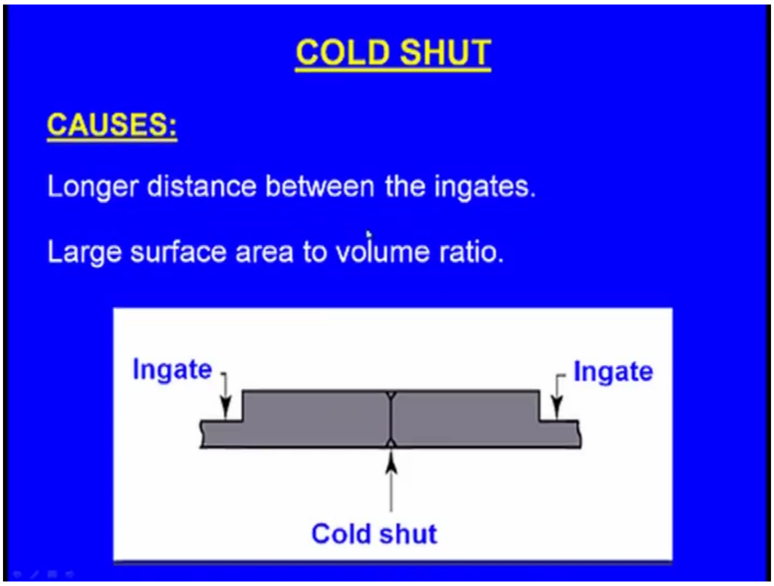

Next one large surface to volume ratio, now longer distance between the ingates what happens when the distance between the ingates is very large by the time the mould the molten metal is entering like this by the time it reaches the center or by the time it reaches the other stream, it travels very long distance and the moulding what say medium are the mould rapidly absorbs it is heat because of that it is temperature drastically comes down and by the time it comes to the center the pouring it is temperature will be very low, then what happens the viscosity will be very high then because of that they are not able to fuse properly.

Second reason is large surface area to volume ratio what is this large surface area to volume ratio large means this ratio is very large surface area to volume ratio is very large means what does it mean surface area is very large. Surface area is very large means what happens more heat is dissipated to the mould wall because of the large surface area of the casting then what happen within no time it is temperature will be falling down, by the time the 2 streams come to the center they will be reaching very low temperature they will be obtaining very less temperature and because of that they are not able to fuse together.

So, this is the another reason large surface area to volume ratio, now what are the remedial measures to prevent the cold shut.

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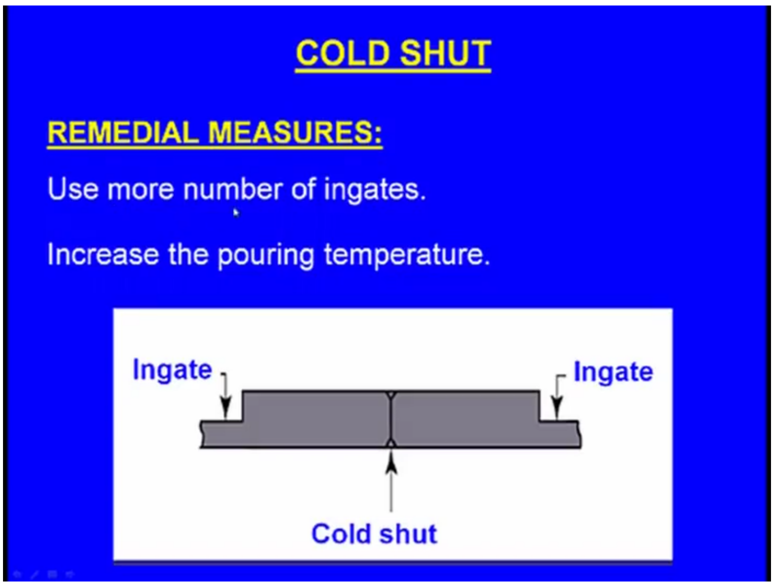

One is use more number of ingates next one secondary is second remedial measure increase the pouring temperature, we know that because of the design of the casting or because of the large surface area of the casting, we know that the melt loses it is what say temperature and heat by the time it travels to the center that be the case increase the pouring temperature than the usual practice then this problem can be minimized.

Next one we have the elephant skin under the second category what is this elephant skin.

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Now, this is the typical appearance of a elephant skin defect you can see here this is the casting and we can see somewhere on the surface of the casting some kind of projection is there and it looks like elephant skin. So, this is an extreme case of magnesium silicate contamination in the melt, in the melt there is a what say a mixing of the magnesium silicate because of that say different streams come and they are not able to fuse properly the melt is contaminated by the magnesium silicate.

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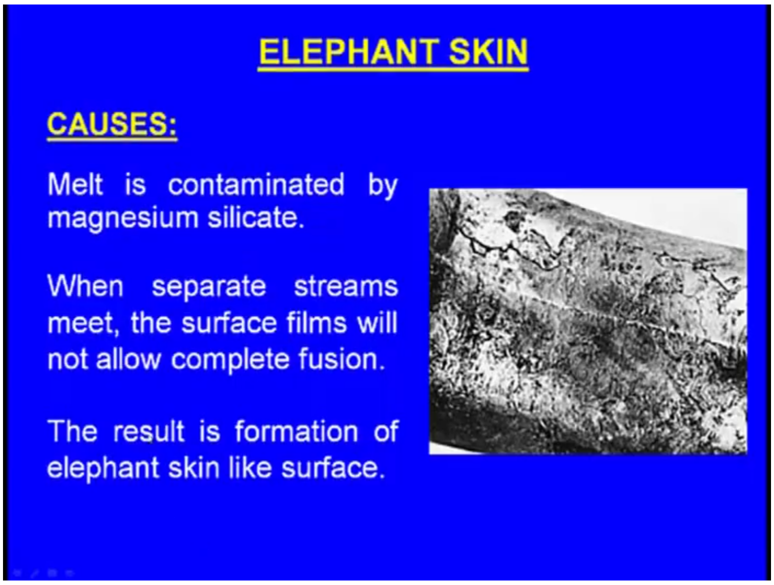

Next one when separate streams meet the surface films will not allow complete fusion then these results in the formation of the elephant skins like surface. So, these are the what say causes of the elephant skin, now how to prevent this ensure proper separation of slags from the melt next one under the second category we have the inclusion defect what is inclusion.

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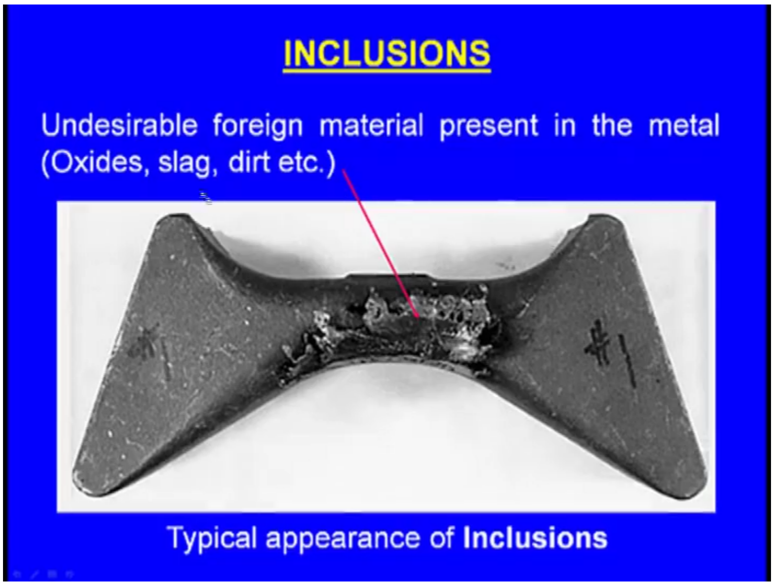

Undesirable foreign material present in the metal like oxide slag death and so on. So, this is the casting and this is the inclusion slag inclusion right and here we can see these are the foreign particles oxides are slags and these will be removed at a later stage and a depression will be caused on the casting.

And again we can see here.

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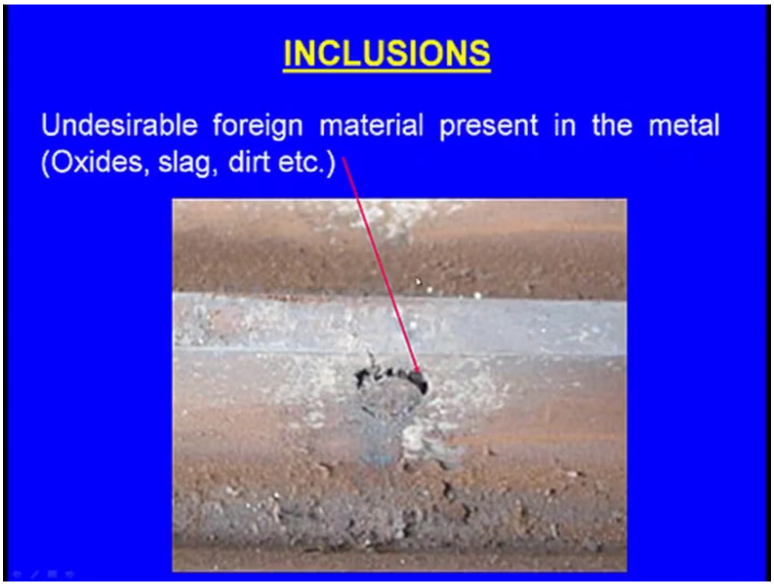

This is a inclusion right undesirable foreign material present in the metal like oxide slag that and so on, what are the main sources of inclusions from where these inclusions are coming.

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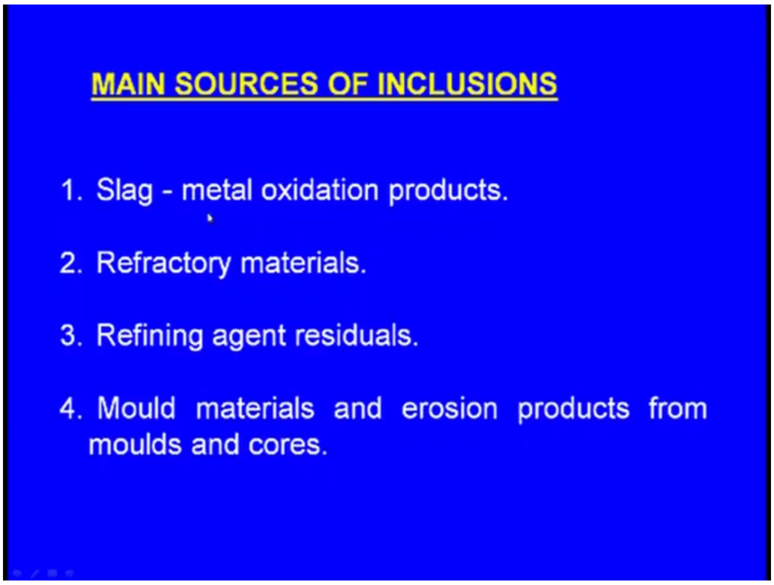

One is the slag metal oxidation products, next one refractory materials, next one refining agent residuals, and next one mould materials and erosion products from the moulds and cores. So, there are different sources from where foreign materials will come and they will be occupying on the surface of the cavity or surface of the casting, one could be slag metal oxidation product or the refractory materials or the refining agent residuals or the moulding materials and they may come due to erosion.

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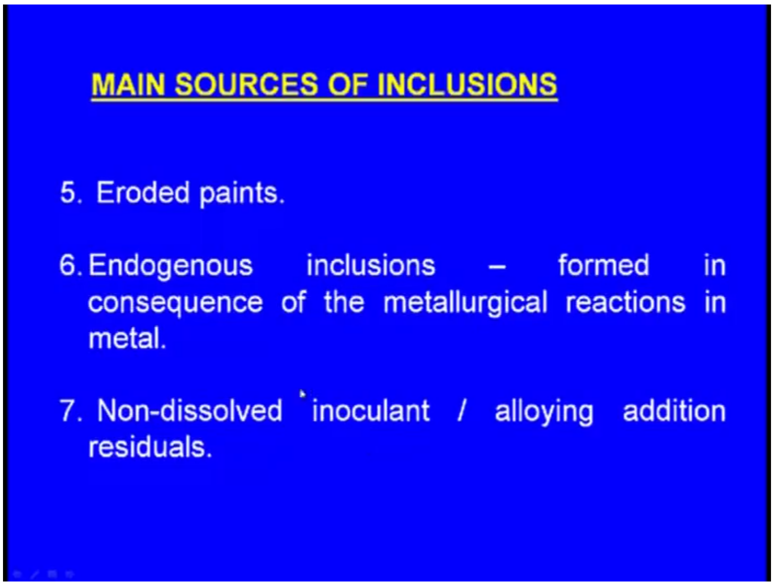

And eroded paints sometimes we use the scrap in the furnace we take what say a what say a unused and what say a scrap materials and put it inside the furnace for melting remelting and these scrap materials may have the eroded paints and they will be collected and they will be coming along with the melt and they will be occupying on the surface of the casting and they have the inclusions they are the foreign materials. Next one the sixth factor that is the endogenous inclusions formed in consequence of the metallurgical reactions in the metal.

Next one non dissolved inoculant allowing addition of the residuals, how inclusions are harmful.

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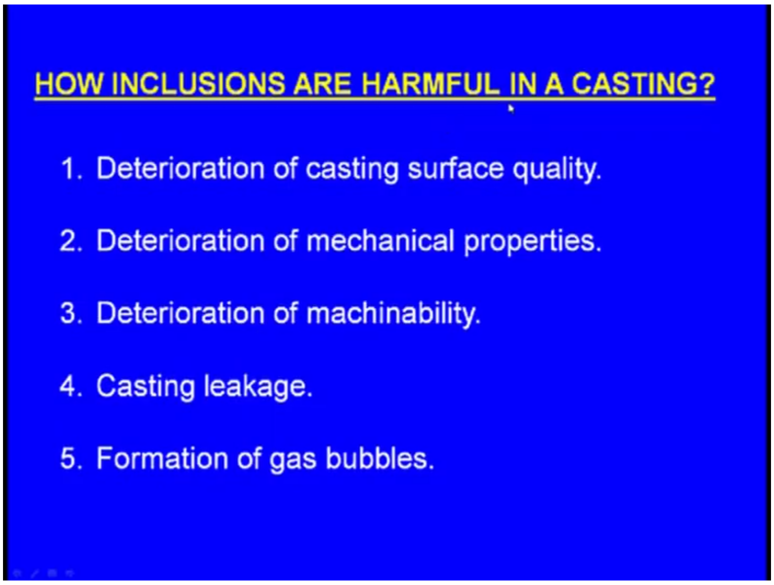

Inside a casting one is deterioration of the casting surface and it is quality the surface of the casting will be deteriorated because of the inclusions. Next one deterioration of the mechanical properties, because of the presence of the these what say inclusions the mechanical properties will be deteriorated, next one the machinability of the casting will be deteriorated after the solidification is over we break the sand, and we clean the stand, then we used to machine it for getting the required geometrical tolerance, for getting the required surface finish it is tough time because of the presence of the inclusions the machinability will be deteriorated.

Next one casting leakage will be there next one formation of the gas bubbles will be there. So, these are all the consequences of the inclusions in a casting.

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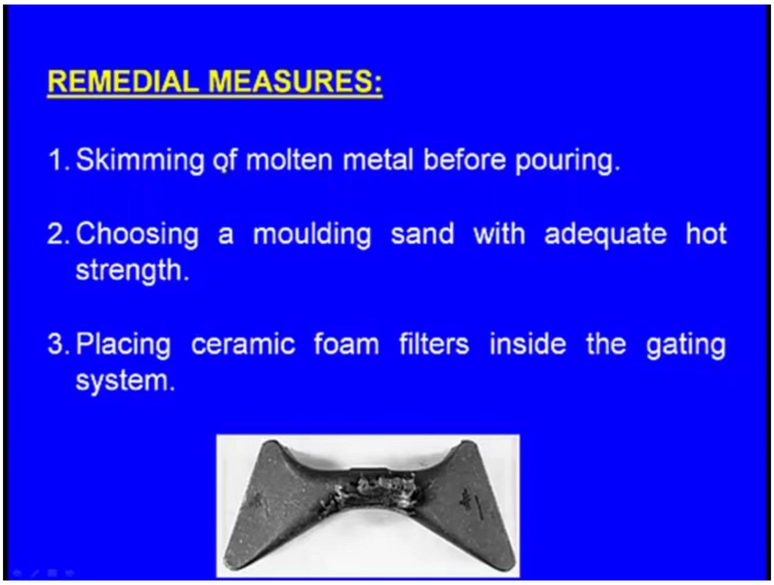

Now, how to prevent these inclusions what are the remedial measures, one is the skimming of molten metal before pouring, the inclusion may come through the molten metal, that be the case through the slags, that be the case the slag must be perfectly removed from the molten metal for that we need to skim the molten metal before tapping the molten metal from the furnace.

Next one choosing a moulding sand with adequate hot strength, now if the moulding sand does not possess required hot strength what happens when we pour the molten metal the sand will be damaged. Now this damaged sand could become it it gets eroded and it can flow along with the molten metal finally, it becomes a foreign material and it can cause a an inclusion. So, always we have to choose a moulding sand which has got the adequate hot strength.

Next one third remedial measure is placing ceramic foam filters inside the gating system these ceramic foam filters are ready made foam filters that are available in a different shapes different sizes. Now once we place the ceramic foam filters inside the what say a gating system, now all the foreign materials that are about to come inside the moulding cavity we will be trapped and they will be stopped near the foam filter. Now this is a what say very effective method placing the ceramic foam filters inside the gating system.

So, we need to learn little more about these ceramic foam filters.

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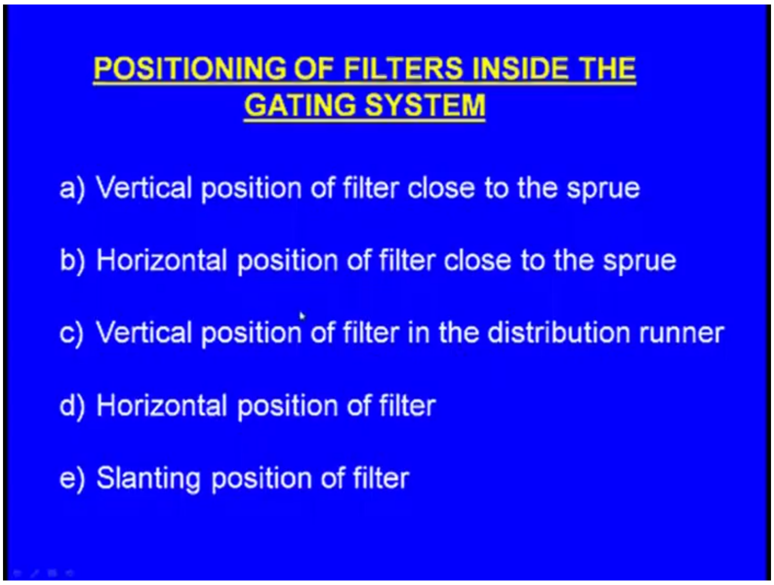

Now, position of the filters inside the gating system, where these are to be positioned these ceramic foam filters, one is vertical position of the filter close to the sprue, nearer to the sprue nearer to the choke this can be placed. Next one horizontal position of the filter close to this sprue it can be positioned in a horizontal way also, next one vertical position of the filter in the distribution of the runner, next one horizontal position of the filter, next one slanting position of the filter in different ways the filters can be positioned inside the gating system.

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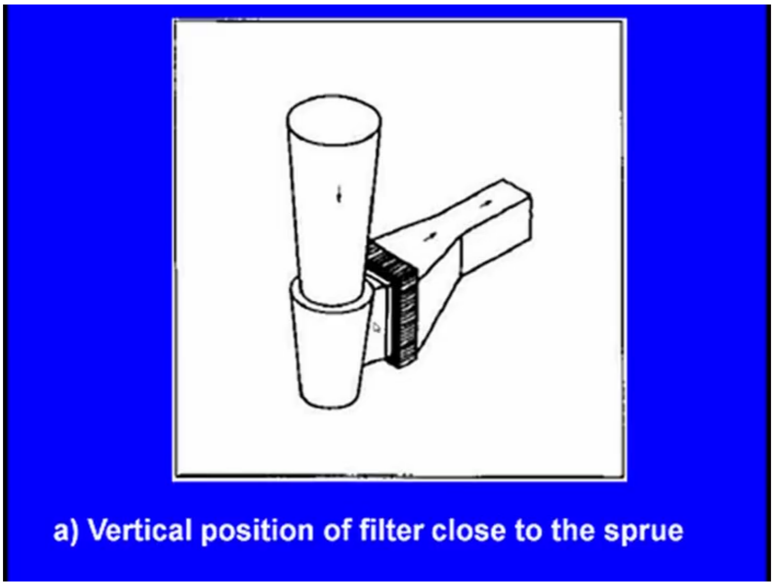

Now here we can see this is this sprue and this is the choke and this is the sprue well and here we can see this is the runner and between the what say a sprue and the runner and this is the filter, vertical position of the filter close to the sprue this is the filter. So, this is one of the ways of placing the filters. Now let us see the second way horizontal position of filter close to the sprue.

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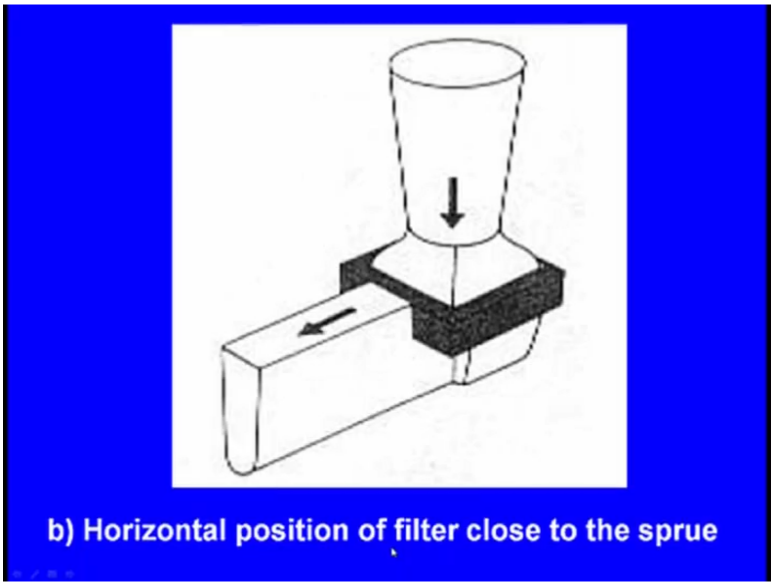

Now this is the sprue and this is the choke and this is the runner.

We are placing the filter in a horizontal way this way also we can place the filter.

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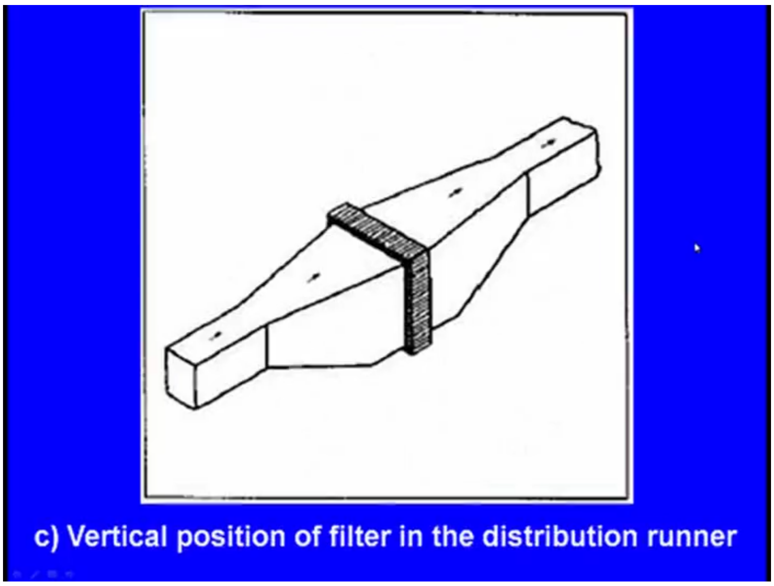

Next one vertical position of the filter in the distribution runner, now this whole thing is runner somewhere inside the runner we are placing this filter. So, this is another way of placing the filter.

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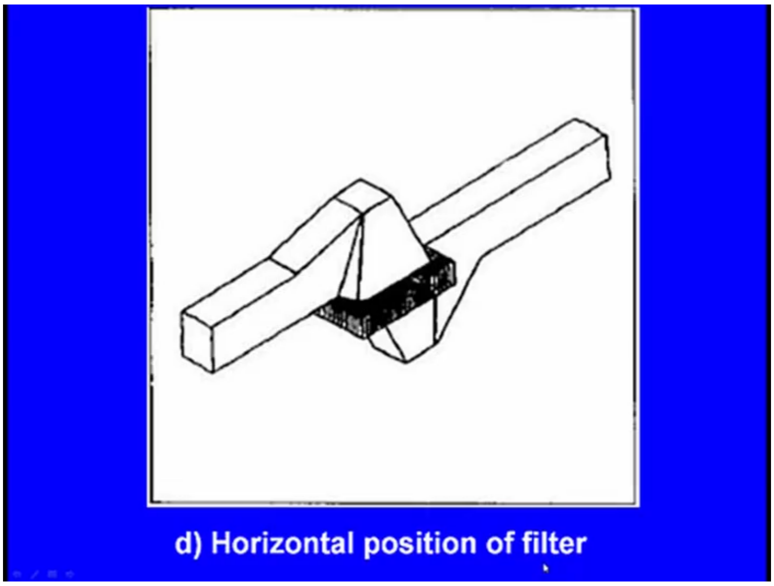

Next one horizontal position of the filter somewhere inside the runner here also the whole thing is runner and here we are placing the filter this is another way next one slanting position of the filter.

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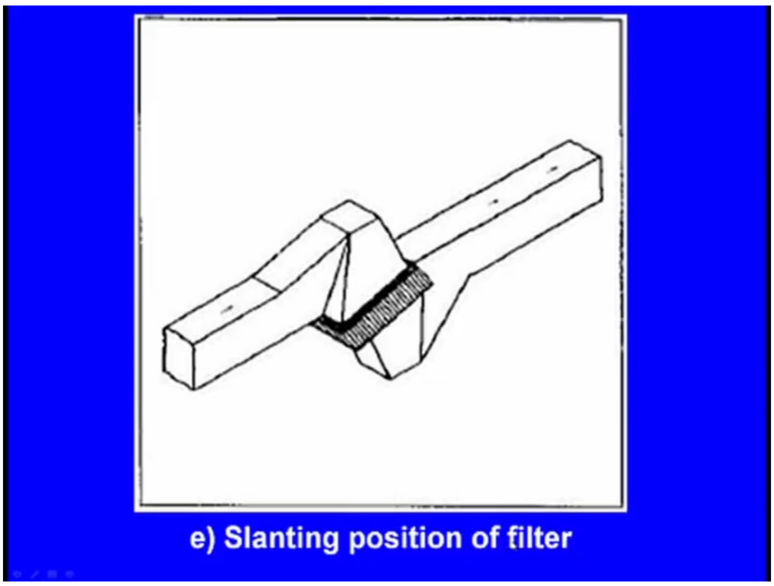

Now, this is the runner the position is placed in a slant position not vertical, not horizontal, now we have seen the different positions of the filters inside the gating system.

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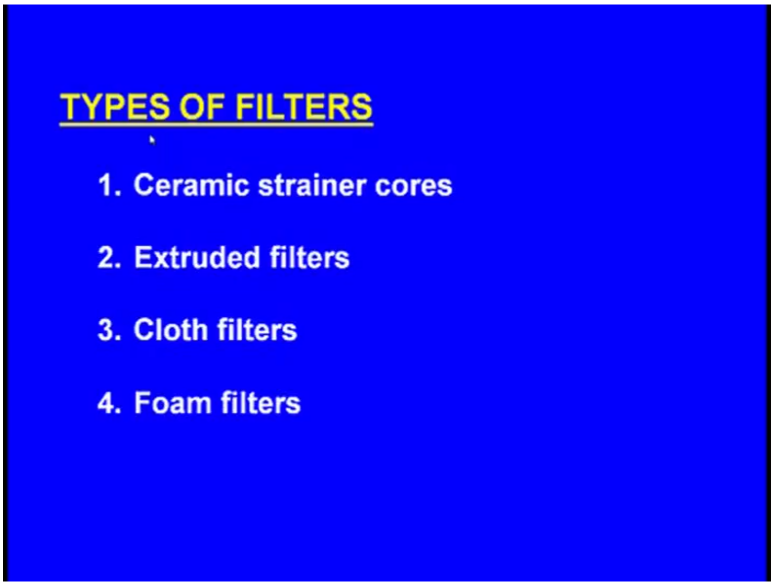

Now what are the types of the filters one is the Ceramic strain strainer cores, second one Extruded filters, third one Cloth filters, fourth one Foam filters. So, these are the 4 types of the filters available, which can be kept inside the gating system to prevent this inclusion defects or to prevent the foreign materials to come inside the moulding cavity.

First let us see the ceramic strainer cores ceramic strainer cores.

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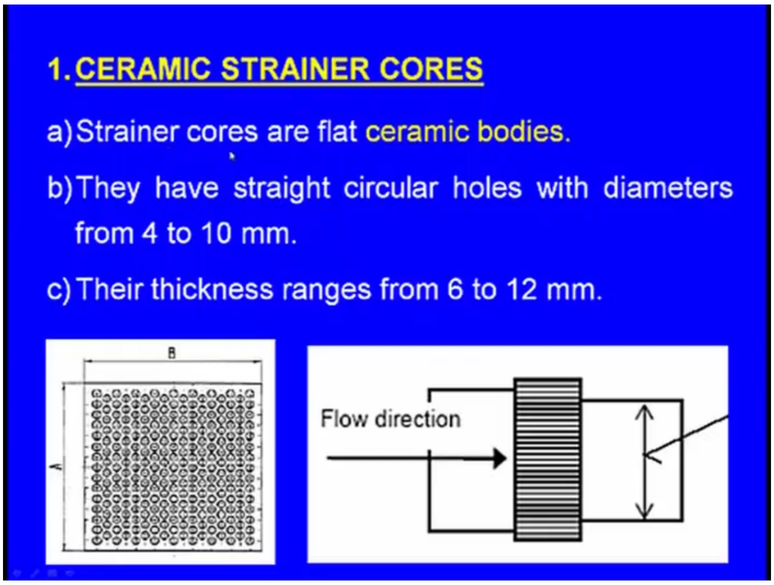

Strainer cores are flat ceramic bodies they have straight circular holes with diameter ranging from 4 to 10 mm, their thickness ranges from 6 to 12 mm, now this is the ceramic strainer core you can see here and they have straight circular holes like this circular holes are there and the molten metal is coming like this and it passes through the what say a strainer pour. Now if any impurity or if any foreign material is present inside the molten metal they will be stopped only the pure metal will be coming outside.

Now, this is the position of the filter and if we see from side we can see the filter like this and we can see a different holes are there several holes and the diameter will be ranging from 4 to 10 mm and the thickness will be 6 to 12 mm. So, this is the shape and what say construction of the ceramic strainer core which is placed inside the gating system next one what is the mechanism of filtration in say in a ceramic strainer core filter.

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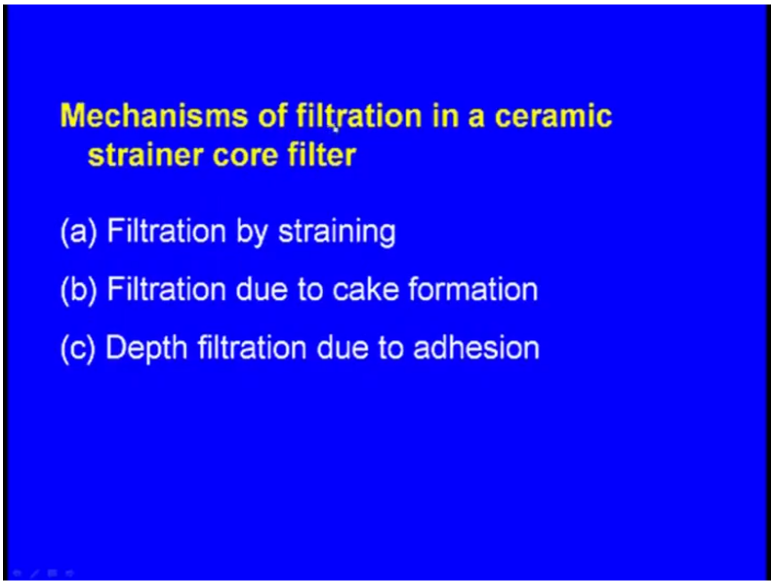

How does this strainer core filter stop the what say a foreign material from entering into the mould cavity.

One is the filtration by straining, next one filtration due to cake formation, next one depth filtration due to adhesion. Now these are the 3 ways by which a ceramic strainer core can filter the foreign materials from entering into the mould cavity let us see this how they workout this is the filtration by straining.

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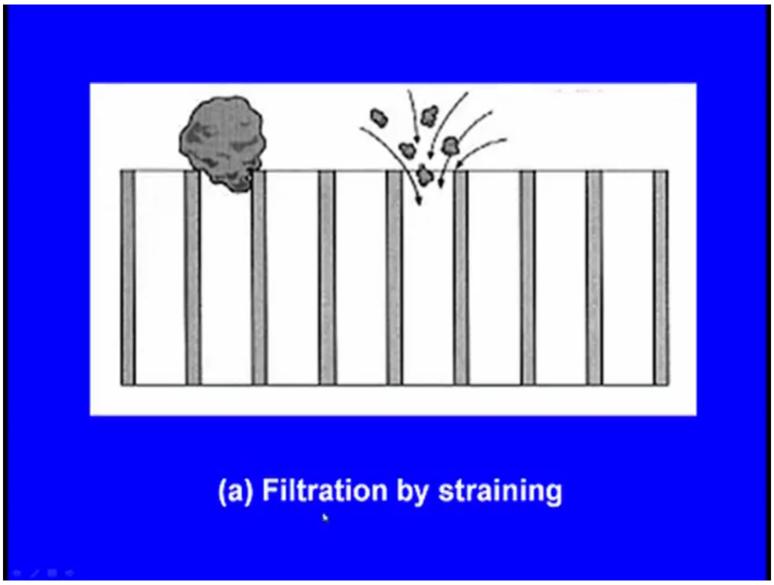

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Now this is the filter, now the molten metal is coming like this and it goes like this, now this is a hole on the strainer core, now this is a foreign body now what happens this foreign particle cannot pass through this small hole or the strainer core finally, it will be stopped.

But the thing is it can stop only a big bigger particles, now what is happening here now small particles are entering they will be passing through. So, that is the advantage is it can stop the larger particles from entering into the passing through the filter it cannot stop the smaller particles.

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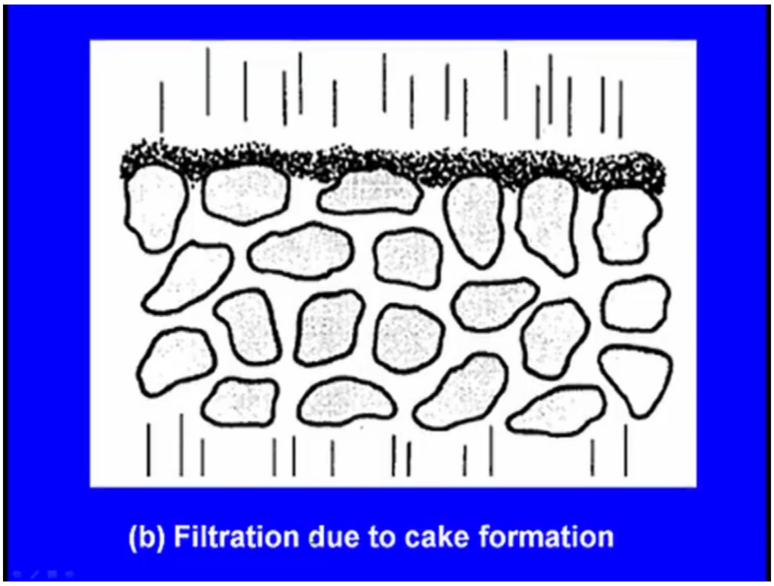

Next one filtration due to cake formation, now this is the filter, now what is happening is now the small in the previous case we have seen the small particles are coming inside, now what happens is there is another mechanism by which it can stop the foreign materials by due to the cake formation.

Now, all these what say a small small particles they are collected on one side on the at the entry of the strainer core like this, now once this cake is formed no more foreign materials can enter into the filter only the pure metal can enter pass through the filter. So, this is the second mechanism by which a strainer core can prevent the foreign particles from entering into the mould cavity now this is the third mechanism.

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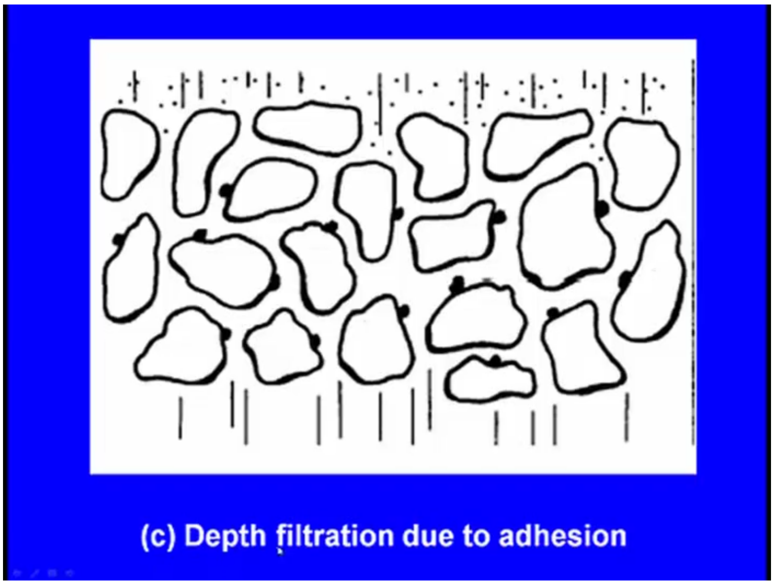

Depth filtration due to adhesion, now previously we have seen that it was a able to stop the larger particles from entering into the filter.

Now, if the small particles are going inside now what is happening, now the small these the this is the filter, now the small particles are adhering to the filter particles due to adhesion, now this small particles can no more go inside the moulding cavity why because they are trapped by the strainer core due to the adhesion. So, we have among the types of the filters we have seen the ceramic strainer cores now let us see the extruded filters. So, this is the second type of the filters how does it look like it looks like this; these are the extruded filters.

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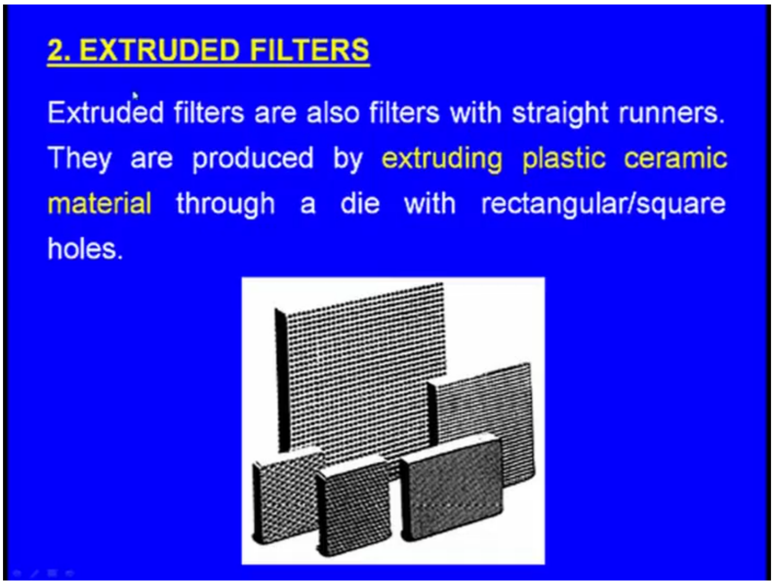

Extruded filters are also filters with straight runners they are produced by extruding plastic ceramic material through a die with a rectangular square holes first one is the right ceramic strainer cores. So, these are made up of the ceramics whereas, the extruded filters are made up of the plastic ceramic material. So, that way the material is different, but the construction is similar, they are produced by extruding plastic ceramic material through a die with rectangular square holes will be there and here we can see this is the filter and several what say holes are there and they will be starting they will be passing it will be there they will be passing through the other side the holes.

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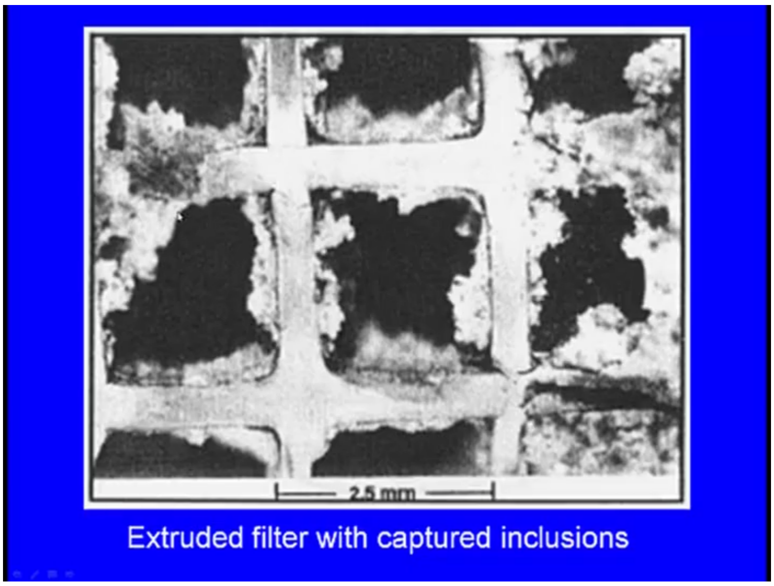

Now this is the extruded filter with captured inclusions, now what is happening is it allows small foreign particles to penetrate into the holes, now they will be captured here this is the hole a rectangular hole inside the what say this filter, now a extruded filter, now it is they are captured here. So, this is one of the mechanisms by which the extruded filters used to stop the inclusions from entering into the mould cavity next one the cloth filters this is the third type of the filters.

Now, these are the cloth filters they look like this.

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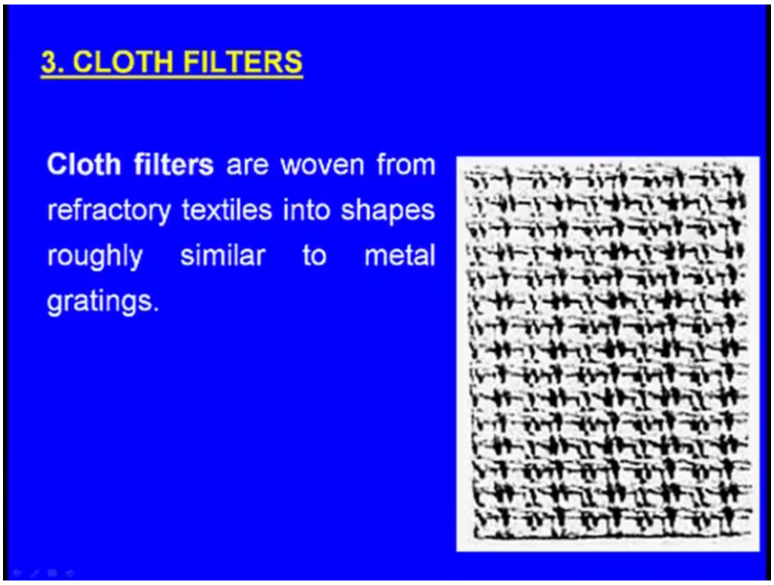

Cloth filters are woven from refractory textiles into shapes roughly similar to metal gratings. So, the this is the what say typical appearance of the cloth filters and cloth filters for the pouring basin.

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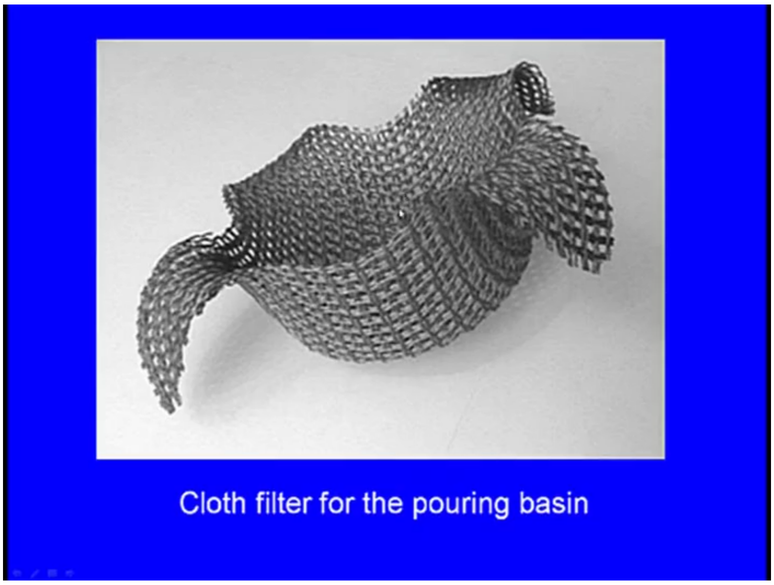

Now, usually they are kept near the pouring basin, now when we place this near the pouring basin the molten metal is poured like this and it passes through that then it enters into the sprue the choke and the gating system runner and so on.

Now, whatever be the what say foreign particles coming along with the molten metal they will be screened here at the pouring basin then only they will go then in this process all the foreign particles that are coming along with the molten metal will be captured by this cloth filter. So, this is the mechanism of the cloth filter finally, we have the foam filters.

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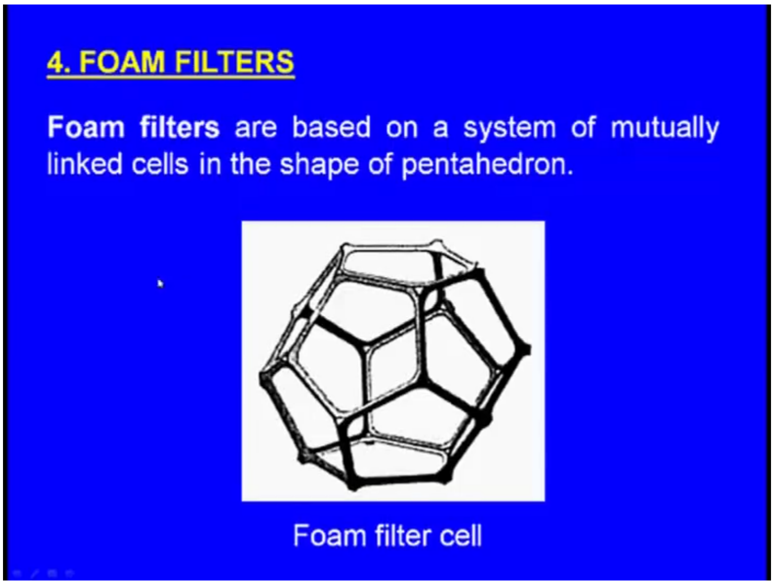

So, this is widely use these foam filters. So, these foam filters are based on a system of mutually linked cells linked cells in the shape of pentahedron.

Now, this is the what say a shape of a single cell of a foam filter it looks like this like the in the shape of a pentahedron.

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Now, these are the of what say shapes and sizes of the foam filters they are available in different shapes and different sizes and these are also having different holes here we can see. So, many holes are there several holes are there. Now what is the difference between the holes of these foam filters and the holes of the strainer cores and extruded filters and we have seen ceramic strainer cores and the extruded filters there also we have seen holes.

What is the difference here they the holes were starting from the one side and they were going up to the next side they were straight holes for there in the case of the strainer cores and the what say the other type the extruded filters. Whereas, in the foam filters what is there the holes are different here we can see the shape of a pentahedron and again these are the different foam filters the what is the mechanism of the foam filters capture of the inclusions due to adhesion in say in a foam filter.

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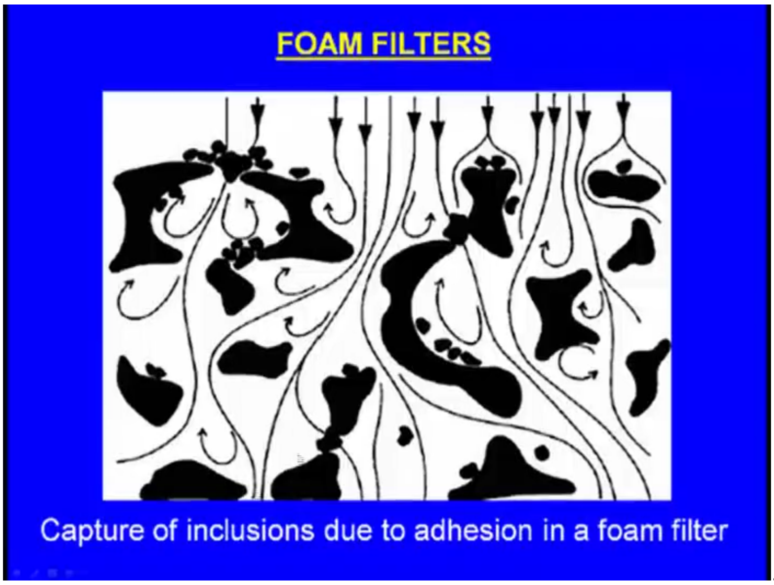

Now, this is the what say magnified view of the foam filter. So, now, this is the foam filter what say cell here we can see and the impurities are coming like this and they are captured by the foam filter due to adhesion and here we can see the what say inclusions are captured here due to adhesion and here we can see these are all the inclusions. So, these are all the inclusions, all these inclusions, all these foreign materials, are what say captured by the foam filters by adhesion.

So, these foam filters are highly effective in most of the castings.

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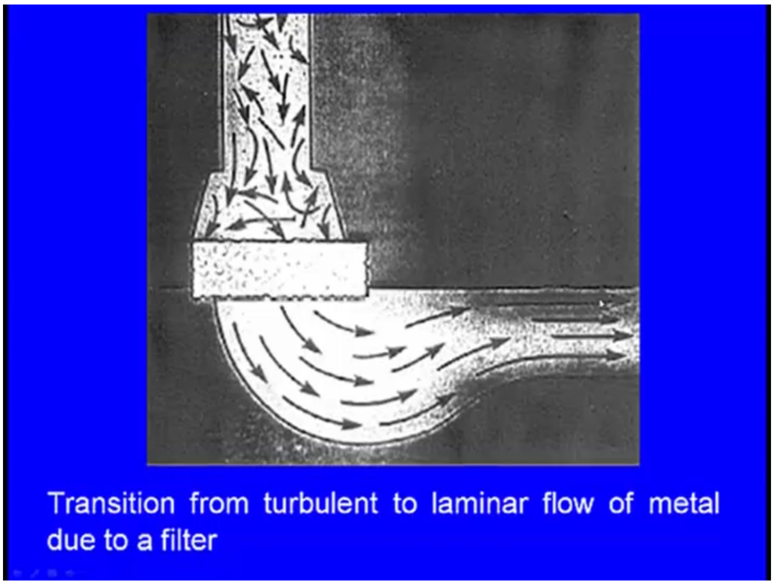

And here we can see there is another benefit of the foam filters and here we can see this is the foam filter and this is kept inside the gating system now the molten material is coming like this and until it has what say come to the what say a foam filter there was turbulence you can see here there is turbulence. Now when it is passing through the foam filter this turbulence will be minimized and we can see almost there is no turbulence here very steady what say a flow is there right transition from turbulent to laminar flow of the metal due to a filter.

So, this is the second advantage that we obtain from the foam filters, friends in this lecture we have seen defects due to the evolution of the gases and defects due to the pouring of the melt and we have seen different defects and they causes and we have seen the remedial measures and finally, in the second category we have seen the inclusions and how to prevent the inclusions and we have seen the concept of the filters we have seen different types of the filters and how does they what say filter the foreign particles we have seen. In the next lecture we will see the defects due to the metallurgical factors defects caused by the moulding materials and so on we will meet in the next lecture.

Thank you.