**Metal Casting**

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**Module – 05**
**Permanent Mould and Special Casting Processes**
**Lecture – 02**
**Die Casting Process-II**

Welcome friends in the previous lecture we have learnt about different types of die casting process. We have seen that die casting process is broadly classified into two types - one is the gravity die casting and another one is the pressure die casting. In the gravity die casting there will be two metallic dies will be there and the molten metal enters into these dies by virtue of gravity, whereas in the case of the pressure die casting again there will be two metallic dies will be there and the molten metal enters into the metallic dies because we apply some external pressure. So, that is the primary difference between the gravity die casting and the pressure die casting.

Again the pressure die casting is classified into two types - one is the cold chamber pressure die casting and another one is the hot chamber pressure die casting. In the case of the cold chamber pressure die casting the furnace where we melt the metal is away from the die casting machine it is not the part of the machine where as in the case of the hot chamber pressure die casting machine the furnace where we melt the metal is a part of the machine it is an integral part of the die casting machine. So, that is the difference between the cold chamber pressure die casting machine and also the hot chamber pressure die casting process.

Now in this lecture we will see the recent advancements in the die casting process. So, one of the recent advancements in the die casting process is the semi solid metal casting process. What is this semisolid metal casting process?

Metal shaping processes at right various temperature, we will see first if we see the liquid casting shaping is carried out above the liquidus temperature no doubt if we are making a casting we melt the metal above the melting point or above the liquidus temperature then we pour the molten metal into the mould cavity. So, that is the liquid casting.

Again, there is another metal shaping process that is the forging rolling extrusion, all these constitute the forming process. So, here how we get the required shape we get the required shape below the solidus temperature. Now, here we can see the difference between the semi solid metal casting and the other process. Here shaping is carried out between solidus and liquidus temperatures we want heat the metal above the liquidus temperature we want cool down the metal below the solidus temperature, this shaping is carried out between the solidus and liquidus temperatures.

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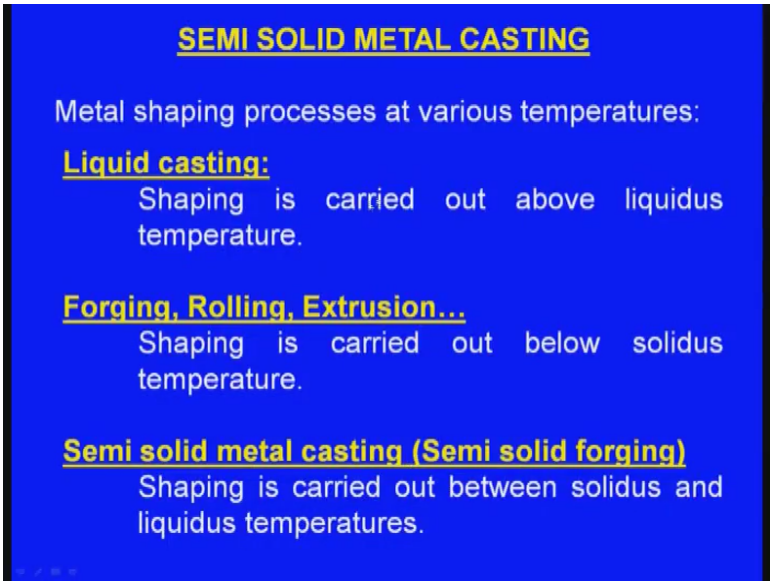


So, that is the special about semisolid metal casting process or semisolid what say forging and here we can see the liquid casting.

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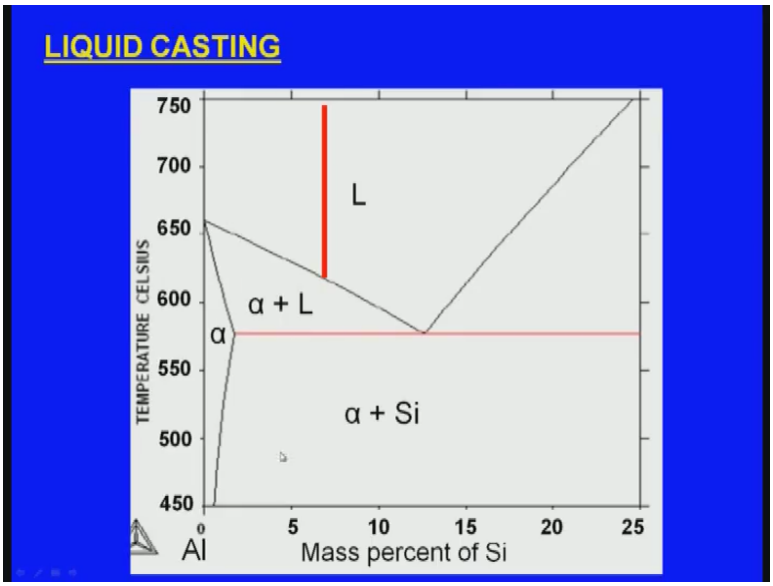


And here in this what say this is the phase diagram of aluminum and silicon and here we can see this is the liquidus temperature and this is the solidus temperature and here we can see this is the mixture of liquid and solid. Now, if you do the liquid casting the casting is carried out above the liquidus temperature. So, this is the liquidus temperature.

Now let us see the forging rolling and extrusion this forming process. Now, I have already told. So, this is the liquidus temperature. Now, this is the solidus temperature,. Now, here the forging and these and other forming process are carried out below the solidus temperature. So, that is the about the forging and other forming process. Now, let us see the semisolid casting. Now, the most interesting feature of the semi solid casting is that the shaping is carried out between liquidus temperature and the solidus temperature, this is the liquidus temperature and this is the solidus temperature.

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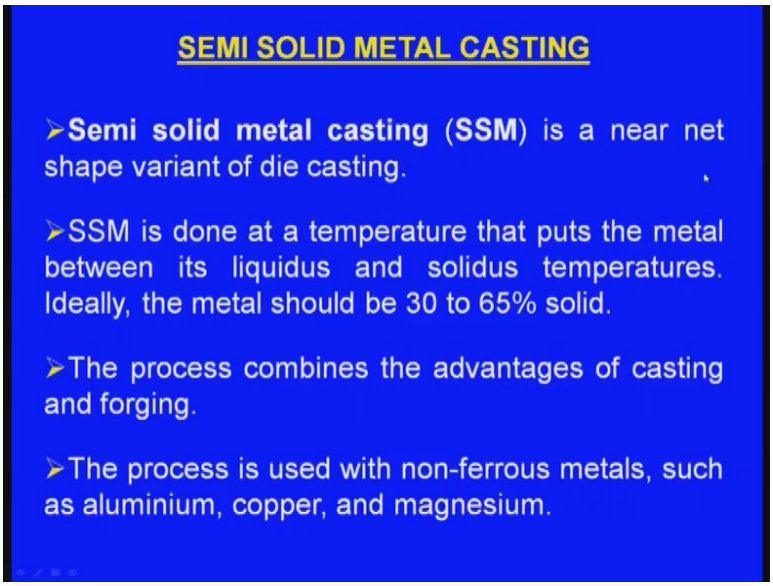


Now, what are the features of semi solid metal casting? Semisolid metal casting is a near net shape variant of the die casting process. Semisolid metal casting is done at a temperature that puts the metal between its liquidus and solidus temperatures, ideally the metal should be 30 to 65 percent solid means it is not totally solid it is not totally liquid.

The process combines the advantage of casting and forging. The process of casting advantage of casting is that we get the required shape very easily because we melt the metal and we pour it into a mould. So, getting the shape required shape is very easy in the case of the casting, but the mechanical properties may not be very good besides this there will be other problems like shrinkage cavities and so on.

Now, in the case of the forging applying the pressure are what say causing deformation to the raw component is very difficult because extensive pressure is required, but we get very good properties. Now, we are mixing these two we are taking the advantage of casting and we are also taking the advantage of forging. So, the process combines the advantages of casting and forging.

The process is used with non ferrous metals such as aluminium copper and magnesium. So, this is all about the semisolid metal casting. So, the deformation is carried out between the liquidus temperature and the solidus temperature and we get the advantages of casting and also the forging. We will get better mechanical properties and this kind of

shrinkage what say defects are not likely to arise in the case of the semi solid metal casting process.

Now, what are the types of semisolid metal casting process? One is the thixocasting another one is the rheocasting another one is the thixomoulding and finally, the sima process. Now, we will see all these one by one.

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First we will see the thixocasting process what is this thixocasting? Thixocasting utilizes a pre cast billet we have to buy this billet in the market and it is precast under certain what say controlled conditions, under certain controlled environment.

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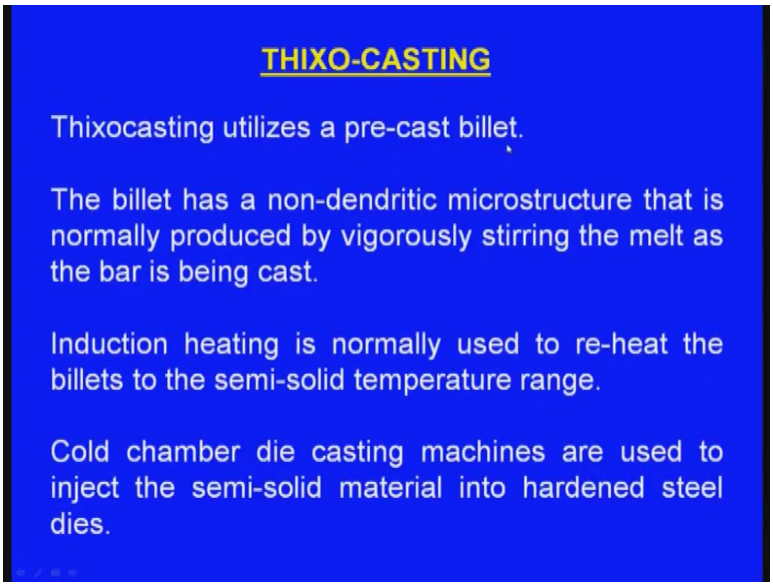


The billet has a non dendritic microstructure you see this this is very important it has a non dendritic micro structure that is normally produced by a vigorously stirring the melt as the bar is being cast, as we are getting this bar right it is it is rigorously stirred. Now, we buy this billet and we bring it and we have to cut it into pieces or to the required what say quantity we have to cut.

Then induction heating is normally used to re heat the billet us to the semi solid temperature range. Now, after cutting these billet us we have to heat it to the semi solid temperature range means above the solidus temperature, but below the liquidus temperature, to a such an extent we have to re heat these billet. Now, we have to put this billet us into the cold chamber machines die there will be two what say dies will be there set of dies we have to put these reheated billet us between these two dies.

Now, cold chamber die casting machine applies external pressure on this dies and this it will be what say formed it will be deformed. Cold chamber die casting machines are used to inject the semi solid material into the hardened hardened steel dies. Now, once we apply pressure on the dies. So, it will be squeezed between the these two dies and what say a preheated and re heated billet will be taking the shape of the cavity between the two dies.

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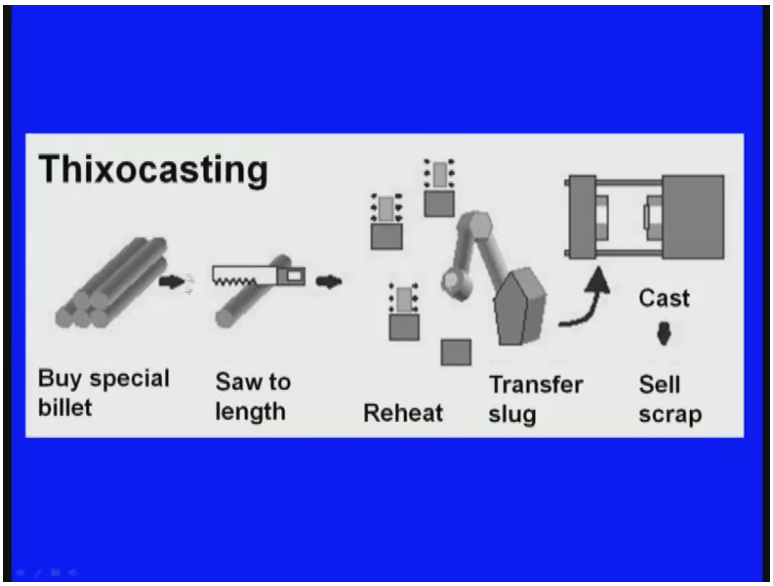


Now, this is what we can say diagrammatically. So, these are the special billet us pre cast billet us. So, these are available in the market which are manufactured with under certain what say special conditions it has got the non dendritic micro structure. Now, we will be cutting this saw to the required length and also to the required quantity we will cut them.

Next one we will put this cut pieces into a furnace means we are re heating them we will reheat them above the solidus temperature, but below the liquidus temperature. Now, these what say reheated slugs are being transferred in to the cold chamber die casting machine we can see here. So, these are the dies.

So, these will be kept inside this two dies. Now, pressure will be applied between these two dies and this slug which is reheated will be squeezed between the two dies and the slug will be taking the shape of the cavity which is available between the two dies. Now, sometimes, some scrap will be there this scrap cannot be reused we have to sell out that scrap. Now, these are the advantages of thixocasting.

Thixocasting has the ability to produce extremely high quality components due to the product consistency. So, this is the advantage of thixocasting.

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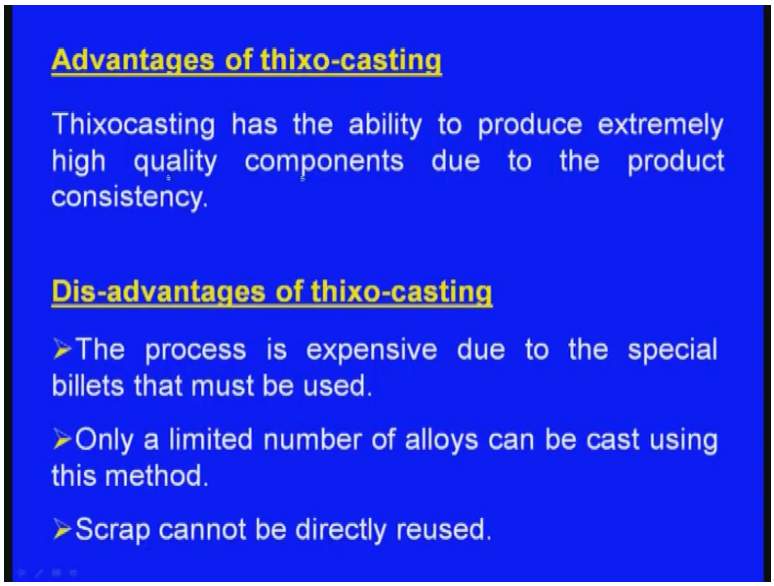


Now, it has got disadvantages and drawbacks as well what are they this process is expensive due to the special billet us that must be used right.

So, these billet us are what say manufactured under special environment and so that some special what say properties are induced. So, these we have to buy from the market that is how the process becomes expensive only a limited number of alloys can be cast using this method. Now, as I have already told scrap sometimes we get this scrap this scrap cannot be used directly again we have to sell, again those people will make the what say precast billet under special conditions again they will select. So, that way scrap cannot be directly used. So, we have completed the thixocasting.

Next we will see the rheocasting, what is this rheocasting? Rheocasting involves preparation of a semisolid what say manufacturing slurry directly from the liquid alloy the alloy is cooled into a semisolid state with the desired solid fraction and then is introduced into a die with no any intermediate solidification steps semi solid slurry with non dendritic solid particles is produced from a fully liquid regular alloy.

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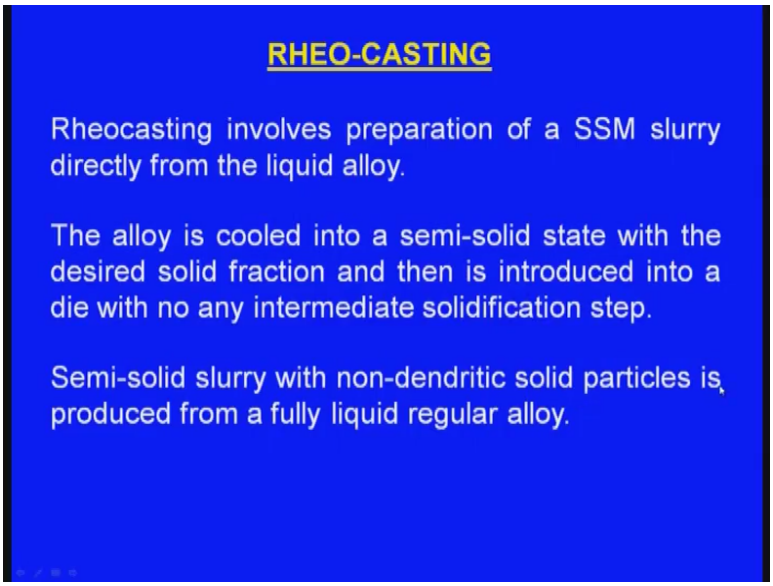


So, here we are not buying a what say pre cast billet from outside here we are making a slurry, so that the component will have the required properties. The semi solid slurry with non dendritic solid particles here again here we are getting the non dendritic what say solid particles. So, when once this casting has the non dendritic what say structure the properties will be good.

So, such a component is produced from a fully liquid regular alloy and here we can see this diagrammatically first we have to buy the ingot. So, this ingot is not a expensive as expensive as the a billet which we buy in the previous process. Now, this we put it inside the furnace you can see here.

Now, you see here and in this what say we are what say stirring finally, it will be transferred to the die casting machine cold chamber die casting machine there external pressure will be applied between these two dies and the slurry will be injected into the cavity which is available between the two dies. Sometimes we get this scrap is no need to what say what say discard that scrap again that scrap can be put inside the what say furnace again from that scrap we can get the slurry. So, that is the rheocasting.

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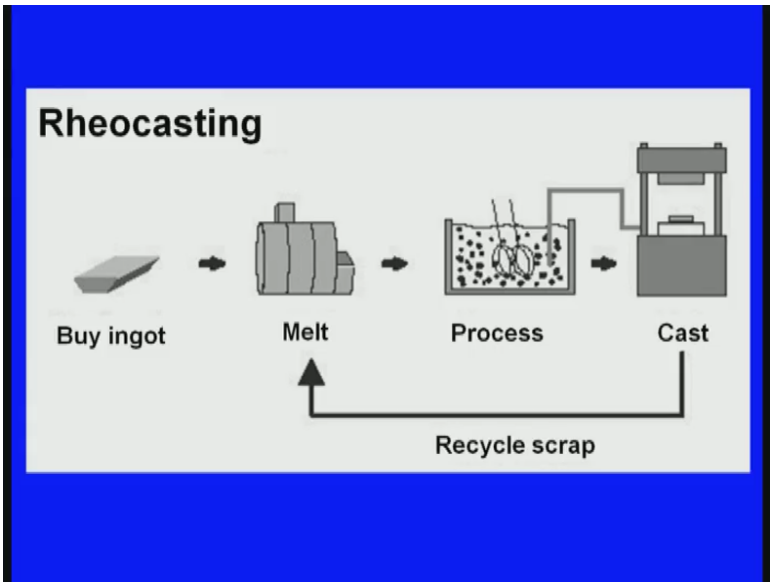


Now, what are the advantages of rheocasting process? No need to buy the pre cast billet us as in the case of the thixocasting. So, because we are buying the precast billet us in the thixocasting process the process becomes expensive. So, such things will not arise here in the case of the rheocasting. Scrap can be reused immediately, immediately if there is any scarp again it can be what say kept inside the furnace and we can get the required slurry.

Now, what are the drawbacks of rheocasting? Obtaining the correct solid fraction is difficult, we have to control the temperature between the liquidus temperature and the solidus temperature we have to get the required solid fraction. So, that required skill. So, skilled workers are required.

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Next one thixomoulding, what is this thixomoulding? Thixomoulding is used for magnesium alloys this can be used only for magnesium alloys it uses a machine similar to injection moulding generally this injection moulding is used for producing plastic components. So, a similar machine is used for thixomoulding.

Now, what is done inside this what say machine injection moulding machine magnesium alloy chips initially we have to make magnesium alloy chips. So, these chips are fed into the back end of heated barrel at room temperature. Now, this barrel is maintained under argon atmosphere to prevent oxidation because magnesium readily what say reacts with oxygen. So, we have to prevent that for that purpose we use the argon atmosphere.

Now, we are what say feeding these magnesium alloy chips to the back end of the heated barrel inside the injection moulding machine. Now, there will be a screw in that. So, as this screw rotates what happens it provides necessary shearing force to generate globular structure needed for semi solid casting. So, there will be a screw as this screw is rotating these chips will be trapped inside the screw and they undergo shearing because of that we get the globular structure for the semi solid casting.

Once enough slurry has developed the screw moves forward to inject the slurry in to the steel die and here we can see diagrammatically. So, this is the what say a machine which is what say very much what say close to the injection moulding machine which is used in the plastic manufacture of the plastic components.

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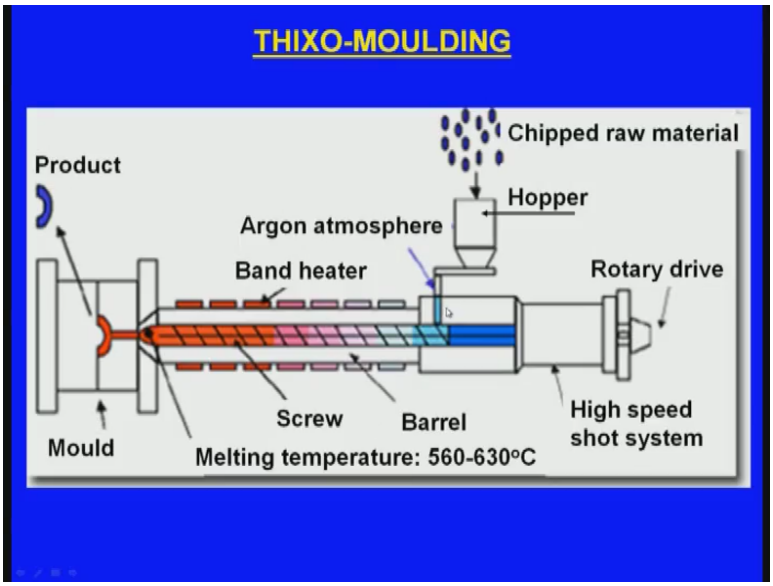


And what is this machine? It has a barrel you see this is a barrel outside barrel. Now, inside there is a screw it rotates and this is connected to a motor you see here, here it is connected to a motor and here there is a feeding hopper. So, there is a hopper will be there to feed the magnesium alloy chips here we feed the magnesium alloy chips.

Now, you see here there is argon atmosphere. So, so that there will not be any oxidation of the magnesium alloy. Now, this there is a heating what say system for this barrel this will be heated up. Now, here we can see these are the two dies this is one die and this is one die

Now, the screw will be rotating as the motor is rotating the screw will be rotating. Now, we what say feed the what say magnesium alloy chips into this hopper and they will be going inside the barrel as this screw is rotating the what say chips undergo shearing and finally, a slurry is formed and because it is heated you see it will be heated between 560 to 630 degrees centigrade.

As the screw further rotates what will happen the slurry will be injected between the two dies. There it solidifies once the slurry solidifies the dies will be withdrawn and the component will be taken out. Again the dies will be closed again the screw rotates the slurry will be injected into the two dies. So, this is the simple principle of thixomoulding next one sima process what is this sima process.

In sima process the cast alloy is first hot worked and then cold worked to the desire degree of deformation. You see first it is hot worked means above the re crystallization temperature then it is cold worked means deformation under the below the re crystallization temperature then the material is then heated between the solidus and liquidus temperatures after isothermal holding for about 15 to 20 minutes the semi solid slurry is cast or it injected between the two dies. So, this is the basic principle of the sima process.

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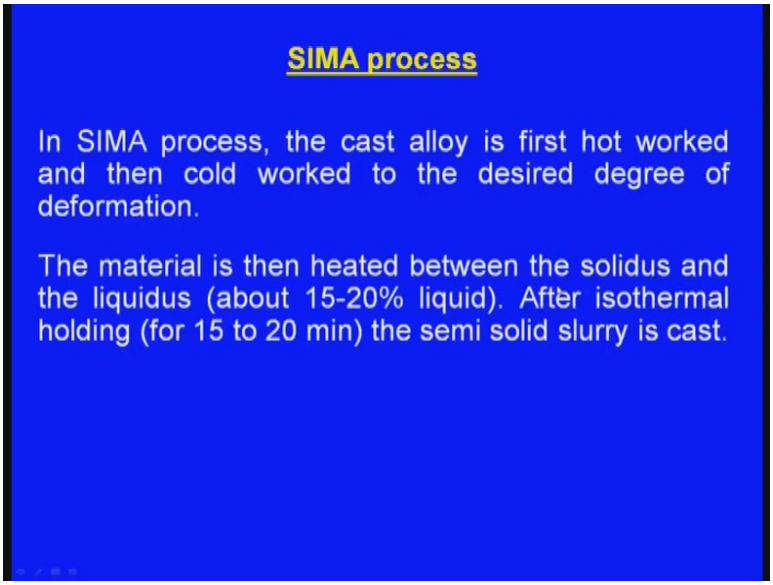


Now, what is the scientific understanding? High angle grain boundaries induced by plastic deformation and re crystallization will be wetted by liquid metal at the semi solid temperature resulting a fine and globular structure. So, this is the scientific understanding this is the scientific principle behind the sima process.

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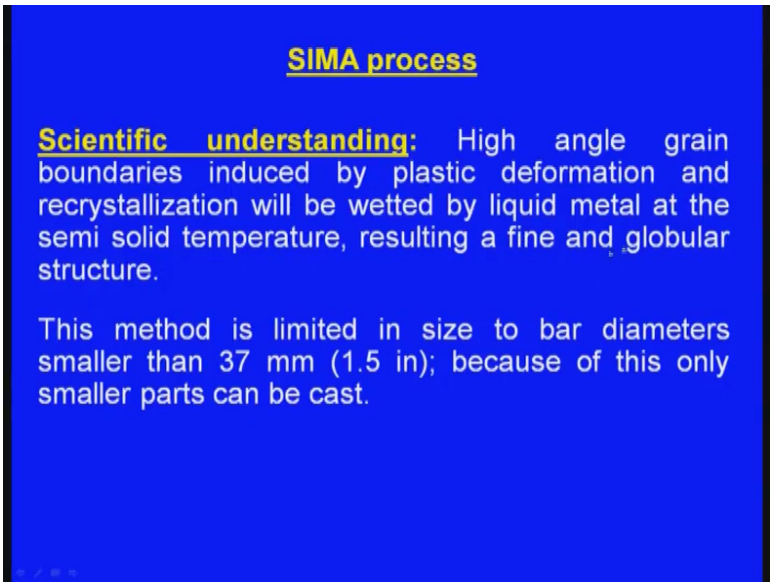


This method is limited in size to bar diameters smaller than 37 millimeters because of this only smaller parts can be cast, so that is the limitation of this process only smaller components can be cast.

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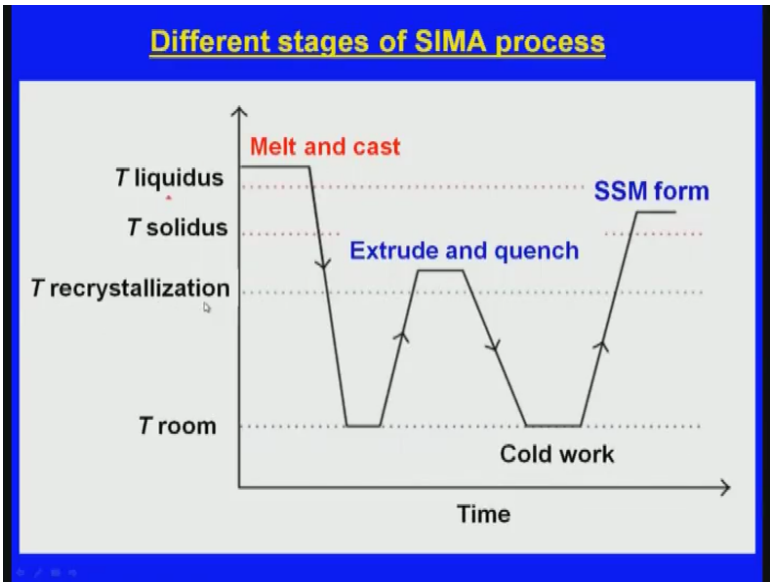


Now, here we can see this process diagrammatically. Now, this is the liquidus temperature and this is the solidus temperature and this is the re crystallization temperature and this is the room temperature. Now, you see here initially it is in the

molten state. Now, then it what is happening it is what say deformation is taking place right.

So, here it is between the liquidus temperature and solidus temperature and below the solidus temperature also there is a deformation. After that what is happening? Deformation extrude and quench between the room temperature and the solidus temperature it is what say extruded and it is quenched. So, this process will be repeated finally, it will be injected into the two dies of the die casting machine between the solidus temperature and liquidus temperature.

So, this is the temperature where it will be injected between the two dies. How is this temperature you see this, so this is the ssm form temperature. So, this is between the liquidus and solidus temperatures.

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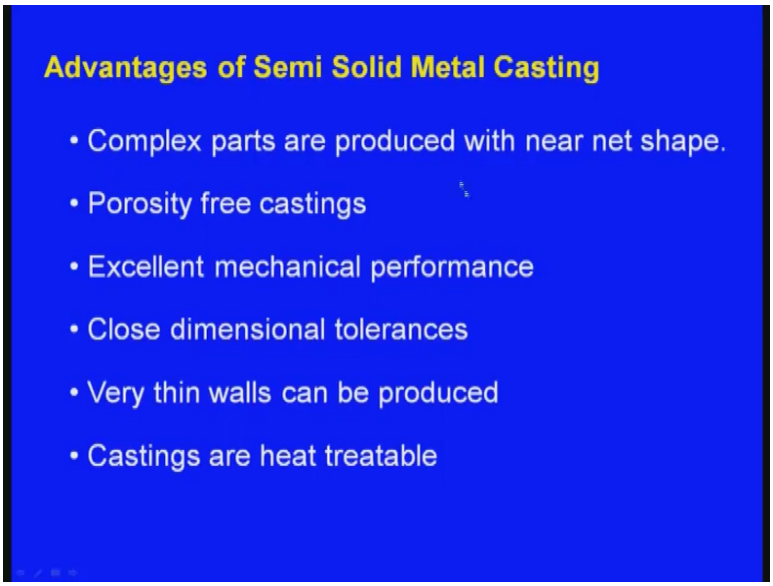


Now, let us see the advantages of semi solid metal casting process complex parts are produced with near net shape very complex parts can be produced. Near net shape means almost no machining or negligible machining is required.

Porosity free castings it is a very good advantage in the case of the castings. So, because of the solidification above say we pour the what say melt at a temperature which is above the what say melting temperature then it cools down to the what say melting temperature then it cools down to the solidus temperature then to the room temperature in this process

there will be shrinkage. Finally we may what say pour the molten metal may occupy all the corners and get the exact shape of the mould cavity, but finally, there may be shrinkage defects.

Sometimes it becomes very difficult to overcome these shrinkage defects, but here what is happening during solidification we are applying pressure first of all we are not heating the melt above the liquidus temperature the melt is heated between the liquidus temperature and the solidus temperature. So, the temperature is not very high it is in a slurry form then we are injecting into the two dies.

So, there will be minimum shrinkage even if there is a shrinkage we are applying external pressure because of that the shrinkages will be totally eliminated. So, there will not be any shrinkage porosity even if what about the gases sometimes what say deserved gases will be there even if there is some deserved gas inside the melt then what happens because we are squeezing the melt these deserved gases will be escaping out. So, the casting will be free from shrinkage porosity and also from the gas porosity.

Next one we get the excellent mechanical properties to the cast components right. So, in the case of the casting mechanical properties may not be very good, but where as in the case of the forging and other forming process mechanical properties are very good. Now, in the case of the semi solid metal casting we are taking the advantage of metal casting as well as that of the forging. So, we get the very good mechanical properties.

Next one close dimensional tolerances means we get very good dimensional accuracies next one thin walls can be successfully produced and castings are heat treatable. So, these are the advantages of semi solid metal casting process these are the disadvantages of semi solid metal casting production facilities need a high level of technology right.

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So, the molten what say slurry has to be heated above the liquidus temperature and below the solidus temperature. So, it require say high level of technology and these staff who are working with this should they should have the sound knowledge of what say these temperatures operators require similar knowledge and training.

Now, with this we are completing the semi solid manufacturing. Now, let us see another variant of what say die casting. So, that is the vacuum die casting.

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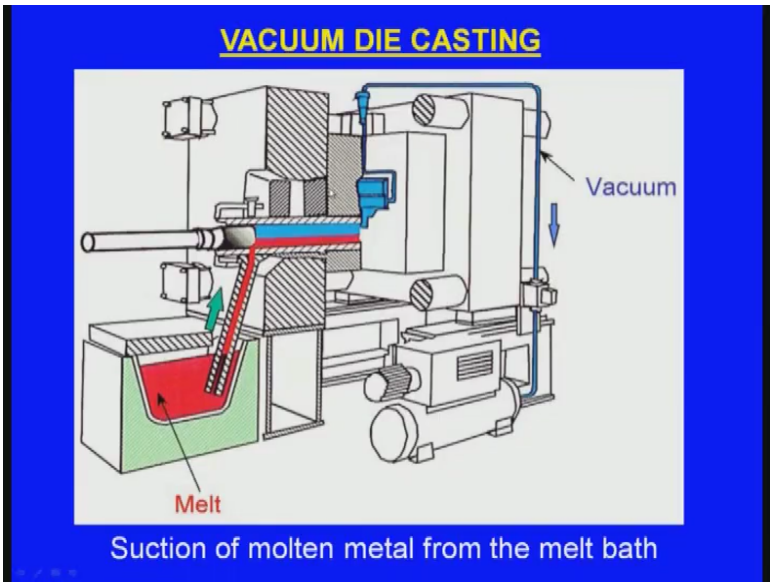

Now, in the vacuum die casting the process is similar to die casting right, but what is the difference? Here we can see this is the die, die means a set of dies two dies will be there and between these two dies again there will be a cavity whose shape is similar to the component which we want. Now, here we can see this is the furnace this furnace is an integral part of the machine.

Now, this is the what say channel through which the molten metal enters and it fills in to the cavity, but here during what say while the metal is what say carried to the set of dies the way the molten metal is entering into the cavity makes the difference. In the case of the hot chamber pressure die casting machine we apply what say external pressure on the plunger as the plunger comes down the molten metal enters into the cavity and here what is happening the molten metal enters into the cavity because of the vacuum that we applied.

And here we are applying vacuum there will be vacuum pump you can see here. So, this is the vacuum what say line is coming here and it is applied to the die casting these dies. Now, as the vacuum is causing suction what will happen the molten metal will be automatically entering into the mould cavity we are not applying external pressure while the molten metal is entering into the cavity.

Once the molten metal enters into the cavity then we apply the external pressure here we can see there is a plunger. So, this plunger will be moving. So, this is the suction of the molten metal from the metal bath due to the application of the vacuum, then what will happen? Injection of molten metal into the die. Now, here there is a piston is there this piston will be what say moving forward and it causes pressure and the molten metal will be injected into the set of dies.

Now, here vacuum always closed, next what will happen there will be solidification. Now, component will be solidified the casting will be solidified. Now, these are the advantages of vacuum die casting. High quality of molten metal because we are applying vacuum, no atmospheric contamination, no oxidation. So, that is how we get the high quality of molten metal.

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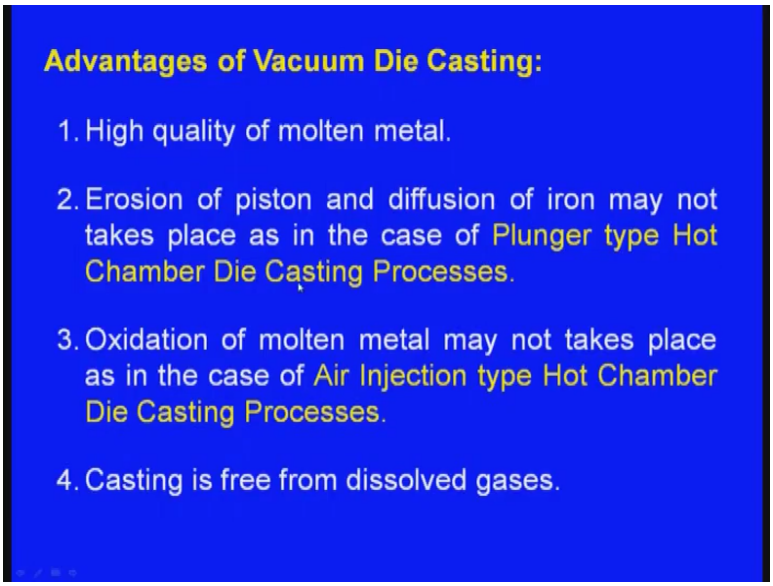


Next one erosion of piston and diffusion of iron may not takes place as in the case of the plunger type hot chamber die casting process. Now, in the case of the plunger type hot chamber die casting process what is happening we apply the pressure on the what say plunger that plunger goes inside the what say that is cylindrical barrel as it comes down the molten metal will be injected inside the two dies.

Now, in this process the plunger is made up of certain heard materials. Now, may be like tungsten or molybdenum. So, these hard elements like tungsten or molybdenum few atoms will be removed from the plunger and there will be diffusing into the molten metal. Now, what is the result? Because these are hard elements the cast component will have a properties the machine ability will be very poor. So, that is the diffusion or erosion diffusion or erosion wont takes place as in the case of the plunger type hot chamber die casting process.

Next one in the hot chamber what say pressure die casting process there is another type that is the air injection type the air will be pressurizing the molten metal and the molten metal will be injected into the dies.

Now, in this process as the air is coming down as it is applying pressure on the molten metal the oxygen present in the air will be reacting with the molten metal and causes oxidation that will not happen in the case of the vacuum die casting. Oxidation of molten

metal may not takes place as in the case of the air injection type hot chamber die casting process.

Next one the casting is free from dissolved gases these are the disadvantages of vacuum die casting. Cost of production goes up because we are applying the vacuum. So, this itself makes the process costly. Next one operation requires skilled workers means in the right time vacuum has to be applied in the right time vacuum has to be stopped. So, this requires skill and a knowledge that is how the operation requires skilled workers means the cast of production goes up because of the trained workers and skilled workers.

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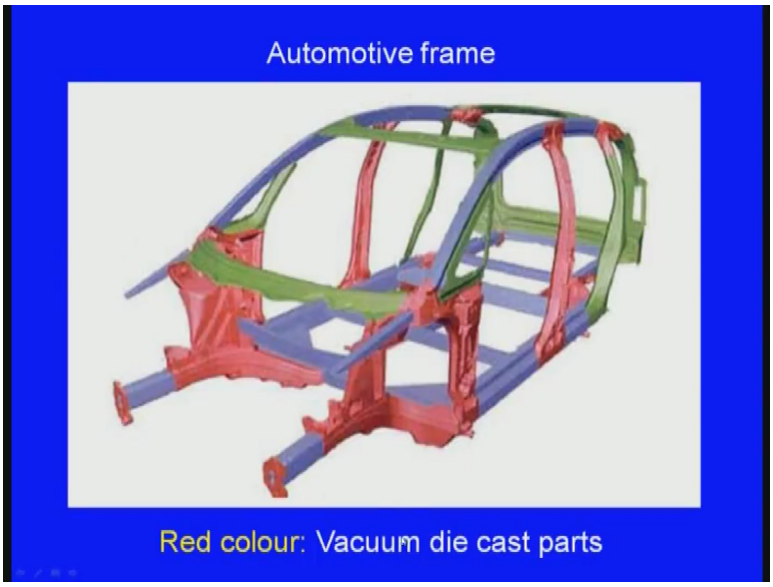


Next one. So, these are the some of the examples of the vacuum die cast parts this is in automotive frame these the red colored what say parts. So, these are the parts produced from the vacuum die casting. So, this is the automotive frame.

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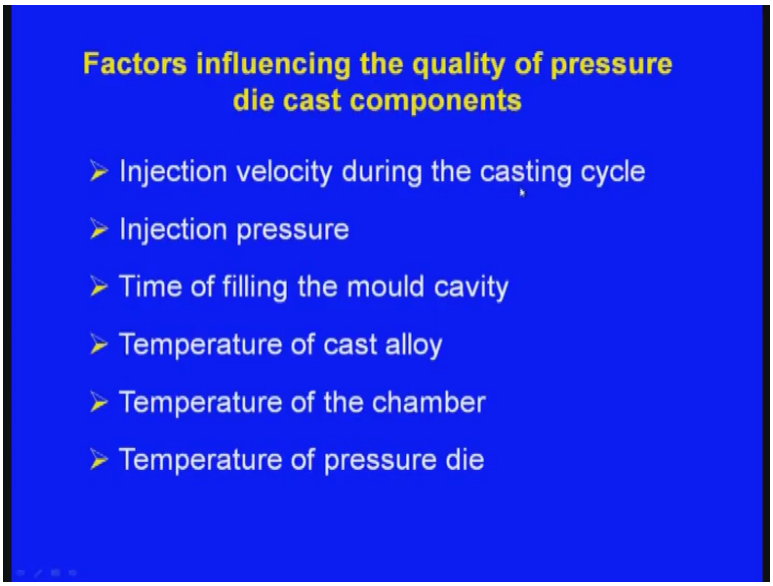


Now, let us see the factors influencing the quality of pressure die cast components one is the injection velocity during the casting cycle, next one injection pressure, next one time of filling the mould cavity, next one temperature of cast alloy, next one temperature of the chamber and finally, temperature of pressure die.

Now, we will see die casting defects what are the defects? That are likely to arise in the die casting process. So, there are three categories of die casting defects.

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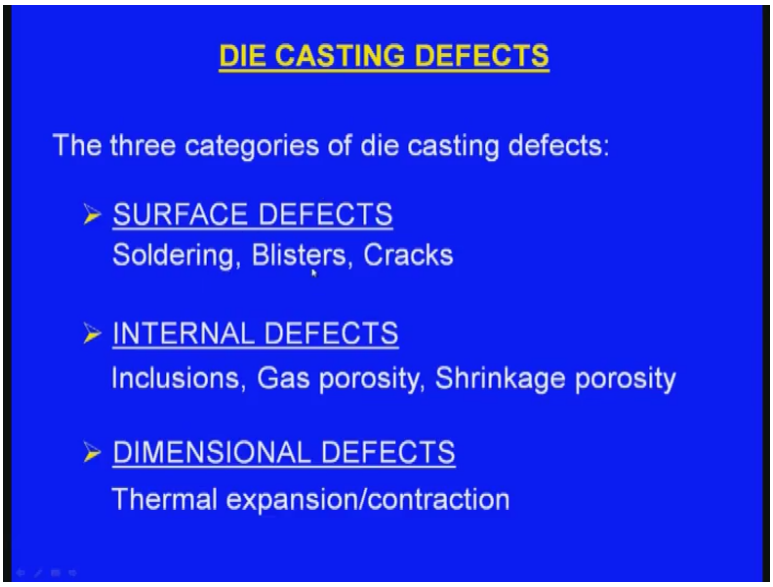

One category first category is the surface defects, second category internal defects, third category dimensional defects. Under the surface defects we have soldering blisters and cracks, under the internal defects we have inclusions gas porosity and shrinkage porosity, under the dimensional defects there will be thermal expansion or contraction.

So, first we will see the soldering. Soldering is the fusion of aluminium means the cast material with iron from the steel surface of the die cavity the dies are made up of ferrous alloys. So, when we are casting what say aluminium cast components in the die casting process this molten metal can react with the iron of the steel dies generally what will happen an oxidized coating on the die cavity protects the cavity surface from the aluminium there will be an oxidized coating will be there.

But if the alloy impinges means it comes and strikes the alloy at a high pressure then what will happen a portion of the die core pin the aluminium will break down the oxidized interface between the die surface and the casting. Now, if the molten metal comes and impinges on the steel blocks what will happen. So, because of that the oxidized coating will be broken that time the cast metal the aluminium may react with the iron in the steel blocks or the iron in the dies steel dies.

So, when soldering occurs in the die casting die the casting sticks to the cavity then what will happen consequently the molten aluminium alloy will be sticking to the dies. So, this is the typical appearance of soldering defect. You see here, this is the background is the die and the molten aluminium is sticking to the die surface, die is damaged and the casting is also damaged.

Second one second category second defect is the blister. What is this blister? Blisters are bubble like bumps on the casting surface gases trapped near the casting surface cause them. When the casting is what say ejected and the casting surface over the blister is not strong enough to with stand the gas pressure the surface yields and develops the blister.

Let us see its appearance yes this is the casting here we can see a kind of a defect like a bubble. So, this is the blister you can see here this is the blister next defect is the crack it is a linear discontinuity of the surface of the die casting. It is a linear discontinuity. The two major causes for cracks are one is the insufficient temperature of die, if the casting die is comparatively cold as the casting freezes there will be excessive internal stresses in the casting. So, this leads to what say crack.

There is another reason excessive temperature of the die. If the die is too hot usually in a local area at a particular what say point crack forms due to shrinkage. So, these are the two reasons responsible for the formation of the linear discontinuities or the cracks. So, this is the typical appearance of a crack here we can see these are the cracks.

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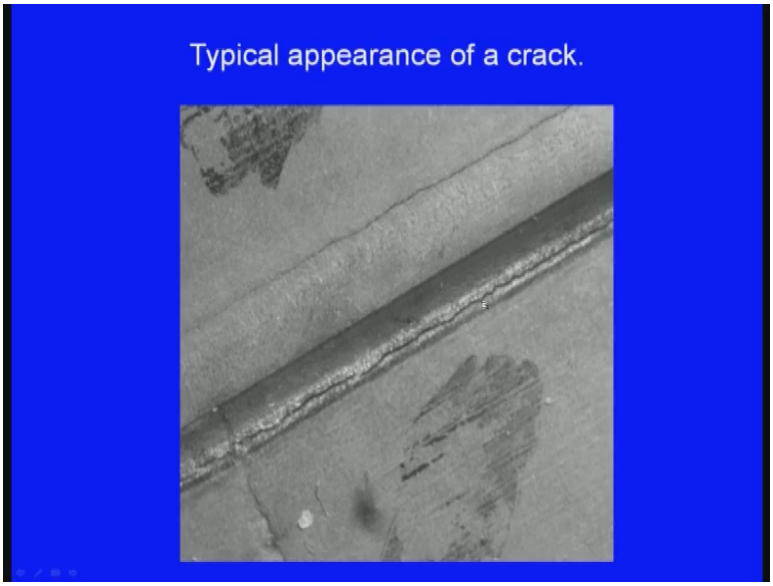


Next one let us see the second category that is the internal defects under that we have the inclusions. The vast majority of these inclusions is non metallic aluminium oxide, other inclusions are silicon, carbide, flux, sludge and so on.

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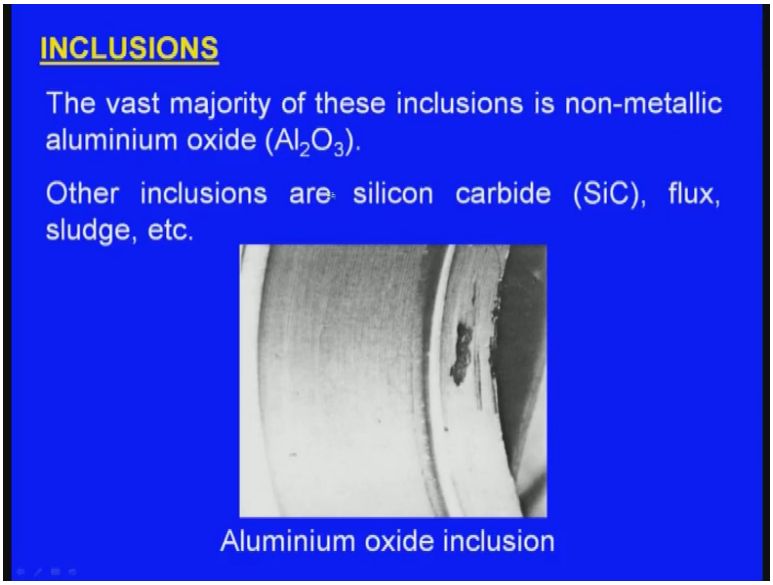

And here can see aluminium oxide inclusion next one gas porosity under the internal defects gas porosity is due to trapped gases. Now, what are the sources of these gases trapped air in the furnace air in the cold chamber or gases from excessive lubricants, we use lubricants. So, that time also from the lubricants gases will be arised.

Now, other causes for gas porosity improper venting there should there will be vent holes to the dies if these vent holes are not enough to allow hot gases that time also this gas porosity defect will arise. Now, this is the typical appearance of gas porosity here we can see these are all the gas porosities.

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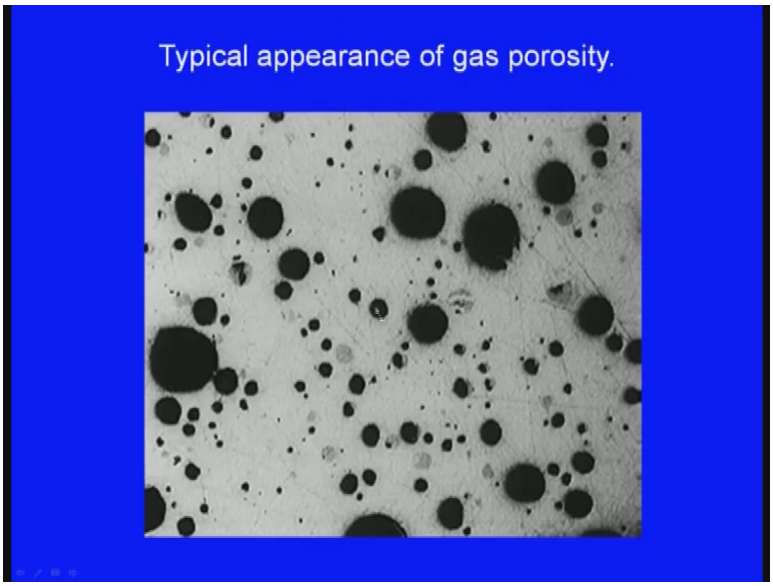


Now, let us go to the third one under the internal defects that is the shrinkage porosity. Shrinkage defects occur at the last place in the casting right during final stage of the solidification. Shrink porosity is characterized by a rough and jagged appearance in contrast to this smooth appearance of gas porosity.

So, there will be two porosities one is the shrinkage porosity and another one is the gas porosity. So, shrinkage porosity is characterized by a rough appearance. Insufficient pressure and uneven thicknesses of sections are common causes of shrinkage porosity. Now, let us go the third category that is the dimensional defects. Thermal expansion or the contraction a dimensional problem can occur when one half of the die is much hotter than the other half.

There will be two dies that we know very well these two dies must be at the same temperature if one half of the die or one die is hotter than the other half this problem can occur flash build up at the parting line may develop which prevents the die from closing properly, it ultimately leads to dimensional problems expansion or contraction.

Now, let us see the dies and die materials. Now, what are the materials used to manufacture the dies that dies should have enough what say hardness they should have enough hot strength they should have enough fatigue strength. So, die should have very what say good properties and it should have what say ideal properties. Now, what are the materials used for making these dies?

So, what is the important materials are. So, these are known as the steels right H11 steel, H12 steel, H12 steel, H19 steel, H20 steel and H21 steel. So, this is the these are the what say elements that are present in this steels. Carbon is present in all these steels besides carbon chromium will be there, molybdenum will be there, tungsten will be there, vanadium, cobalt and nickel. In the case of the H11 steel carbon content is 0.35, chromium content is 5 percent, molybdenum 1.5 no tungsten, vanadium 0.5 and balance is iron and this steel is used for making zinc casting dies.

Next one H12 steel carbon content is 0.35, chromium 5 percent, molybdenum 1.5 percent, tungsten 1.5 percent, vanadium 0.4 percent and balance is iron. So, this is used for making aluminium casting dies, means when we have to make aluminium casting. So, for that the dies are made up of this H12 steels. Next one H13 steel carbon content 0.35, chromium 5 percent, molybdenum 1.5 percent, vanadium 1 percent and this steel is also used for making aluminium castings.

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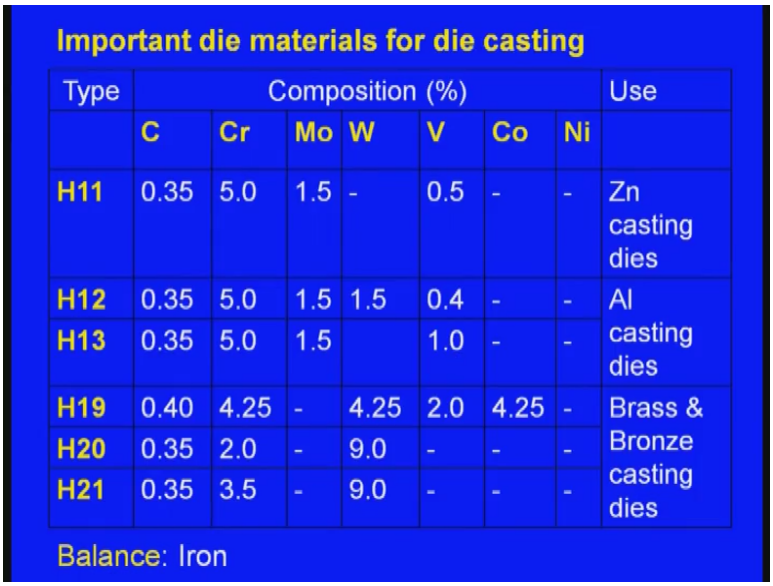


Next one, H19 steel carbon content 0.4 percent, chromium 4.25 percent, tungsten 4.25 percent, vanadium 2 percent and cobalt 4.25 percent. And this is used for making this what say steel use used for making brass and bronze castings. Next one H20 steel carbon content 0.35, chromium 2 percent, tungsten 9 percent and this steel is also used for making the dies in the case of the bronze and brass castings. And finally, H21 steel carbon content 0.35, chromium 3.5, tungsten 9 percent. So, these also used for making the dies where brass and bronze castings are to be made.

So, in all these cases iron is the base element. Now, die casting types dies types what are the types of the dies. So, there are four types of dies are there one is the single cavity die produces one casting at a time. Second one is the multiple cavity die produces more than one casting at a time. Next one family die produces number of different parts here also different parts are there, but same casting more than one casting same casting, but here different castings. So, that is the family die. Next one unit die, unit die allows use of replaceable cavities in the standardized main die frame for low at lower die costs and here we can see this is the single cavity die means. So, this is the shape of the cast component only one component can be produced at a time. So, that is the single cavity die.

Now, this is the multiple cavity die and here we can see this is one casting, this is one casting, this is one casting, this is one casting, this is one casting and this is one and this

is one. At a time in this die we can see there are 6 cavities are there, but all the cavities are similar. So, at a time with one injection we can produce 6 similar castings. So, this type of die is known as the multiple cavity die and next one is the combination die in the combination die we can see different parts can be produced this is one part and this is one part and this is one part. Now, with one injection these different parts can be cashed at a time. So, this is the combination die and this is the unit die.

So, this unit die what say includes a replaceable die at a lower cost that is the unit die. Now, let us see quickly how to make the or how to manufacture the die. When manufacturing a die casting die the following are of vital importance machinability right electrical discharge machining heat treatment dimensional stability surface treatment and weldability.

Now, cost involved in die making. You can see here this is a like a like an ice berg you see only little cost is appearing outwards apparently say this is the steel cost maybe this much and this is the die making cost. So only this much appears to be what say manufacturing or the die cost, but there are several hidden costs are there.

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Production and maintenance cost right preheating is there. Now, we have to do the welding and scrap will be there that also costs us, heat treatment repair will be there last production adjustment will be there delivery delays and etcetera and etcetera all this

elements contribute to the total cost of the die.So, these are the costs involved in the die making.

Now, die maintenance before injecting the metal make sure that the die has been preheated to preheated to 175 degrees centigrade. So, this is the first step in the die maintenance when the die casting machine is running run consistent cycle times with each cycle element consistent heat expansion contraction stress should be uniform. Next one minimize build up on the cavity surfaces this could be solder carbon or waxes usually a result of inappropriate die release application. So, we have to minimize the buildup on the die cavity surfaces.

Next one is the die spray die spray can be applied through different methods. A manually held spray next one individual spray nozzles mounted in fixed positions on the machine are the die next one a series of spray nozzles mounted on a moving arm that reciprocates in and out between the open die faces called reciprocator.

A series of spray nozzles mounted on a moving arm you can see here spray is it is what say spraying is going on and this spray nozzles are mounted on a moving arm and here we can see this is one die you and spraying is going on and finally, these are the structural components of a die casting machine.

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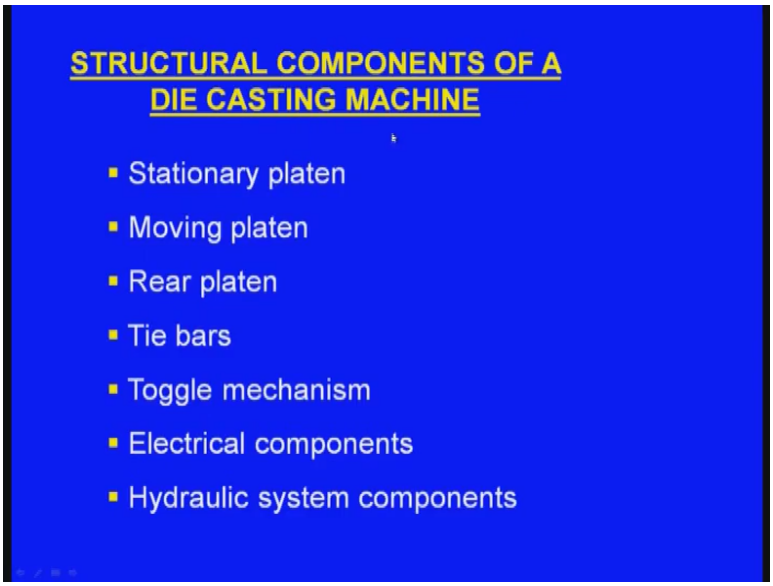

What are the structural components of a die casting machine, we have learnt different types of what say die casting machines and different types of the what say variants in the die casting process and what are the finally, what are the structural components. One is the stationary platen, second one is the moving platen, third one is the rear platen, forth one is the tie bars, next one is toggle mechanism, next one electrical components and finally, hydraulic system components. So, with this we are completing the die casting process.

So, friends in this lecture we have seen two advanced variants of the die casting process - one is the semi solid manufacturing that is the what say the metal is heated above the liquidus temperature and below the solidus temperature then it is injected into the dies. Again we have seen different types of the semi solid manufacturing and other variant is the vacuum die casting. So, with this we are completing the die casting process and in the next lecture we will be learning about the investment casting process.

Thank you very much.