**Metal Casting**
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**Module - 05**
**Permanent Mould And Special Casting Processes**
**Lecture - 08**
**Vacuum Sealed Moulding And Squeeze Casting**

Good morning friends. Today let us learn about to 2 Special Casting Process, one is Vacuum Sealed Moulding Process and the other one is the Squeeze Casting Process. First let us see the vacuum sealed moulding process.

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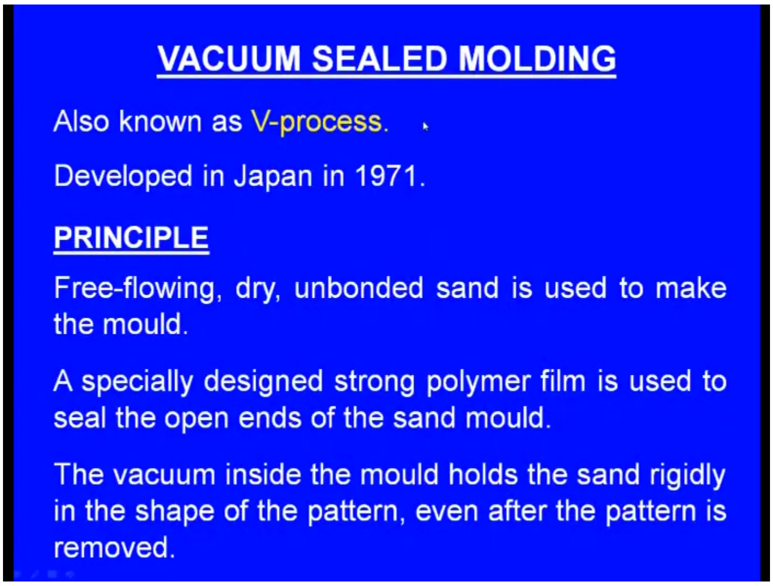


What is this? What is its history? And what is its principle? This is also known as V-process simply because vacuum is used so it is also known as V-process and this V-process was developed in the year in Japan in the year 1971 and what is the principle in this molding process? Free flowing dry unbounded sand is used to make the mould you see, so this is a special characteristic of this process. In the conventional sand casting process, we prepare the sand by mixing the base sand, moisture, clay and some other additives.

So, these are the ingredients of the conventional molding sand. But here, free dry and unbounded sand is used to make the mould no moisture, no clay and no additives. Next a specially designed strong polymer film is used to seal the open ends of the sand mould. The sand mould will be sealed using a strong polymer film. The vacuum inside the mould holds the sand rigidly in the shape of the pattern even after the pattern is removed. So vacuum will be applied to hold the dry sand strongly and in the shape that is required by using vacuum and here, we can see the vacuum molding machine and here we can see vacuum is applied here.

So, this is the general setup of a V-process or the vacuum sealed molding process. Now what are the steps involved in V-process?

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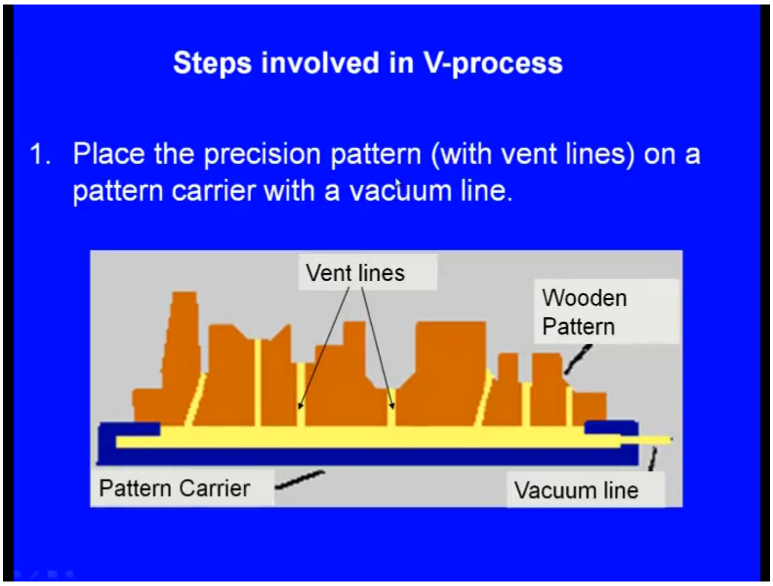


First step is place the precision pattern with vent lines on a pattern carrier with a vacuum line and here a wooden pattern is used. You see here. So this is a wooden pattern and on this pattern there will be several vent lines are there. Here you can see this in one vent line, this is another vent line and likewise there are several vent lines are there. Now all this vent lines are connected to the vacuum line, you see here. So this is the vacuum line. Now why this vent lines, means this pattern this wooden pattern will be covered the strong polymer film then, vacuum will be applied and as the vacuum is applied the polymer film will be set through this vent holes.

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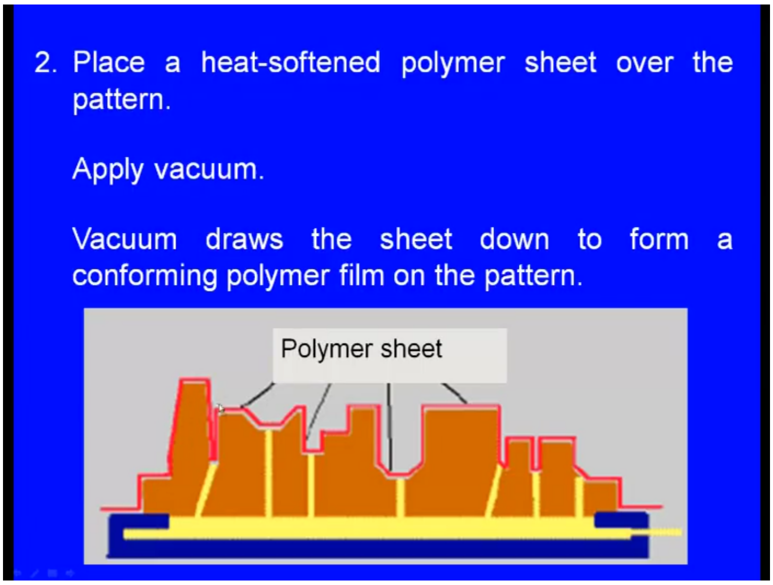


So that is the purpose of this vent lines. Second step place a heat softened polymer sheet over the pattern. So this is the pattern and here we can see a kind of red colored one, so this is the polymer sheet. So this, it should be heat softened and say it is kept sheet kept over the pattern such that this sheet will be occupying all the what say corners and the details of the pattern. It will be here. Then, you apply vacuum here. Then what will happen? Vacuum as the vacuum is applied the polymer sheet will be sucked. So vacuum draws the sheet down to form a conforming polymer film on the pattern. As the vacuum is applied, the polymer sheet will be drawn. So that it will be sticking to the whatsay details of the pattern sticking.

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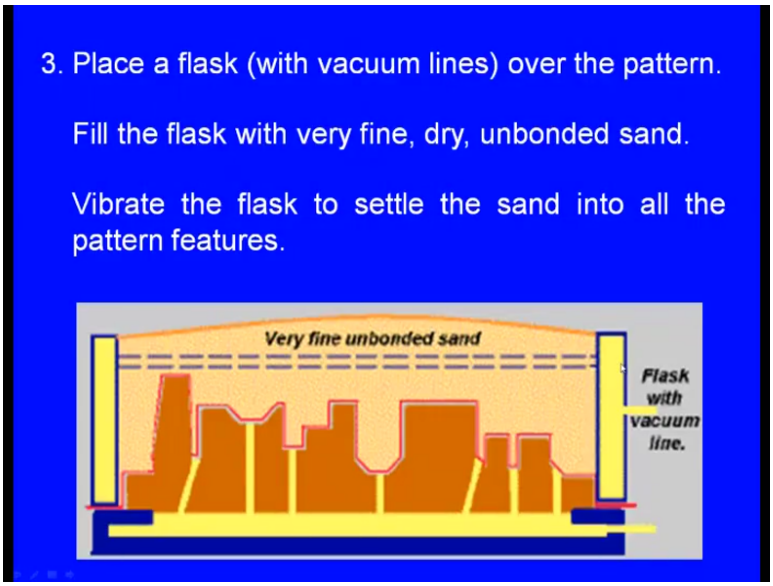

The next step, place flask with vacuum lines over the pattern. So this is the flask. So this flask also what say is attached to vacuum. Here you can see, there is a vacuum line. So this is a special what say molding flask. Now this special molding flask with vacuum line should be kept around the or over the pattern. Fill the flask with very fine dry unbounded sand. Now we have to place the fine dry and unbounded sand inside this flask. Now it should there is no question of compaction as in the case of the whatsay green sand molding. Vibrate the flask to settle the sand into all the pattern features. It should be vibrated. So that, this fine and dry sand goes all around the whatsay details of the pattern. Next step is the there must be some excess sand must be there you can see here see there is excess sand.

So this excess sand must be removed. So, level the sand and form a sprue cup. So here a sprue cup is formed. Now one more plastic film is to be kept, place a plastic film on the top of the mould to form a vacuum tight seal.

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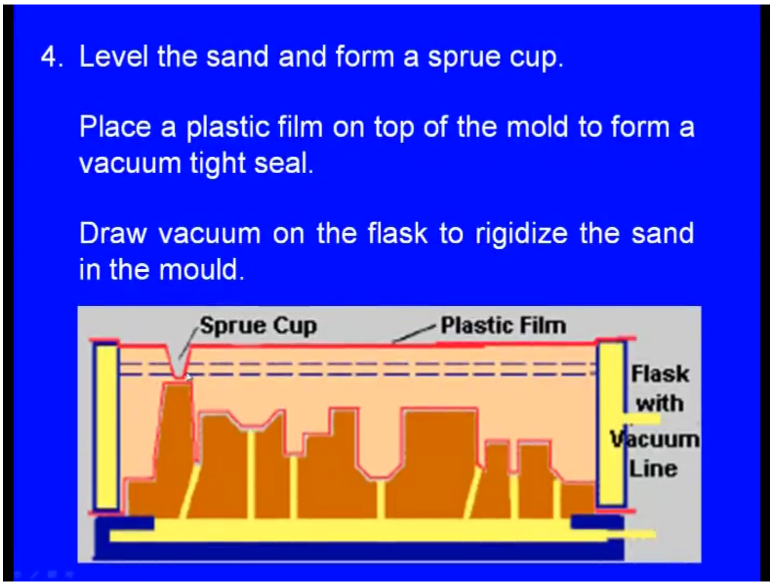


So one more vacuum what say one more plastic sheet is kept here and it is sealed here, you can see here, it is sealed and this side also it is sealed and previously, we have used another what say one more what say polymer sheet so that is also sealed to the molding box here or to the special molding flask and here. On all the 4 sides, the polymer sheet is what say closely sealed. Now place a plastic film on the top of the mold to form a vacuum tight seal, draw vacuum again and here we have to draw the vacuum, apply the vacuum. Draw the vacuum on the flask to rigidize the sand in the mould. Once we apply the vacuum here, what will happen? The sand will be held rigidly.

So that is the purpose of this second vacuum. Next one release the vacuum from the pattern carrier. Now here remember we are using what say 2 what say vacuums at 2 places.

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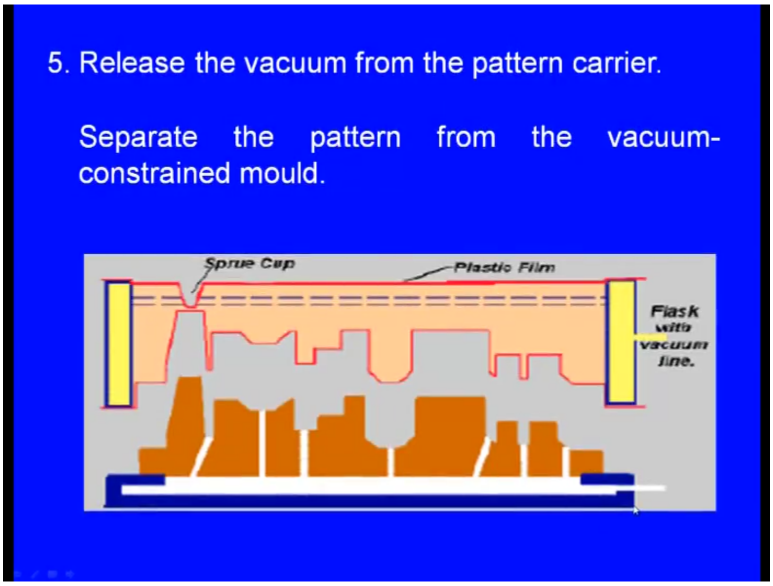


One is at the molding box, one is at the pattern. This molding wax vacuum will be continued for some more time. But the vacuum which we have applied to the pattern will be withdrawn, will be released here. Then, what will happen? It will be whatsay detached from the sand mould. Now you see here, this is the sand mould. Now remember the sand mould is compressed of dry and fine sand, no moisture and no clay. Now, then the question is how it is bonded because of the vacuum? This sand now, it is concealed by polymer film, at the top there is polymer film or the plastic film. At the bottom also there is plastic film, you see here right. Down it is what say sealed on all the four sides of the flask, here it is sealed and here it is sealed, here it is sealed and here it is sealed. Now the pattern is withdrawn.

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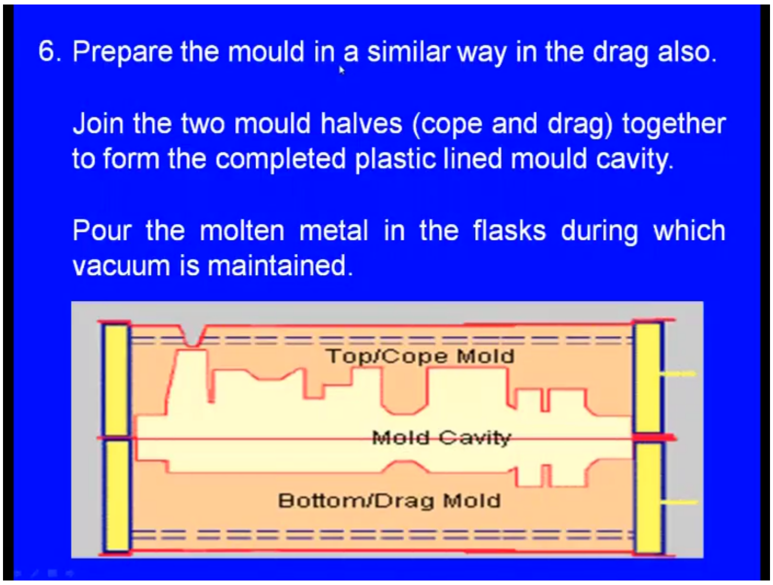


Now prepare the mould in a similar way to the drag also. So far we have seen how to prepare the mould for the cope. In a similar way, we have to prepare the mould for the drag also. Now these are to be joined. Join the mould halves cope and drag together to form the completed plastic lined mould cavity. So this is the cope and this is the drag remember this is the cope, for the cope at the top and the bottom there is a polymer what say sheet is there. It is covered and concealed by polymer film. For the drag also both at the top and the bottom there is polymer film and it is concealed by polymer film.

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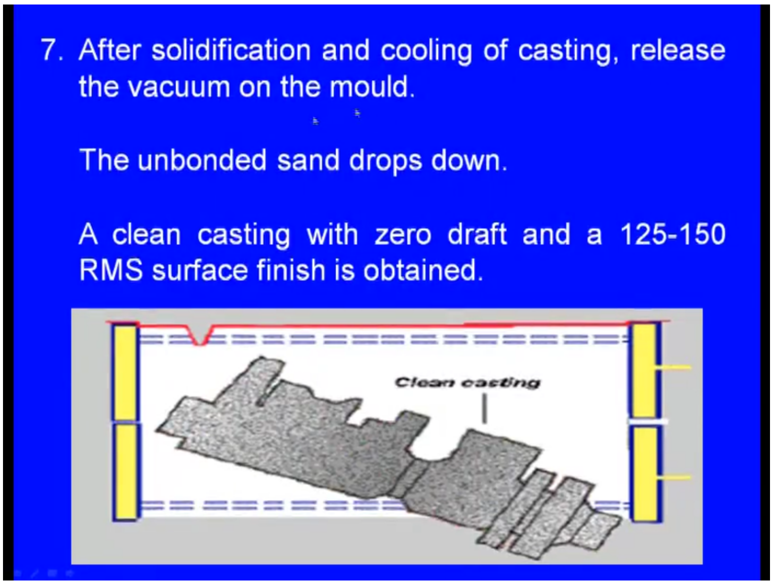


Next one after solidification and cooling of the casting, release the vacuum on the mould. Now we have to pour the molten metal, here we have to pour the molten metal. During pouring of the molten metal this polymer film will be burnt, but the molten metal is straight away going there is no what say gap between the moulding sand and the molten metal that is why, the vacuum will be intact. So the vacuum will be there and the molten metal will be filling the cavity. So this continues vacuum continues till the solidification is over and after solidification and cooling of the casting release the vacuum on the mould.

Then what will happen the unbounded sand will be dropping down a clean casting with zero draft and a 125 to 150 RMS surface finish will be obtained. So this is the finished casting. So these are the important steps involved in the vacuum sealed moulding process. Now what are the advantages of vacuum sealed moulding simplified sand control.

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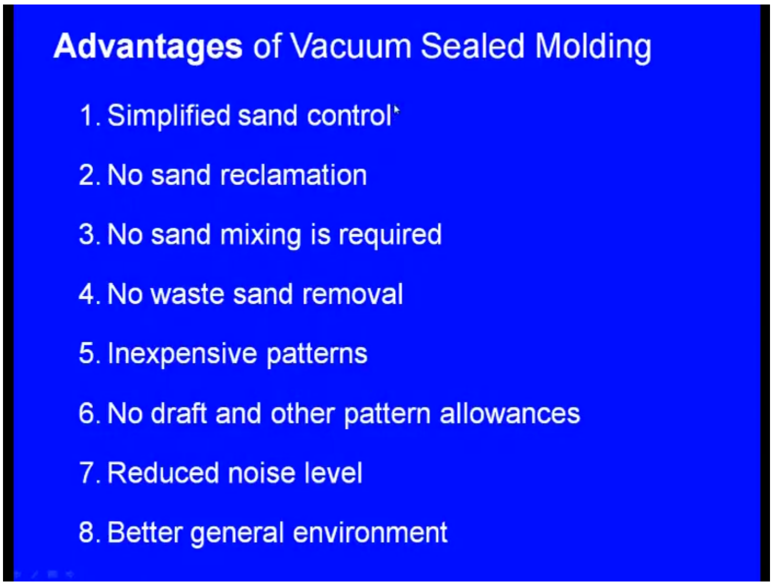


First of all there is no sand control in the case of the green sand moulding, so we prepare the green sand by mixing base sand, moisture, clay and the additives. So, this ingredients are to be controlled very carefully, otherwise the molding set may not have the required properties. So, here that sand control problem is not there, just take the dry sand and use it for the making the mould so simplified sand control. Next one no sand reclamation means what is that? In the case of the green sand molding after the casting is solidified, we have to shake out means break the sand into pieces the mould into pieces. Then that sand has to be taken, again that should be what say crushed into small small pieces if any metallic pieces are included those are to be removed if any sand lumps are included those are to be removed.

So this is the sand reclamation again, it should be conditioned with the moisture and a little more clay, this is the reclamation. Here there is no question of reclamation, straight away that sand can be taken and another mould can be made. No sand mixing is required, that is true. Next one no waste sand removal. In the case of the green sand molding, every time when we pour the molten metal, little sand is wasted. So here, no waste of sand here. Next one inexpensive patterns, casting patterns are not very costly. Next one no draft and other pattern allowances, in the case of the sand molding green sand molding we give draft to the pattern.

So that during withdrawal of the pattern it would be easier to withdraw the pattern and also pattern is given certain allowances and here draft is not required because we are not withdrawing the pattern. The way we use to withdraw in the case of the green sand molding once you we release the vacuum automatically pattern will be removed. So no draft is required and other pattern allowances are also not required. So that is how there will be minimum machining. Next one reduced noise level. In the case of the green sand molding, there will be noise will be there, noise will be generated. Sand will be mulled in a sand Muller. So that causes noise and there will be sand conditioning plant will be there because of that noise will be generated and here, no noise is generated. In fact, there will be very little noise will be there.

Next one better general environment, in case of the green sand molding, we mix the sand, we mix the clay, we mix the additives because of that there will be pollution will be there and here there is no pollution. Here there will be a better environment. Next one reduced cleaning costs in the case of the green sand molding, we have to take the casting by a shakeout break the mould into 2 or 3 pieces, take the casting outside. Then, it should be cleaned because sand will be adhering to the casting by water cleaning or by pressurized air the casting has to be cleaned. Here, there is no such cleaning. Once we withdraw the vacuum, the casting falls down and the sand here as in the case of the green sand molding sand will not be sticking to the casting.

So here the cleaning cost is reduced. Next one reduced smoke and fumes in the case of the green sand molding because we are mixing clay and mixture then we pour the molten there will be smoke and fumes. So that will not be there in the case of the vacuum sealed molding and no shake out. You see here. So just they release the vacuum, the solidified casting will be falling down. No sand lumps, better finish on the castings, better dimensional accuracy because we are not giving any pat what say pattern allowances. No draft allowance and other allowances will be very minimum. That is, how there will be better dimensional accuracy in the case of the vacuum sealed molding and less energy consumption, why? Because we are not running any sand Muller.

We are not running any sand conditioning what say plant just take the dry and clean sand and use it. That is how there will be lesser energy consumption. Next one reduced pattern maintenance. In the case of the green sand molding the pattern will be kept inside molding box and a sand will be compacted because of that the pattern will be undergoing wear or sometimes it will be damaged and it has to be repaired or it must be replaced. In the case of the vacuum sealed molding the patterns life will be very longer because they are not compacting the sand. We are not applying any mechanical force that is how the life of the pattern will be longer compared to the Green sand molding.

Now these are the limitations of the vacuum sealed molding. What are these limitations? One is skilled workers are required. Yes, in the right time the vacuum must be applied and the vacuum must be applied to the required degree. So that requires the skill

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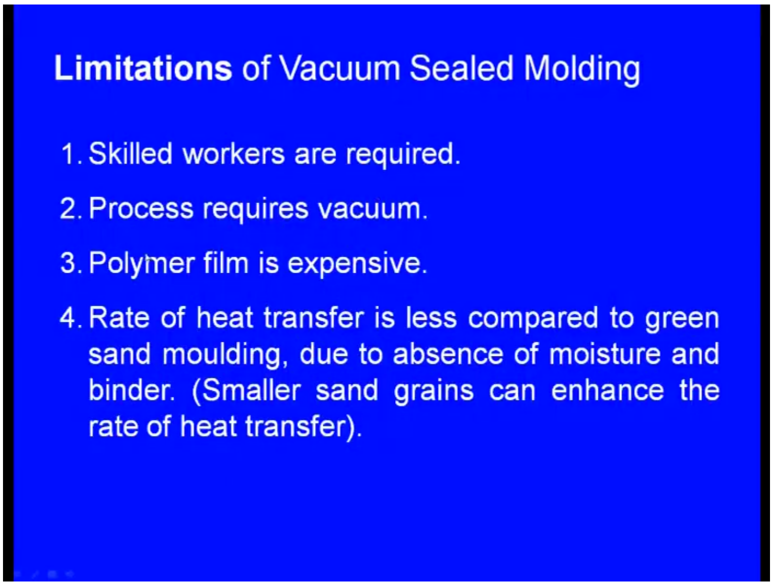


So that is how skilled workers are required. Next one process requires vacuum. The vacuum machines these are costly and that is how the cost of the production goes up. Again, we use the polymer film to what say conceal the molding box, to conceal the molding sand at both at the top and the bottom, we use the molding film what say vacuum polymer film. So that is how the process becomes expensive. Next one rate of heat transfer is less compared to green sand molding, why? In the case of the green sand molding, there will be moisture because of the moisture the heat transfer would be maximum.

But here there is no moisture in the molding sand that is how heat transfer will be less compared to the green sand molding. But however, you can see here smaller sand grains can enhance the rate of heat transfer. So we have seen that in the case of the vacuum sealed molding, we use clean and dry unbounded sand. But if the sand grains are smaller, so they enhance the rate of heat transfer. But remember that this sand what say sand this dry sand of smaller grain means small what say the grain finest number will be maximum or higher grain finest number such a sands cost will be higher.

Now, what are the process parameters of this vacuum sealed molding? or the V-process? Molding sand based variables type shape size and size distribution. Type means there are different types of the sands are there: silica sand, olivine sand, zircon sand. So, these are the types of the sand.

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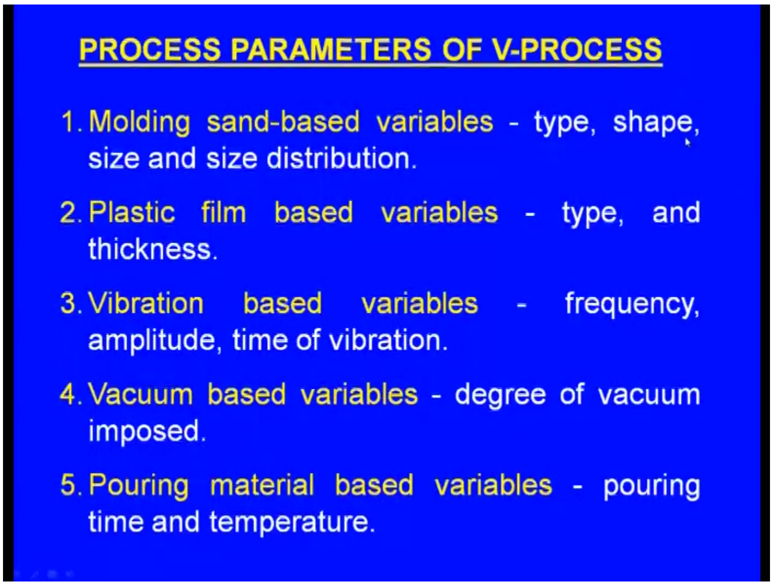


Next one is the shape, the common shapes are the round, angular and sub angular. So these shapes also will be influencing the molding process. Next one size and size distribution. Next one plastic film based variables - type and thickness. Next one vibration based variables – frequency amplitude and time of vibration. What is the frequency of vibration and what is the amplitude and what is the time of vibration?

So these parameters would influence the quality of the casting. Next one vacuum based variables. What is that? Degree of vacuum imposed. Next one pouring material based variables - pouring time and temperature. What is the pouring temperature and what is the pouring time? These parameters would influence the quality of the casting. Now here, we can see Ishikawa diagram of the vacuum sealed molding process. So here, we can see there are 5 types of parameters are there. So these are the sand parameters. So these are the alloy parameters. So these are the vacuum parameters. These are the plastic film what say parameters and these are the vibration parameters and of the sand parameters sand type.

What type of sand it is? Is it the silica sand, Zircon sand, Olivine sand? And here, we can see, this is the shape. Is it angular, circlu what say round or sub angular? Next one what is its size, Fine or coarse size distribution? Next one degree of vacuum. Plastic film variables: type and thickness. Next one vibration: time, amplitude, frequency. And alloy: pouring temperature, pouring time. So, all these parameters would influence the quality of the casting.

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Important process variables and their typical ranges

| Process parameter | Range |
|---|---|
| Sand size | 5 - 150 AFS mesh |
| Vibrating frequency | 10 – 36 Hz |
| Vibrating time | 10 – 50 seconds |
| Degree of vacuum | 250 – 350 mm Hg |

Important process variables and their typical ranges, now, we can see here sand size 5 to 150 AFS mesh can be used. Vibrating frequency 10 to 36 Hertz, vibrating time 10 to 50 seconds, degree of vacuum 250 to 350 mm of the mercury. And here, we can see a modern vacuum moulding plant, looks like this. Next one again, a modern vacuum moulding plant looks like this.

So with this, we are completing the vacuum sealed moulding. Now we will start the squeeze casting process. Squeeze casting process is also known as Liquid metal forging.

Squeeze casting is a method combining casting and forging technologies. What are the steps in the squeeze casting process?

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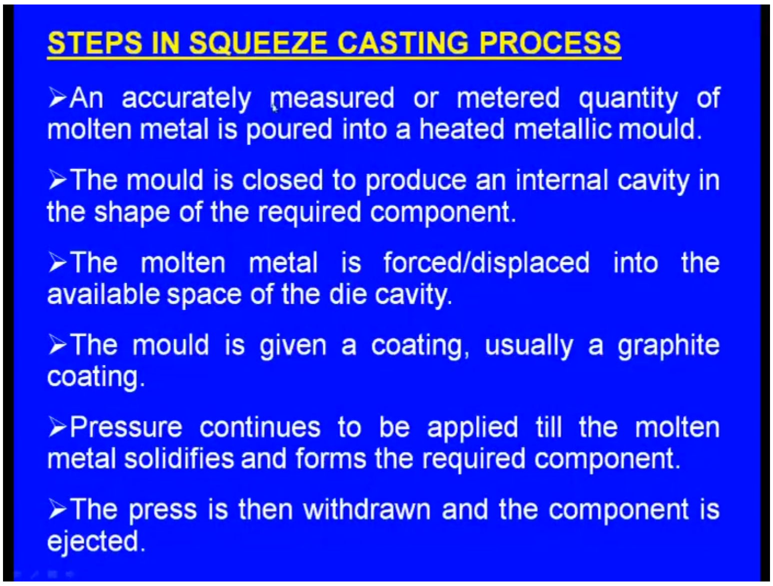


An accurately measured or metered quantity of molten metal is poured into a heated metallic mould. Here a metallic mould is used, similar to the die casting.

But there is a difference. The mould is closed to produce an internal cavity in the shape of the required component. The molten metal is forced, displaced into the available space of the die cavity. After the molten metal is poured into the metallic mould, it is forced into the available space of the die cavity. Before that the mould is given a coating, usually a graphite coating. Pressure continues to be applied till the molten metal solidifies and forms the required component.

So here, we can see the basic difference between the whatsay Squeeze casting process and the Die casting process. In the case of the die casting process, we apply the pressure. So that the molten metal will be injected into the die cavity. Once the molten metal is injected inside the die cavity, we stop applying the pressure. But here the pressure continues to be applied till the molten metal solidifies and forms the required component. So that is the difference between the die casting and the squeeze casting process. The press is then withdrawn and the component is ejected and here we can see an illustration.

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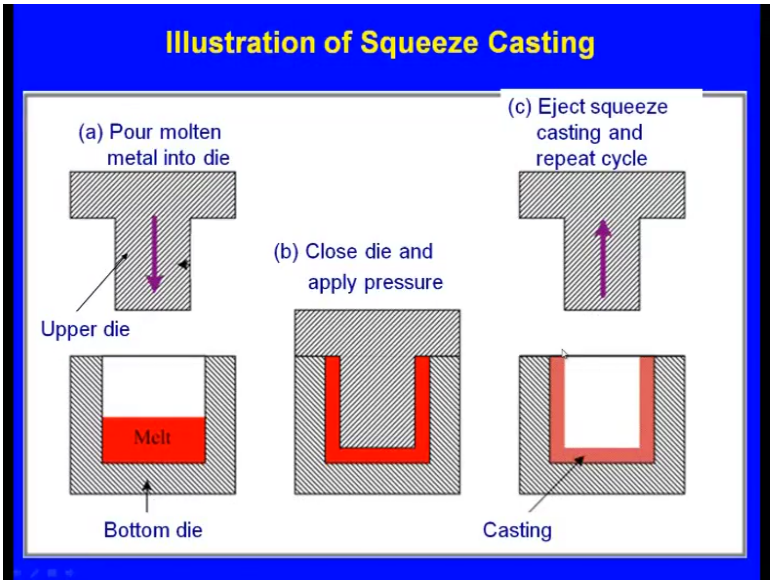


So, this is the die metallic die and here this is the upper die and here we can see the molten metal is poured into the die. Then, the upper die comes down and presses. Yes, it has pressed here. We can see here and you remember this pressure will be applied till the molten metal is completely solidified. Yes, after sometime the molten metal will be completely solidified. Then, the upper die will be withdrawn and it will be going up. Now this is the solidified casting.

So this is the simple principle of the squeeze casting process. Now, what is the classification of squeeze casting process? Broadly, it is classified as direct squeeze casting and the other one is the indirect squeeze casting process. So 2 types, one is the Direct squeeze casting and the other one is the Indirect squeeze casting. Under the direct squeeze casting there are 2, 2 more what say sub classifications are there With molten metal movement that is one type, another one is Without metal movement. Under the Indirect squeeze casting there are 4 types are there, one is the Vertical clamping and injection, second one is the Horizontal die closing and Vertical injection, third one is the Vertical die closing and Horizontal injection and the fourth one is the Horizontal clamping and Horizontal injection.

First we will see, what is this direct squeeze casting? And what is this indirect squeeze casting? We will see the difference between these two and we will see the sub classifications.

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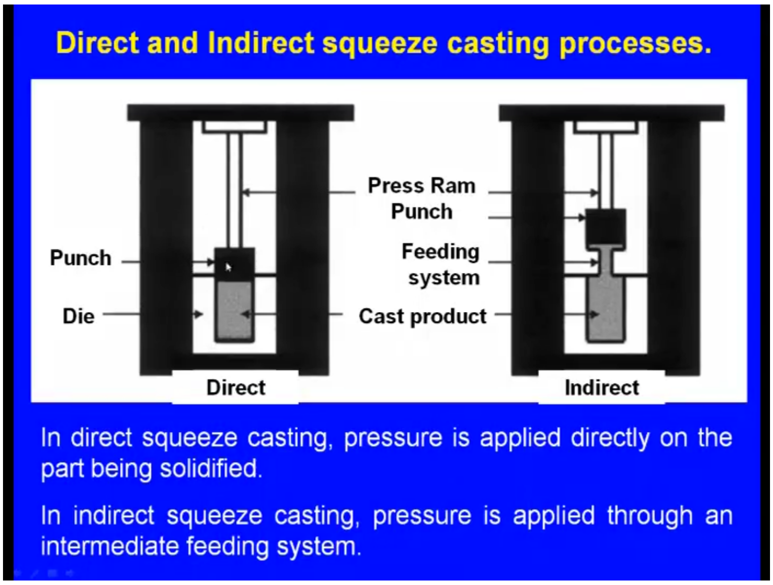


So here, we can see this is the direct squeeze casting and this is the indirect squeeze casting and here we can see, this is the die, this is the die and here also this is the die. Now this is the punch here, this is the punch and here also, this is the punch. Now the molten metal, this is the die and the molten metal is poured here and the punch is coming down and it is applying pressure on the molten metal. And here we can see, this is the molten metal.

So this is the feeding system. So this feeding system is not there in the case of the direct squeeze casting. So between punch and the molten metal, there is feeding system. Now after the molten metal is filled with the die cavity, the punch comes down and applies pressure till the solidification is over, that is the difference between the direct and indirect squeeze casting process. So in the case of the direct squeeze casting, pressure is applied directly on the part being solidified. So this is the part being solidified and the punch is directly coming and applying pressure on the part being solidified. Yes, we can see in this diagram.

But in the case of the indirect squeeze casting process, pressure is applied through an intermediate feeding system and here we can see this is the feeding system this feeding system is not part of the casting. Now the pressure is applied on this feeding system. Now this feeding system in turn will apply pressure on the part being solidified.

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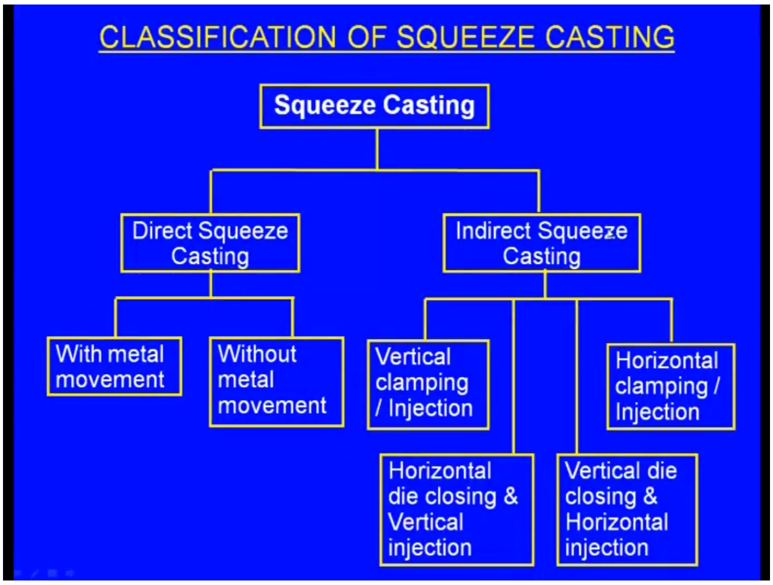


So we have seen, the difference between the direct squeeze casting process and the indirect squeeze casting process. Now let us concentrate on the direct squeeze casting process. So under the direct squeeze casting process, we have 2 types one is the with metal movement and the other one is the without metal movement. Let us see, what are these?

So in the case of the whatsay direct squeeze casting process, there are 2 types. We have already seen, without metal movement and with metal movement and without metal movement, we see here. So this is the die, this is the die and this is the molten metal and the punch is directly coming down and it is applying pressure downwards. Yes, here it is in that punch is totally closing and it is applying pressure. After the whatsay application of the pressure, after the solidification of the component the punch is going up, the component is rejected or the it is ejected. Now, what we can see here? There is no metal movement here, only application of the pressure that is all. No metal movement. But in the case of the with metal movement category, let us see here.

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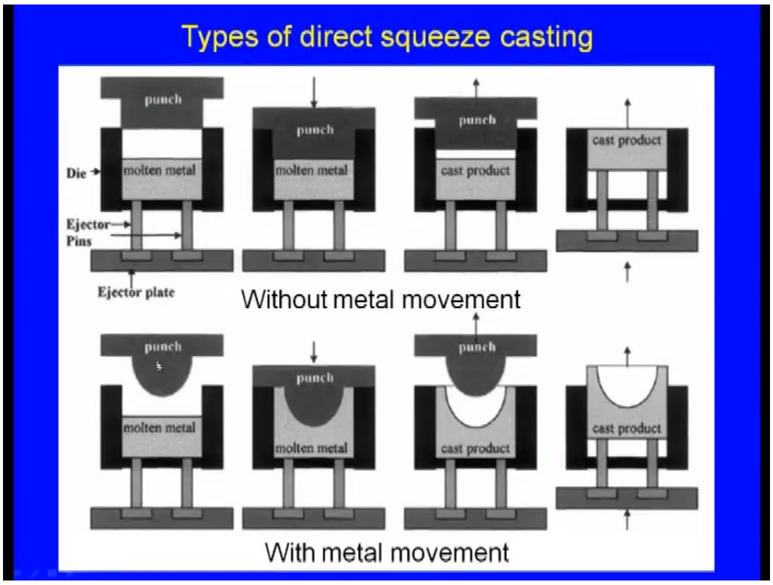


So this is the whatsay die and this is the molten metal and this is the punch. This punch comes down and applies pressure on the molten metal. As the punch is coming down, you see, what will happen? The metal will be, some metal will be displaced from its previous position, you see here. So, there is a metal displacement is there or metal movement is there. Then, the part solidifies. After solidification of the part, the punch goes up and the component will be ejected, that this is the component. So these are the whatsay 2 types and the difference between the 2 sub categories of the direct squeeze casting process with metal movement and without metal movement.

So, the one without metal movement is suitable for making ingot type components whereas, the one with metal movement is suitable for casting wide range of shaped components. Where we want to make only ingot type of components, there we can go for the first one, the one without metal movement. If we want some comp what say complex shaped components then, we have to go for the other one, means the one with metal movement. Now, we can see an illustration, direct squeeze casting with metal movement. Yes, this is the die and molten metal is being poured, the blue colored one is the molten metal.

So this is the upper die or the punch. So this will be coming down and applies pressure on the molten metal and here you can see it is squeezed, the molten metal is squeezed here and molten metal is solidifying here. After solidification of the molten metal, it is ejected and here remember there is metal movement because of the whatsay complex shape of the component. Now let us concentrate on the indirect squeeze casting process.

So in the indirect squeeze casting process, there are 4 types. Vertical clamping and Vertical injection, Horizontal die closing and Vertical injection, third one is the Vertical die closing and Horizontal injection and the fourth one is the Horizontal clamping and Horizontal injection.

Now this is the Vertical clamping and Vertical injection and here we can see. So these are the dies. So these dies will be closed vertically and this is the injection and the molten metal is coming here and this is the plunger. This plunger pushes the molten metal into the dies and it will be pressing till the solidification is over. Here we can see Vertical clamping and Vertical injection. Next one Horizontal die closing and Vertical injection.

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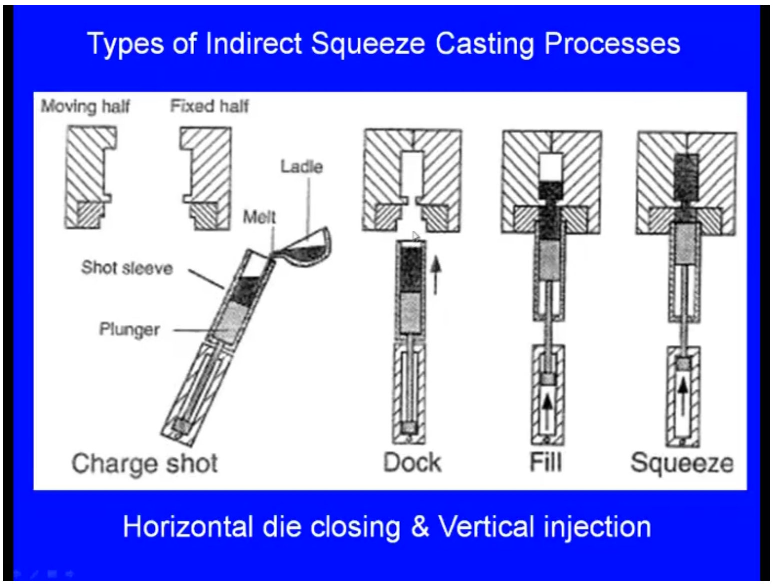


So here, we can see this is one die and this is one die. So they will be closing horizontally. Then, what will happen? So here we can see, this is the molten metal. The molten metal will be injected into to the die cavity. So here, it is the vertical injection. Then after injection, so it the pressure continues to be applied till the solidification is over. After solidification, the dies will be withdrawn and the solidified casting will be taken out. So here, it is the Horizontal die closing and Vertical injection.

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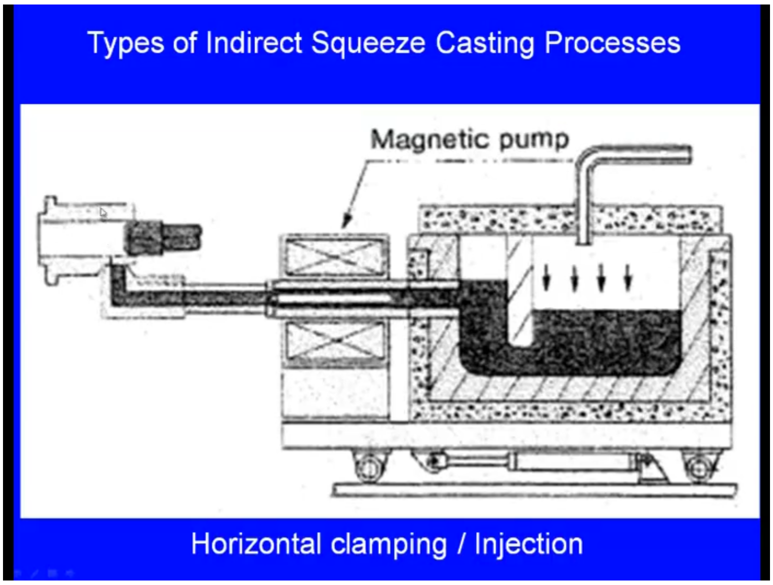


Finally, Horizontal clamping and Horizontal injection and here we can see these, these are the dies, these are the dies and they are closed what say clamped horizontally and this is the whatsay punch.

So, the molten metal is coming here, like this it is coming and it will be going inside the die cavity and here there is a piston, this piston will be applying pressure on the molten metal and continues to apply pressure till the solidification will be over. So here, it is the horizontal clamping and horizontal injection. Now development of this squeeze casting process.

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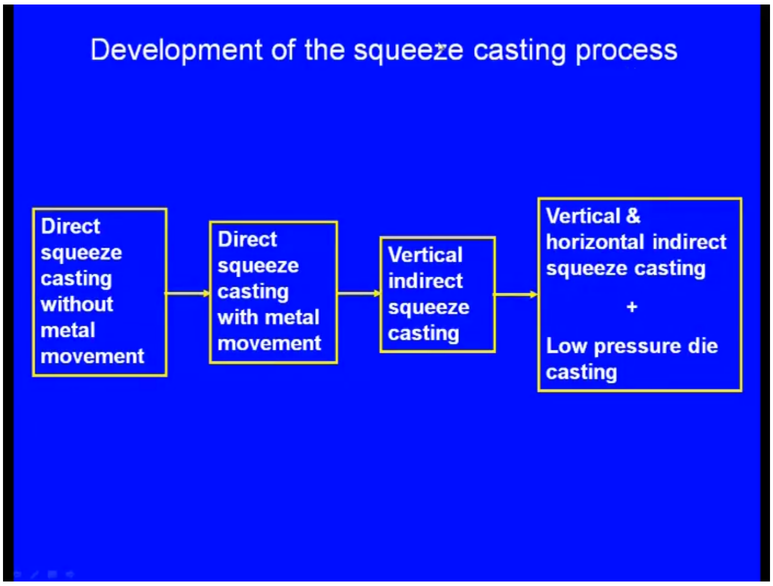

What are the steps involved? We have seen that what say squeeze casting is there are different types of squeeze casting process; one is the direct squeeze casting without metal movement or direct squeeze casting with metal movement or so on. What to use, when? We can see here, this is the block diagram for the whatsay use of the different process.

So here first, we can use the direct squeeze casting without metal movement means here the whatsay ingots or the blocks are made where there is no metal movement. Next one direct squeeze casting with metal movement after making the ingots, next we can make the parts, here metal movement is there. Next one vertical indirect squeeze casting. So, here also ver what say metal movement will be there. Next one here we can see, from there vertical and horizontal indirect squeeze casting plus low pressure die casting. So these are the whatsay final process, where we can get the final components.

Now, what are the advantages of squeeze casting process? Parts of fine details can be produced. Sometimes, we may come across a components, where there will be what say very fine details will be there on the component. Then, what happens? If we choose any other casting process so the molten metal, may not fill those fine details. Here because we are applying pressure on the molten metal, whatsay molten metal will be squeezed and it will be injected into those fine details. So, parts of fine details can be produced very easily. Now shrinkage defects are very less.

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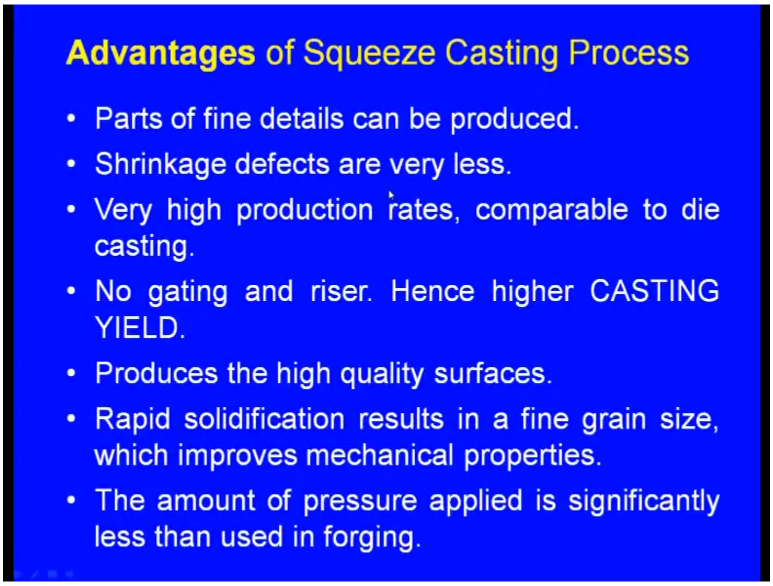


Why? Because, we are applying pressure and the pressures will be applied till the solidification will be over, that is why there will be very less shrinkage defects. Very high production rates comparable to die casting. No gating and riser. Hence higher Casting Yield. There is no gating system here and also no riser. What is this Casting yield? You see, casting yield is defined by weight of the casting divided by weight of the poured metal multiplied by 100. In the case of the sand casting, the casting yield will be 70 to 80 percent, means if we are what say melting 100kgs of molten metal, we can make only 80kgs of the casting, 20kgs of the molten metal is not used for making the component.

As the casting yield becomes higher and higher it would benefit the industry. But here the casting yield is hundred percent. Produces the high quality surfaces because the moulds are made up of the metallic bonds, we get the very good surface finish. Next one rapid solidification results in a fine grain size which improves mechanical properties solidification is very rapid why? Because the moulds are metallic ones because the moulds are metallic once they absorb heat rapidly, that is how we get the fine grains and because of that there will be good mechanical properties. The amount of pressure applied is significantly less than used in the forging. Forging is the whatsay process where we get very good mechanical properties. But the amount of pressure applied in the case of the forging is very much, is tremendous. That much force we need not apply here, but we get the almost same properties here. The amount of pressure applied is significantly less than the one which is used in the forging.

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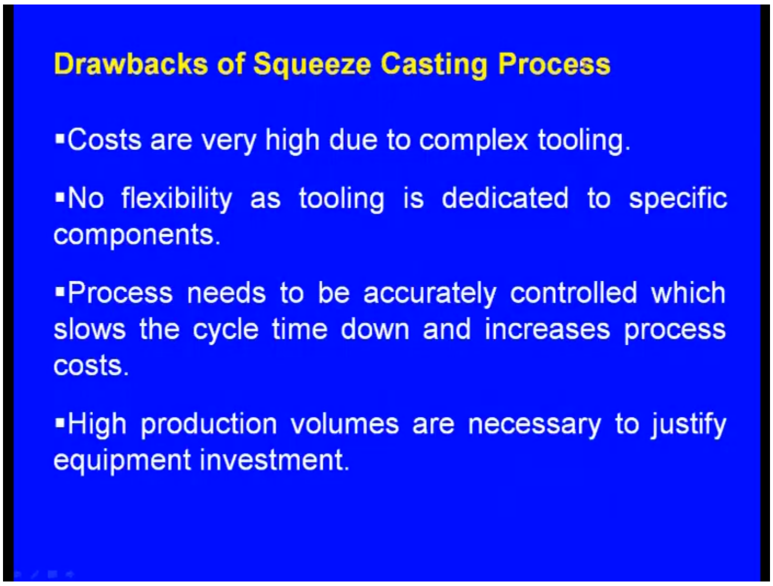


Now, these are the drawbacks of squeeze casting process. Costs are very high due to complex tooling. No flexibility as tooling is dedicated to specific components. So that tooling means these dies are meant for making particular components. If we want to make some other components, these dies are to be changed. That is how the cost would go up. Process needs to be accurately controlled which slows the cycle time down and increases process costs. Process needs to be accurately controlled. Next one high production volumes are necessary to justify the whatsay initial whatsay investment. Sand casting, if we take even 5 components, 10 components can be made. But once we procure, procure this squeeze casting what say machine, so high production volumes must be there, otherwise the cost we cannot justify.

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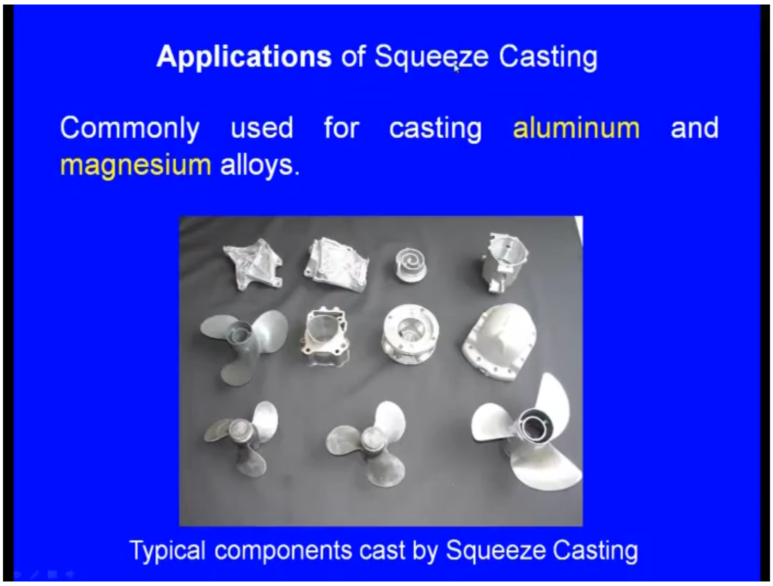


Now these are the typical applications of the squeeze casting. Now it is commonly used for casting aluminum and magnesium alloys. Remember, squeeze casting is used for aluminum and magnesium alloys and these are the typical components produced by squeeze casting process, you can see here. So this is a whatsay fan blade. So, all these are made by squeeze casting process.

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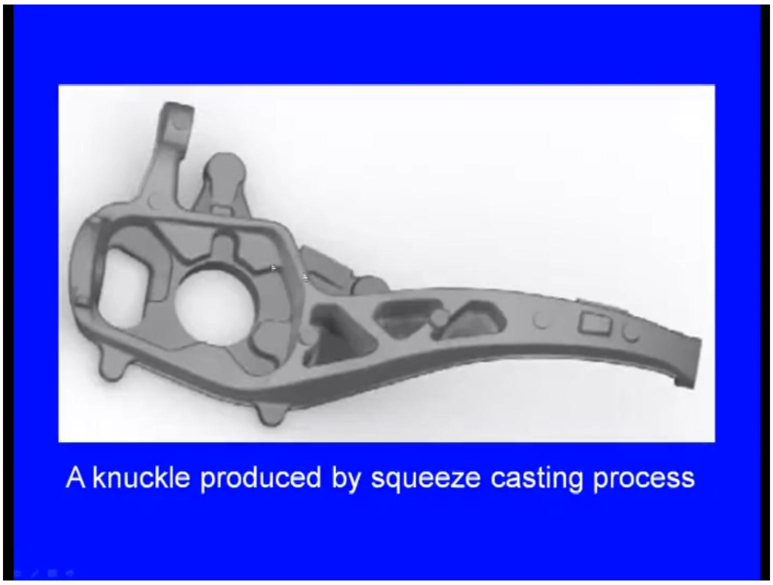


A knuckle produced by squeeze casting process, you can see here. It has got very fine details and this is produced by squeeze casting process.

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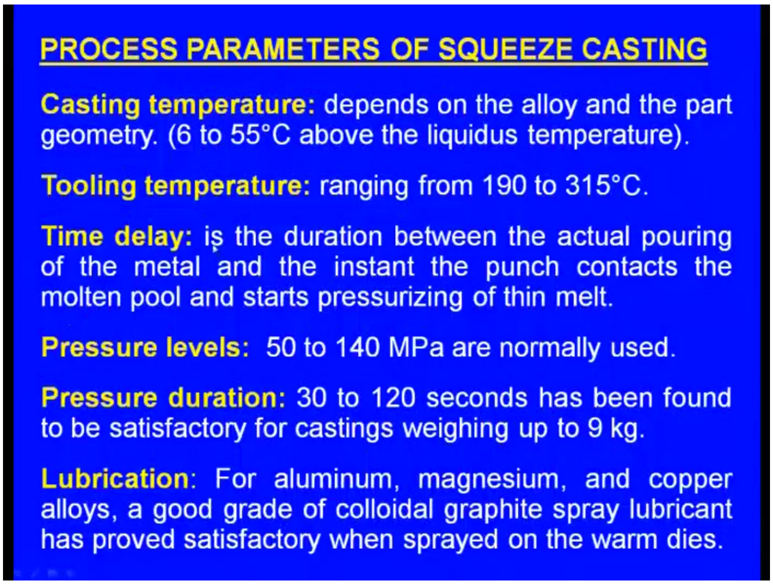


Now what are the process parameters of squeeze casting process? One is the Casting temperature. Now, this casting temperature depends on the alloy and the part geometry and this casting temperature should be 6 degrees to 55 degrees centigrade above the liquidus temperature.

Next one, next parameter is the Tooling temperature. The tooling temperature will be ranging from 190 degrees to 315 degrees centigrade. Next one is the Time delay. What is this time delay? It is the duration between the actual pouring of the molten metal and the instant the punch contacts the molten metal and starts pressurizing a of thin melt. So this is the time delay. Next one Pressure levels 50 to 140 mega pascals are normally used. Next one, Pressure duration 30 to 120 seconds has been found to be satisfactory for castings weighing up to 9 kilograms.

Next one, Lubrication, for aluminum, magnesium and copper alloys, a good grade of colloidal graphite spray lubricant has proved satisfactory when sprayed on the warm dies. So what is the lubricate lubricant used? It is the colloidal graphite spray. Now what is the difference between the squeeze casting and to its nearest casting process? So now, we have learnt several what say casting what say process, die casting we have learnt, gravity die casting we have learnt, semi solid what say process we have learnt and today, we have learned the squeeze casting process. What are the difference between the squeeze casting and its nearest casting process? Now, first let us see the difference between the Die casting and the Squeeze casting. In the case of the die casting, pressure is applied while filling the mould cavity and not after filling. Yes, here also we use the metallic mould, in the case of the die casting and in the case of the squeeze casting also we use the metallic mould. But in the case of the die casting, pressure is applied as long as the molten metal is filled with the in inside the cavity, once the whatsay cavity is filled with the molten metal we stop applying the pressure.

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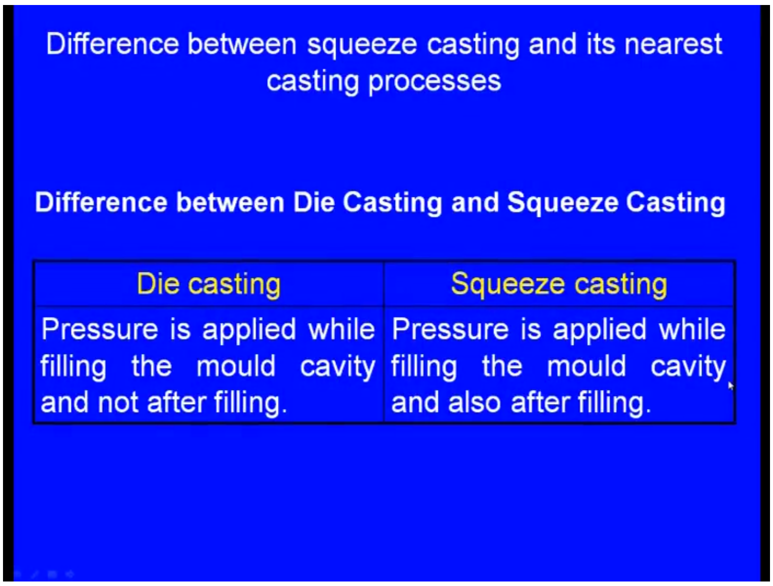

In the case of this squeeze casting pressure is applied, while filling the mould cavity and also after filling, not only during filling also after filling, till the cast component is solidified. That way die casting and squeeze casting are different.

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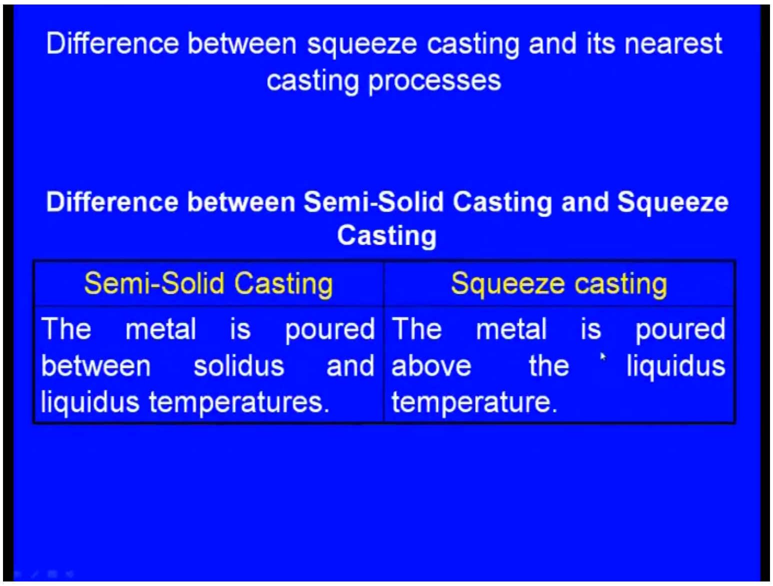


Next one let us see the difference between semi solid casting and squeeze casting. In this case of the semi solid casting the metal is poured between solidus and liquidus temperatures whereas, in the squeeze casting the metal is poured above the liquidus temperature not below the solidus line.

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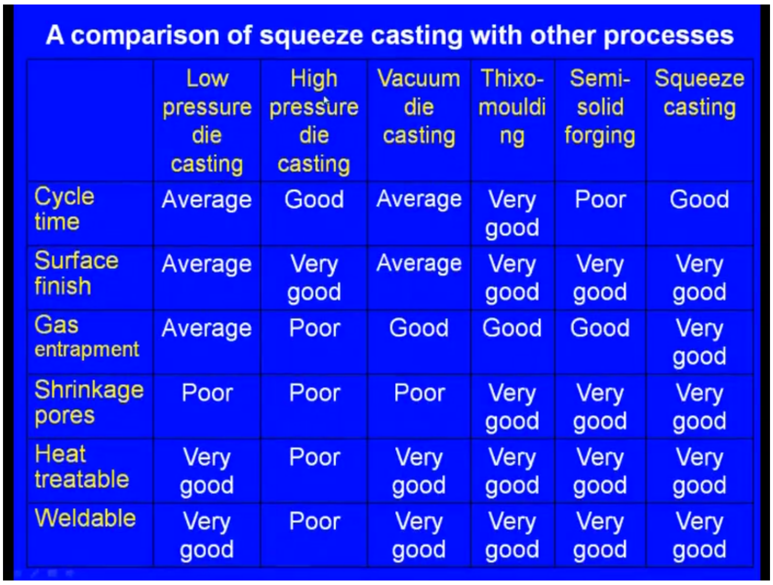

A comparison of squeeze casting with other processes

| | Low pressure die casting | High pressure die casting | Vacuum die casting | Thixo-moulding | Semi-solid forging | Squeeze casting |
|---|---|---|---|---|---|---|
| Cycle time | Average | Good | Average | Very good | Poor | Good |
| Surface finish | Average | Very good | Average | Very good | Very good | Very good |
| Gas entrapment | Average | Poor | Good | Good | Good | Very good |
| Shrinkage pores | Poor | Poor | Poor | Very good | Very good | Very good |
| Heat treatable | Very good | Poor | Very good | Very good | Very good | Very good |
| Weldable | Very good | Poor | Very good | Very good | Very good | Very good |

Now, let us see a comparison of squeeze casting with other process. Here we can see Low pressure die casting that is one and let us take another process High pressure die casting. Next let us consider Vacuum die casting. Next let us consider Thixo-molding, this is a semi solid what say casting process. Semi solid forging and finally, this is the Squeeze casting which is today's subject. Now let us consider some properties: Cycle time, Surface finish, Gas entrapment, Shrinkage pores, Heat treatability and Weldability. Now in the case of the Low pressure die casting, cycle time is average, surface finish is average, gas entrapment is average, shrinkage pores poor, heat treatability very good, weldability very good.

In the case of the High pressure die casting, cycle time is good, surface finish very good, gas entrapment poor, shrinkage pores poor, heat treatability poor and weldability poor. In the case of the Vacuum die casting, cycle time average, surface finish average, gas entrapment good, shrinkage pores poor, heat treatability very good and weldability very good. In the case of the Thixo-molding process, cycle time is very good, surface finish is very good, gas entrapment good, shrinkage pores very good means very what say shrinkage pores will be very less or may not be there, may not be any shrinkage pores that is a meaning. Next one Heat treatability very good and Weldability very good. In the case of the Semi solid forging, cycle time poor, surface finish very good, gas entrapment good, shrinkage pores very good, heat treatability very good and weldability very good.

In the case of the Squeeze casting process, let us see now. Cycle time good, surface finish very good, gas entrapment very good, shrinkage pores very good means shrinkage pores will be very minimum. Sometimes, there may not be any shrinkage pores, that is the meaning. Next one heat treatability very good and Weldability very good. Now it we review all this whatsay properties and all this process, what we can observe, in the case of this squeeze casting process, every property is very good; only in case of the cycle time it is good. Otherwise, all the properties are very good. So that way, squeeze casting is superior to its nearest casting process.

Now let us see the cost wise performance, a comparison of the component properties and cost. Let us compare the properties and the cost and here we can see Sand casting, here Die casting, Gravity casting, Rheo casting, Squeeze casting, this is the Forging.

So these are the process, we are considering now and this is a graph, where x axis x axis represents the component properties and y axis indicates the whatsay cost of production.

In the case of the sand casting, the properties are poor and cost is also whatsay very low. In the case of the die casting, the properties are better compared to the sand casting, but cost is little higher. Gravity die casting, the properties are better than die casting and cost is almost same and in the case of the Rheo casting, the properties are significantly improved and the cost is almost same. But in the case of the squeeze casting, we can see here properties are fairly improved, but the cost is little higher, little higher than the sand casting and other what say casting process. Now here we can see this is the forging.

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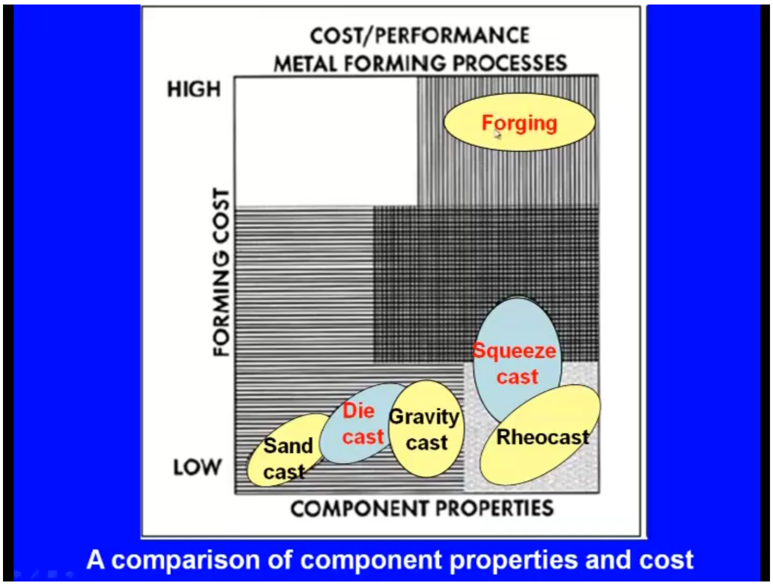



Now when we look at this forging, one thing we can notice, properties are very good. We can see these are x axis indicates the component properties, properties are very good, but what about the cost of production, cost of production is also very high in the case of the forging. But in the case of this squeeze casting, the properties are same as forging, you see, the properties are same as forging, but the cost of the production is almost one third of the cost of the production of forging. That way, it gives us very good mechanical properties at much lesser cost of production.

So this is the whatsay cost and properties comparison of the squeeze casting process. Now again, we can see a comparison of the squeeze casting with other what say process. (Refer Slide Time: 41:27)

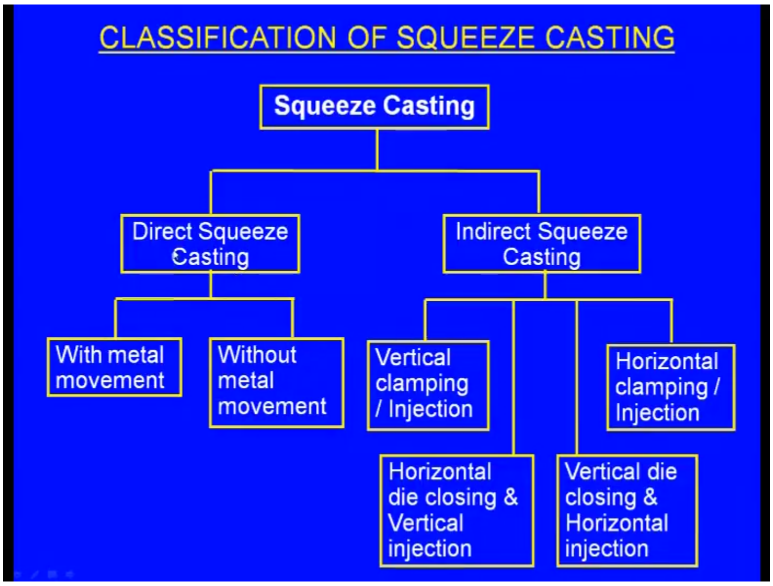
A comparison of squeeze casting with other processes

| Characteristics | Squeeze Casting | Forging | Die Casting | Sand Casting |
|---|---|---|---|---|
| Shape Complexity | High | Low | High | High |
| Surface Roughness | Fair | Poor | Fair | Coarse |
| Mechanical Properties | High | High | Poor | Fair |
| Dimensional Accuracy | Good | Fair | Good | Poor |
| Level of Porosity | Few | Limited | High | Medium |
| Availability for Anodization | Good | Good | Poor | Poor |
| Availability for Heat Treatment | Good | Good | Poor | Good |
| Productivity | High | Good | High | Fair |
| Needs for Secondary Machining | Few | High | Few | High |
| Casting Cost | Medium | High | Low | Medium |

So this is what say we will consider squeeze casting, forging, die casting and sand casting and here we can see the properties: Shape Complexity, Surface Roughness, Mechanical Properties, Dimensional Accuracy, Level of Porosity, Available for Anodization, Availability for Heat Treatment, Productivity, Needs for Secondary Machining and Casting Cost and when we look at the squeeze casting, shape complexity very high what say complex features can be obtained. Surface roughness fair and mechanical properties are high, dimensional accuracy good, level of porosity few and availability for anodization good, availability for heat treatment good, productivity high, needs for secondary machining few, very few cases we need what say secondary machining and casting cost is medium not very high. But in the case of the forging, you see, shape complexity low, surface roughness poor, mechanical properties high, dimensional what say accuracy fair, level of porosity limited, availability for anodization good, availability for heat treatment good, productivity good, needs for secondary machining very high and casting cost is very high you can see here.

And in the case of the die casting, shape complexity high, surface roughness fair, mechanical properties poor, dimensional accuracy good, level of porosity high, level of anodization poor, availability for heat treatment poor, productivity high, needs for secondary machining few and casting cost low. And with the sand casting, shape complexity is very high, surface roughness very coarse, mechanical properties fair, dimensional accuracy is very poor, level of porosity medium, availability for anodization poor, availability for heat treatment good, productivity fair, needs for secondary machining very high. Next one casting cost medium.

So in that way also squeeze casting proves to be superior compared to forging, die casting and sand casting. Now in today's lecture, we have learnt two special casting process. One is the vacuum sealed molding process. So here, we use clean unbounded sand dry and unbounded sand for making the sand mould and for that purpose for what say rigidly for rigidly holding the sand, we have to apply the vacuum. So that is how, this is also known as V-process. So this gives us a very good environment and the cost of production will be very good, reasonable and we have also learned squeeze casting. (Refer Slide Time: 44:02)




And the squeeze casting we have seen, there are 2 types: one is the Direct what say Squeeze Casting and the other one is the Indirect Squeeze Casting. Again, direct squeeze casting is classified as with metal movement and without metal movement. Indirect squeeze casting is classified as Vertical clamping, Vertical Injection, Horizontal closing and Vertical injection, Vertical die closing and Horizontal injection and finally, horizontal clamping and Injection.

So with this, we are completing this today's lecture, that is whatsay Vacuum Sealed Molding and the Squeeze Casting Process. We will meet in the next class.

Thank you.