# Manufacturing Process-I

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## Module - 2
## Lecture - 6
## Metal Casting

Good morning. We have seen that metal casting is the primary manufacturing process. In fact, it was the oldest manufacturing process. In the earlier episodes we have seen the principle of metal casting and the different terms that come across in the metal casting process. We have also seen the classification of the metal casting process.

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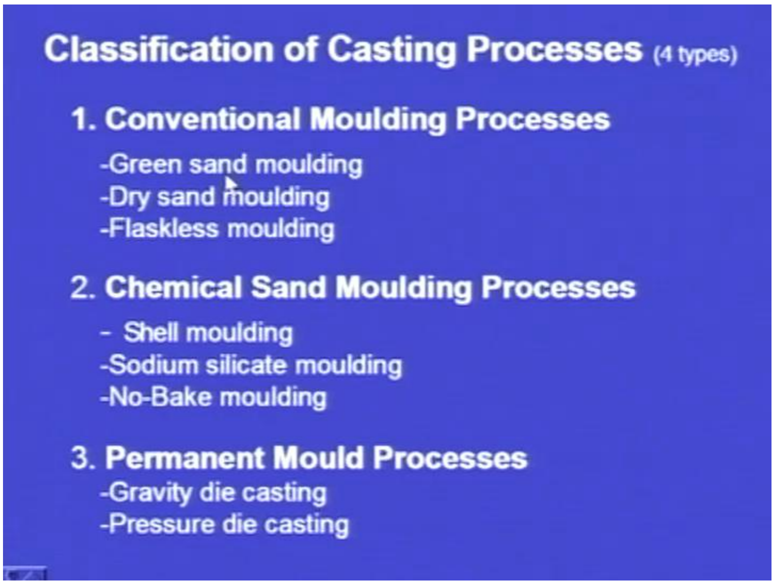


The metal casting process is broadly classified into four types: conventional moulding process; second one chemical sand moulding process, third one permanent mould process, and the fourth one special casting process.

And again the conventional moulding process, it is divided into green sand moulding, dry sand moulding, and flaskless moulding. We have learnt this in the previous episodes.

And the chemical sand moulding process, they are classified as shell moulding, sodium silicate moulding and no-bake moulding. These also we have learnt in the previous episodes.

And in the permanent mould process, the material is made up of a metal or an alloy. Again, this is classified as gravity die casting and pressure die casting. These we have learnt in the previous episodes.

And the fourth classification of the casting process is the special casting process.

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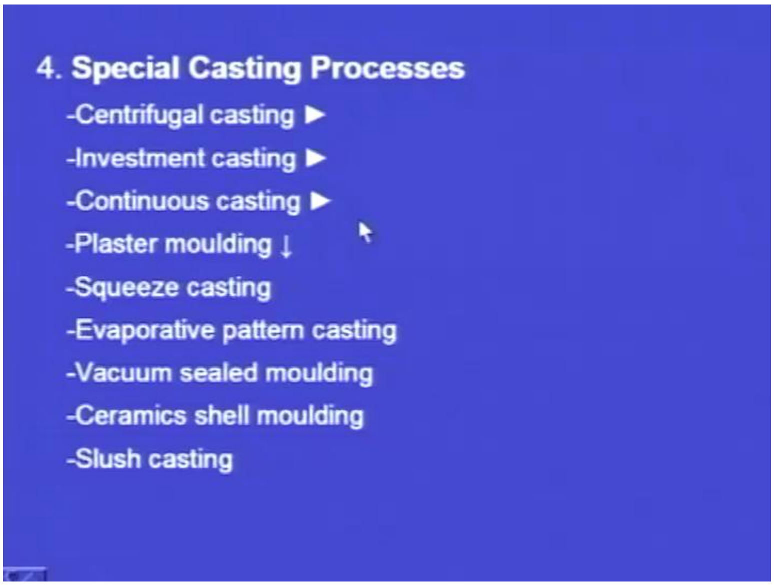


There are namely nine types of special casting process. One is, centrifugal casting process; second one, investment casting process; third one, continuous casting process; fourth one, plaster moulding; fifth one, squeeze casting; sixth one, evaporative pattern casting; seventh one, vacuum sealed moulding; eighth one, ceramics shell moulding and ninth one, slush casting.

Among this, in the previous episode we have seen the centrifugal casting, investment casting and the continuous casting. In the centrifugal casting we use metallic mould and the metallic mould is rotated at a predetermined speed. At that time we pour the molten metal.

In the case of the green sand moulding or in the other casting process, the molten metal is poured into the cavity by virtue of gravity. Here, the molten metal is occupying the cavity by virtue of the centrifugal force falling on it. Because of the centrifugal force falling on it the metallic the molten metal is occupying the mould cavity and the mould continues to rotate until the molten metal solidifies. When the molten metal solidifies, we stop rotating and we eject the casting outside.

Again, we have seen, that the centrifugal casting is sub-classified into three types: one is true centrifugal casting, the other one is semi-centrifugal casting and the third one is the centrifuging.

One of the advantages of the centrifugal casting process is, the casting yield is 100 percent in most of the cases. And we have seen the investment casting, which we call it as precession casting also. We also call it as last wax process. This process is used where extreme precision is important, where extreme tolerance is important, extreme dimensional tolerance is important, we use this process. Here, we use wax as the pattern material. And its advantages and its limitations and applications we have seen in the earlier episode.

We have also seen the continuous casting in which the casting is continuously made. We have seen, that there are three types: vertical continuous casting, horizontal continuous casting and continuous casting in traveling mould. We have seen the applications of this process and its advantages and limitations. In continuous casting also, the casting yield is 100 percent. So, among the special casting process we have learnt centrifugal casting, we have also learnt investment casting and we have also learnt continuous casting. Today, let us see the plaster moulding.

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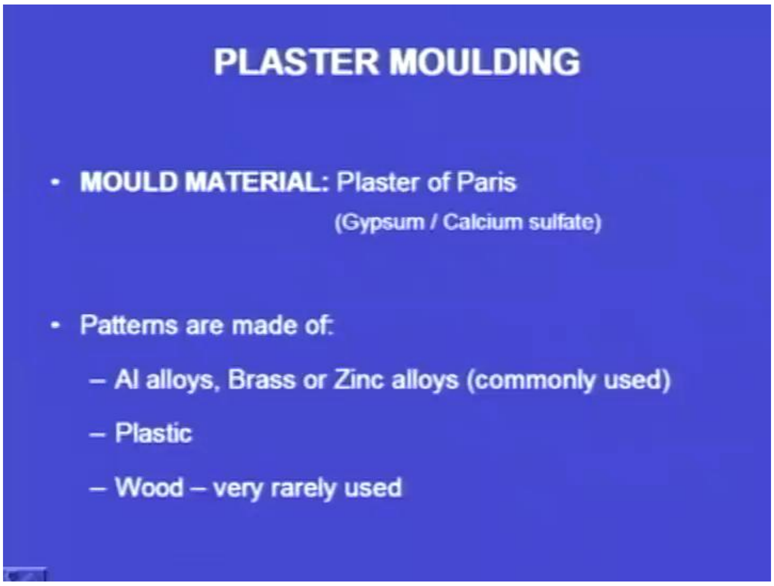


Plaster moulding, here the mould material is Plaster of Paris. It is made up of gypsum or calcium sulfate, that is, the plaster of, that is the mould material. In the case of the conventional casting process, the mould material is sand. In the case of the die casting, the mould material is a metal or an alloy. In the case of the investment casting, the mould material is wax. Here, the mould material is Plaster of Paris. And what is the pattern made up of? In most of the cases the patterns are made up of aluminum alloys, brass or zinc alloys. These are widely used. Sometimes plastic is also used and wood very rarely used.

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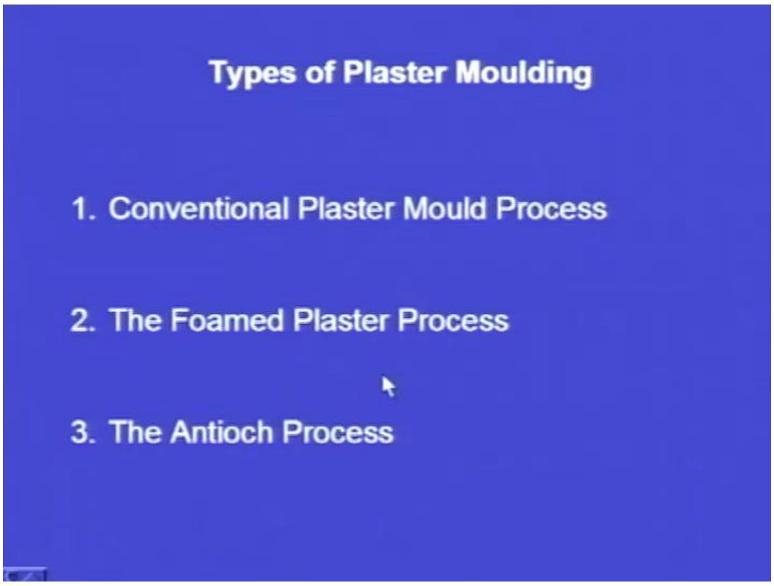


And types of plaster moulding. One is conventional plaster moulding process. Second one, the foamed plaster process and the third one, the Antioch process.

Let us see this process in detail. First, let us see the conventional plaster moulding process.

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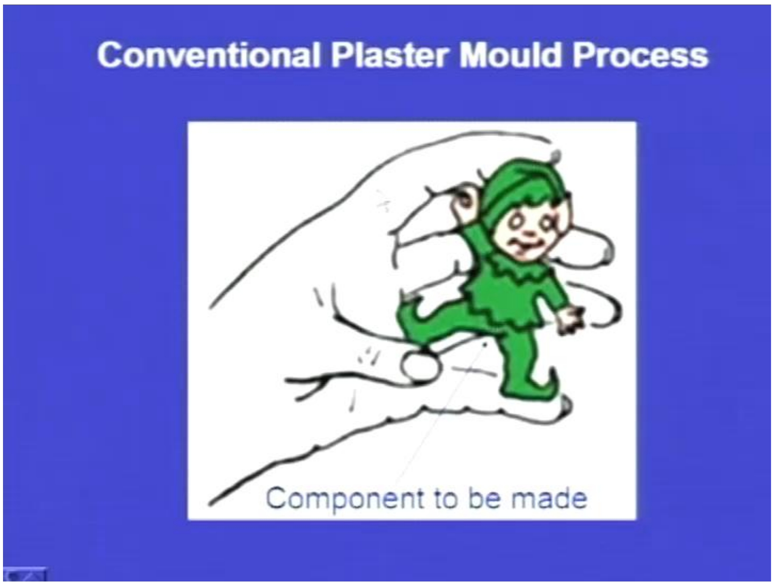


The conventional plaster moulding process. So, let us take a small example. So, let us say, this is the casting to be made. This kind of casting we want to make. So, this kind of pattern we will be using. This kind of, preferably a metallic pattern will be used.

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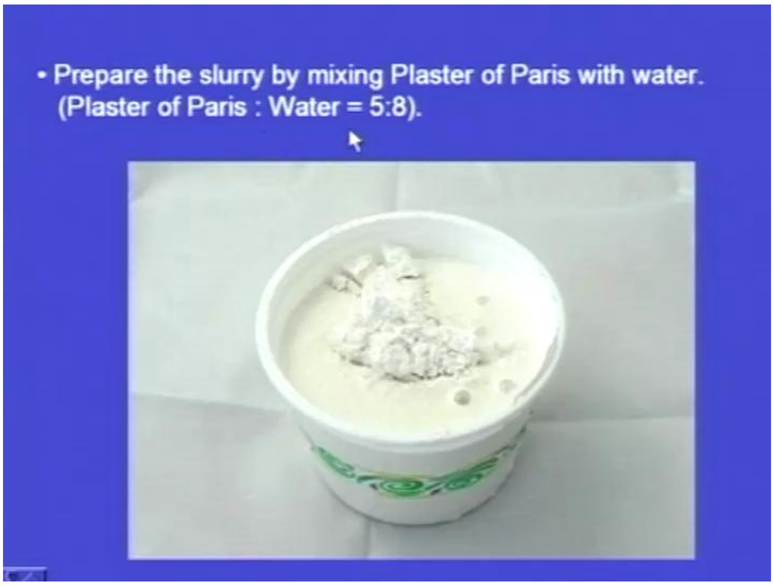


And next, we have to prepare the slurry by mixing Plaster of Paris with water. Plaster of Paris is to water, that ratio is 5 is to 8, means 5 parts of Plaster of Paris and 8 parts of water. We will mix Plaster of Paris with water and we make a slurry. The slurry will looks like this. So, this is the Plaster of Paris slurry.

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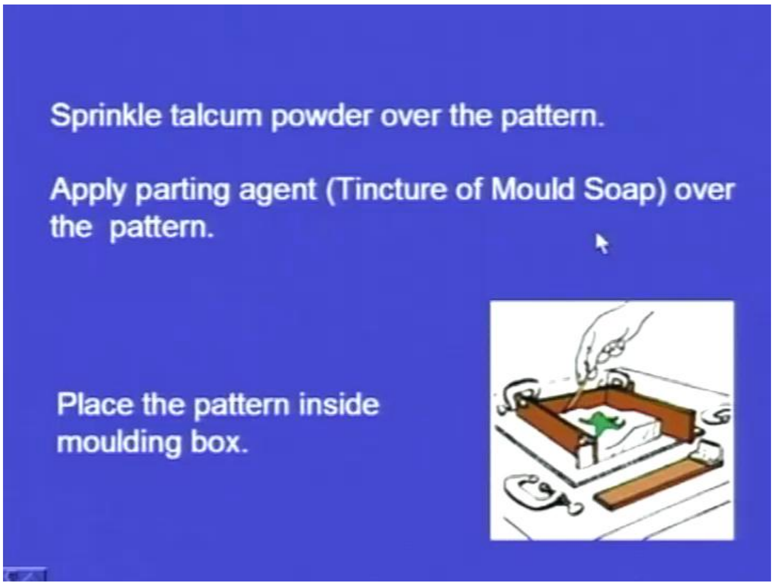


Next one, we have to sprinkle talcum powder over the pattern to get a fine finish over the cavity surface. Next one, apply parting agent, which is the Tincture of Mould Soap over the pattern. So, this helps us for parting purpose, so that the plaster will not be sticking to the pattern.

Next one, place the pattern inside the moulding box. Here, we are, this is the moulding box and here we are placing the pattern. In most of the cases we have to split the pattern, one like the way we do in the conventional sand casting process, one half will be moulded in the drag, other half moulded in the cope.

However, sometimes if we split the pattern, alignment will become a problem. If the upper half of the pattern and the lower half pattern are not properly aligned, it will become a problem, the casting will be defective.

So, if it is difficult to make a split pattern, we, instead of making a split pattern what we can do is, here we have taken a bed of clay. Over the bed of the clay we have just pressed the pattern, so that half of the pattern will be going inside the bed of the clay. Now, over this, in the remaining surface we will fill with the Plaster of Paris.

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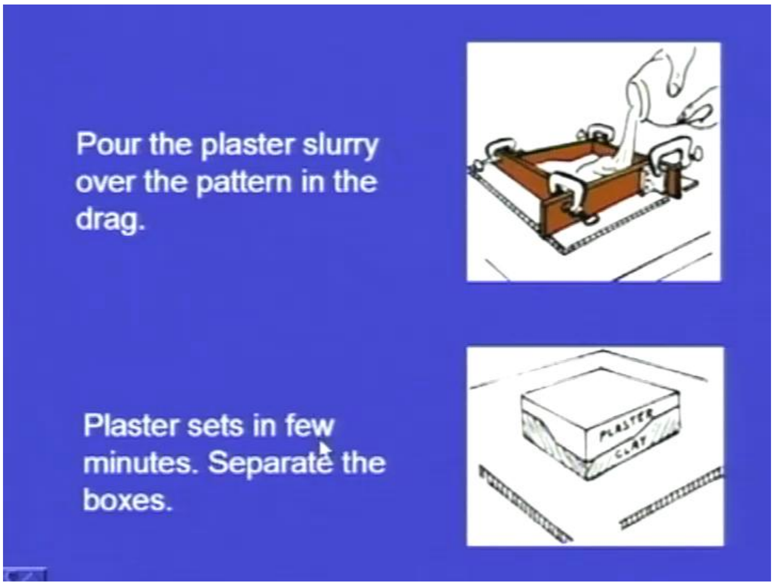


Now, pour the plaster slurry over the pattern in the drag. Now, we are pouring the plaster of slurry. Inside there is a pattern and that pattern is pressed over a bed of clay, and the plaster sets in few minutes. Then, we have to separate these boxes. We have clamped these boxes. These boxes are to be separated. We can see here, this is the plaster region here. This plaster we have poured and this is the bed of clay where we have pressed the pattern.

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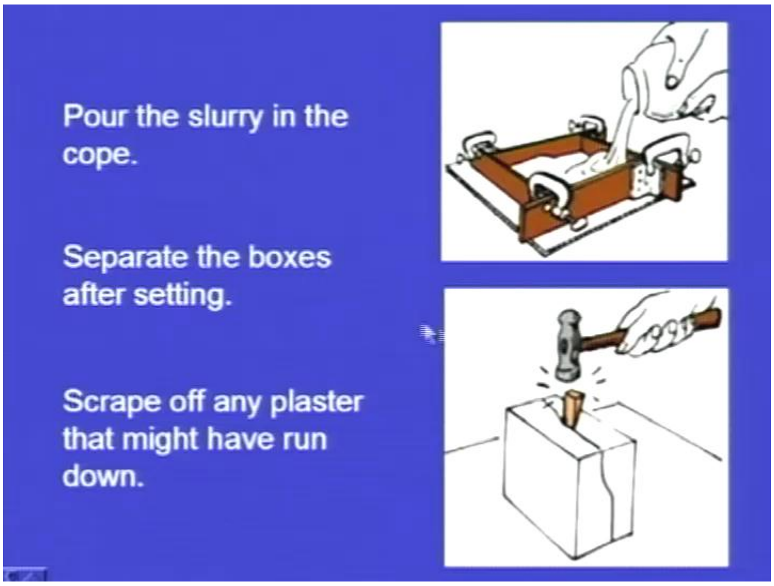


Next one, pour the slurry in the cope box also. Means, already one drag pattern box is already prepared over. That means, the drag box is prepared over a bed of clay. Now, that bed of clay will be removed.

Now, we will make the system upside down, so that the portion of the pattern, which was pressed in the bed of clay will be upside now. In that position, now you pour the slurry in the cope box and after 15 minutes the slurry will be setting. It will become hard again.

We have to separate the boxes. After separating the boxes, the two boxes joint together will be looking like this. Remember, inside there is pattern. So, far we have not withdrawn the pattern. Now, there is a possibility, that little amount of slurry plaster, slurry might have run across the sides, that slurry we have to break off making a small hammer. Using a small hammer and a chisel we have to break off. We have to scrap off that small amount of slurry that might have run over the sides of the plaster moulds.

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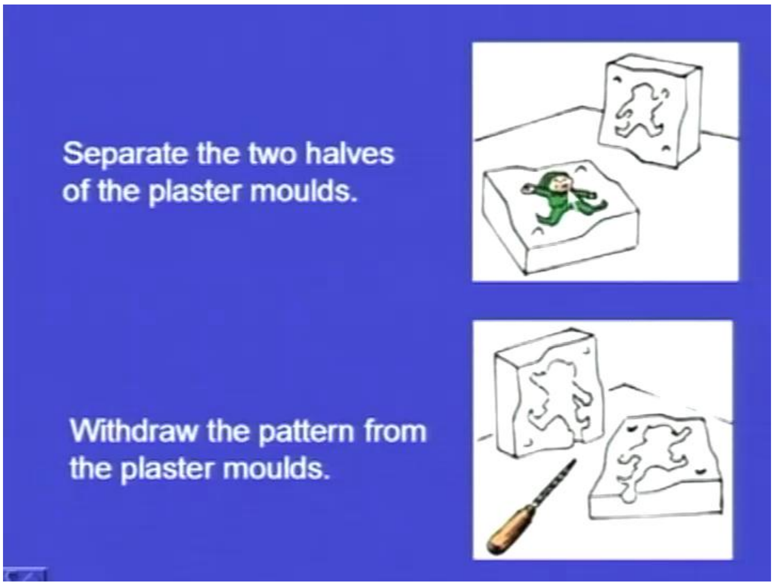


Next one we have to separate these two plasters, plaster moulds. Yes, we have separated here and inside there is the pattern. Now, we have to withdraw this pattern carefully, so that the cavity will not be damaged. Yes, we have withdrawn the patterns.

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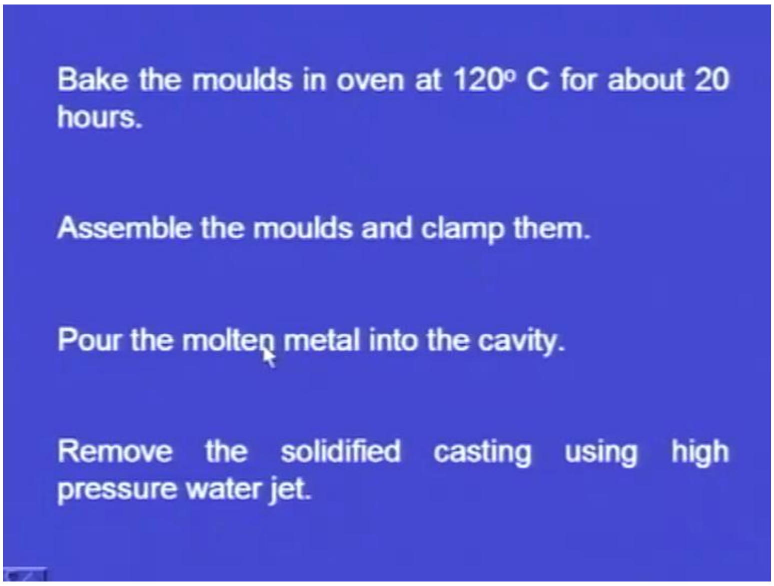


Now, we have to bake these plaster moulds in an oven, for 120, at 120 degrees for about 20 hours. This takes time, but this is required to impart required strength to the plaster moulds. Next, after baking is over, assemble the moulds and clamp them. Then, pour the molten metal into the cavity. The molten metal flows into the cavity and it fills and after sometime the molten metal solidifies.

After solidification is over, next we have to remove the solidified casting and for that purpose we use high pressure water jet. Using high pressure water jet we remove the solidified casting from the plaster moulds.

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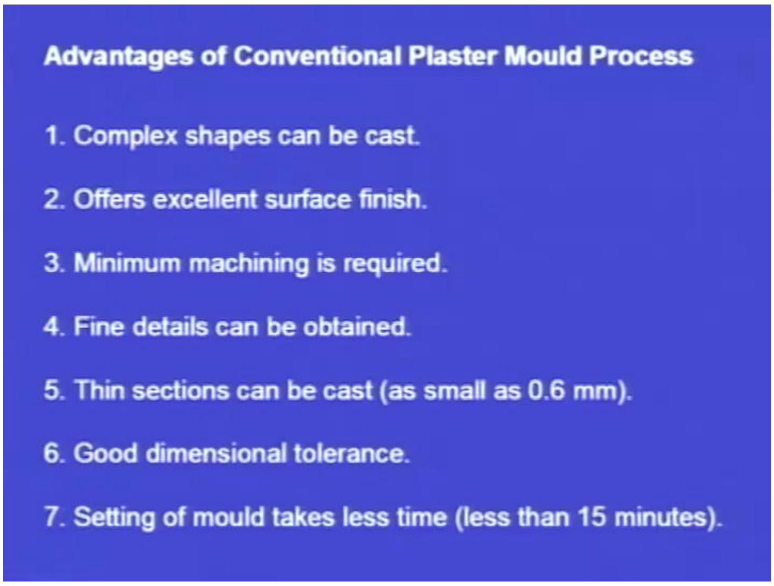


So, we have seen the different steps involved in the plaster moulding process, how to make the plaster mould and how to pour the molten metal, how to bake the plasters, plaster moulds, we have seen.

And let us see the advantages of the conventional plaster moulding process. One is, complex shapes can be cast. Yes, even the example that we have studied is a complex shaped one. Complex shapes can be cast and it offers excellent surface finish.

In the case of the conventional sand casting process, the mould is made up of sand and because of the sand the surface of the cavity will be rough and the casting, finally obtained will be rough.

But here, the mould material means made up of plaster. The plaster creates a fine surface finish inside the cavity. The result is, we get excellent surface finish on the solidified casting. So, minimum machining is required, fine details can be obtained. The casting may be big at somewhere, small details may be there, which may be small.

If it is a sand casting process, the molten metal may not flow inside that small detail. But in this case, the molten metal flows inside the small details and this small details can be successfully cast. Thin sections can be cast successfully; thin sections as small as 0.6 mm can be cast.

And good dimensional tolerance in the case of the conventional sand casting process. The cast size of the casting, that we finally obtain, will be more than the size of the casting, which is actually required. For that we have to machine it, which requires efforts and which requires time.

Here that problem is not there. The final size of the casting we obtain will be the size of the casting actually required. So, it possess good dimensional tolerance and the setting of the mould takes 115 times, 15, sorry, 15 minutes. Of course, we bake it for few hours, for setting takes only 15 minutes.

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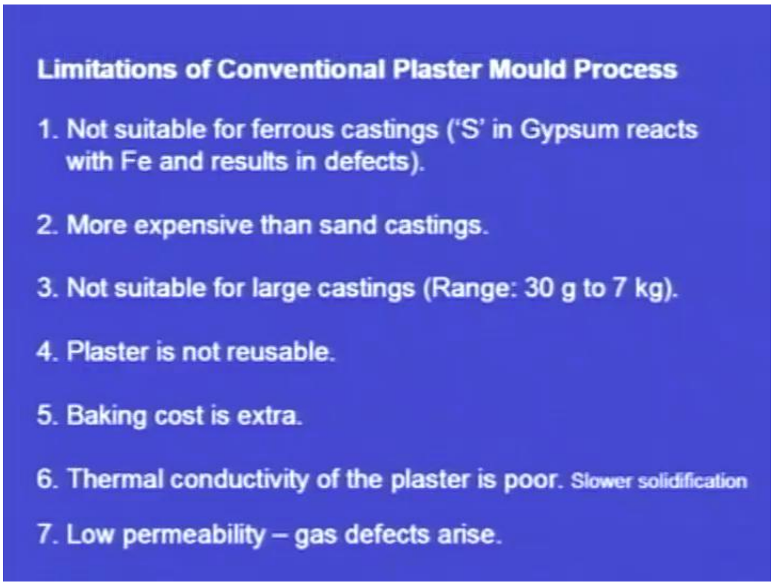


Now, let us see the limitations of this conventional plaster moulding process. This process is not suitable for making ferrous castings, why? Because in the gypsum, that is, in the Plaster of Paris sulfur is present. This sulfur reacts with iron and it leads to defects. So, the Plaster of Paris mould cannot be used for making iron castings. It is used only for nonferrous castings.

This process is more expensive in the case of the conventional sand casting process. What is the mould made up of? It is made up of sand. This sand is not so costly, but here the mould material is plaster and it is costly and that be used only once. In the case of the sand casting process, the sand can be used again and again, but in the case of the, plaster of, Plaster of Paris process, the plaster can be used only once and it is very costly. So, the whole process is very expensive.

And this process is not suitable for making large castings. Maximum, we can make up to 7 kgs, say, the range is 30 grams to 7 kgs. Yes, I have already told this plaster is not reusable only once in the case of the conventional sand casting process. We can use the sand again and again here only once. So, that increases the cost of production.

And baking cost is extra. Yes, after the plaster is set we have to bake it for about 20 hours. For 20 hours we have to keep the plaster mould in an oven and we have to run the oven for 20 hours that increases the cost of production.

Next one, thermal conductivity of the plaster is poor, that is well known. Then, what happens when we pour the molten metal? It takes more times for solidification. So, the process becomes delayed. This, this is another drawback of Plaster of Paris process.

And finally, the regarding the permeability. In the conventional sand casting process we have seen one important property, that is, the permeability. The moulding sand possess a property called permeability where the moulding sand allows hot gases to pass through it. Yes, when we pour the molten metal, hot gases are generated. These hot gases will be passing through the moulding sand. So, that is the permeability property.

Here, in the case of the plaster moulding, the permeability of the plaster is very poor and when we pour the molten metal, if the hot gases are generated how they will escape? Sometimes they may be struck up inside the mould cavity and results in defects; they result in gas defects.

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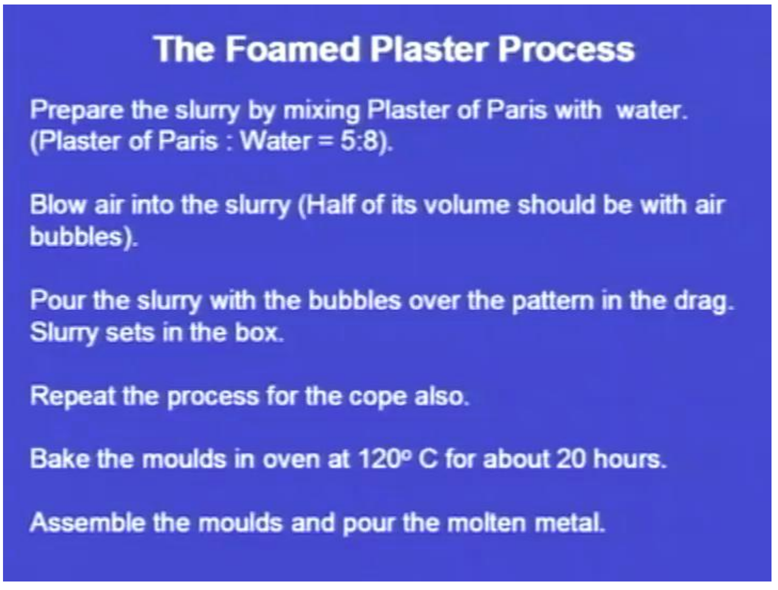


Next one, let us see the, the second type of the plaster moulding, that is, the foamed plaster process. In fact, this is an improved version of the conventional plaster moulding process. One of the drawback or the major drawback of the conventional plaster moulding process is, the permeability is very poor. Gas defects arise because of this poor permeability. So, in this process, in this improved process we will make an attempt to improve the permeability of the mould. Let us see how we will do this.

First one, prepare the slurry by mixing Plaster of Paris with water; Plaster of Paris each to water ratio is 5 is to 8, means, Plaster of Paris 5 parts and water 8 parts. Next one is, blow the air into the slurry. Half of the volume should be filled with air bubbles. So, this is very important, half of the volume should be filled with the air bubbles.

At this stage pour the slurry with the bubbles over the pattern in the drag. Slurry sets in an, in an about some 20 or 30 minutes. Next, repeat the process for the cope box also in the same way the way we have done for the conventional plaster moulding process. The slurry sets in about 30 minutes. Next, bake the moulds in oven at 120 degrees for about 20 hours.

Now, what happens is, we have used the slurry with air bubbles. We have poured the slurry over the pattern where air bubbles are present. Now, under this stage when it is allowed to dry, under this stage when it is allowed to bake there will be permeability. The gas bubbles will be dried up and they will leave some porous holes in the plaster mould. So, the permeability is increased. Next, assemble the moulds and pour the molten metal. So, in this process we are increasing the permeability of the system.

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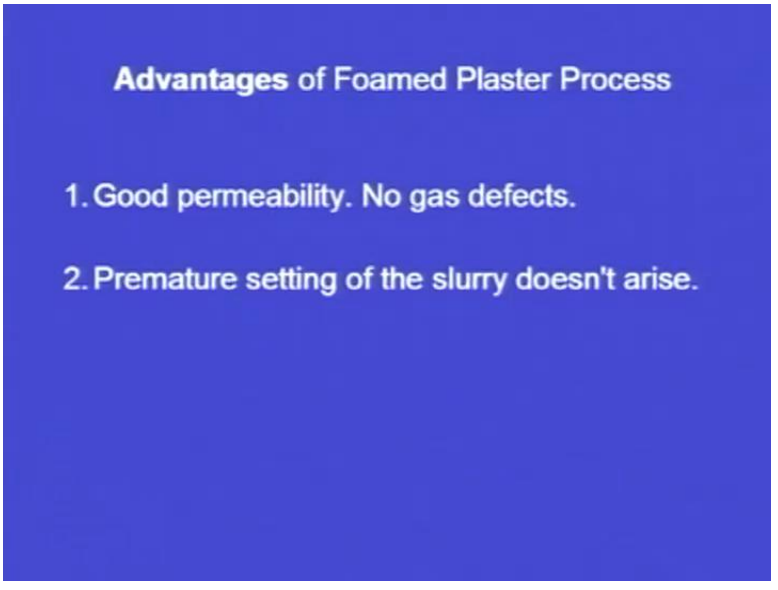


Advantages of this foamed plaster process. Good permeability; yes, that is what we have gained. We have made attempt to increase the permeability of the mould and gas defects will not arise. And because we are using additional water, not additional water, we are using air bubbles, the premature setting of the slurry does not arise.

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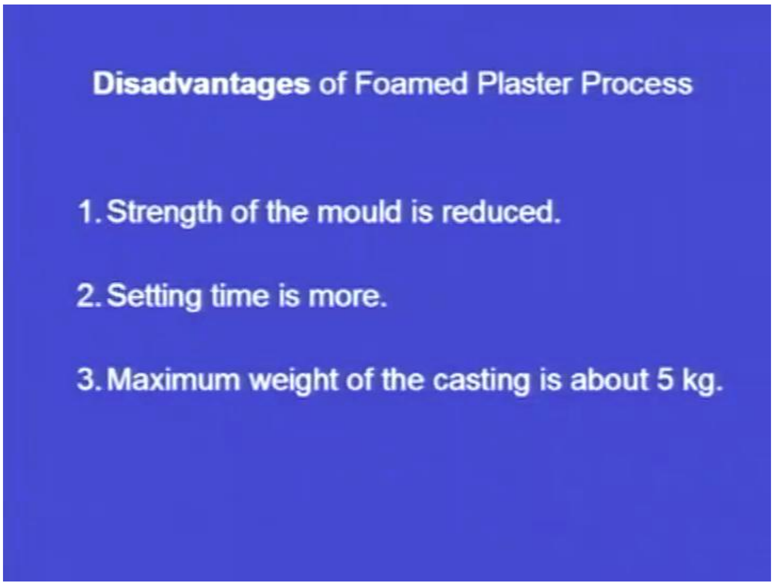


Disadvantages of the foamed plaster process. The strength of mould is reduced. Yes, half of the volume of the plaster slurry is filled with the air bubbles, half of the pattern, half of the mould are, is filled with air bubbles. Of course, when we dry the system, these air bubbles will leave porous holes, means, the strength of the mold is reduced.

Setting time is more, and maximum weight in the case of the conventional plaster moulding process, maximum weight is about 7 kg. Here, the maximum weight of the casting, that we can make, is about 5 kg. The maximum weight has come down.

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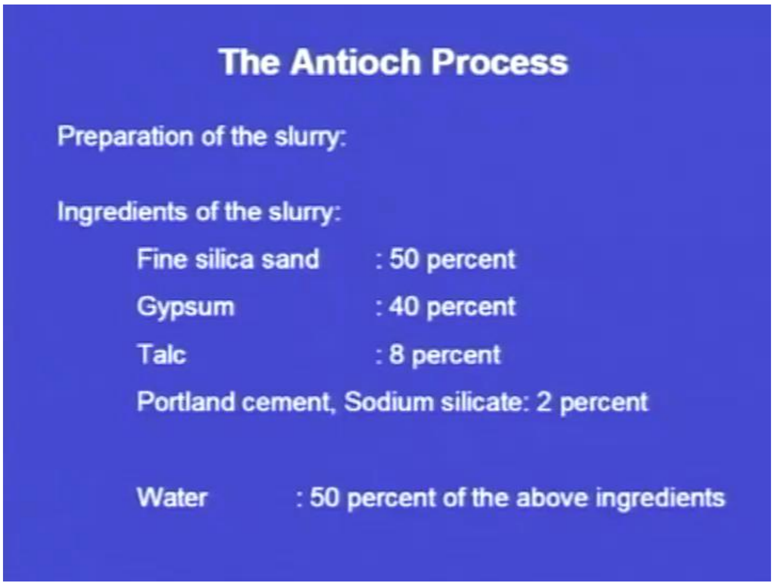


Next one, the third process of the plaster moulding process, that is, the Antioch process. This is further improved version of the conventional plaster moulding process. Yes, one of the drawback or the major drawback of the conventional plaster moulding process is the pour permeability. This we have overcome by using, by, or by blowing air, air bubbles. But the drawback is, the maximum weight of the casting that we could make has come down, only 5 kgs can be cast. So, still there is a need to enhance the properties, so that even larger castings can be made.

So, in this process we use fine silica sand. In the case of the conventional plaster moulding process, the mould is made up of Plaster of Paris and water that is all. Here, we are using fine silica sand, very fine silica sand, fresh silica sand 50 percent and the gypsum that is, the plaster we are using 40 percent, talc 8 percent, portaland cement, sodium silicate, about 2 percent. So, these are the solid ingredients. Next, we add water. Water should be 50 percent of these solid ingredients. Then, we make the slurry.

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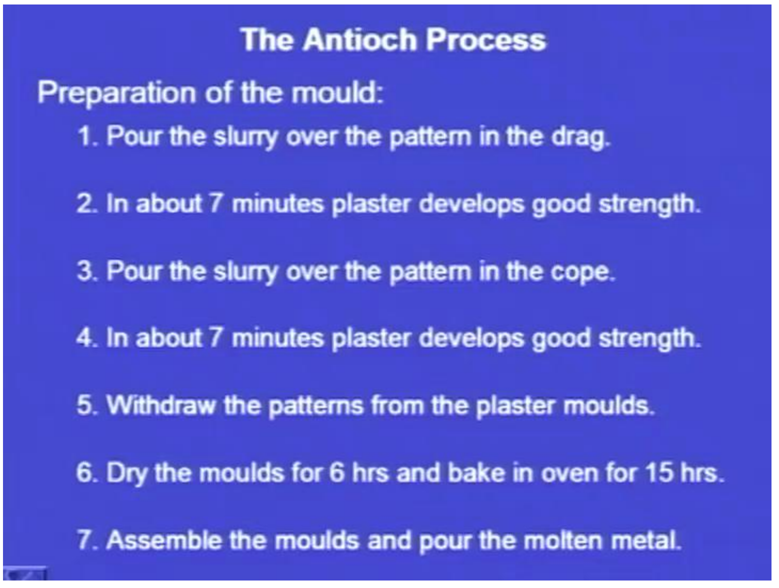


Process, the step by step, let us see. Pour the slurry. First, we have to make the slurry with the ingredients discussed above and pour the slurry over the pattern in the drag. In about 7 minutes this plaster develops good strength; it takes only 7 minutes per setting.

Next, pour the slurry over the pattern in the cope box also. Again, in an about 7 minutes this plaster sets and develops good strength.

Next one, withdraw the patterns from the plaster moulds. Dry the moulds for 6 hours, then we have to bake them in an oven for 15 hours. Next step, assemble the moulds and pour the molten metal.

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Yes, we are pouring the molten metal. Here, we can see the poured molten metal and these are all the moulds.

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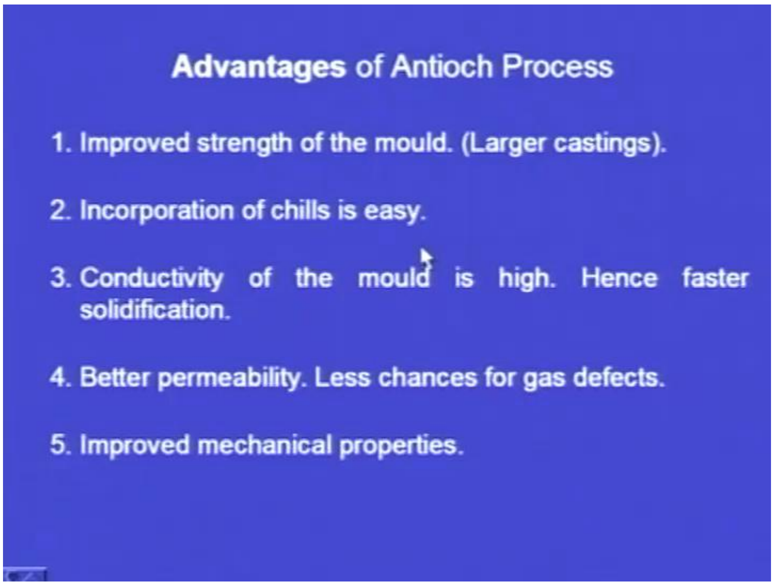


Advantages of the Antioch process. Improved strength of the mould, so larger castings can be made. Next advantage is incorporation of chills is easy. What are these chills? In the case of the conventional sand castings, these chills are widely used. When the, when the molten metal is poured into the cavity during solidification, the solidification should start from the walls of the mould, slowly it should propagate towards the razor and razor should solidify at the last. So, that is the progressive solidification or the directional solidification.

The razor should solidify last means, until the last minute razor should, there should be liquid metal in the razor. But sometimes what happens is, due to the uneven thicknesses of the castings sometimes the part, which is away from the razor, it may be in liquid state because its thickness may be more. But the path, the section, which is away from the razor should solidify first because its thickness is more, it is in liquid state. But a section, which is nearer to the razor, it is solidifying first.

Now, we have to regulate the solidification. The section, which is away from the razor should solidify first at any cost and if its thickness is more, we take some steel blocks, which we call them as chills and we place them in the mould, so that that heat will be dissipated to these steel blocks. The steel blocks extract heat from this casting portion and ensure that that section will be solidified first. So, these are the chills.

So, in the case of the conventional plaster moulding process, incorporation of these chills is very difficult, but in this Antioch process, incorporation of the chills is easy.

Again, another drawback of the conventional plaster moulding process is the conductivity. The thermal conductivity of the mould is very poor, that results in slow, slow air solidification of the casting. The casting takes long times for solidification, that here what we are doing, we have added 50 percent of this fine silica sand. The thermal conductivity of the silica sand is more than the plaster, hence plaster solidification.

And another drawback of the conventional plaster moulding process is the pour permeability because of which gas defects arise. Here, what we are doing? We are using fine silica sand and fine silica sand process permeability and because of this permeability gas defects will not arise. And finally, this Antioch process offers good mechanical properties to the casting.

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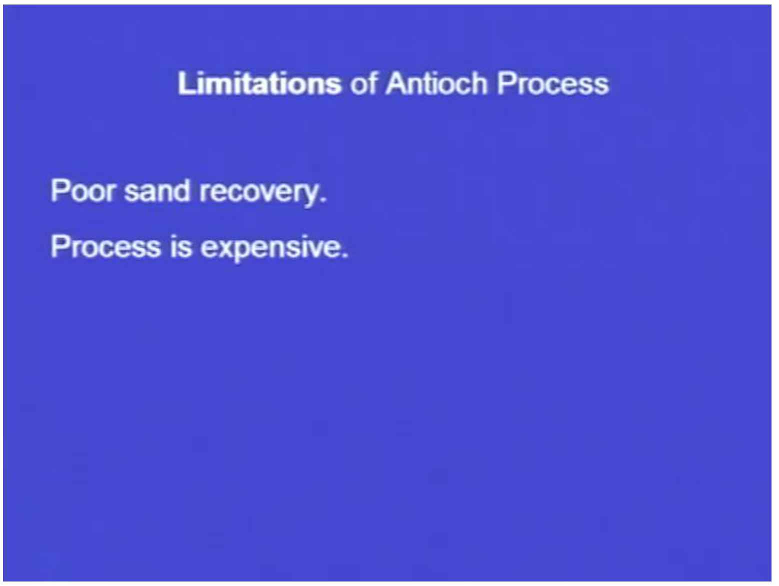


And it has got limitations. The Antioch process has got limitations are poor sand recovery. In the conventional sand casting process after solidification is over we break the mould. That sand can be used to make another mould to make another casting and after solidification again we will break it again we can use that sand for making another casting that cycle can, goes on for making several castings, but here what we are doing we are mixing 50 percent of this silica sand with plaster and it is very, very difficult to take that sand back

So, the recovery of the sand is very poor and the plaster cannot be used again it is very difficult to extract the sand which is mixed with the plaster after we break the mould. So, the sand cannot be used ultimately the process is expensive.

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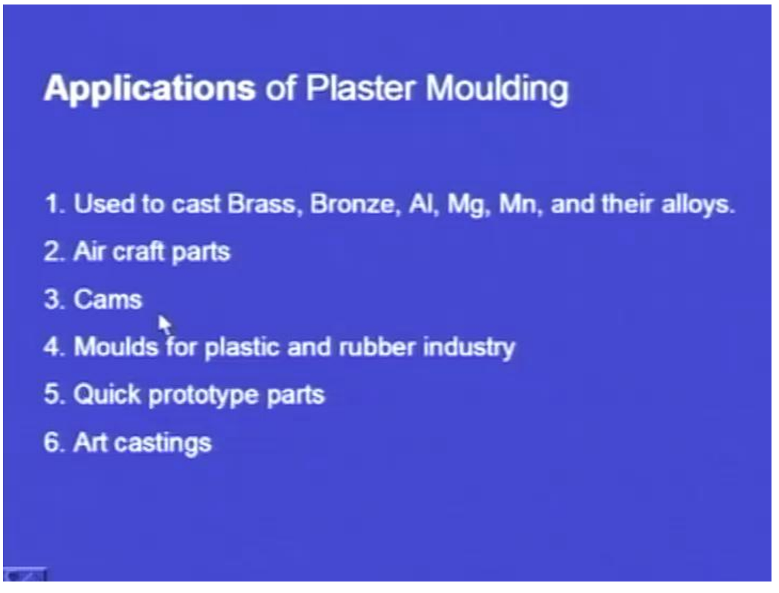

Applications of the plaster of moulding: used to cast brass, bronze, aluminum, magnesium, manganese and their alloys; air craft parts; next, it is used to cast cams; moulds for plastic and rubber industry; quick prototype parts. So, this is an important application of the Plaster of Paris process.

Whenever we are making a new component, first we make prototype. Initially, we make a prototype and we evaluate its performance and we feel some modification is required. Immediately, some components, we change the design and immediately by casting process we have to make the components.

When we are making a component prototype, there is no much time for machining. If we make these components by conventional sand casting process, they take lot of time and the time required for evaluation of the prototype will be more, for machining time is required. But here, the components are made by plaster of mould process, so there is no machining is required, minimum machining, machining, is required. We get excellent surface finish, good dimensional tolerance.

So, immediately we change the design and we get the modified component. Again, we test the prototype, again some modification by, may be required. Immediately, we change the design and we make the casting by Plaster of Paris moulding process and we get the casting.

So, in the evaluation of the prototype this process helps us, so that the casting or the component can be modified quickly and it can be evaluated. And finally, this process is also used for making art casting.

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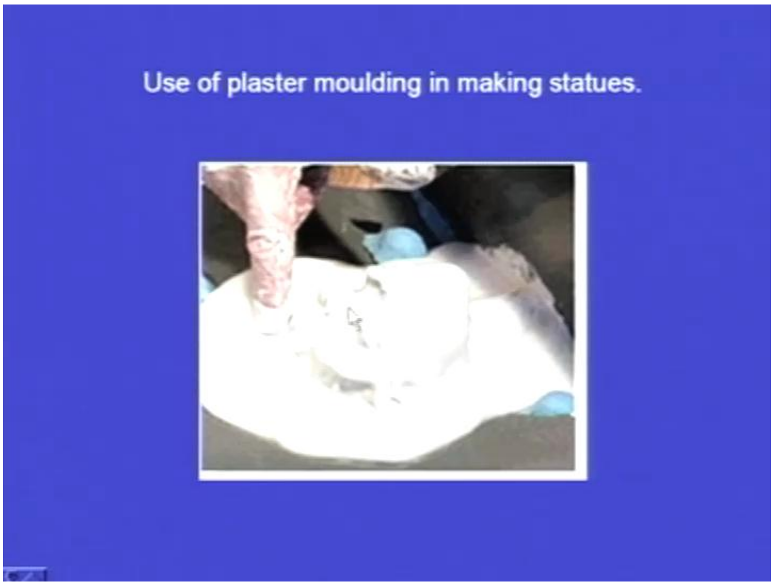

And here, we can see this process is being used for making statue. Here, they have used the pattern, the human space, that is the pattern and over that they are pouring in the Plaster of Paris, and a bronze statue will be made. So, this is also used for making art castings.

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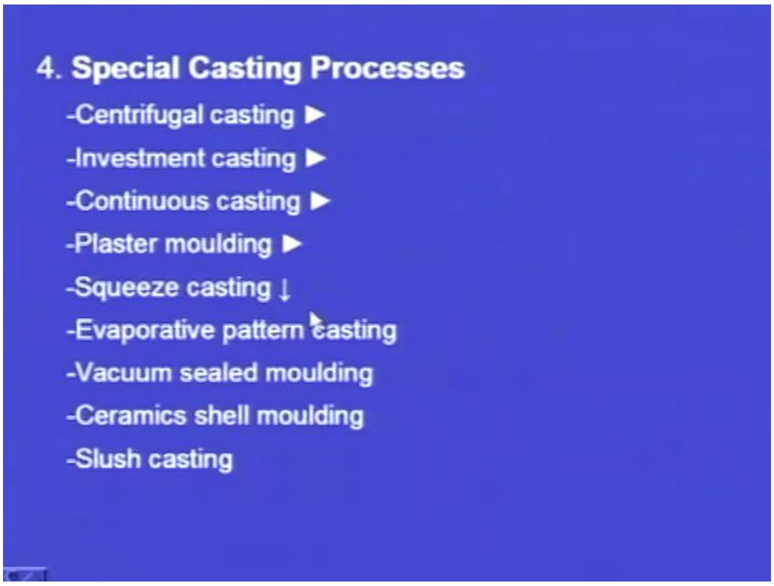


So, among the special casting process, we have seen centrifugal casting, we have seen investment casting, we have seen continuous casting and we have seen plaster moulding.

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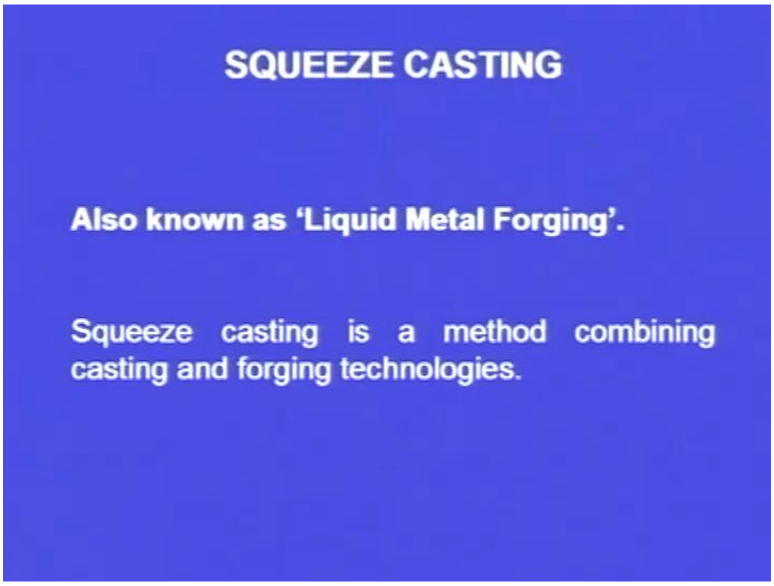


Next, let us see the squeeze casting. Squeeze casting, so this is also known as liquid metal forging. So, this process is a method in which the casting and forging technologies are combined. In the case of the casting process, the process of giving the shape to the metal is easy because we are making a cavity and we are pouring the molten metal into the cavity. So, giving the shape is easy, but the mechanical properties are not so good.

On the other hand, we can also give a required shape to a metallic component by forging, but for that forging operation we have to use extensive pressure, but the mechanical properties are very good.

So, why do not we mix these two? So that the mechanical properties will be good; so that the external pressure, which we, we are going to apply will not be so high. So, this is the concept of the squeeze casting.

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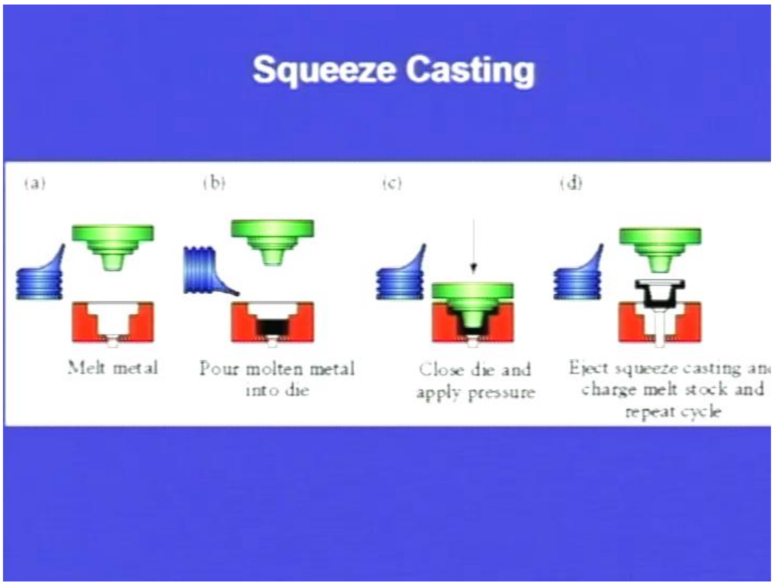


Let us see the step by step. Here, we can see this is the die and here we can see a cavity and this is the ladle in which molten metal is present. So, this is the lower die and this is the upper die. And here, we are pouring the molten metal. Yes, the cavity is filled with the molten metal.

And in the next stage, after the molten metal is poured into the cavity, the upper die is pressed over this lower die and the liquid metal is trapped between the lower die and the upper die. Now, what is happening? This is similar to forging. In forging we press, here also we are pressing. In the case of the casting process we pour the molten metal and allow it to take the shape. Here also, we are pouring the molten metal. So, this is the mixture of casting and forging. And after sometime the casting is solidified, then using ejector pins we are taking the casting outside. So, these are the important steps involved in squeeze casting.

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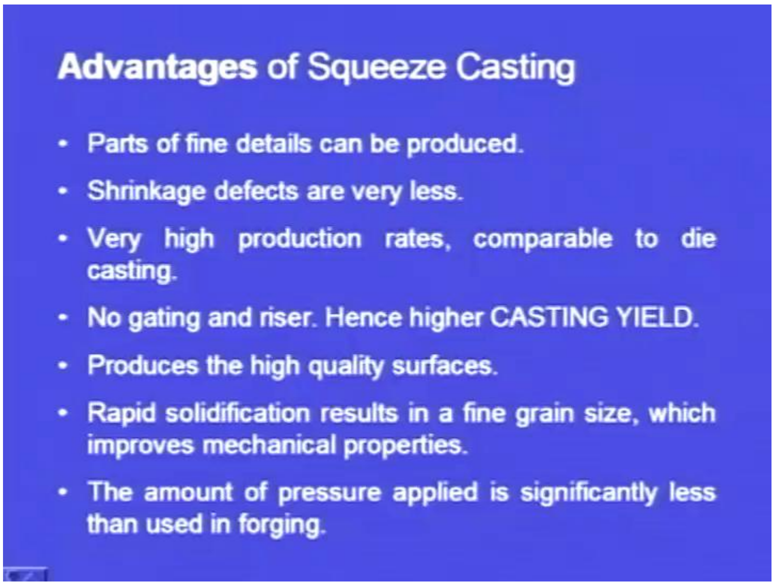


Advantages - fine details can be produced, which is not possible in the case of the conventional sand casting process. And shrinkage defects are very less.

Next one, high production rates compared to die casting; the production rate is very high. And here, we are not using any gating system, no sprue, no razor, then what happens? The casting yield is high.

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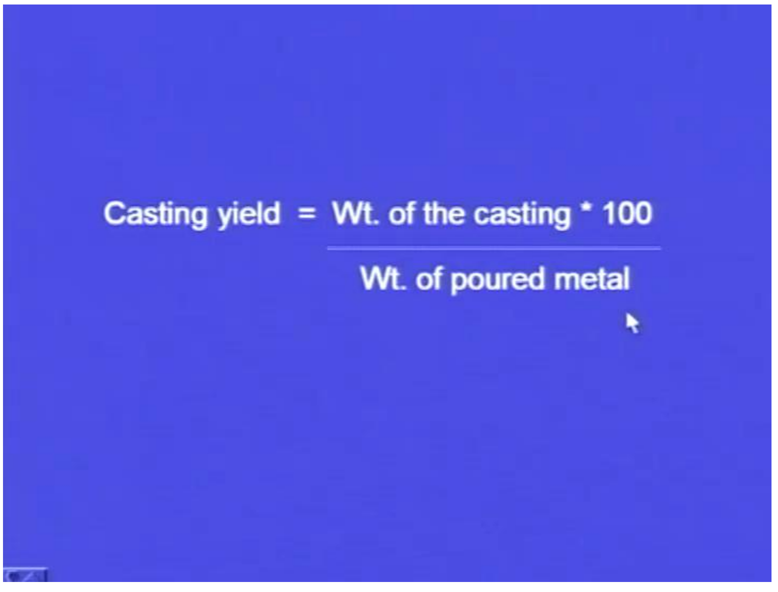


What is casting yield? Casting yield is the weight of the casting multiplied by 100 whole divided by the weight of the poured metal. Yes, the weight of the poured metal is more than the weight of the casting.

In the case of the conventional sand casting process, if the casting weight is say 10 kgs, there will be molten metal will be solidified in the sprue passes, molten metal will be solidified in the gating system, molten metal will be solidified in the razor. So, the poured metal will be more than 10 kgs if the weight of the casting is 10 kgs. So, weight of the poured metal is always more than the weight of the casting.

So, this is the casting yield. Weight of the casting multiplied by 100 and whole divided by the weight of the poured metal. This casting yield, in general, for the sand casting process it will be between 70 to 80 percent. And here, the casting yield is high because there is no gating system. So, this is a profit for us. This decreases the cost of production and produces high quality surfaces.

And what about the solidification? Solidification is rapid, so that results in fine grain size and mechanical properties are improved. In the case of the forging, yes we get good mechanical properties, but the external force, that we apply, will be more. For that we have to use hydraulic presses, they are very costly. So, the production cost goes up in forging.

But here we are not applying extensive pressure, moderate pressure is enough. So, that decreases the cost of production, but still we are getting good mechanical properties like in forging.

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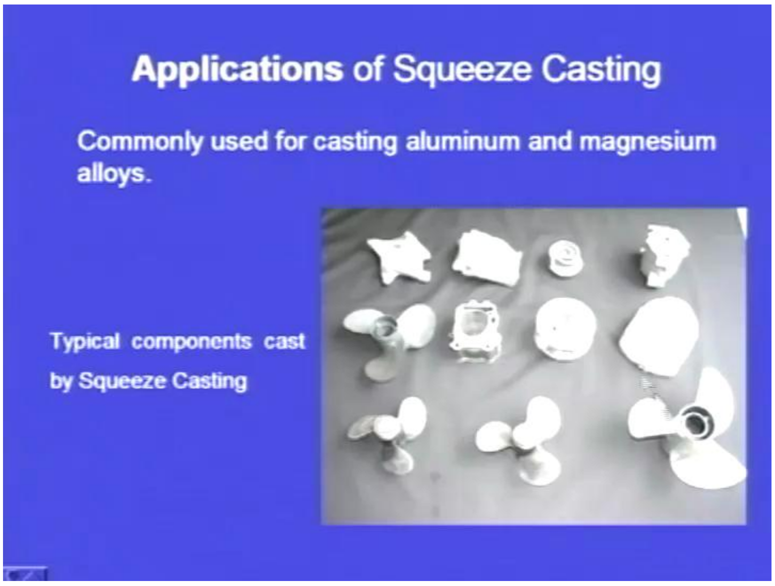


So, these are the typical applications. So, this is mainly used for making aluminum and magnesium alloys. So, these are the typical components made by squeeze castings.

We can see so many shapes, all these shapes are made by squeeze casting. So, we have seen, among the special casting process we have seen centrifugal casting, we have seen investment casting, we have seen continuous casting, we have seen plaster moulding and we have also seen squeeze casting. Next, let us see the evaporative pattern casting.

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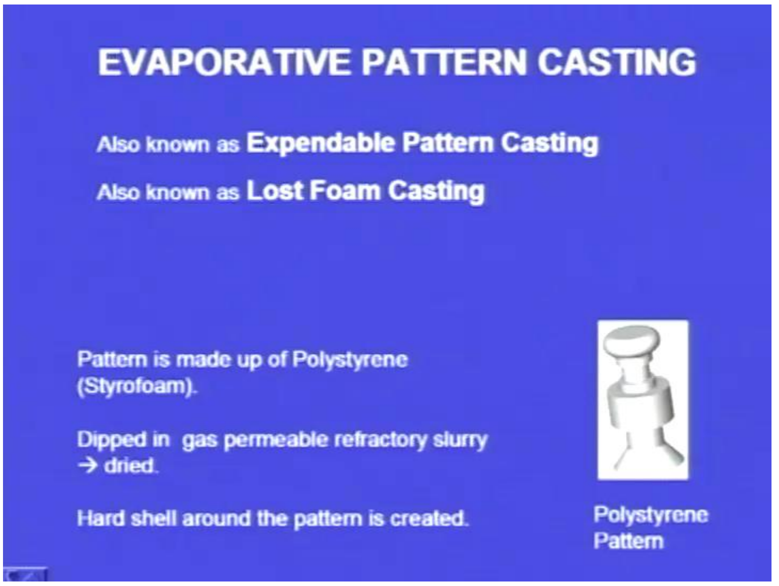


Evaporative pattern casting, this process is also known as expendable pattern casting. This process is also known as lost foam casting. And here, the pattern is made up of polystyrene or the Styrofoam. Let us see the step by step procedure in this evaporative pattern casting.

First, we have to, this is the pattern, this is the polystyrene pattern, means, this kind of shape we want to produce. So, first we have to dip the pattern in gas permeable refractory slurry, then we have to dry it. Then, hard shell is created; fine and hard shell is created around the pattern.

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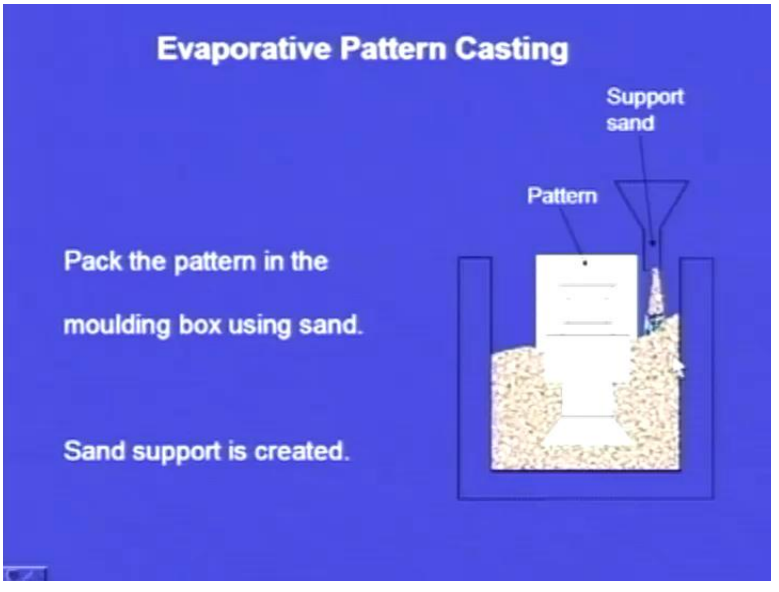


Next one, place the pattern in a box. So, this is the pattern and this is the box. Next one, we are putting the sand, fine sand, we are placing around the pattern and we are packing the pattern inside the sand. Now, the sand support is created. The sand will be filled up to this level.

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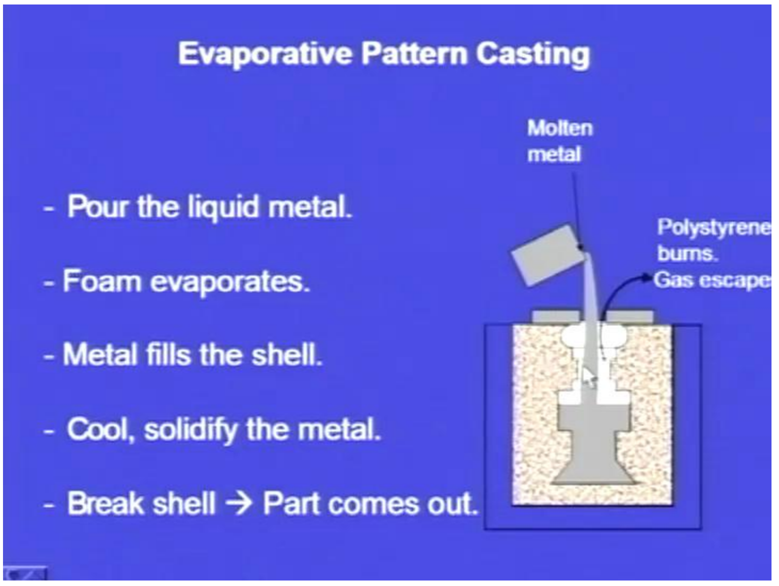


Next one, at this stage we pour the liquid metal. Yes, this is the liquid metal and we are pouring. Now, what happens is, as we pour the liquid metal it goes and falls on the pattern, the polystyrene pattern, immediately, the polystyrene pattern evaporises. It evaporises and that evaporated pattern, it escapes in the form of gas from this mould cavity.

As we keep pouring the molten metal, the pattern keeps on melting and evaporises and it escapes. Finally, the entire pattern will be burning and it will be evaporised and it will be escaping from the cavity. And the molten metal is filled with cavity, means, we are replacing the molten metal with the pattern material. Next, after some time the molten metal solidifies.

Next, yes around this polystyrene pattern there is a shell. We have created a shell and that shell has got a fine surface finish inside and because of that even the solidified casting will have a good surface finish. Now, that shell we have to break and the path comes out. So, these are the important steps involved in evaporative pattern casting.

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Advantages of evaporative pattern casting. These are used for precision castings and this process can be used for ferrous and nonferrous metals also. The plaster moulding cannot be used for ferrous castings, but here this process can be used for ferrous and nonferrous metals. We obtained high dimensional accuracy in this process.

Next one, thin sections can be cast and also, complex shapes can be cast. And another advantage is only one flask. In the case of the conventional sand casting process we are using two flasks, one is the drag and another one is the cope.

So, sometimes if this drag and the cope are not aligned properly, the resultant casting will be defective and that casting has to be rejected. That problem is there and here, that problem does not arise. Only one flask, so moulding is easy. In the case of the conventional sand casting process, the drag box and the cope box should be aligned carefully, for that skilled workers are required.

Here, only one flask, the process is easy, even semiskilled worker can do this job. Says, few steps are involved, the process is not complicated and no need to mix binders and other additives. In the case of the conventional sand casting process we are mixing clay, we are mixing other additives, here there is no need.

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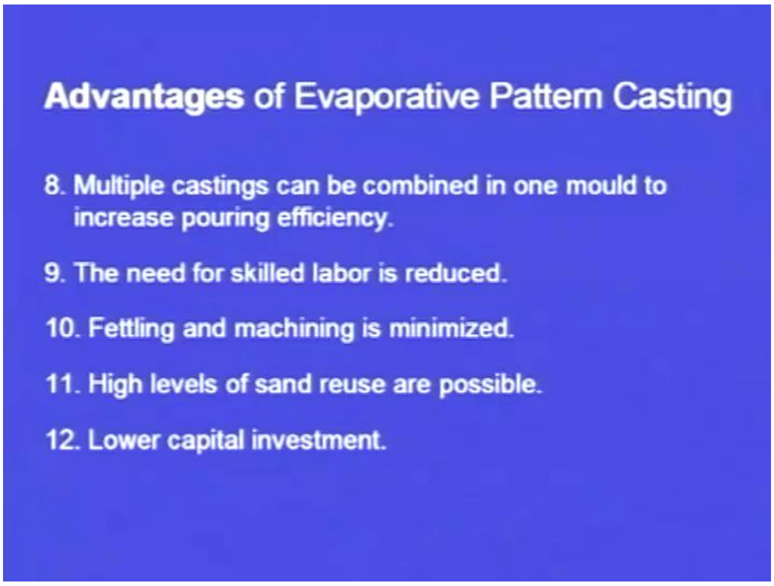


Next one, multiple castings can be combined in one mould to increase the pouring efficiency. Yes, if the sizes of the castings are small. So, these can be combined with a central sprue, the way we do in the case of the investment casting, and more castings can be cast at a time using a central sprue. So, this is another advantage. By this we can increase the casting yield and we can decrease the cost of production.

Yes, another advantage, the need for skilled labor is reduced. In the case of this conventional sand casting process and other precision casting process, skilled workers are required. Sometimes it is difficult to get skilled workers. Even if we get the skilled workers we have to pay them more; that increases the cost of production. Here, even a semiskilled worker can do this job; that decreases the cost of production.

And in the case of the conventional sand casting process, the metal is solidified in this sprue, metal is solidified in the gating system, metal is solidified in the razor. These are the unwanted projections. After solidification, after breaking up the moulding we have to cut this and we have to machine it. This is known as fettling.

This fettling increases the cost of production. For that extra labor is required, extra time we have to spend. Finally, the process will be more expensive. Here, there is no sprue, no gating system, no razor. So, finally, there will be no need for fettling because there is no fettling that decreases the cost of production, machining is minimized.

Next one, the sand can be reused. In the case of the plaster moulding, the sand cannot be used, that is the drawback of the plaster moulding that increases the cost of production in the case of the plaster moulding. But here we can reuse the sand. Only little portion may not be useful, about 5 percent that can be neglected, but the sand can be reused.

And what about the capital investment? What are the equipments required? Costly equipments are not required, so the capital investment is low, means, the cost of production will be less. So, this is another advantage of this process.

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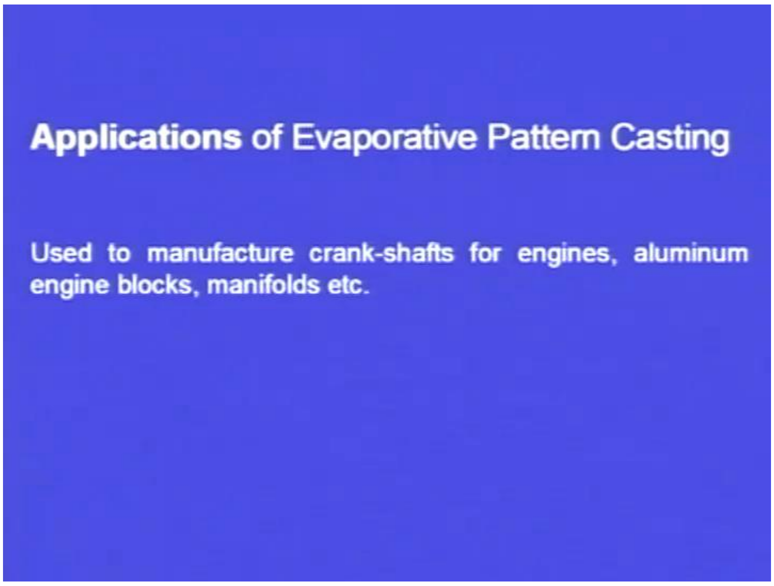


Applications of evaporative pattern casting. This process is used to manufacture crank-shafts for engines. This process is used for making aluminum engine blocks and manifolds, etcetera.

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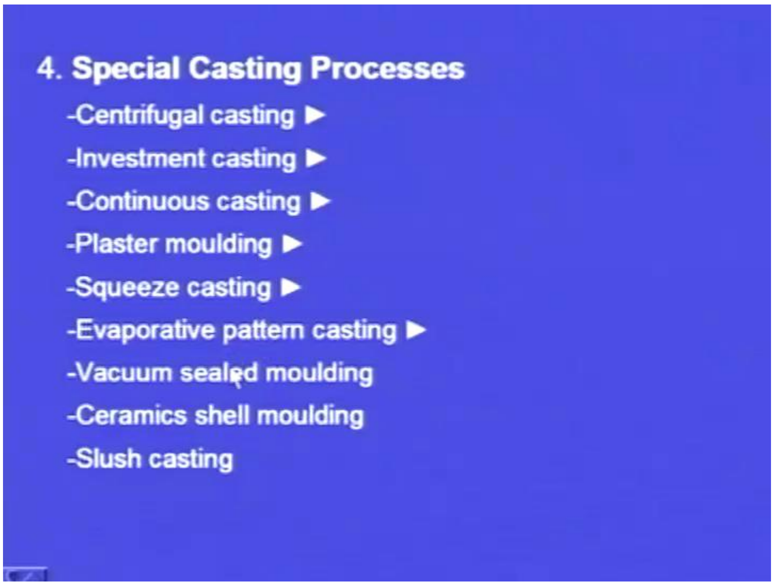


So, in this episode we have seen the plaster moulding, the squeeze casting and the evaporative pattern casting. We have seen, that the plaster moulding is classified into conventional plaster moulding process, the foamed plaster process and the Antioch process. So, there are three sub-classifications of the plaster moulding.

We have also learnt in this episode the squeeze casting, which is the mixture of casting and forging. So, which we also call it as liquid metal forging. And we have also learnt in this episode evaporative pattern casting, which is also known as expandable pattern casting, which is also known as last foam casting.

Thank you.