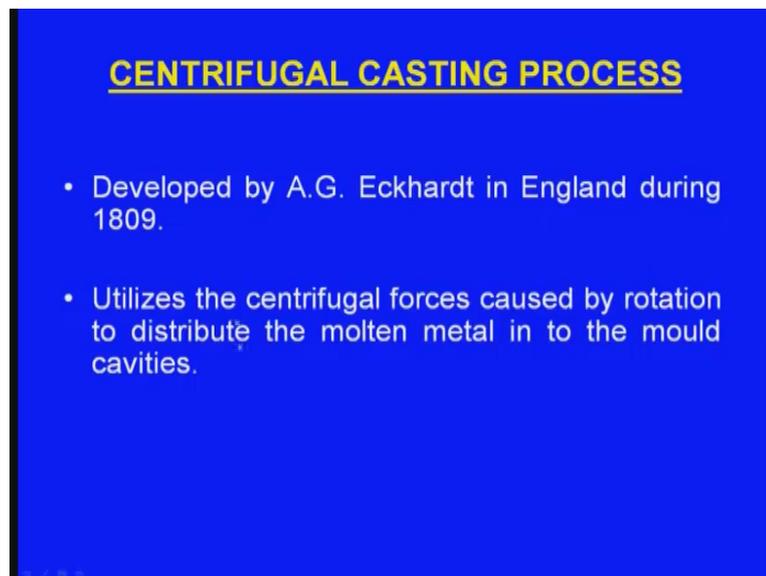


Metal Casting
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Module - 05
Permanent Mould And Special Casting Processes
Lecture - 06
Centrifugal Casting Process

Welcome friends, in our previous lecture we have learnt about continuous casting process. Now, today let us learn about centrifugal casting process. Now, the question is what is this centrifugal casting process and when it was started.

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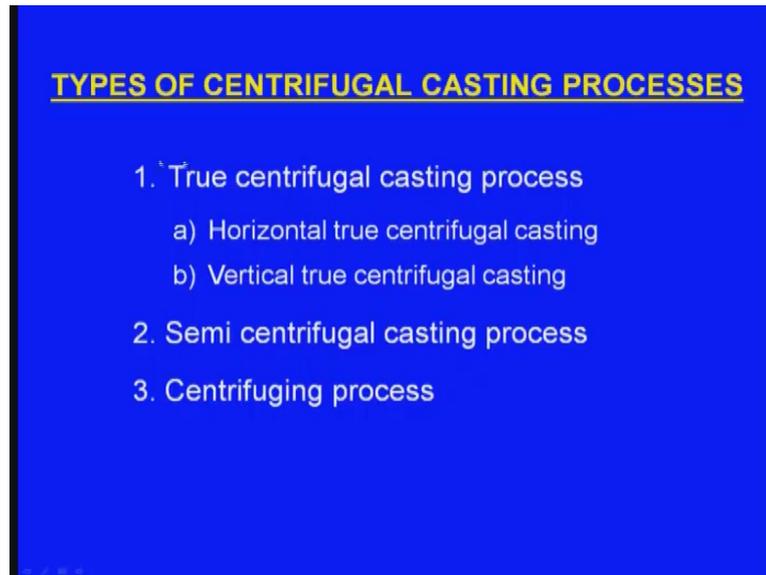


CENTRIFUGAL CASTING PROCESS

- Developed by A.G. Eckhardt in England during 1809.
- Utilizes the centrifugal forces caused by rotation to distribute the molten metal in to the mould cavities.

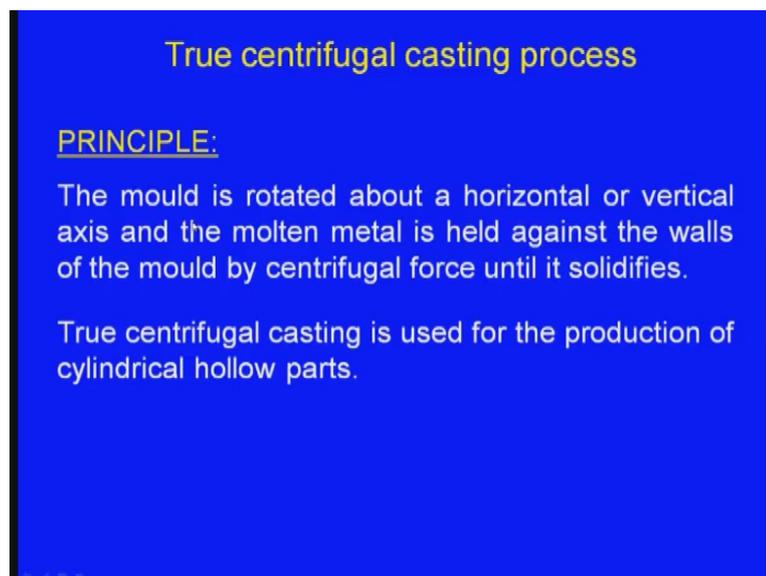
So, this was developed by A G Eckhardt in England during 1809. Now, what is its sup
rends? It utilizes the centrifugal forces caused by rotation to distribute the molten metal
to the mould cavities. As the mould is rotating molten metal will be distributed into the
mould cavities. So, because of this centrifugal force the molten metal will be sticking to
the mould that is how we get the required geometry of the casting. So, this is the simple
principle of the centrifugal casting process.

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Now, these are the types of centrifugal casting process. One is the true centrifugal casting process. In this again we have two classifications one is the horizontal true centrifugal casting process and the other one is the vertical true centrifugal casting process and the second category is the semi centrifugal casting process and the third one is the centrifuging process. So, first we will see the true centrifugal casting process and also the horizontal true centrifugal casting. Now, what is this true centrifugal casting process, what is the principle?

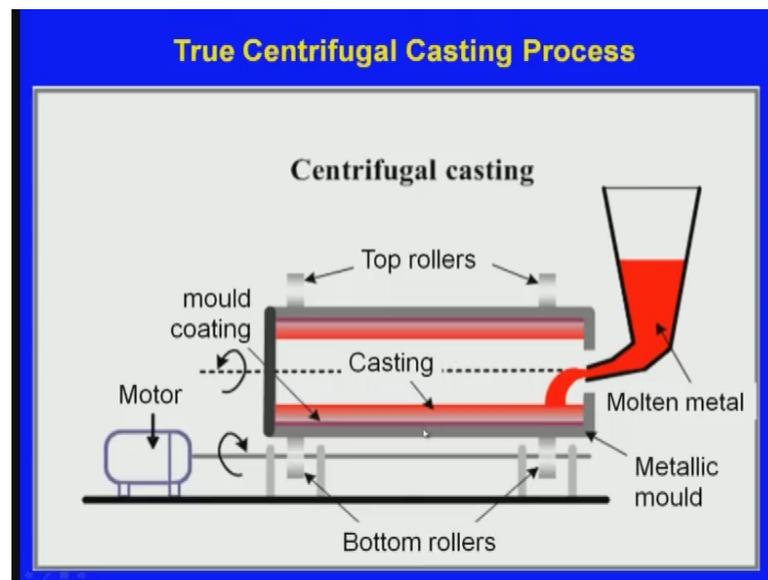
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The mould is rotated about a horizontal or a vertical axis and the molten metal is held against the walls of the mould by centrifugal force until it solidifies. The mould is rotated about a horizontal or a vertical axis.

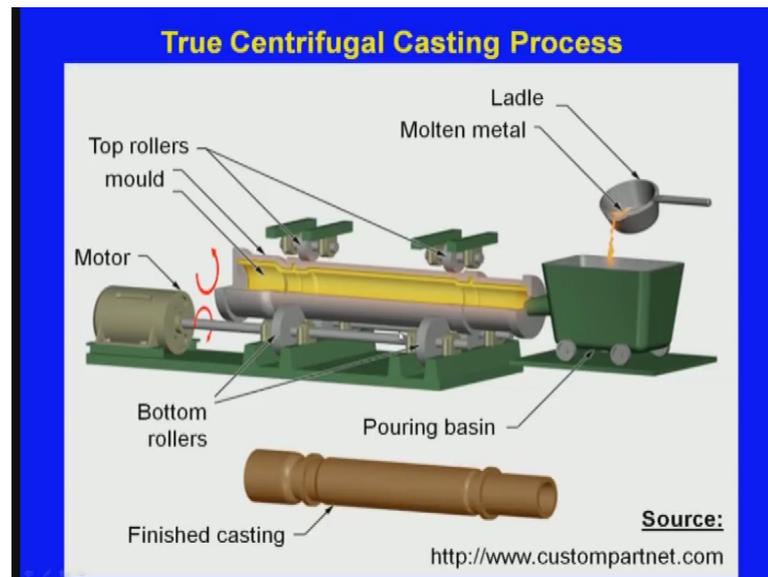
As it is rotating molten metal is held against the walls of the mould. Now, true centrifugal casting is used for the production of cylindrical hollow parts. So, this is the main application of the true centrifugal casting process.

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Now, here we can see the principle is here the molten metal is being poured and this is a metallic mould a cylindrical metallic mould we can see here and it is supported using rollers here there are the top rollers and here there are bottom rollers as the top rollers and bottom rollers are rotating even this metallic mould will be rotating. Now, it is that time the molten metal will be poured into the mould and during pouring the mould will be rotating at a pre determined speed. And this rotation continues till the molten metal inside this mould what say metallic mould solidifies after solidification the rotation of the mould stops then we get the sol solidified cylindrical hollow casting. So, this is the motor which drives the metallic mould and here we can see.

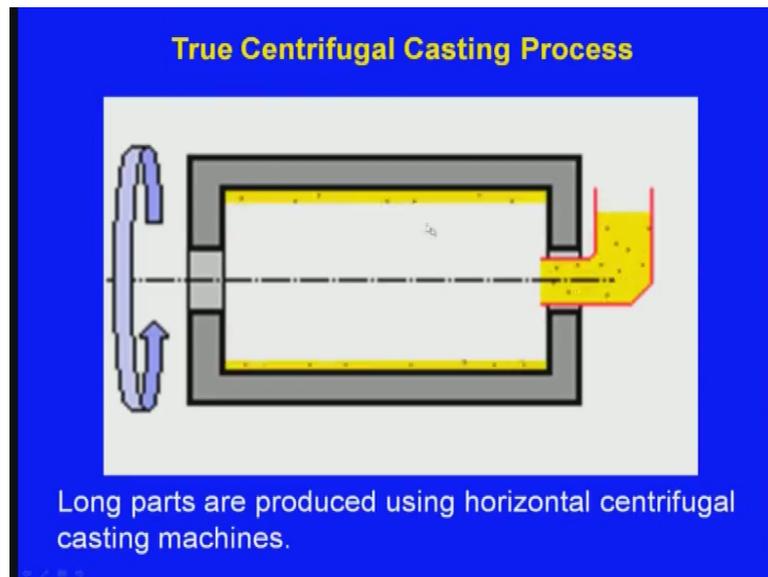
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The more details of this setup and here we can see this is the ladle and this is the pouring basin and here we can see this is the metallic, metallic mould this is the cylindrical metallic mould. And here we can see these are the bottom rollers on which the metallic mould is supported and these are the top rollers.

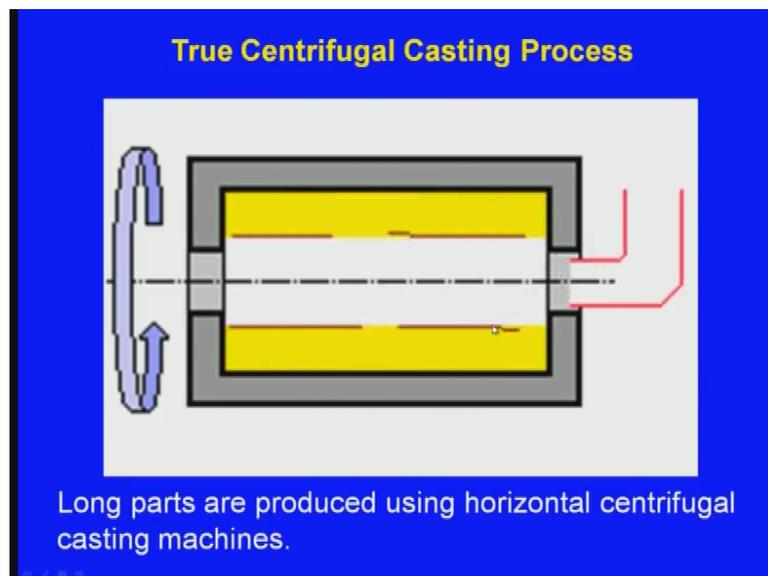
Now, this is the metallic mould and yes you can see as the molten metal is being poured the metallic mould will be rotating and this rotation continues till the solidification of the metal will be over. After that yes we can stop the rotation of the metallic mould then what happens we get a finished casting like this, this is a hollow what say cylindrical casting. So, is the example of the centrifugal casting process and here we can see the Animation.

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So, this is the metallic mould the cylindrical mould and here the molten metal is entering.

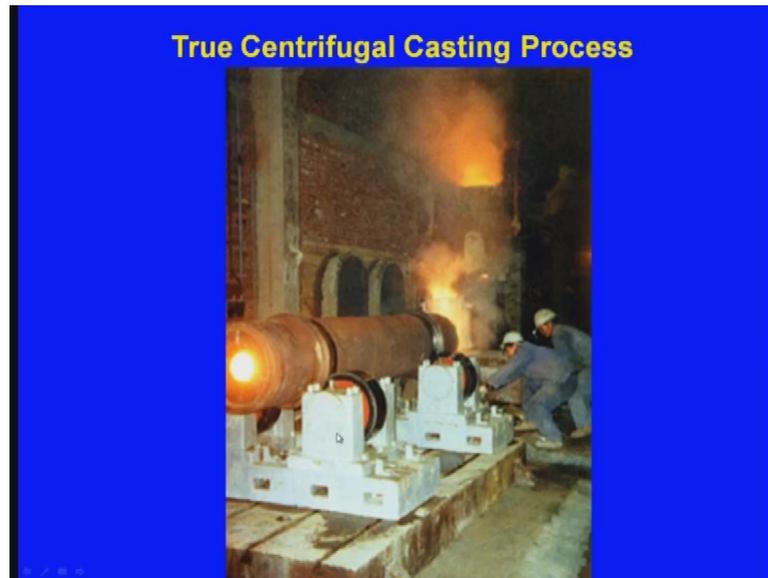
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As it is entering with the molten what say metallic mould will be rotating and the molten metal will be sticking to the walls of the mould and the rotation continues till the molten metal solidifies, then the metallic mould will be what say detached and we get the solidified casting.

So, long parts are produced using horizontal centrifugal casting process.

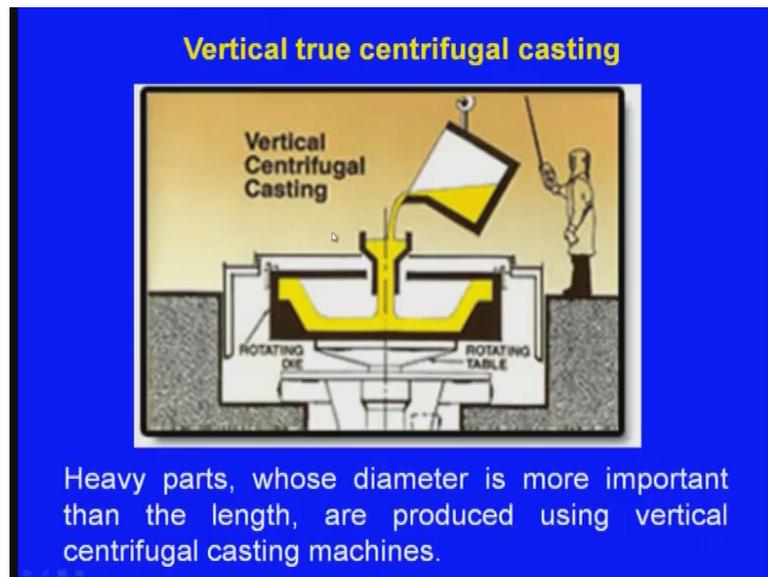
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And here this is the true photograph of a true centrifugal casting process here we can see this is the metallic mould this is the metallic mould and this is the what say ladle through which molten metal is coming to the cylindrical metallic mould. And here we can see these are the bottom rollers and here is one roller and here is another roller and the other sides also there will be two rollers and at the top part also sometimes there will be rollers and as these rollers are rotating the metallic mould will be rotating it is that time the molten metal will be entering into the metallic mould cylindrical metallic mould.

So, we have so far we have completed horizontal true centrifugal casting. Now, let us see the vertical true centrifugal casting process.

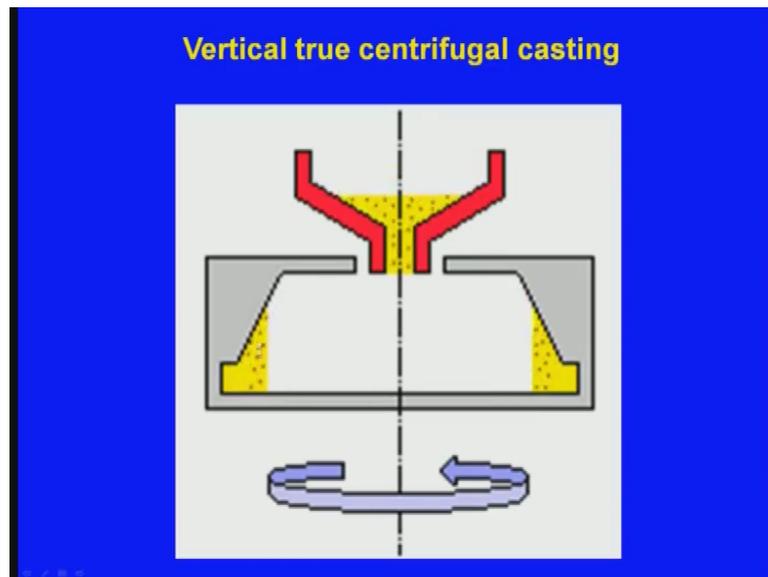
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Now, why we should go for the vertical true centrifugal casting process, why not the horizontal true centrifugal casting process, this is used right for heavy parts whose diameter is more important than the length. At such times we use the vertical true centrifugal casting process. Principle is the same there will be a cylindrical mould will be there and it will be rotating, but here the diameter is more important than the length.

And here we can see this is the rotating what say mould and the molten metal is being poured as the molten metal is entering into the mould the mould will be rotating and this rotation continues till the molten metal solidifies inside the mould what say metallic mould and here we can see the animation.

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This is the metallic mould, vertical and it rotating about a vertical axis and the molten metal is coming like this and because of the centrifugal force and it will be going to the sides of the mould it will be going towards the walls of the mould and this rotation continues till the molten metal solidifies.

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- True centrifugal casting is carried out as follows:**
1. Applying ceramic slurry to the mould wall, drying and baking.
 2. Rotation of the mould at a predetermined speed (300 to 3000 rpm).
 3. Pouring a molten metal directly into the mould (no gating system is employed).
 4. The mould is stopped after the casting has solidified.
 5. Extraction of the casting from the mould.
 6. Finishing - Removal of impurities at the centre using machining, grinding or sand-blasting.

Now, true centrifugal casting is carried out as follows first step is we have to apply the ceramic slurry to the mould walls because it is possible that the molten metal may stick

to the metallic mould, so that should not happen. To prevent this we apply a ceramic slurry to the mould wall and it should be dried and also it should be baked.

Next step is rotation of the mould at a predetermined speed and it can start from 300 rpm to and it can go upto 3000 rpm. Then once this what say mould what say keeps on rotating at this pre determined speed we have to pour the molten metal to the mould. A nd most surprising thing is here no gating system is required we have seen the design of the gating system for a sand mould and also what say we have seen the dye casting here no gash gating system is required. The mould is stopped after the casting has solidified till that time the mould has to rotate.

Then the next step is extraction of the casting from the mould and finally, the next step final step is the finishing means what is that? Removal of impurities at the centre using machining, grinding or sand blasting.

Now, in the molten metal there will be some impurities will be there. So, these into impurities will be subjected to lesser what say centrifugal force as the mould is rotating the particles having lesser dense are subjected to lesser centrifugal force. So, that is how they are collected at the center. So, these are to be removed using machining, grinding or the sand blasting.

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Advantages of True Centrifugal Casting Process

1. Flexibility in casting composition:
(Exception: 0.40 to 0.85% C due to segregation).
2. Wide range of available product / metallurgical characteristics:
3. Can form very large parts.
4. Central core is not required for making a hole or pipe.
5. Employment of gates and risers is not required.
(100 percent casting yield in many cases).
6. Relatively very light impurities move inwards towards centre, which can be removed easily.
7. Fettling costs are reduced. Little scrap generated.
Cost of production is less.

Now, what are advantages of the true centrifugal casting process flexibility in casting composition? Of course, there is an exemption right, so maybe that exemption is for 0.4 to 0.85 carbon due to segregation.

The next advantage is the wide range of available product metallurgical characteristics. We can get different types of hollow what say cast components and also we can get what say different metallurgical features and can form very large parts.

The next advantage is central core is not required for making a hole or pipe and we know that in the greens and casting if we want a hollow casting or if we want a hole inside a casting we used to place a core. So, this core has to be made and that should be carefully kept inside the mould then we have to pour the molten metal. That is not enough after solidification we have to separate the moulding box we have to what say break the mould then we have to separately remove the core. So, all this headache is not there in the case of the true centrifugal casting process. We get the hollow cast components we get the holes inside the cast components, but no core is required that is the advantage.

Next one employments of gates and risers is not required no gating system is there we have seen that is for that is for 100 percent casting yield in many cases. Now, the question is what is this casting yield.

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$$\text{Casting yield} = \frac{\text{Wt. of the casting} * 100}{\text{Wt. of poured metal}}$$

Let us see this is the definition for the casting yield casting yield means it is the ratio of weight of the casting divided by weight of the poured metal whole multiplied by 100. Remember that weight of the casting is not equal to the weight of the poured metal if the weight of the casting is 100 kgs we always pour more than 100 kgs maybe 125 kgs or maybe 130 kgs. So, weight of the poured metal is always greater than the weight of the casting.

So, this is the casting yield, casting yield means weight of the casting divided by weight of the poured metal multiplied by 100. So, this should be maximum if the industry has to get benefit. So, in the case of the what say green sand casting the casting yield will be say between 70 to 80 percent, but it is never 100 percent, but here we get close to 100 percent because there is no gating system. As the molten metal is consumed for the gating system there will be what say this casting yield will be coming down.

Next one relatively very light impurities move towards the center which can be removed easily. Now, the question is how to imp, what say remove the impurities if it is a green sand casting the impurities will be inside the casting, but here the impurities are subjected to lesser centrifugal force because of that they will be segregated to the center. Now, after solidification yes they can be identified and they can be removed by machining or by brushing or by chipping. So, impurities removal is easier in the case of the centrifugal casting process. Next one fettling cost are reduced fettling means unwanted what say elements if there are any such elements we need to remove them like cutting up the gating system riser, these are the fettling what say process. So, these are reduced first of all there is no gating system. So, fettling cost are reduced and little scrap is generated, cost of production is less.

Now, these are the disadvantages or the drawbacks of the true centrifugal casting process.

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Disadvantages of True Centrifugal Casting Process

1. Suitable only for axial symmetrical components.
2. More segregation of alloy component during pouring under the forces of rotation.
3. Secondary machining is often required for inner diameter.
4. Centrifugal castings require very high investments.
5. Skilled labors are to be employed for this process.
6. Inaccurate internal diameter.
7. Long lead time possible.

First one is suitable only for axial symmetrical components only for axial symmetrical and for making hollow components not for all the components. Second disadvantage is more segregation of alloy component during pouring under the forces of rotation. Now, this is another drawback of the centrifugal casting process. If the generally we use the alloys, now in the alloys there will be different elements will be there if the density of different alloying elements are what say almost close there, there is no problem.

Sometimes it is possible that the density of one alloy one alloying element will be very high and the density of another alloying element will be very less at such times what happens, the elements having highest density will be subjected to larger what say centrifugal force and the element having the lesser what say density will be subjected to lesser centrifugal force. Then what will happen? The element having the lesser density it will be moving towards the axis or the center of the casting and the elements having the higher density will be subjected to higher centrifugal force and they will be moving away from the center of the casting that is how there will be segregation of the alloying elements in the centrifugal casting process. So, this must be handled very carefully.

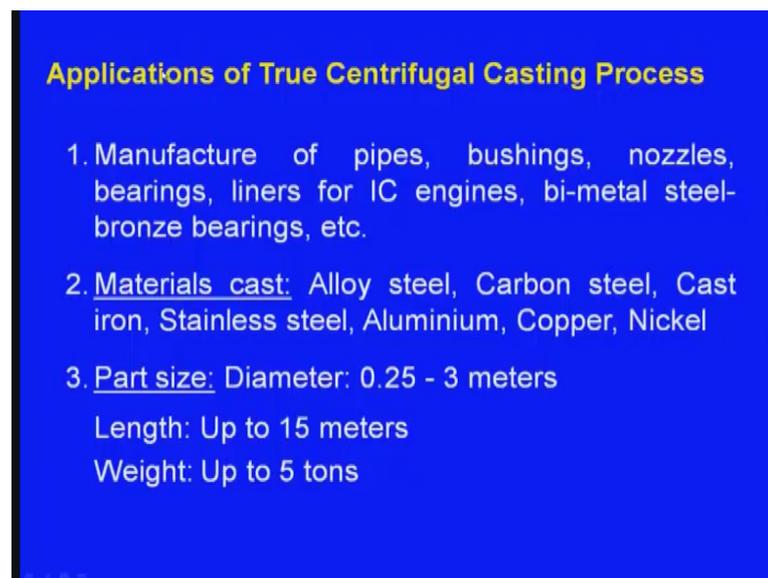
Next one secondary machining is often required for inner diameter yes in the inside inner surface of the casting all the impurities will be collected because they are subjected to lesser centrifugal force. So, these are to be removed sometimes machining is required

next one centrifugal castings require very high investments that setup is very costly and expensive.

Next one skilled labours are to be employed for this process right because the mould is to be rotated at a pre determined speed and it all depend upon what say a temperature for a particular temperature or for a particular alloy it has to be what say rotated at different what say speeds. So, this all what say comes by experience. So, to operate this setup experienced and skilled workers are required that is how the process will be costly or it becomes what say expensive.

Next disadvantage is the inaccurate internal diameter and finally, it another disadvantage is the long lead time may happen. So, these are the topics of the disadvantages of the true centrifugal casting process.

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Applications of True Centrifugal Casting Process

1. Manufacture of pipes, bushings, nozzles, bearings, liners for IC engines, bi-metal steel-bronze bearings, etc.
2. Materials cast: Alloy steel, Carbon steel, Cast iron, Stainless steel, Aluminium, Copper, Nickel
3. Part size: Diameter: 0.25 - 3 meters
Length: Up to 15 meters
Weight: Up to 5 tons

Now, what are the applications of true centrifugal casting process? Manufacture of pipes, bushings, nozzles, bearings, inner, liners for IC engines, bimetal, steel bronze bearings and so on. Now, what are the materials cast? Alloy steel, carbon steel, cast iron, stainless steel, aluminum, copper, nickel. Now, let us see the part size, diameter varies from 0.25 meters to 3 meters. You can see the diameter can be 3 meters means very large and length up to 15 meters and weight up to 5 tones means small castings can be made and very big castings can be made.

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Now, these are the components produced by true centrifugal casting process.

You can see here these are the hollow what say tubes or the hollow components cast components are produced by true centrifugal casting process.

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We will see some more yes these are the tubes or the components produced by true centrifugal casting process.

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Next one again these are the components produced by true centrifugal casting process.

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Again these are also the components produced by true centrifugal casting process.

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Again you can see here these are also components produced by true centrifugal casting process.

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Bimetallic pipes using centrifugal casting

Bimetallic pipes can be produced by centrifugal casting.

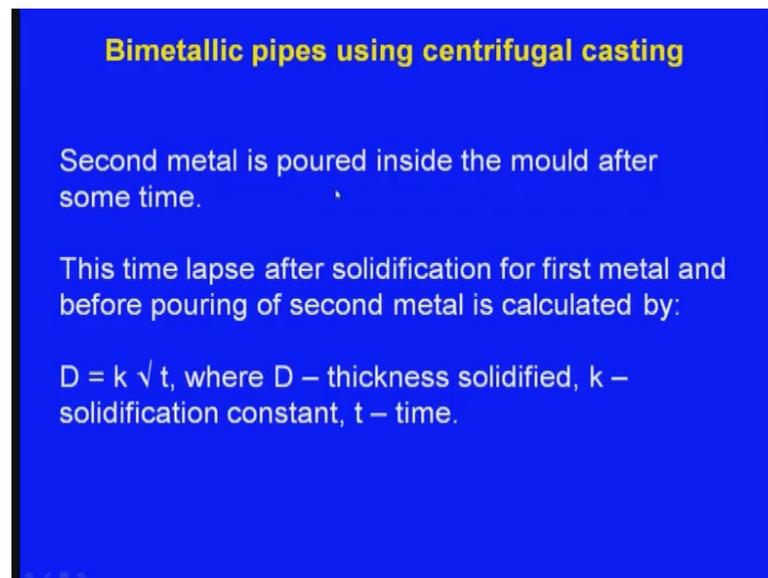
Some bimetallic combinations:

Outer Layer	Inner Layer
5 % Cr steel	S.S.
SS	MS
MS	Cu
MS	Al
Cu	G.C.I
Al	G.C.I
S.S	G.C.I
M.S	Ni – hard

Bimetallic pipes using centrifugal casting process, bimetallic pipes can be produced by centrifugal casting process and some bimetallic combinations are as follows we can see here. So, these are the outer layer common what say alloys and these are the inner layer for outer layer it is you can see 5 percent chromium steel and for inner layer it is stainless steel for outer layer stainless steel, and for inner layer mild steel for outer layer mild steel

and inner layer copper for outer layer mild steel, and for inner layer aluminum for outer layer it is copper and for inner layer it is GCI, and for aluminum outer layer and the inner layer is GCI, outer layer is stainless steel and the inner layer is GCI, outer layer is mild steel and the inner layer is nickel hard steel.

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Bimetallic pipes using centrifugal casting

Second metal is poured inside the mould after some time.

This time lapse after solidification for first metal and before pouring of second metal is calculated by:

$D = k \sqrt{t}$, where D – thickness solidified, k – solidification constant, t – time.

Second metal is poured inside the mould after some time and this time lapse after solidification for the first metal and before pouring of the second metal is calculated by D is equal to k root of t, where D is the thickness solidified and k is the solidification constant and t is the time. So, far we have seen true centrifugal casting process and the two sub classifications within that. Now, let us see the semi centrifugal casting process. Now, what is this semi centrifugal casting process?

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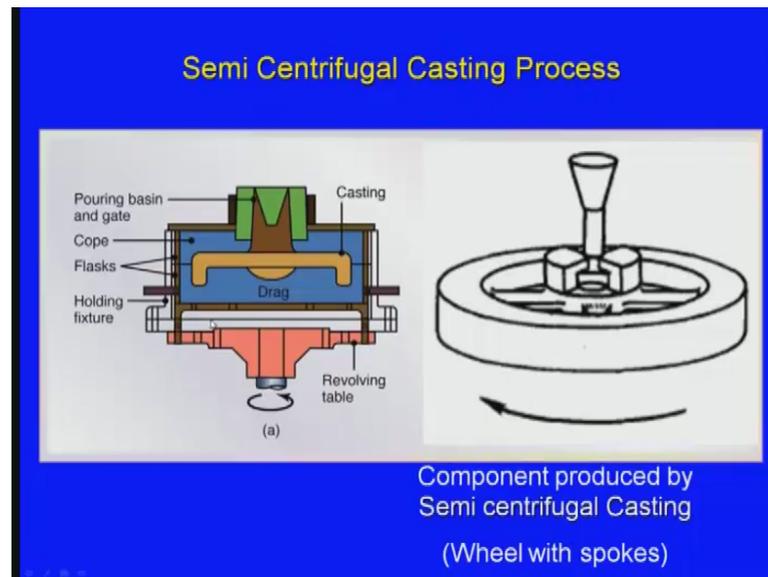
SEMI CENTRIFUGAL CASTING PROCESS

- Semicentrifugal casting manufacture is a variation of the true centrifugal casting process.
- The main difference is that in semi centrifugal casting the mould is filled completely with molten metal, which is supplied to the casting through a central sprue.
- The forces generated by the rotation of the mould ensure the distribution of molten material to all regions of the casting.

Semi centrifugal casting right manufacture is a variation of the true centrifugal casting process, yes here also the centrifugal force will be upright on the mould and also on the mould terminator, but there is a variation. What is that variation, what is the difference? The main difference is that in semi centrifugal casting process the mould is filled completely with molten metal which is supplied to the casting through a central sprue. In case of the true centrifugal casting process yes no doubt the what is there is a cylindrical mould and it is rotated, but finally, the cast component will be hollow there will be a hole inside, but here in the case of the semi centrifugal casting process we will not get the hollow components that is the main difference.

Now, see again let us say the main difference is that in the case of this semi centrifugal casting the mould is filled completely with the molten metal the force is generated by the rotation of the mould ensure the distribution of the molten material to all regions of the casting because of the forces generated by the centrifugal force the molten metal will be what say uniformly distributed into the mould.

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And here we can see yes this is the revolving table will be there and this semi centrifugal casting process in this process the mould will be rotating about a vertical axis always. And here there is a revolving table is there and here we can see this is the molding box molding box means yes there will be drag, drag means lower molding box and there will be cope there will be means the upper molding box and here there is the pouring basin pouring basin and this is the mould cavity. And as the mould is rotating about the vertical axis the molten metal is being poured into the mould. Then what happens? As the mould is rotating molten metal is entering the molten metal will be subjected to the centrifugal force. So, it will be going away from the center if there are any minute details tiny details oh on the sides of the casting yes molten metal will be definitely entering into those tiny features.

So, that is the advantage of the semi centrifugal casting process and here we can see so this is the pouring basin and this is the cope and this is the drag and here we can see a component produced by the semi centrifugal casting. So, this is the wheel with spokes and here we can say this is the pouring basin and here internally we can see there are ribs are there, narrow ribs are there if we cast this component using ordinary what say sand casting process no doubt the outer part we may get, but the internal ribs it may not be possible for us. Sometimes there will be some discontinuities will be there, but these discontinuities can be overcome using the semi centrifugal casting process because of the centrifugal force that is falling on the molten metal, so even this what say place where

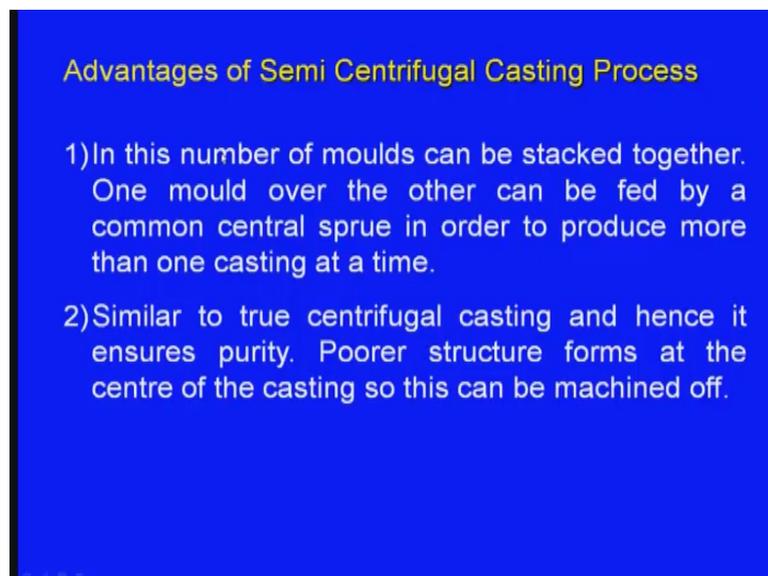
there are there may be some discontinuities there also molten metal will be successfully flowing. And this is the semi centrifugal casting setup.

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Advantages of semi centrifugal casting process.

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In this number of moulds can be stacked together one mould over the other can be fed by a common central sprue in order to produce more than one casting at a time means one mould can be placed over another mould and all these can be connected by a central

same common sprue and molten metal can be supplied to all these moulds at a time means at a time we can produce more than one casting.

Second advantage is similar to true centrifugal casting and hence it ensures purity. Poorer structure forms at the center of the casting, so this can be machined. So, if there is any what say impurity again that will be collected at the center and that can be machined off.

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These are the applications of the semi centrifugal casting process wheels you can see this kind of wheel. So, this is manufactures by semi centrifugal casting process pulleys you can see here these are the pulleys. So, these pulleys are manufactured by semi centrifugal casting process.

So, far we have seen that true centrifugal casting process and the sub classifications within that then we have seen semi centrifugal casting process. Now, let us see the third classification of the centrifugal casting process that is the centrifuging process.

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CENTRIFUGING PROCESS

PRINCIPLE:

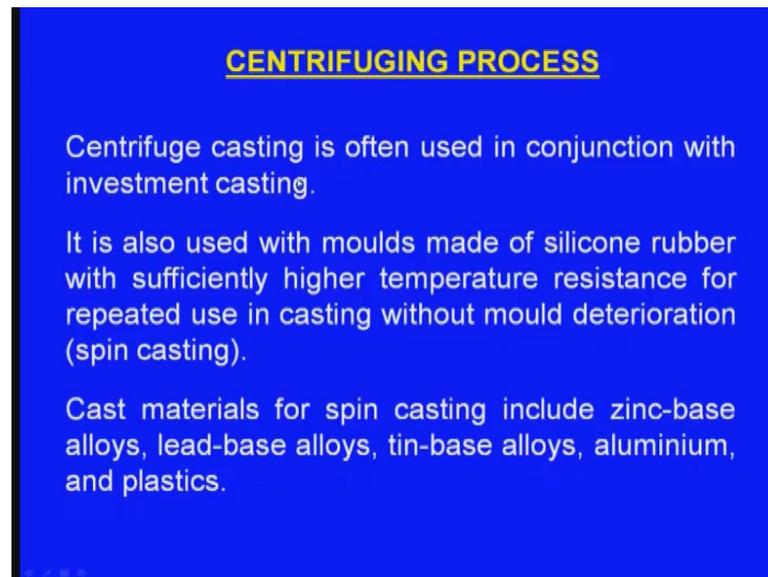
In centrifuge casting manufacture, moulds employed to produce the desired castings are arranged around a central sprue.

These moulds contain all the necessary geometry for the cast part, as well as the gating system. Runners travel from the central sprue to the mould entrances.

This provides a means of increasing the filling pressure within each mould and allows for reproduction of intricate details.

What is the centrifuging process and what is its principle? In centrifuge casting manufacture moulds employed to produce the desired castings are arranged around a central sprue here several castings at a time are manufactured within a using a single mould, if it is the true centrifugal casting process or the semi centrifugal casting process only one casting in a one mould, but here within a single mould there will be more castings. So, that is the special feature of the centrifuging process. These moulds contain all the necessary geometry for the cast parts as well as the gating system. Runners travel from the central sprue to the mould entrances. This provides a means of increasing the filling pressure within each mould and allows for reproduction of intricate details.

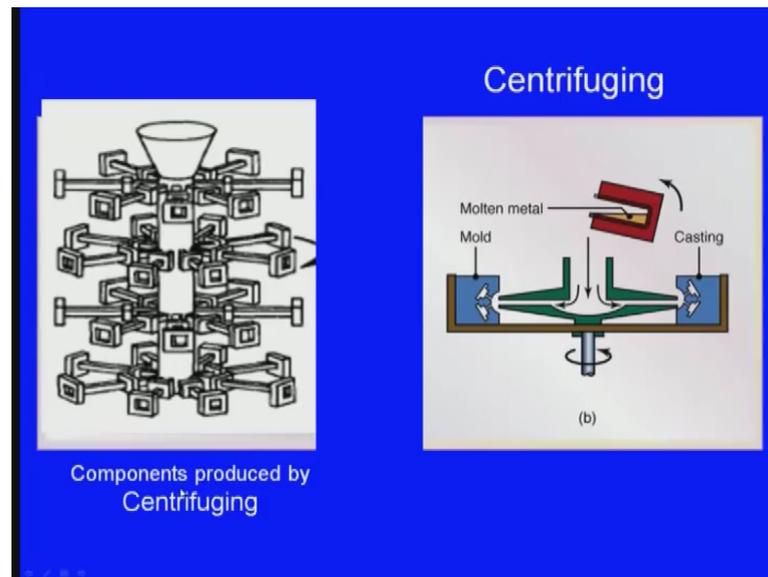
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Centrifugal casting is often used in conjunction with investment casting process because investment casting process involves manufacture of what say tiny what say castings sometimes castings with internal not internal tiny features intricate shapes in which it is very difficult for the molten metal to enter or in to penetrate at such times we use the centrifuge process. Then what happens? As the mould is rotating because of the centrifugal force that is falling on the molten metal the molten metal will be passing through the tiny details it is used it is also used with moulds made up of silicon rubber with sufficiently higher temperature resistance for repeated use in casting without mould deterioration. So, this process is known as spin casting means same thing, but here the moulds are made up of silicon rubber in such a case we call it as the spin casting.

And cast materials for spin casting include zinc-base alloys, lead base alloys, tin base alloys, aluminum and plastics.

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Now, here we can see the setup you can see here there is a again this also what say carried out about a vertical axis similar to the true what say semi centrifugal casting process. But what is the difference between the semi centrifugal casting process and the centrifuging. In the case of the semi centrifugal casting process there will be one mould will be there and it will be rotating about a vertical axis, but only one component is manufactured using one mould, but here there is only one mould nut there will be more components will be there. For example, this is one component this is another component and this is another component, this is another component means all along the circumference there will be several what say what say mould cavities will be there each cavity meant for one casting.

So, all this are cast at a time all this are joined. So, after solidification we have to remove we have to cut and we get so many castings at a time and here we can see more details you can see here this is the central sprue and here this is the one casting, this is one casting, this is one casting, this is one casting. Likewise there are several castings are connected to this central sprue. Now, when we pour a molten metal as the molten metal is entering into this central sprue it will be rotating the mould will be rotating and because of that there will be centrifugal force the applying on the molten metal and because of that because of the centrifugal force falling on the molten metal they will be passing through the tiny what say cavities.

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Advantages of Centrifuging process

1. Ensures better quality.
2. Castings when generated on large scale will be economical.
3. These castings generate high yield.
4. The castings obtained by this method cannot be satisfactorily obtained by other casting methods.
5. Cleaning and fettling cost of the castings can be reduced.
6. Denser castings having physical properties similar to those of forged products.
7. Rejection percentage is very low.
8. Easy way to achieve directional solidification

What are the advantages of centrifuging process? Ensures better quality, castings when generated on large scale will be economical just. Now, I have told you the case of centrifuging process using a single mould several castings can be made with one sprue, several castings may can be made at a time. So, that becomes that is economical castings when generated on large scale will be economical.

These castings generate high yield because for several castings there is only one central sprue. So, the molten metal consumed for the gating system is very less that is how casting yield will be higher. The castings obtained by this method cannot be satisfactorily obtained by other casting methods. The what is say filling up of the mould by the molten metal is excellent because of centrifugal force falling on molten metal.

Next one cleaning and fettling cost of the castings can be reduced denser castings having physical properties similar to those of the forged products rejection percentage is very low because most of the castings are sound castings no discontinuities. Next finally, easy way to achieve directional solidifications this directional solidification we have already learnt. So, I do not want to repeat again.

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CENTRIFUGAL FORCE

Centrifugal force acting on a rotating body is,

$$\mathbf{C.F. = mv^2/r}$$

where, m – mass (kg)
v – peripheral speed (m/s)
r – radius (m)

Gravitational force, **G.F = mg**
where, g = acceleration due to gravity (m/s²).

$$\mathbf{G\ factor = C.F./G.F. = mv^2/r.mg = v^2/rg}$$

Solving, further we get, **N = 42.3 $\sqrt{G\ factor/D}$**

Now, let us see centrifugal force centrifugal force acting on rotating body is CF is equal to $m v^2$ by r where m is equal to mass in kilograms, v is the peripheral speed meters per second, r is the radius in meters.

Now, gravitational force GF is equal to mg where g is the acceleration due to gravity meters per second square, g factor is equal to CF divided by mg that is equal to $m v^2$ divided by r into mg that is equal to v^2 by rg . Solving further we get n is equal to $42.3 \sqrt{g\ factor / d}$. So, this is the formula for the speed that is to be what say operated.

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Expected requirements of a centrifugal casting machine

1. The machine must be able to accelerate the mould to a predetermined speed, maintain smooth spinning, and decelerate to a stop in a reasonable time frame.
2. There must be a way to heat and coat the mould before pouring the molten metal.
3. There must be a means to pour the molten metal safely into the rotating mould at a controlled rate, position, and orientation.

Now, expected requirements of a centrifugal casting machine what are the requirements? The machine must be able to accelerate the mould to a pre determined speed maintain smooth spinning and decelerate to stop in a reasonable time frame. There must be a way to heat and coat the mould before pouring the molten metal otherwise what happens the molten metal may stick to the mould. So, to prevent this we have to give a ceramic slurry coating this must be drained and this must be heated and also it must be baked. So, thus that much provision must be there within the machine. There must be a means to pour the molten metal safely into the rotating mould at a controlled rate position and orientation.

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Expected requirements of a centrifugal casting machine

4. There must be a means of adding inoculants or fluxes for some special applications:
5. Once the metal is poured, a proper solidification and cooling rate must be established in the mould to obtain a desired casting microstructure.
6. There must be a means of extracting the solidified casting quickly from the mould at elevated temperatures without deforming the casting.

There must be a means of adding inoculants or fluxes for some special applications. The role of the inoculants and the fluxes we have already seen, so even this centrifugal casting machine should have means of adding these inoculants and fluxes. Once the molten metal is poured a proper solidification and cooling rate must be established in the mould to obtain a desired casting microstructure. Next one there must be a means of extracting the solidified casting quickly from the mould at elevated temperature temperatures without deforming the casting.

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COMMON MOULD MATERIALS

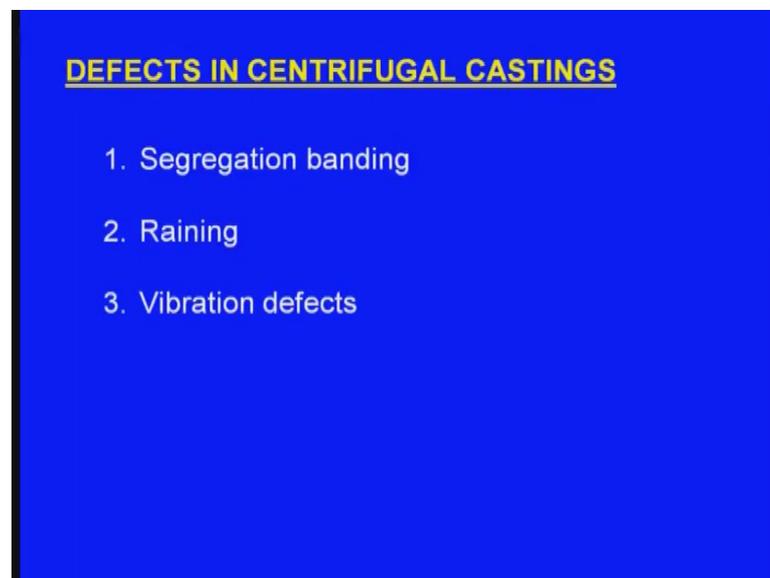
- Metallic permanent moulds
- Refractory-lined metal moulds
- Sand-lined metal moulds
- Graphite

The **metallic permanent moulds** are most widely used because of their reusability, accurate casting geometry, and high productivity.

Common mould materials. First the most common mould material is the metallic permanent moulds. So, these are widely used. Next one refractory lined metal moulds, next one sand lined metallic moulds and finally, graphite moulds.

The metallic permanent moulds are most widely used because of their reusability, accurate casting geometry and high productivity. So, these are the common mould materials among these metallic what say moulds are widely used. Now, let us see the defects in the centrifugal casting moulds. So, they there are three types of major defects in the centrifugal casting process.

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One is the segregation banding, second one is the raining, third one is the vibration defects.

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DEFECTS IN CENTRIFUGAL CASTINGS

SEGREGATION BANDING:

Bands are annular segregated zones of low melting constituents, such as eutectic phases, oxide or sulfide inclusions.

It occurs in true centrifugal casting, generally where the casting wall thickness exceeds 50 to 75 mm.

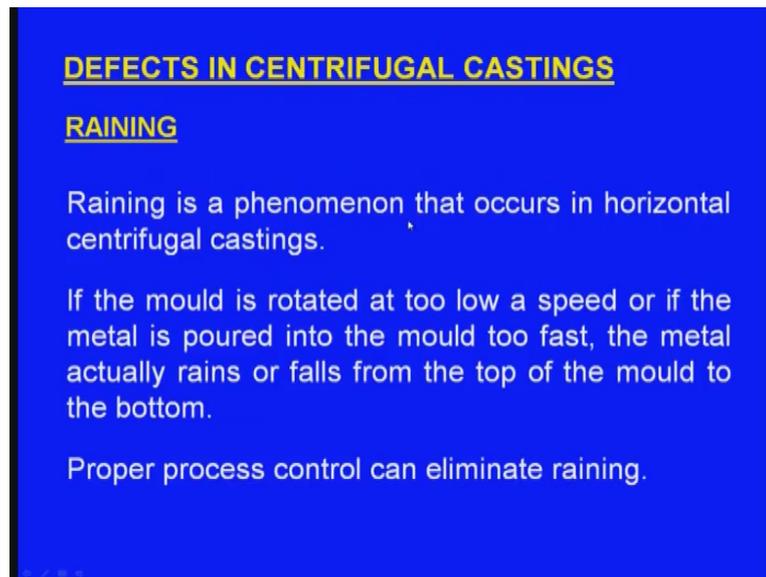
Banding is more prevalent in alloys with a wide solidification range.

Minor adjustments to casting operation variables, such as rotational speed, pouring rate, and metal/mould temperatures, will usually reduce or eliminate banding.

First let us see the segregation banding bands are annular segregated zones of low melting constituents such as eutectic phases oxide or sulphide inclusions. So, these are the segregation banding.

It occurs in true centrifugal casting generally where the casting wall thickness exceeds 50 to 75 millimeters. Banding is more prevalent in our lives with a wide solidification range. Minor adjustments to the casting operation variables such as rotational speed pouring rate and metal mould temperatures will usually reduce or eliminate this defect. Now, let us see this second defect that is the raining. Now, what is this raining?

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DEFECTS IN CENTRIFUGAL CASTINGS

RAINING

Raining is a phenomenon that occurs in horizontal centrifugal castings.

If the mould is rotated at too low a speed or if the metal is poured into the mould too fast, the metal actually rains or falls from the top of the mould to the bottom.

Proper process control can eliminate raining.

Raining is a phenomenon that occurs in horizontal centrifugal casting process. If the mould is rotated at too low a speed or if the metal is poured into the mould too fast the metal actually rains or falls from the top of the mould to the bottom. Just like rain the molten metal will be falling down why this is happening too low speed of the mould or too high speed of the pouring of the molten metal. So, these are the main reasons for the raining of the molten metal from top to the bottom.

So, proper process control can eliminate the raining. So, that is y sometime back we have seen that to operate this process skilled drivers are, skilled labours are required only those people skilled people know at what say rotation there will not be any raining. So, if the moulds rotation is too low there will be raining or if the rate of what say entry of the molten metal is a too high that time also there will be rain. So, these can be controlled by experience that is why experienced and skill workers are required to operate this machine.

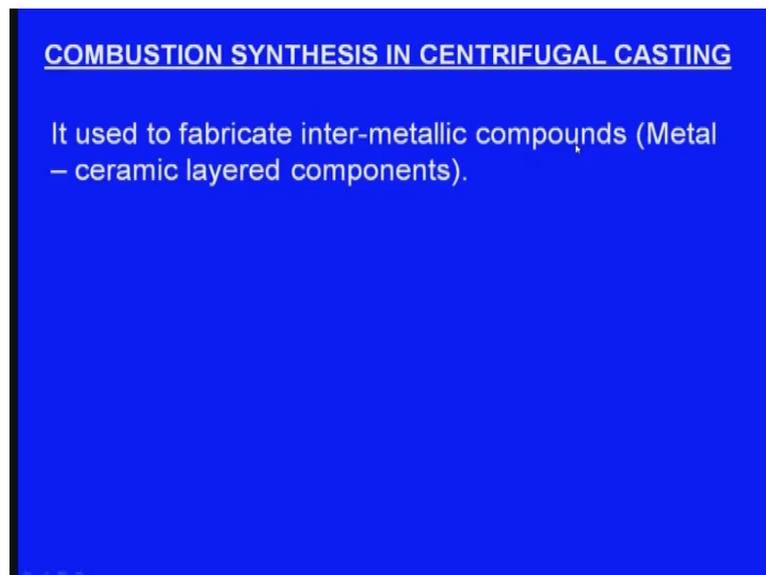
Finally let us see that vibration defect.

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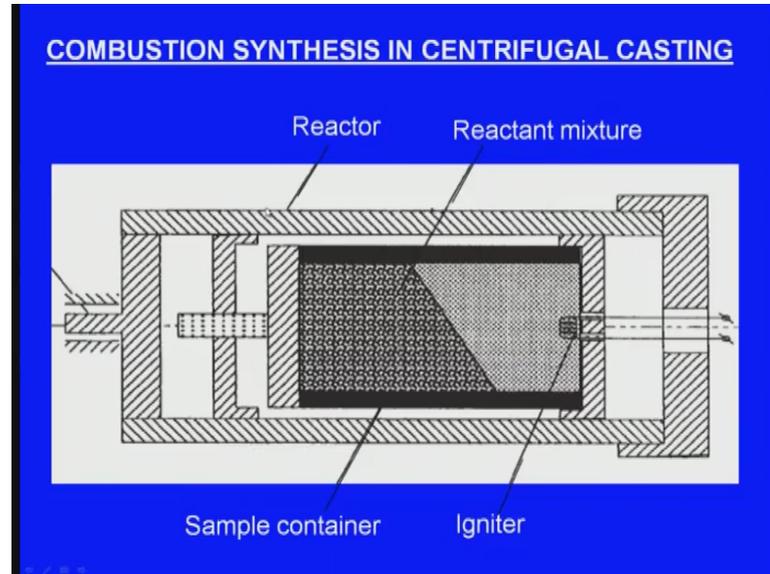
What is this vibration defect? Vibration can cause a laminated casting and it can be reduced to a minimum by proper mounting careful balancing of the moulds and frequent inspection of rollers, bearings and other equipment. So, using what say these parameters we can minimize the vibration defects. Now, recent trends in the centrifugal casting process.

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fabricate inter metallic components this centrifugal casting process is used in which there will be what say combustion, combustion based synthesis will be taking place.

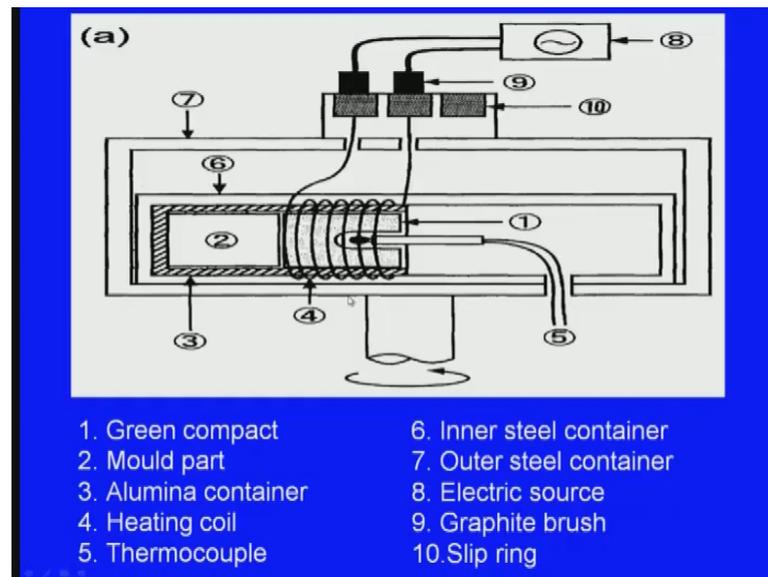
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And here we can see this process in details using a diagram, so this is the combustion synthesis in the centrifugal casting process. So, here we can see this is the reactor this is the reactor and this is the sample container and this is the igniter which call what say initiates the combustion.

Now, this is the reactant mixture. Now, what will happen when this reactant mixture because if this igniter will be reacting and there will be combustion inside the chamber and because of that as we have seen previously we can fabricate inter metallic components means where one layer is made up of metal and the other layer is made up of ceramic layered components. So, this is the recent trend means using the combustion synthesis in the centrifugal casting process.

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And the next one is the using a yes in the previous case we were using the combustion and instead of combustion why not electrical heating. So, that is the next what say development in the this process and here we can see this is the green compact and the this is the mould part and third one is the alumina container this is the alumina container and the fourth is the heating coil this is the heating coil means this is heated using electricity, fifth one is the thermocouple and sixth one is the inner steel container this is the inner steel container, seventh one is the outer steel container, eighth is the electric source this is the electric source and the ninth one is the graphite brush this is the graphite brush and tenth one is the slip ring this is the slip ring.

Now, the principle is same we want to manufacture what say bimetallic parts for the case place where there will be components where there will be metal ceramic layered components will be there.

Now, using the electricity part and there is a coil heating coil this will be heated up and here there is a green compact is there and because of that green compact yes this will be heated up and we get the required component. Required component means one layer will be metal and the other layer will be ceramic layered component. Now, with this we are uh coming to the end of this lecture we have seen the principle of the centrifugal casting process and we have seen the what is a broad classifications of the centrifugal casting

process one is the true centrifugal casting process, the second one is the semi centrifugal casting process and the third one is the centrifuging process.

In the case of the true centrifugal casting process there will be either horizontal mould or a vertical mould will be there and these will be rotating at a predetermined speed and the molten metal enters into these moulds, but in this case we get a hollow component or a cast component with a hole inside. So, that is the specific feature of the true centrifugal casting process. And we have seen the semi centrifugal casting process what is this? This is a variation of the true centrifugal casting process and it all the mould always rotates about a vertical axis. But what is the difference between the two centrifugal casting process and semi centrifugal casting process? In the case of the true centrifugal casting process we always get a hollow cast component or a cast component with a hole inside whereas, in the case of the semi centrifugal casting process we get a we there will not be any hollow what say cavity will be there we always get a means the molten metal is always completely filled with the what say by the mould and the third one we have seen that is the centrifuging process.

In the case of the in both these two cases they may centrifugal semi casting process and the centrifuging process the mould will be rotating at about a vertical axis, then difference between semi centrifugal casting process and the centrifuging process? In the case of the semi centrifugal vesting process yes there will be a mould will be there and it will be rotating about a vertical axis, but only one cast component can be produced using a single mould. But in the case of the centrifuging process using a single mould several castings can be made and again in the case of this semi centrifugal casting process the what say cast component will have a symmetrical geometry whereas, in the case of the centrifuging process there the cast components may not have a symmetrical geometry. So, that is the difference between the semi centrifugal casting process and the centrifuging process. So, with this we are completing this lecture and we will meet in the next lecture.

Thank you.