Principles of Casting Technology
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Lecture – 15
Special Molding Processes
Full mold, Plaster molding, Vacuum molding, etc

Welcome to the lecture on Special Molding Processes. So, in this lecture we will discuss about some of the special type of molding processes, a processes were molds are made by some special methods. Among them we will discuss about full mold process, plaster molding, vacuum molding, apart from that there are certain varieties of vacuum molding then graphite molding all these things, we are going to discuss in this lecture.

So, let us start with the full mold process or full mold casting what we call it as.

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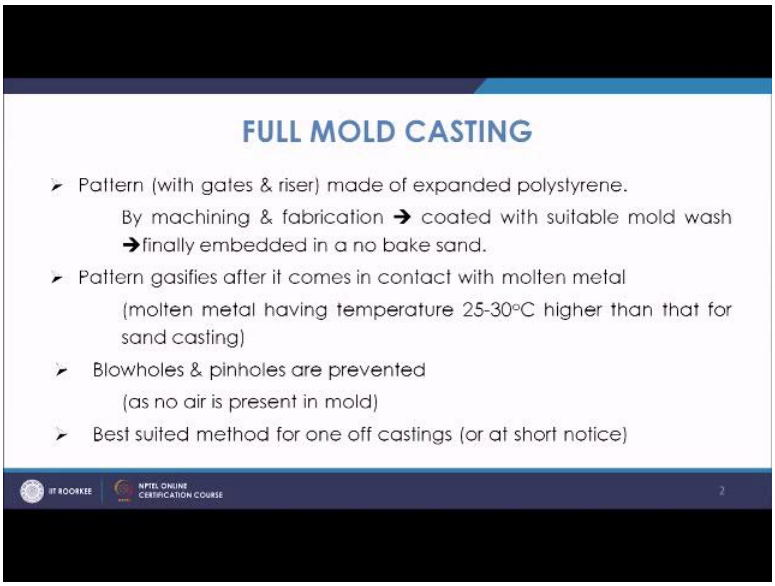

Now, this is known as a full mold means the mold basically has the pattern into it, when we are casting and we are trying to pour the molten metal into the cavity in normal circumstances the cavity is hallow, where as in this case the cavity is not hallow rather it is full. So, that is why it is known as the full mold casting.

Now, in this case this cavity is basically filled with certain material that is made from polystyrene. So, that is expanded polystyrene. So, it is also known as expanded

polystyrene method, so expanded polystyrene casting EPC. So, there are many names to it, so in that what happens you make all this pattern as well as the gates and risers attached to the pattern they are all made from this expanded polystyrene it is nothing, but the polystyrene material in the form of beads we will discuss later and they are expanded and they conform to the cavity. So, they are made by machining and fabrications. So, you have the polystyrene first of all you have the sheets and from there by machining and by fabrication, you are sizing them to the proper patterns shape and then you are coating that with suitable mold wash so that you are getting the adequate surface properties, on that pattern and finally you will embed that in a no bake type of sand.

So, basically you have the polystyrene. So, what you do is the pattern that we can see here the pattern is prepared from pre expanded polystyrene granules. So, there are pre - expanded polystyrene granules, they are put in the cavity I mean its kept in a metallic die and this die is heated from outside either by steam or by the hot air and due to that increase in temperature, these granules or polystyrene they expand on heating. So, they expand and they join together and they conform to the cavity of the die, the shape of the die and they take a solid shape. So, so they are which are injected or gravity filled in the walled ammonium or copper dies and then we are heating them under a steam or in hot water, they expand and joined together to form a solid shape conforming to die cavity.

So, once you are getting that, that is your pattern, now to that you attached these sprue and riser, gates whatever required for the poring of the molten metal.

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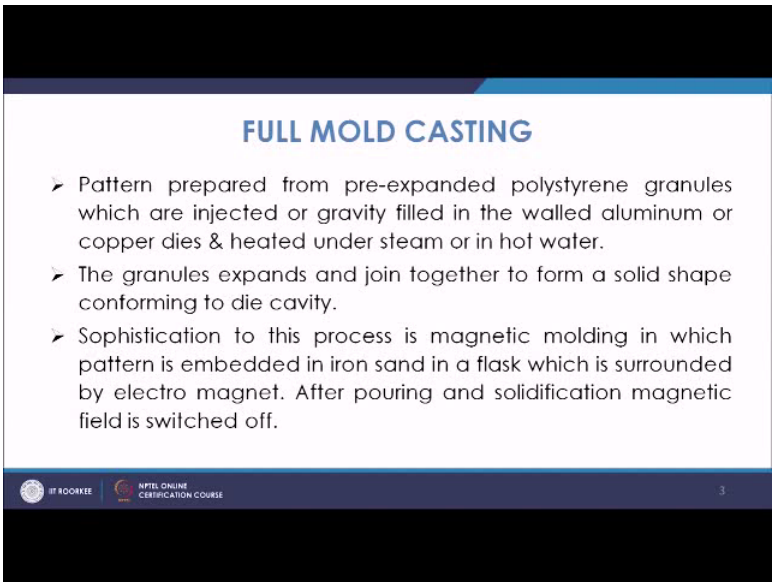

Now so, then we are also doing the coatings or we are doing the mold wash. So, that you have adequate surface finish. Now, when we pour the liquid metal, then this polystyrene material when it comes in contact with the hot metal it automatically gasifies. So, suddenly it gasifies and wherever the molten metal goes, because molten metal is surrounded by this loose sand or no bake type of sand. So, wherever it goes once it goes there it basically solidifies and on the periphery you have this no bake type of sand. So, it gets. So, that place where earlier there was polystyrene it is filled with molten metal. So, we are giving the molten metal temperature normally 25 to 30 degree C higher. So, that it is should be able to gasify it there should not be any traces of the material inside.

Blowholes and pinholes are prevented, so because there is no air inside, because in earlier cases when the cavity is hallow, there is air inside it. You must have adequate measures or you must ensure that the cavity which is having the air this air should be thrown off; in this case there is no air it is filled with this polystyrene pattern material. So, since there is no air there is no likelihood of having any air related defects like pinholes or blowholes.

Now, this method is best suited for one of casting. So, these are this method is normally preferred, when you get the order of one casting. So, making pattern for one casting doing everything is a very tedious and it is not at all economical. So, in those cases or if you are at so at short notice you have to deliver the product in those cases you go for

such methods. So, we can see that you have the formed polystyrene pattern; you have a sprue all that then once it is you are putting the molten metal into it, as the molten metal comes here it will all gasify, molten metal comes through it and wherever molten metal goes, they all gasify and it takes the shape of. So, all this you are getting as the material by which you are casting.

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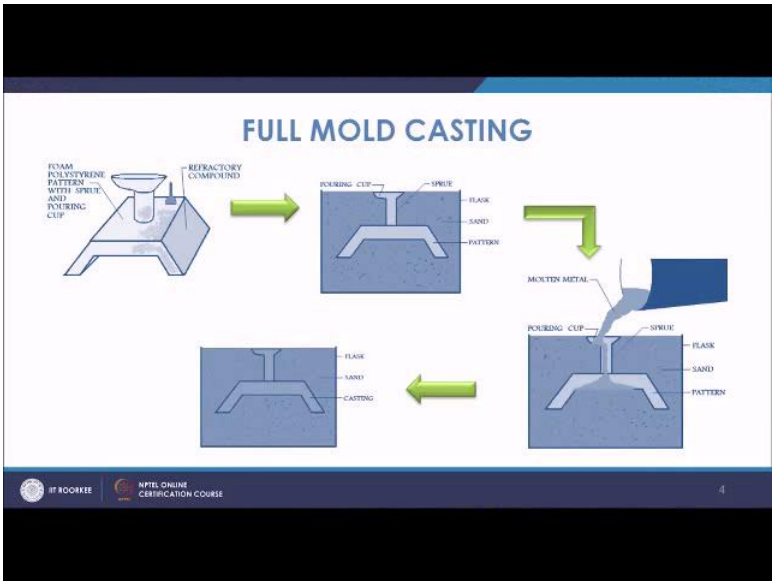

So, which is your casting and this is all that addendums that is your sprue or poring basin. So, you are basically getting this product or the cast. So, this is known as full mold casting. Now there is another sophistication in this process, that is magnetic holding. So, what magnetic holding does basically the same pattern, pattern made of polystyrene it is kept in iron sand in a flask, so embedded in iron sand. So, iron sand is nothing, but you have iron sorts mixed with iron powder or you know the product of machining. So, that those product. So, in that basically iron powder mixed and then that is basically giving the support from all the sides and this pattern is from all the size enveloped with this iron sand. And then they are basically hold together by a magnetic field, by electro magnet.

So, what you do is once you pour the molten metal, then molten metal will go and wherever it touches on the way to this pattern then it will go and it will gasify it and since it is surrounded with iron. So, these are the good conductivity. So, it will solidify also quickly and then once you ensure that there is proper solidification already as solidification is finished you can remove this magnetism which is being created. So,

magnetic field is switched off and then quickly you are getting the product. So, there is no problem of fettling and other things. So, this way this is also variety of since we are using this magnetic field it is also known as magnetic type of molding that is magnetic molding. So, this is about full mold casting or evaporative pattern casting.

Next is, plaster molding process. So, we have heard earlier that plaster is used as a pattern material, but plaster is also used as the molding material. So, we know that the gypsum plaster, when it is mixed with water it is set and gives hardness.

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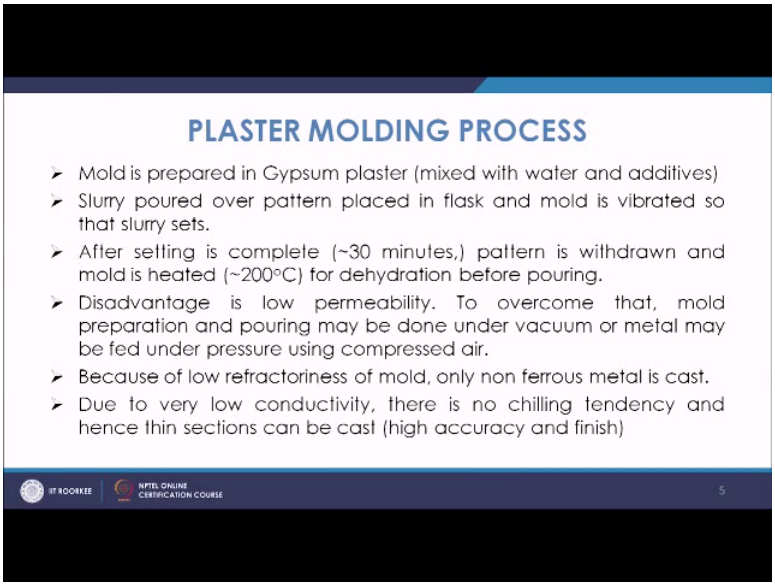

So, in this case you are preparing the mold with the gypsum plaster mixed with water and also we add the additives, so that you get the desired properties, I mean specific properties what we want to achieve. So, once you are mixing the gypsum plaster with water and the additives, this is in the form of slurry. So, this slurry is basically poured over the pattern.

So, pattern is there on that this slurry is pour and this slurry being in liquid state it has good flow ability it will go in all the corners. So, slurry is poured over pattern and mold is vibrated so that slurry sets. So, mold will be vibrated little bit after sometime the slurry will set in may be in about 30 minutes, the slurry sets completely. Then you can withdraw the pattern and mold is heated may be close to 200 degree C for dehydration all the water is blown off before pouring.

Now, in this case basically the disadvantage is that it has low permeability, in this case the disadvantage only disadvantage with this plaster molding is that the permeability to low. So, sometimes what has been practiced, that may be the mold preparation and poring you try to do under vacuum. So, if you try to do under vacuum then the possibility of the air related defects because entering air amount is less negligible. So, in that case the defects which are likely to come because, of the low permeability issues like gaseous defects blows, those things their probability becomes quite less.

So, in that case you may use, the pouring or mold preparation by using the vacuum or even sometimes you use you feed the metal under pressure using compressed air. So, these two means are used may be in this. So, that the issue of permeability is not there. Now in this case, because it is reflection is not so high. So, normally we restrict casting of non ferrous materials by when we try to use this plaster as remolding material.

Now, further because its conductivity is too low. So, the chilling tendency is not there, if the conductivity is higher the rate of heat transfer through the mold surface will be higher like, what we have seen in the stand the conductivity is not so high, but if we take their molding material as the metal the conductivity becomes quite high. So, in that case in the case of plaster also the conductivity is quite low. So, because of that the chilling tendency is quite low. So, chilling is not there and since the heat transfer is very slowly. So, liquid method remains in liquid it for longer amount of time and that ensures that even in the final sections, the thinner sections liquid metal go easily. So, in this way you can have thin sections cast easily and plaster anyway the surface has a very good finished. So, good precision with good precision and good finish, you can obtain the casting. So, that is the advantage of plaster molding.

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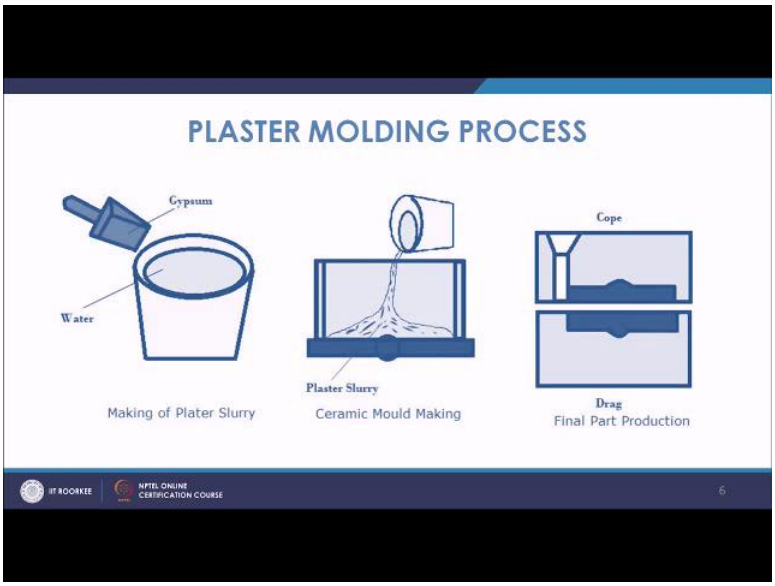

So, you can see the schematic you make the slurries, pour on this slurry on the pattern once you get these two halves, you have the portion from where having this scrucope and then you have the poring machine through which you pour the metal and it is comes and gets solidified. Now vacuum molding process the name indicates, that you use vacuum to make the mold and then the poring is done. So, in this case the advantage is that there is no use of binder and moisture.

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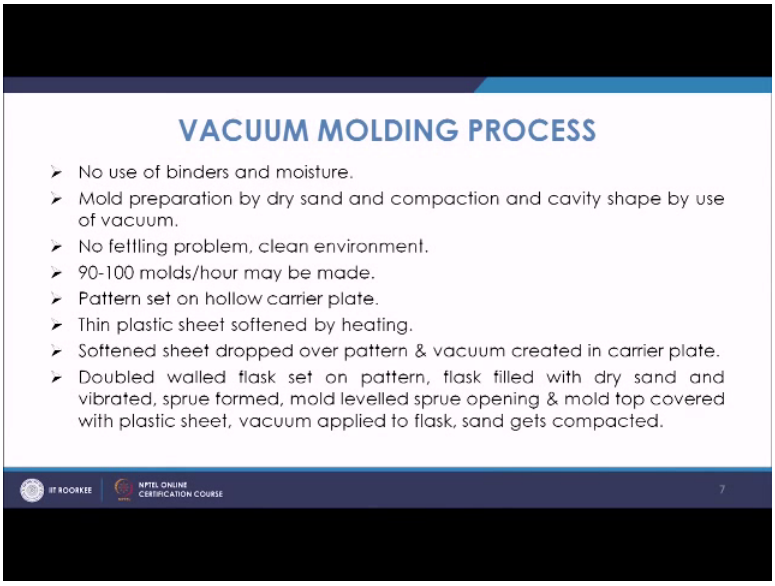

So, first of all the problem related to binders and moisture that is gone, the cost basically on the cost aspect also you can see the benefits then mold preparation is done by dry sand and compaction cavity shape by use of the vacuum. So, you have dry sand, the compaction or basically keeping the mold at its position, keeping the molding material or sand at its position. So, that you get the desired cavity shape, that is done by using the vacuum.

Since you have nothing to be taken out the molding materials like sand in normal case you have sand mold that is to be broken if they are lot of fettling issues. So, these issues are not there because you are using the loose sand. So, there is no fettling problem and you have clean environment, because you are not using the binders and moistures, which are likely to generate a large amount of gasses it may be harmful. So, that way it is clean also. The productivity is quite high 90 to 100, molds per hour you can make.

Now, coming to how you do it? So, what you do is you have a carrier plate. So, you have that is hallow and you are putting the pattern on it, then you are putting a thin plastic sheet over it and it is heated, so where it is softened and it goes over the pattern. Now this softened sheet, which is dropped over the pattern and vacuum created. So, that the pattern is completely enveloped by this thin plastic sheet.

Now, double walled flask set on pattern flask filled with dry sand and vibrated sprue formed mold leveled sprue opening and mold top covered with plastic sheet, vacuum applied to flask, sand gets compacted. Now this tells that what is the process. You have a double walled flask set. So, flask is you can you can have the figure, you have this flask both side once you get this. So, this here you have a plastic sheet here once this plastic sheet goes on it. Then on the rest portion you are putting this, sand this lose sand and further you are completely creating vacuum, so that this sand is taken the shape and inside you have a cavity.

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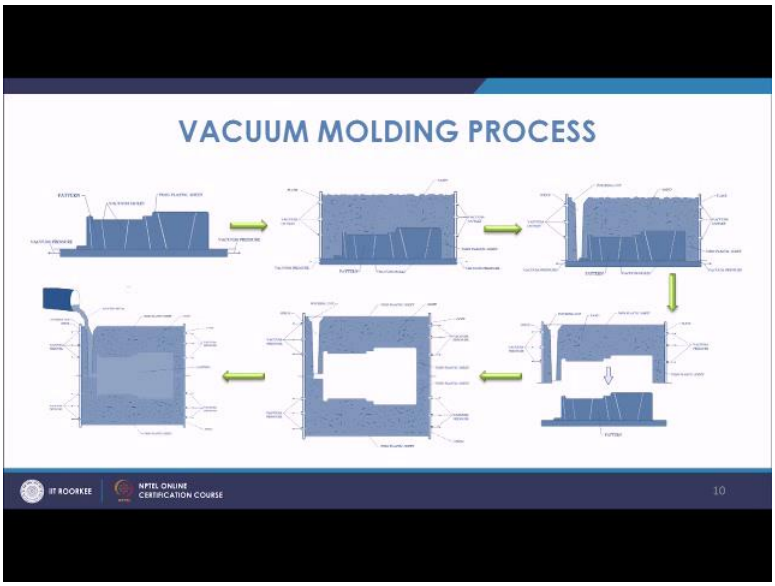

So, this pattern will be taken was drawn, but this vacuum here will be maintained, because you have a layer of the plastic sheet. So, you can take the pattern out and you will have a cavity generated. So, both ways for the co-portion as well as the drag portion, you will make the cavity, you will attach them and then also you will maintain the pressure, I will vacuum to be created. So, that there is vacuum inside and once you pour, then the after getting solidification once you release the vacuum, then this I am till that time the product as I have already solidified so you get the lose sand out.

Let us see. So, this flask is filled with dry sand and vibrated, then you make the sprue, sprue is formed and mold is leveled mold is having a level of the molding material or that is sand, this sprue mold opening and mold top is covered with plastic sheet so that for maintaining the vacuum you have not to do the extra things, vacuum is applied to the flask and because of the vacuum the sand gets compacted, you have to see that sand does not entering to the cavity and also not towards the vacuum machine. Vacuum in carrier plate released and mold is stripped after the solidification is complete.

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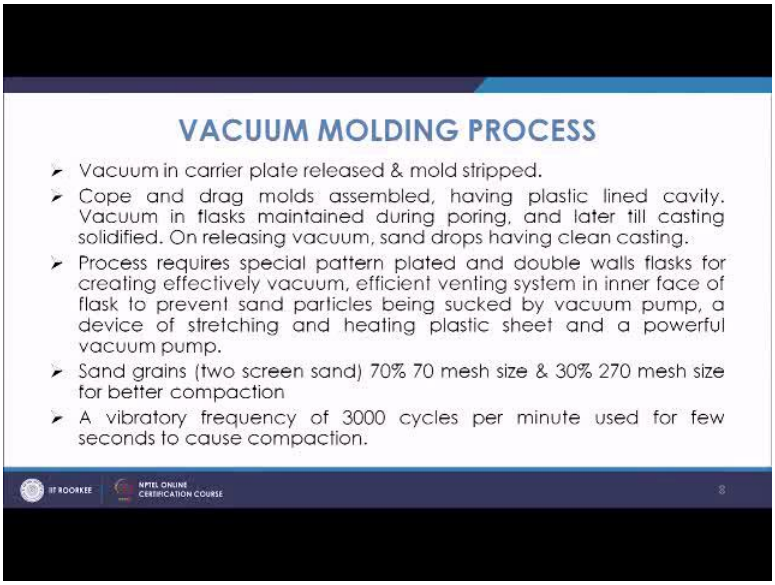

So, mold is stripped, now here there is no solidification basically cope and drag molds are assembled and having plastic lined cavity. So, you have the cope and drag molds which you have assembles. So, you have the cavity inside and you have the plastic lined cavity is there. Vacuum is in the flask is maintained during poring and till the casting is solidified you try to maintain the vacuum, so that is requirement you have to maintain this vacuum once you release the vacuum, the sand drops having clean cast, if the sand is loosed under the action vacuum only they were bonded. So, sand gets loose and it will go off and you can take the casting out.

So, you require a basically special pattern plate and double wall flask for this so that you have effectively the creation of vacuum, effective ventilating system in the inner face of flask to prevent sand particles being sucked by the vacuum pump, a device for stretching and heating plastic sheet and a powerful vacuum pump. So, these are the devices which are required for this and then you can go for this vacuum casting. It is seen that it is advised to have two screen of sand, so there should be some core and more of the core sand 70 mesh size, 70 percent of that and then 30 percent, you have 270 mesh size.

So, this way you have the 2 kind of one course and one fine sands, where those good compaction, good strength. So, that it can assist the metal static pressure. Then there is vibratory frequency also given for a certain type of cavity or size of the box, so you have some data given for certain size. So, this way you go for vacuum casting.

Now there is modified vacuum process also in that basically you use the EPS pattern, expanded polystyrene pattern you are using applied with refractory coating and loose sand grains are poured around the pattern and compacted by vibration followed by application of vacuum for full consolidation.

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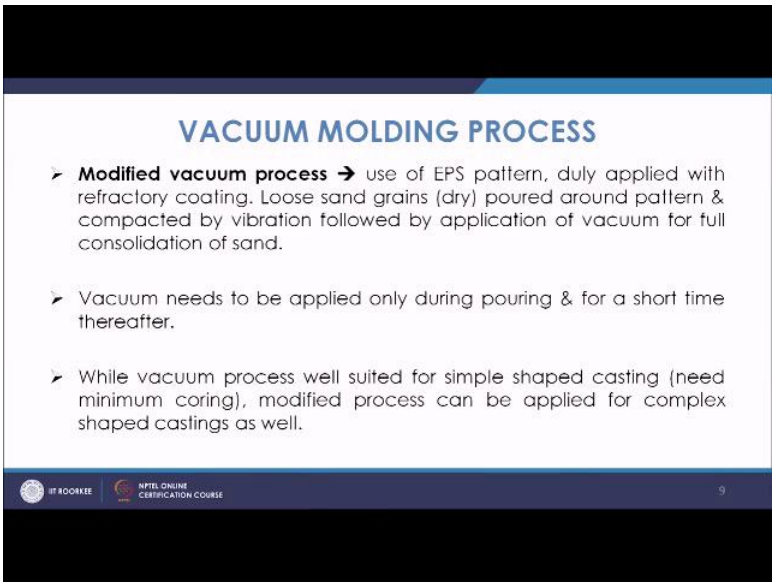

So, in this case what you do is, instead of cavity being the hallow, you have the EPS pattern, on that basically you have to putting loose sand and then try to have the compaction by the use of vacuum. Then vacuum needs to be applied only during pouring and for a short time they are after, while vacuum process well suited for simple shaped casting, now in that case the difference in this modified vacuum process and the earlier vacuum process was that in the vacuum process you need to have a simple shaped of cavity, where as if there is complex shaped cavity using this modified process because you have a pattern. So, that requirement maintaining the vacuum inside the cavity is not that much a troublesome job in this case, because it is any way in well up with certain pattern material. So, that is why this is the modified kind of vacuum molding process and in that even complex shaped product can be cast.

Then there is one that is known as VRH Process. So, it is basically this vacuum process were also invented in Japan and here this also was in Japan and now this case, what is done is the it is based on the CO_2 process, but here a vacuum is also maintained. So, the

reaction or silica gel formation it is all done under vacuum. So, since there is no air the hardening is controlled hardening is fast.

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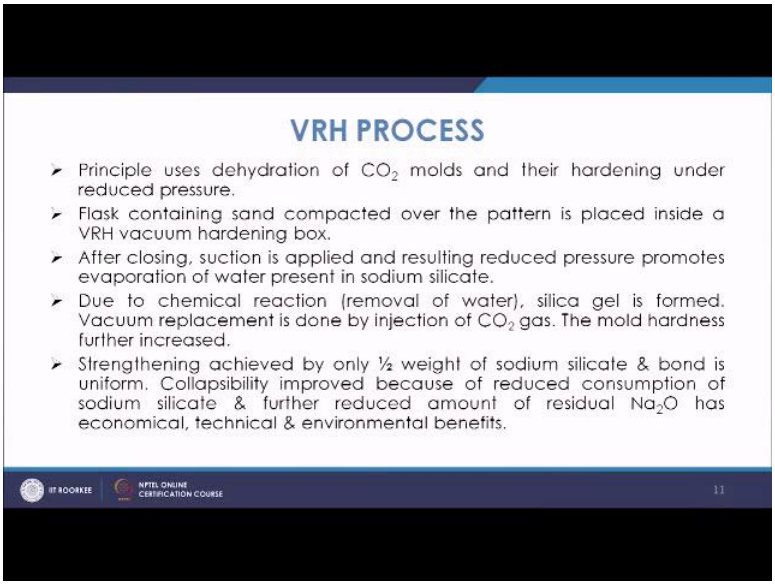

So, what is done is, here principle uses dehydration of CO2 molds and they are hardening under reduced pressure. So, you have reduced pressure under that basically you do this dehydration or removal of the moisture from that sodium silicate or CO2 mold. So, flask containing sand compacted over the pattern placed inside a VRH vacuum hardening box. So, you are putting that flask, containing this sand and then after closing section is applied and resulting reduced pressure promotes evaporation of water presenting sodium silicate. So, water and I mean there is water in the sodium silicate water vapor is there. So, that this is basically water will try to go off. So, because the sodium silicate is mixed with sand, for the CO2 Process, so once you reduce the pressure the water vapor will try to go off water present in the sodium silicate, they will try to up rise and they will try to go off.

Now, due to chemical reaction and due to a removal of water this silica gel will be formed and this you may know that in the case of CO2 molding, the silica gel formation is basically giving the strength. So, vacuum replacement is done by injection of CO2 gas. So, once you reduce the pressure and there is vacuum, that basically is compensated by moving the CO2 gas into it which does the hardening. So, the mold hardness further

increases. So, this way you see that one is removal of the water from the silica gel and then further strengthening by the injection of CO2 is strengthening.

So, in this case sodium silicate is consumed only half, than the normal portion normal cases and also this hardening is very much uniformed, because of the reduced pressure condition this hardening is more uniformed since we are using less amount of sodium silicate. So, collapsibility also is better in this case and there is reduced amount of Na2O also gives benefits in terms of economical technical and environmental benefits. So, this is about the VRH Process.

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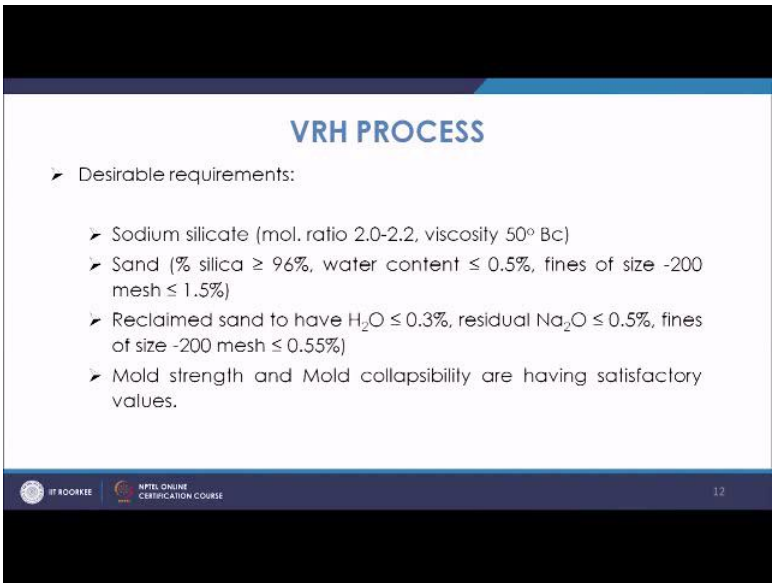

Now in this VRH Process we can see that, we have to use the sodium silicate of mol. ratio 2.0-2.2, viscosity of 50 degree (Refer Time: 24:59) and then sand is 96 percent silica, water content 0.5 percent, less than that. So, these are the requirement for the sand, to be or the in gradients to be in the case of this VRH Process, that you have you must have less amount of water residual NA2O should be quite less, fines should be quite less, because they will increase the amount of binder to be utilized and they will affect the process characteristics. Satisfactory you have mold strength and collapsibility values are reported in this. Another variety is ceramic molding process as the name indicates here we use the ceramic refractorys, so it uses chemicals and ceramic slurries for mold preparation.

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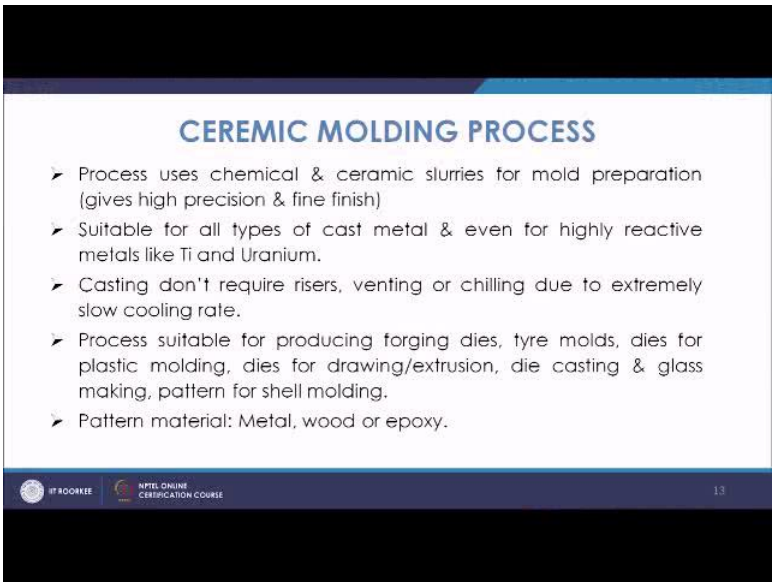

For all types of cast metal it is applicable even for very reactive metals like titanium and uranium we use them, it does not require risers venting or chilling due to because of the extremely slow cooling rate, in this case there is extremely slow cooling rates, you do not require risers. Suitable for making this forging dies, tyre molds, dies for plastic of all this were accuracy required all that places you use this ceramic molding die casting glass making patterns for shell molding all that is made by this process.

Pattern material can be any one like metal wood or epoxy. So, in this what you do is you make this slurry, you mix this ceramic aggregates that is nothing, but ceramic refractories, particles as per the requirement of the properties and you have a liquid d binder that is modified alkyl silicate and alcohol based silicon ester. So, this is one binder which is alcohol based and when binder is begins to set refractory particles start locking to each other and start getting the strength and slurry powder will be kept over the pattern, which will set quickly in 3 to 5 minutes, because of the solvent being alcohol and it goes into all the cavities no running is required, no vibration is required, pattern is withdrawn and ceramic mass is removed from flask treated with a catalyst to promote full chemical stabilization.

Then further we are heating in the furness to explain all liquid binder completely, then poured and it is cooled slowly, it is done to 900 degree C by mistake it is written; 90 degree C it is 900 degree centigrade up to that is heated and then it is poured and allowed

to cool slowly so that is about the ceramic molding. Then another variety of this molding is graphite molding where we use the graphite as the mold.

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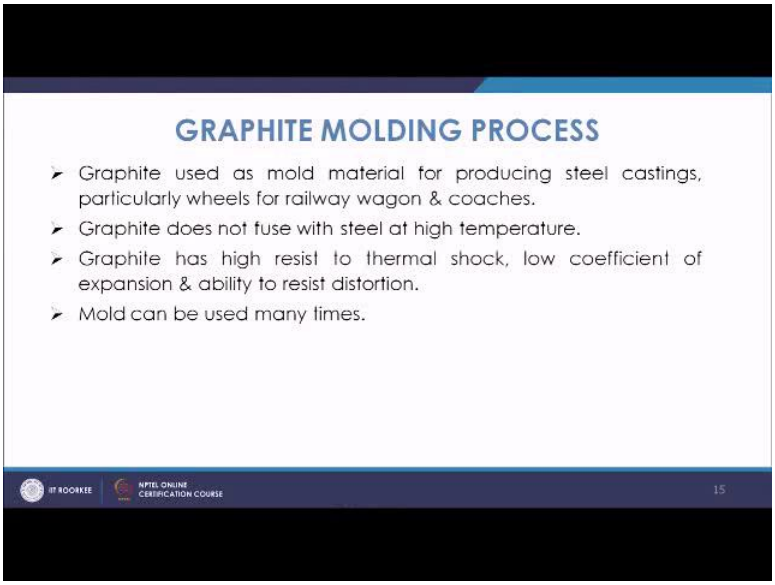

So graphite is used as molding material for producing steel castings, particularly wheels, for railway wagon and coaches, so graphite is a very good conducts of heat, we use the graphite it as I mean there is basically very good ease off machining is there for graphite, you can make the molds quite easily. It does not fuse with steel at high temperature. So, this is also one of the important properties, because of which we preferred the graphite to be used for the molding. It has a high resistance with thermal shock low coefficient of expansion and ability to resist distortion. So, that is why we preferred the graphite also for, as a molding material it can be used repeatedly and it gives very good quality it can be used many times.

So, we have discussed about these different kinds of molding processes, which are under this special categories, we will be discussing other special casting processes, when we talk about the casting process in future.

Thank you.