Principles of Casting Technology
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Lecture - 14
Special sand Molding Processes
Processes based on organic binders

Welcome to the lecture on Special sand molding processes and in this lecture we will discuss about processes based on organic binders. So, in the last lecture we discussed about the processes based on inorganic binders and we discussed the binder being sodium silicate and we had discussed about the different processes.

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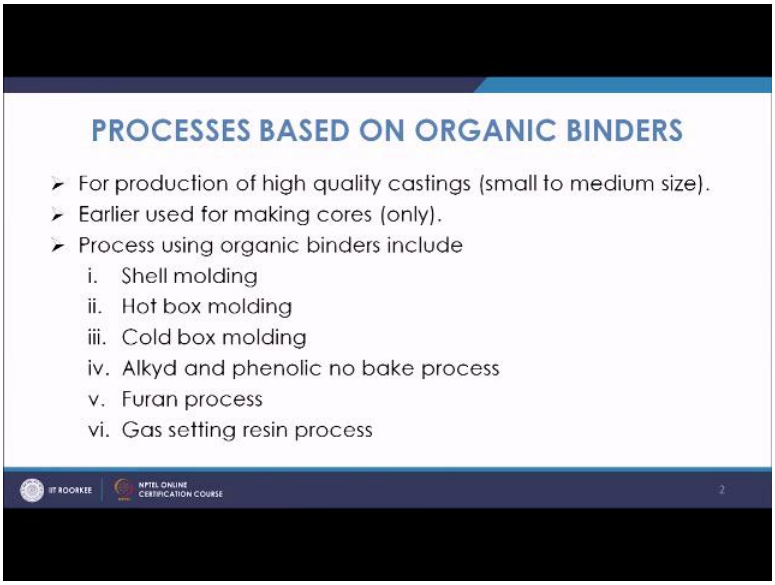

Now, in this lecture we will discuss about those binders which are based on organic materials. So, what happens that for production of high quality castings you know earlier we used the inorganic binders only, but in those cases the cores which you make they are normally quite big and heavier they take also time. So, you use to make only the cores normally from these improved processes, now we with the use of organic binders, basically you can make the cores of good strength, normally you can make a light core with small thickness, but having good strength and good properties.

So, in those cases these organic binders are used, even in casting also you can have the mold of lighter weight and for quality castings you can use this organic binders to make

the shells. So, these shells even if they are having small thickness, they have adequate strength. So, among the varieties, we have shell molding hot box cold box molding, alkyd and phenolic no bake furan and gas setting resin processes. So, these are the different types of processes which are used and they are based on the use of organic binders.

Let us come to the shell molding process. So, it is based on the concept of a shell building. So, what we do is here basically you have a pattern plate on that you have patterned is fixed and this pattern is heated and sand resin mixture is basically put on that pattern. So, what happens that when it comes in contact with the heated pattern, there is polymerization taking place and then there is an amount of thickness of the shell is generated. So, what happens after certain time you are basically inverting and then you are getting one half of the mold being generated by and in the form of shells.

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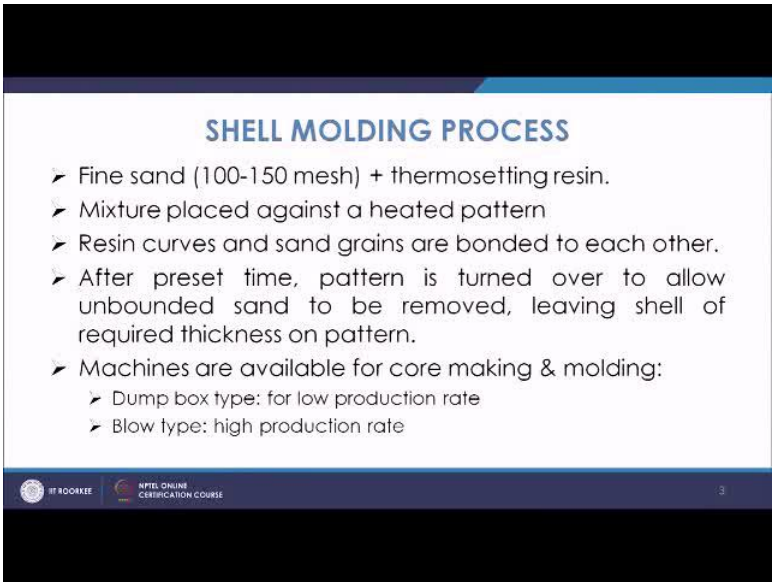

So, you have fine sand and you are using the thermo setting resin. Mixture is placed against a heated pattern, resin and sand grains are bounded to each other, after some time pattern is turned over to allow un bounded sand to be removed leaving shell of required thickness on pattern and machines are available for core making and molding. So, what happens that you have a sand resin mixture, so sand is coated with the resin, and this is the pattern, this is heated; so once this quoted sand comes in contact with this heated

pattern, there is because of the high temperature the polarization takes place and there bounding takes place.

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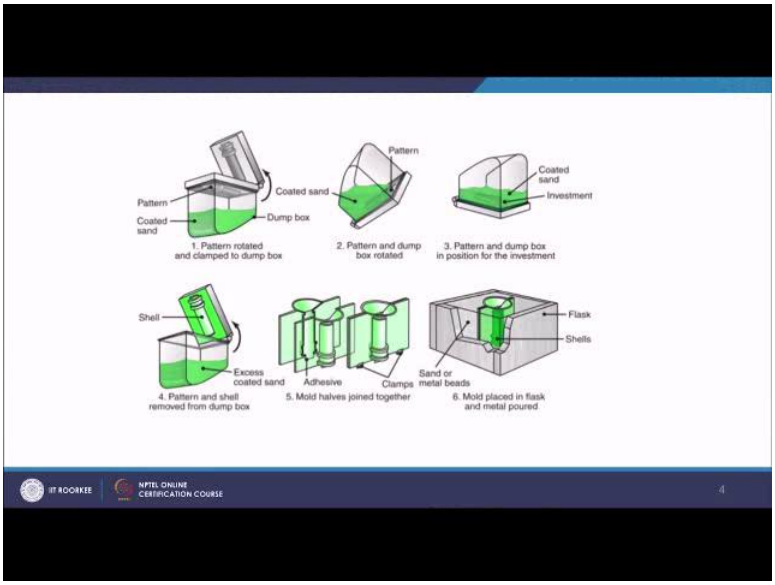

Because of that slowly with time a thickness of the shell is formed, after some time after a predetermined time this is again inverted, then these unbounded sand particles they are left over in this portion and you get one half portion of the mold or the core be it. So, this way you can get the halves either dragged or cope portion of the shell, and this can further be assembled and put in the flask and further you can have something to support it because this coarse this shells are having very small thickness. So, they may not be able to with stand the metallostatic pressure, so, what you do is you are supporting it from all the sides and then further you are pouring.

So, this way what happens here that; that is what it was known as shell molding, because with time a shell is formed and the pattern is heated and because of that heat, this is taking place; there are some methods, here basically you have two types of molding methods used, one is dump box type and another is bore type. So, one for low production rate and another is for higher production rate manual and physical mechanized, where the boring takes place by machine, so you will have large production rate.

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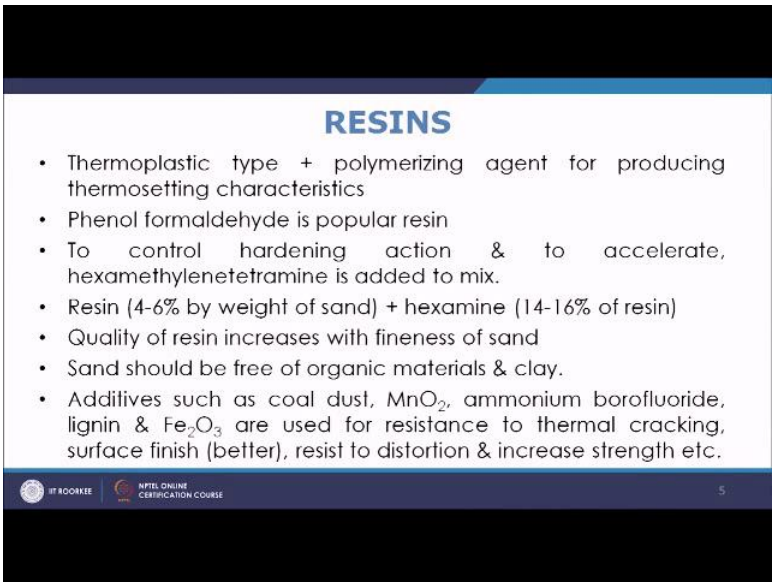

So, in this basically resin is thermo plastic type plus you are adding certain polymerizing agent, so that you get this thermo setting characteristic; normally phenol formaldehyde is the resin which is used. The control hardening action and to accelerate you are adding the hexa that is hexamethylenetetramine. So, that is working as a catalyst. So, that the hardening action is accelerated.

Resin is about 4 to 6 percent by rate of sand, and hexamine is taken as 14 to 16 percent of that of the resin. So, this way you can have the composition as you take some sand and 4 to 6 percent of the weight of the sand will be the resin and then that is phenol formaldehyde and further of the amount of the resin 14 to 16 percent is taken as this catalyst that is hexamine. So, quality of resin will increase with fineness of sand, sand should be free of clay because clay is increasing the amount of binder to be used. So, that is why clay is not required to be in the sand, you try to have a sand which is should be free of clay. You also use large number of additives like coal dust, manganese oxide, ammonium borofluoride, lignin and iron oxide. So, they are providing you the specific objectives in attaining like resistance to thermal cracking, surface finish resist to distortion and strength increase. So, you have to add these additives, so that you get these specific properties.

Now, to facilitate the reviews of the pattern from the mold, you are also using certain release agents. So, some lubricating materials like zinc stearate, calcium stearate or

carnauba wax these are basically used. So, that there is not much of the sticking of the pattern with this shell developed and that is why these agents are used.

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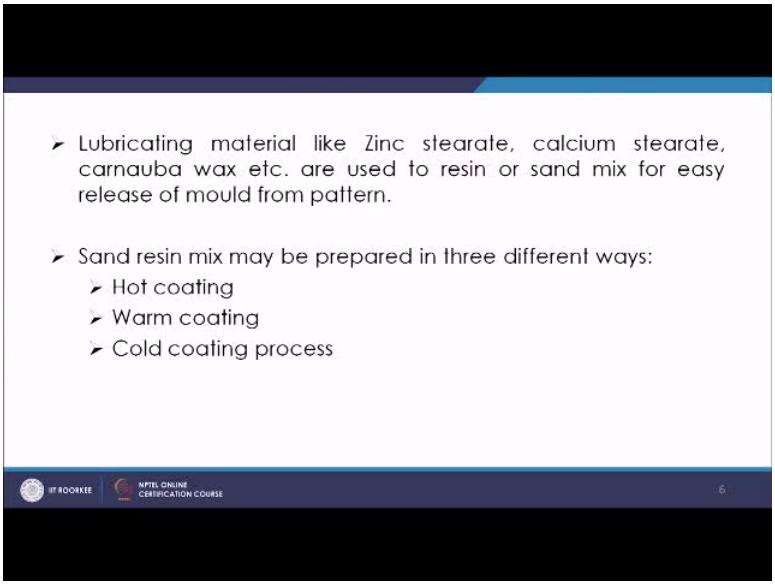

Now the sand mix is basically made in three different ways, so that coating of the resin on the sand takes place in 3 ways, one is hot coating, warm coating and cold coating process.

Now, the name indicates that it is basically related with certain temperature which is operating temperature. Let us see one by one what is called hot coating process, in this hot coating process basically, the sand mass which is given, this sand mass is heated to certain temperature like 122 to 175 degree centigrade.

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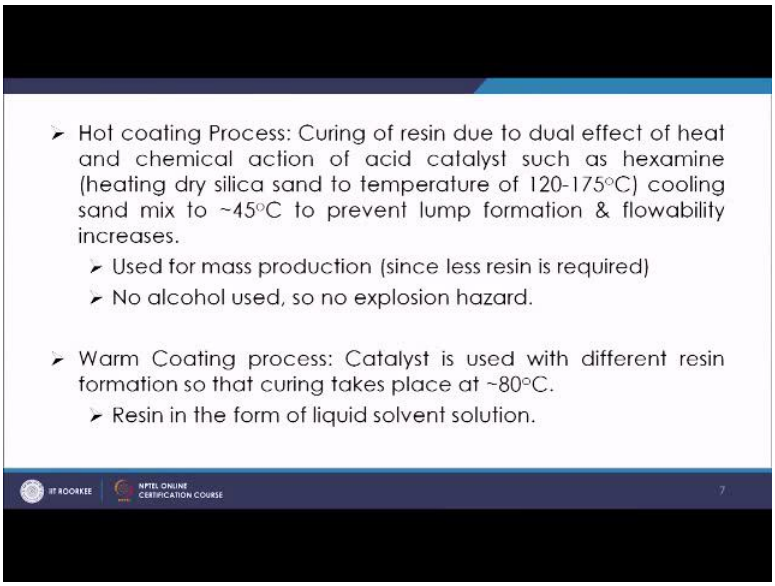

So, caring of a resin due to dual effect of heat and chemical action of acid catalyst such as hexamine, so heating dries silica sand to temperature of this and cooling the sand mix to 45 degree C to prevent lump for formation and flowability increases.

So, what happens in this case is that once you have the sand coated with the resin and once you are blowing with the pattern to this, I mean then in that case this sand mix itself is heated. So, what happens due to this heat the polymerization takes place and it forms a solid mass. So, in this case there is no need to invert; as we have seen in the case of shell molding, we are inverting, so that the sand which has not a stuck to the pattern they are basically left over and you can take them out. So, in this case this method of turning over is not required, basically you are giving that much quantity of sand which has to form that shell.

So, this sand mass itself is heated to 120 to 180 degree centigrade or 175 degree centigrade and then due to that temperature, it hardens quickly and forms a spongy hard mass. So, that is why it is known as a hot coating process because you are heating to certain temperature. This is used for mass production because less resin is required you are heating to certain temperature and because of the heating polymerization is taking place.

Then warm coating, because you try to avoid this heating, so warm coating the heating is done may be (Refer Time: 10:45) to the level of 80 degree centigrade. So, in this case

resin is in the form of a liquid solvent solution, in this case catalyst is used with different resin formation, so that curing is taking place at a lower temperature and you are using a liquid solvent, that is why since it is done at a lower temperature zone that is why it is known as warm coating process.

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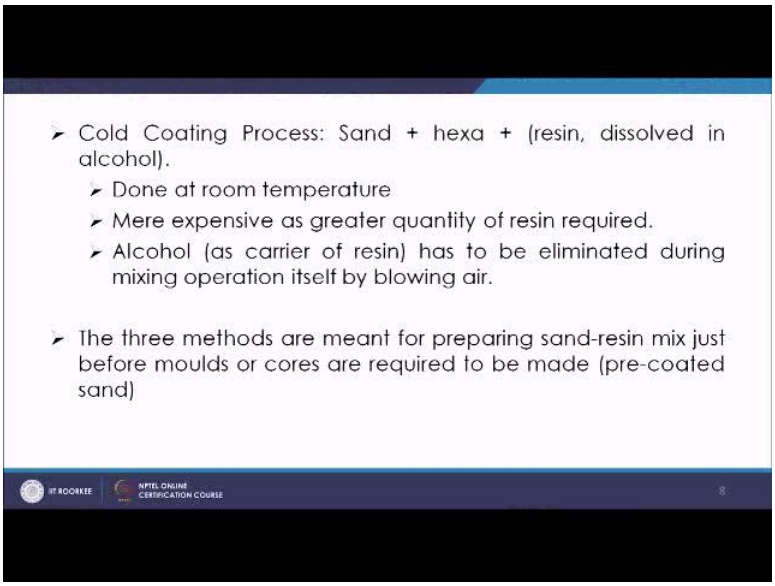

Then last is cold coating, where it is should not be done at any temperature, but at the room temperature. So, here sand plus hexa plus resin, resin is dissolved in alcohol. So, that solvent is alcohol here and it is done at room temperature. So, basically it is more expensive because in this larger quantity of sand is required, but the problem of heating or that is reduced. So, in this case you do not need to go for heating and it is done at room temperature itself, but then alcohol, it has to be eliminated during mixing operation itself by blowing airs.

So, alcohol as to be because alcohol that way, alcohol if it remains that may be lower (Refer Time: 11:58) and that may be dangerous. So, that is why in this case alcohol as to be eliminated before you have further mixing operation by. So, you are using the blowing air to remove the any trace of alcohol.

So, the three methods are used for preparing the sand coat, sand resin mix and then they are used.

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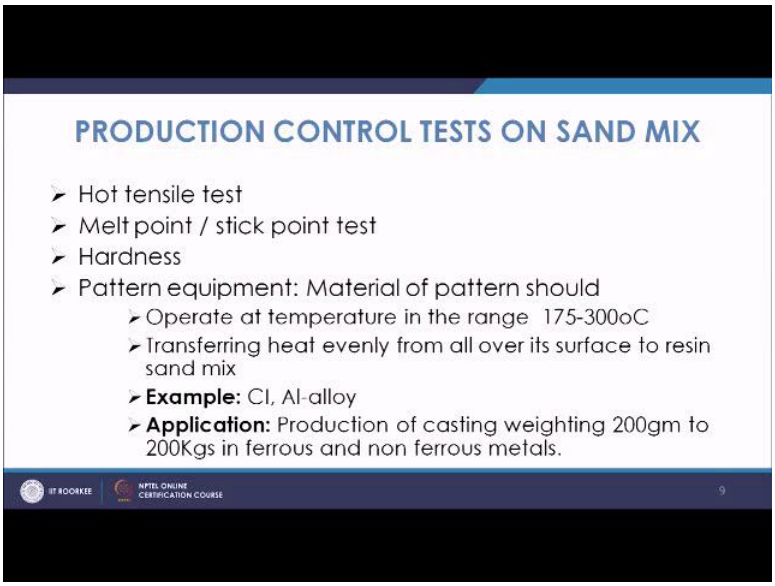

Now they are basically different tests which are done on this sand coat, and they are hot tensile test it is done at different temperatures or are different time may be 1 minute and 5 minute after that, similarly for melt point or stick point test, then hardness test. So, this way you do to ensure that your shell which has be made will come to the expectation of withstanding the pressures or forces of the metal.

Now, pattern equipment is normally taken as a metallic pattern because it has to be heated to a certain temperature of the range of 200 to 300 degree centigrade. So, you are using either aluminum or cast iron and that is used as a pattern material and you can make the castings from 200 gram to 200 kgs in ferrous or non ferrous materials, so this way it is versatile process.

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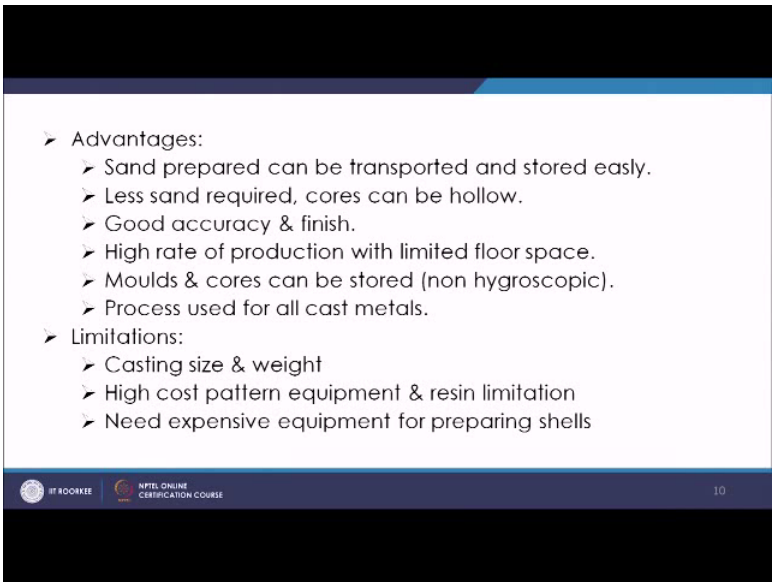

You have many advantages of these processes and you can see that sand prepared can be transported and stored easily you have less sand required, because you are making a shell which is very thin one and it as good sufficient strength.

So, sand required is very very small, and cores also are not required to be completely through or poor pure solid, basically they can be hollow also. You have a good accuracy and finish, high rate of production with limited so in small space, you can have a high rate of production. Moulds and cores they can be stored for large amount of time because these moulds and cores are non hygroscopic, if you make the mould and core of normally in organic binders, normally they are hygroscopic they will observe the moisture from the atmosphere and they get spoiled, but in this case that problem is not there and it can be used for all the cast metals, also it has certain limitations and the limitation is about it is cost because you have to use a sophisticated equipment; size and weight limitation is there you cannot make a very large size or large weight material, in this and you need expensive equipment.

So, you have to ensure that you are making the product in a mass scale, so that you can justify the amount which you incur on purchasing the equipment. So, these are the advantages and limitations of this process.

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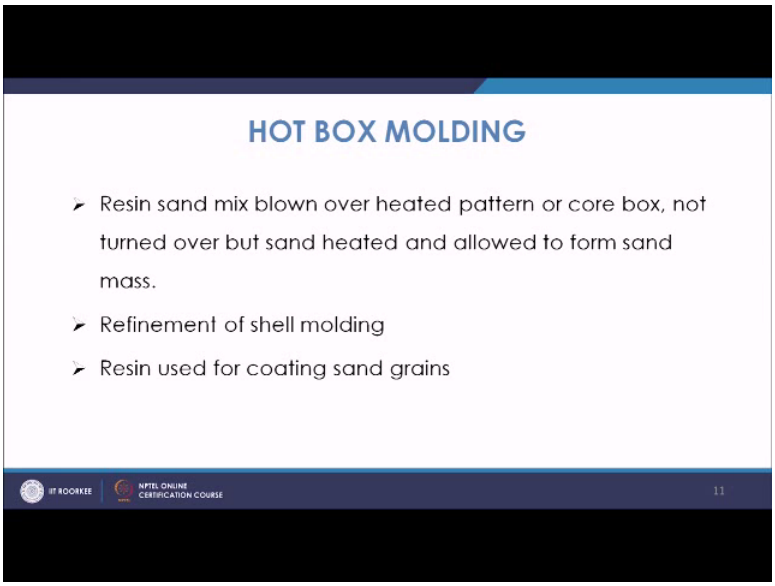

Next is hot box molding - in hot box molding, resin sand mix is blown over heated pattern or core box not turned over but sand heated and allowed to form sand mass. Now, in this case what is happening is, it is not turned over. So, resin sand mix will be blown over on the pattern and then it is a basically refinement of shell molding; here in fact, you do the similar process as shell molding, but here we are not inverting, you are blowing this resin sand mix and then you are heating in the box the sand mass, so that it forms a certain thickness of shell.

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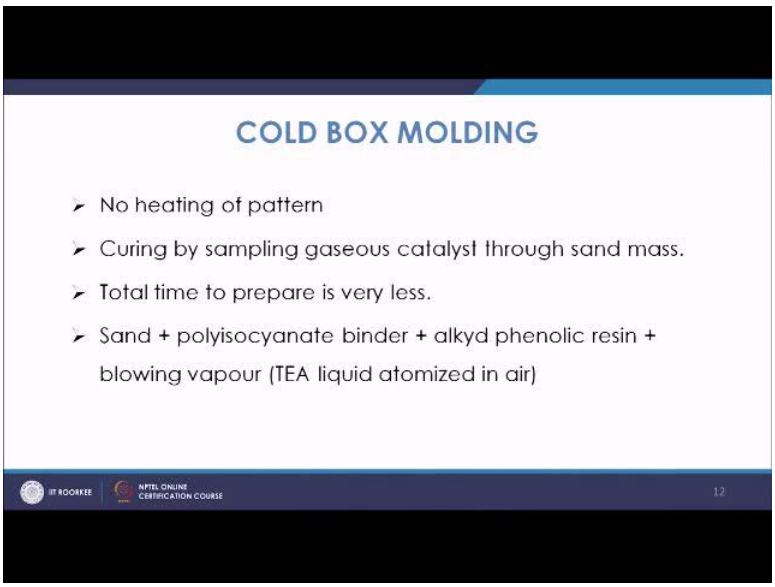

In the cold box molding in the box itself, in the hot box molding you are heating the sand mass here you are not heating the sand mass and not heating the pattern, curing is by simply passing the gaseous catalyst through sand mass. So, total time to prepare is very less and sand plus the binder plus alkyd phenolic resin and then this is the binder and this is the resin and then in that basically the vapour is blown. So, this vapour is tea liquid atomized in air. So, this vapour working as catalyst when it is blown in the sand mask and then you binder then it automatically does the binding operation and it makes a hard mass, this way hardness is achieved. So, hot box and cold box these are the molding methods, based on the temperature.

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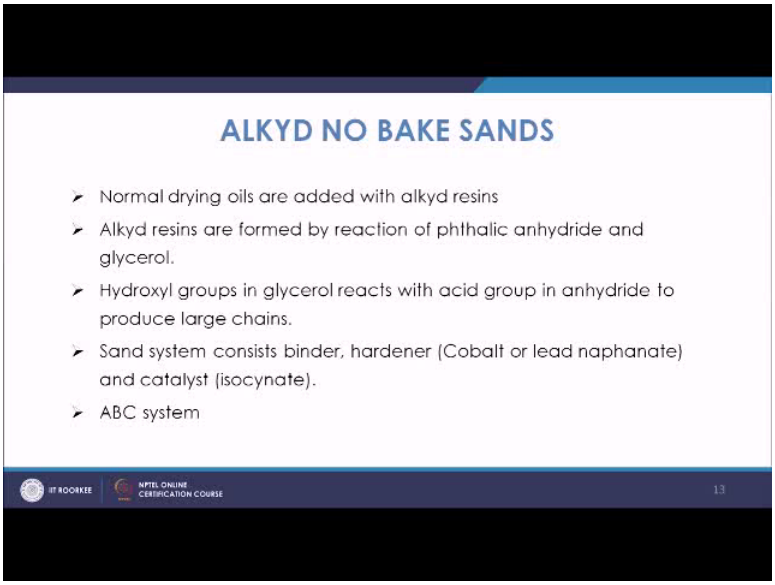

Then one or the other variety is alkyd no bake sands. So, in that case basically as the name indicates the baking is not required, in this case you use the normal drying oils. So, normal drying oils which are used for making cores that is known as core oil, now in that case you are mixing these oils with certain resins. So, that is known as alkyd resins. So, they are formed by reaction of phthalic, anhydride and glycerol.

So, basically they are reaction product of petroleum, they are by products of petroleum making and there by reaction of phthalic anhydride and glycerol. So, what happens, the hydroxyl group in this glycerol reacts with acid group in anhydride to produce large chains. So, what happens? In earlier cases when you are making the cores and we are using the core oils we needed to bake it, but in this case when you use the resins in these

oils, you do not need to bake it, because of the use of the reaction, because of this hydroxyl group reacting with acid group. So, they form a large chain and to do the polymerization large strength develops.

So, the sand system consists of binder, hardener and hardener is cobalt or lead naphanate. So, this is the hardener in this case and in this case there is no baking. So, basically you are using a catalyst and that is isocynate. So, this is the catalyst which is a poisonous gas, but it is used, so once that passes the curing action takes faster. So, at fast rate the curing action takes place. Now in this case you have A B C system, what do you mean by A B C system? A B C system means your binder, hardener and then you have catalyst. So, A B C system means there is A binder is certain percent of the sand, then B is certain percent of the binder and similarly C is also certain percent of the binder.

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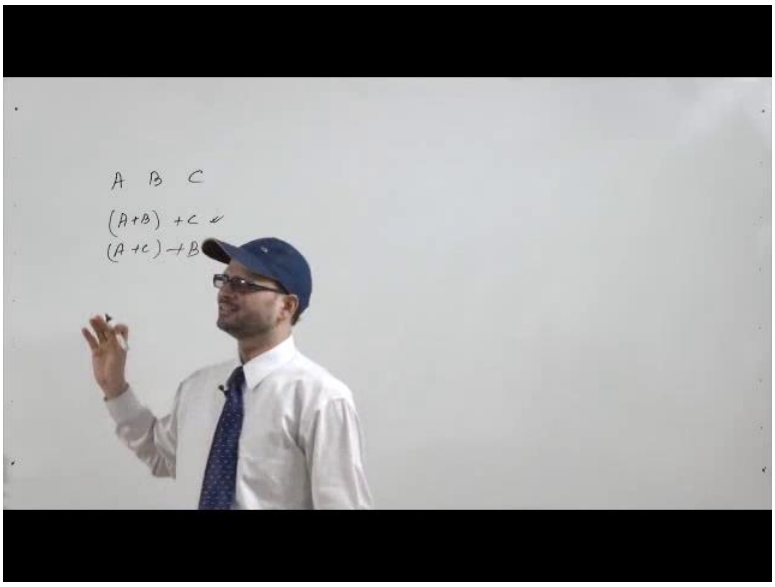

So, this way you have A B and C - binder, hardener and catalyst. Now there are two ways, A B C is binder hardener and catalyst, either you can first mix A plus B, and then plus C, or A plus C, and then plus B. So, there are certain differences, this is giving you slow curing strength initially, but overall strength is higher in such cases where as it gives you initially good strength, but overall the strength will be moderate in such cases. So, you are basically coating initially with a binder and plus mixing the sand with this A plus B and then putting C and in that case you have A plus C and then putting B and this

is how the two systems are used, but this is preferred. So, that is why A B and C system is preferred.

The other type of no bake sand is one is phenolic no bake sand. So, in that phenolic no bake sand basically the advantage is that they are completely nitrogen free. So, in that case once they are nitrogen free they are well suited for production of steels.

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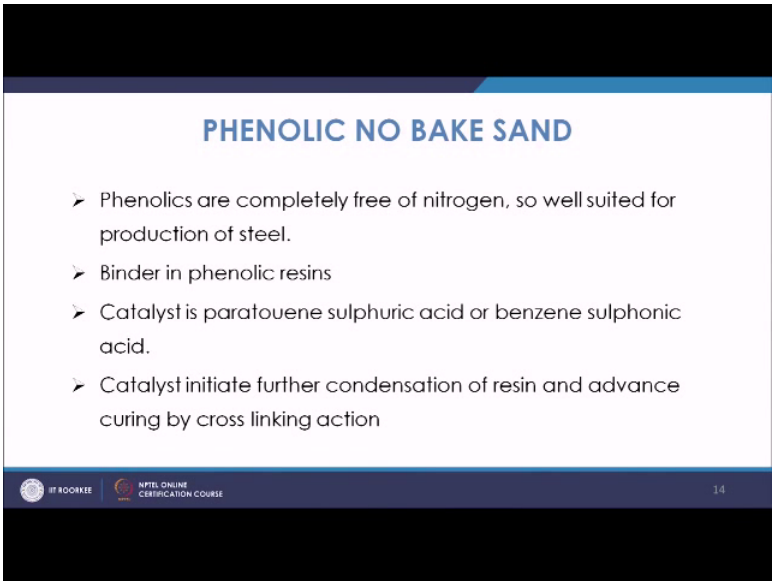

So, there is no probability of having any defects like phenol porosities. So, these phenolic resins are normally used as binders in such system which is free of nitrogen. So, catalyst is paratouene sulphuric acid or benzene sulphonic acid. So, this is the catalyst in these cases and catalyst initiate further condensation of resin and advance curing by cross linking action.

So, basically in these cases your sand plus resin that is your phenolic base resins and plus you have catalyst like paratouene sulphuric acid or benzene sulphuric acid and they give you without any baking need a baking you get a hard mass, where you can further do the casting; then there is another process that is known as furan process.

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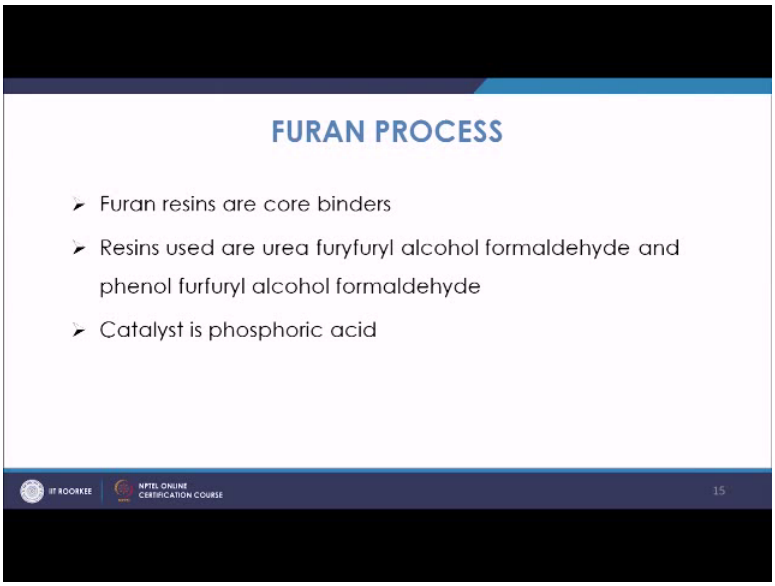

So, here you have furan resins, they are the core binders basically furan resins are used as the binders. So, these resins are furfuryl alcohol formaldehyde or phenol furfuryl alcohol formaldehyde. So, they are different types of resins which are used and they give you strength based on different type of catalyst and basically the advantage of such system is that you do not need any baking and in these cases the dimensional finish is better, the time required is less, good productivity is attained, in this case the catalyst is phosphoric acid, this is about the furan process.

Then in the end this is a SO2 process, this SO2 process here the SO2 gas is used, the problem is that in this case because of the environmental concerns this process is not preferred. So, here also again for the hardening action to take place the SO2 gas is used and since being acidic in nature this is not very much preferred, but these are the different kinds of methods which are used for making the molds using organic binders and they are used quit extensively for making of cores because they take very less time what needs to be mentioned is that in most of the cases the Benzes life is quite sort. So, they are to be used the probability is quite good and benzene life is sort, so they are to be used. Production rate is quite fast, so they can be used for mass production basis.

Thank you.