Fundamentals of Manufacturing Processes
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Lecture - 24
Casting: Investment & Permanent Mould Casting

Hello. I welcome you all in this presentation related with the subject Fundamentals of the Manufacturing Process. And in this presentation I will be talking about the two special casting processes.

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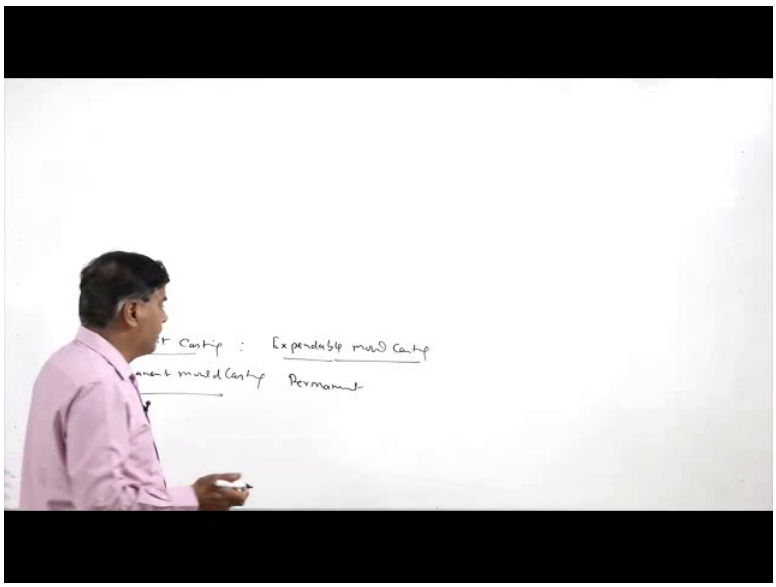

These are investment casting process and permanent mould casting process.

So, nature wise these two processes are the different: this is expandable means expandable mould casting and this is permanent mould casting. Means, here after producing one casting the mould has to be broken and in the new mould is to be prepared. But in case of the permanent mould casting the same mould will be used repeatedly for production of the casting.

So, the second one the permanent mould casting processes is good for the very high volume production purpose, while for the limited volume productions or the investment casting is good. So, we will be going through the principle of the investment casting process.

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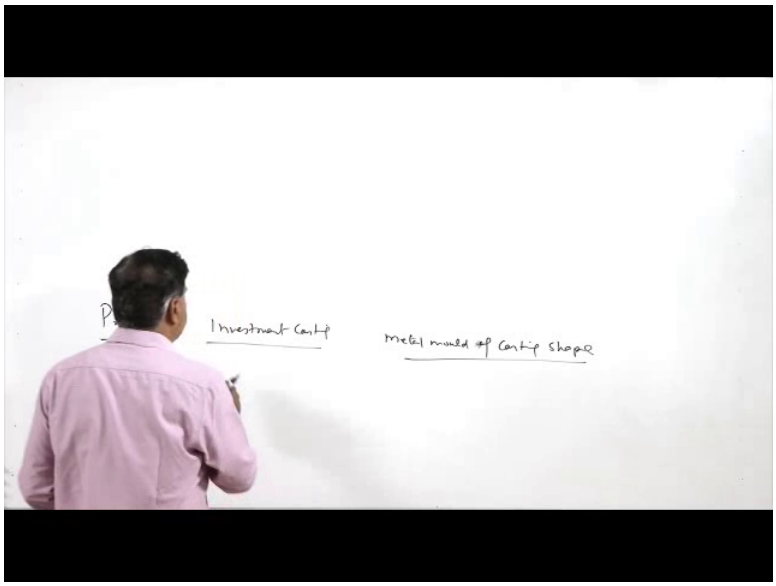

Investment casting process: so in this casting process first of all we need one metal mould of the casting shape means, the cavity having the shape corresponding to the casting which is to be produced.

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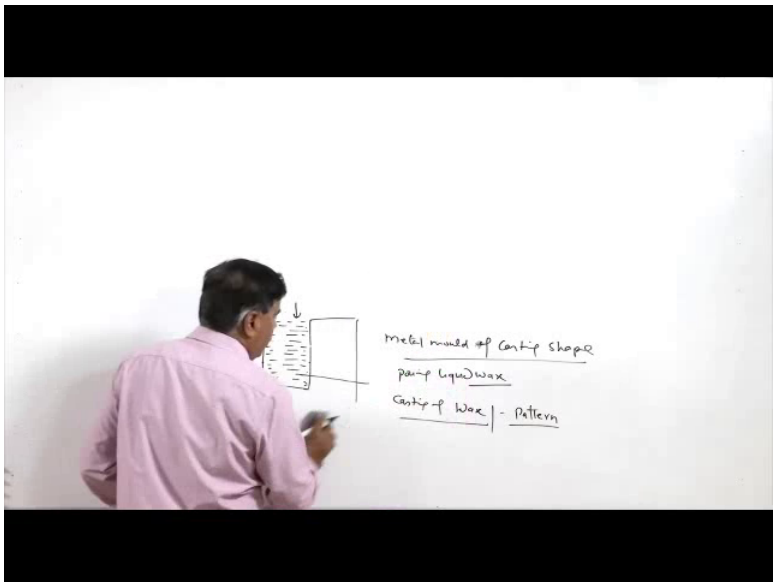

So, say this is the mould of the metal. So, in this metal mould what we do; we pour the pouring of the liquid wax. So, the liquid wax is poured into the metal mould. So, that it takes the shape of the mould, on the solidification of the wax we get the basically casting

of the wax; is the cast product is wax. Now this wax is used as pattern for producing the mould further.

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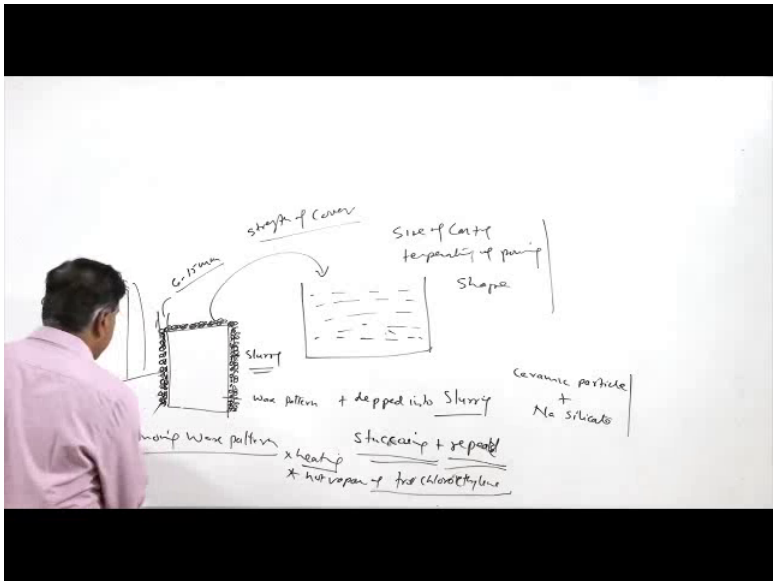

So, this pattern of the wax say which we have got in this shape this is the wax pattern. Now this wax pattern is now dipped wax pattern is dipped into slurry; slurry of what ceramic particles and sodium silicate. So this slurry, the wax will be dipped into this slurry so slurry will be now coated over the; slurry will get applied over the surface of the wax patterns. So, this is slurry which has been applied. Over this slurry now we basically a sprinkle the either silica or zircon sand particles so they get stick with the slurry.

So what we do basically, this process is called is called Stucuoing- s t u c u o i n g; wherein the silica or the zircon sand particles are applied over the slurry which is sticking with the wax pattern. So, when this process is called stucuoing. So, these sand particles now will get applied with the slurry attached with the wax pattern and then it is dried.

So, this process of stucuoing is that done repeatedly means one layer of the silica and zircon sand has been applied then again it will be dipped into the slurry, and then it will be taken out and the zircon and silica sand will be applied again that stucuoing will be done repeatedly. So, this process is basically repeated until we get the layer of the silica sand; of the silica grains over the wax pattern of the sufficient thickness.

So, when this thickness is in the range of 6 to 15 mm thickness. So, thickness of the shell will be governing a strength of the basically this cover or the shell which is being formed. As per the size of casting the temperature of pouring of the molten metal temperature of pouring of molten metal and the shape of the casting will govern the thickness which is to be used. Once the sufficient thickness of this silica grains over the wax pattern by stucuoing process has been applied then the wax pattern is removed.

So, once when we have applied this silica or zircon grains of sufficient thickness then this process is stopped. There is one more thing once the sufficient size of this one has been applied then we need to take out the wax pattern, but when stucuoing is done repeatedly what we do initially over the wax pattern fine size the silica or zircon sand grains are applied and then gradually increasing grains sizes are applied. So, initially we applies the fine stucuoing is done using the finer silica or zircon sand then cores grains are applied. So, this is how it is repeated all around the wax pattern. So, initially fine and then cores once. Once if this has been achieved through the desired thickness then wax pattern needs to be taken out.

So, for removing the wax pattern removing wax pattern basically two methods are used: one is heating of the entire system where in this coated or the shell which has been informed and the pattern itself. So, heating will be leading to, the heating will cause the melting of the wax and then additionally the hot vapors of trichloroethylene are applied. So, that whatever residual wax is left all that is removed.

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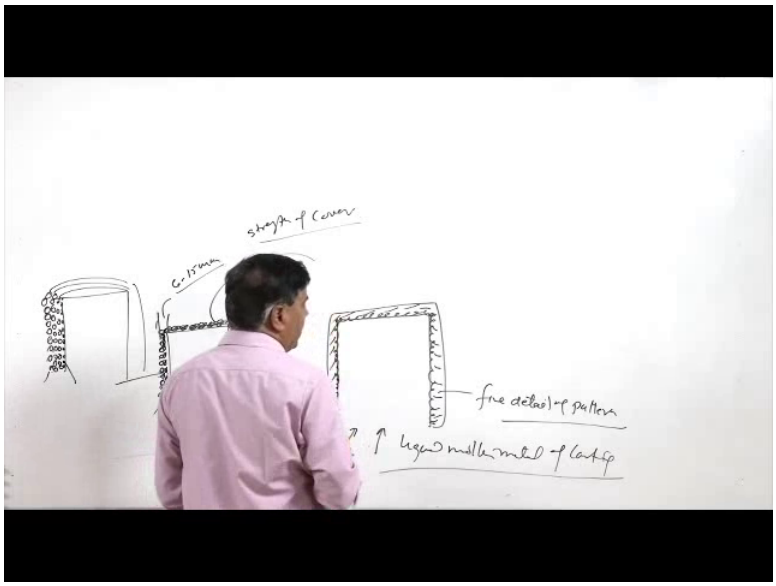

So, once the wax pattern has been removed it will be left with the shell of these grains, wherein we have fine grains in the inner surface and the cores once on the outer surface. So, like this one shell is formed.

Now this shell will be having all fine details of the pattern of the wax which was removed. Now this shell will be filled in with the liquid molten metal of casting. So, whatever molten metal is to be poured that will be poured into the shells so that the casting of the desired size and shape can be achieved. So, this is how what is there in the investment casting basically the fine shell or the mould is prepared which will be providing the finer details of the wax pattern. And these can be produced easily with the help of the investment casting process.

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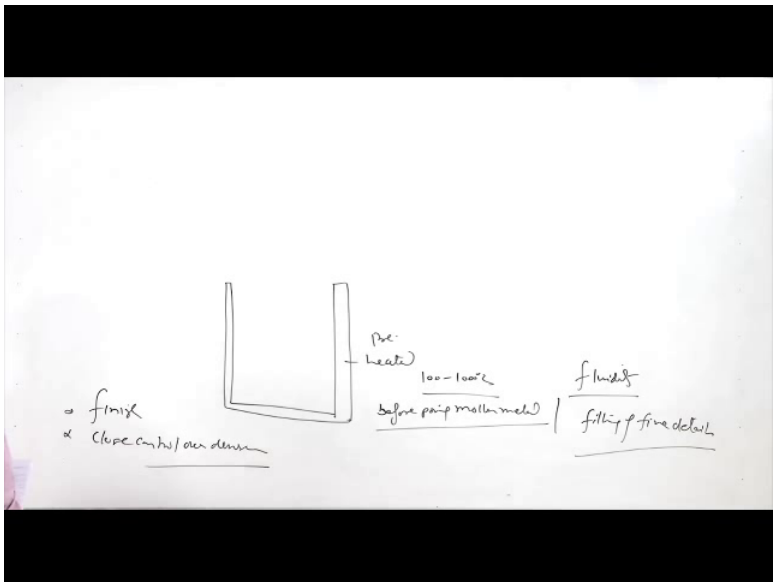

So shell is like this. So, this shell which is been produced is basically heated or what we can say it is pre heated pre heated. This pre heating can be done in the range of 100 to 1000 degree centigrade before pouring the molten metal.

So, this pre heating basically improves the fluidity and the filling of the fine details. So, because of these two features like the pre heating as well as the finer smother surface of this shell which has been prepared helps to produce very good surface finish as well as close control over the dimensions. So, these are the two features which are realized through this process.

Now, application wise: this process has been traditionally used by the jewelers for making the jewelries, as well as for making the ornaments, statues and also the surgical equipments.

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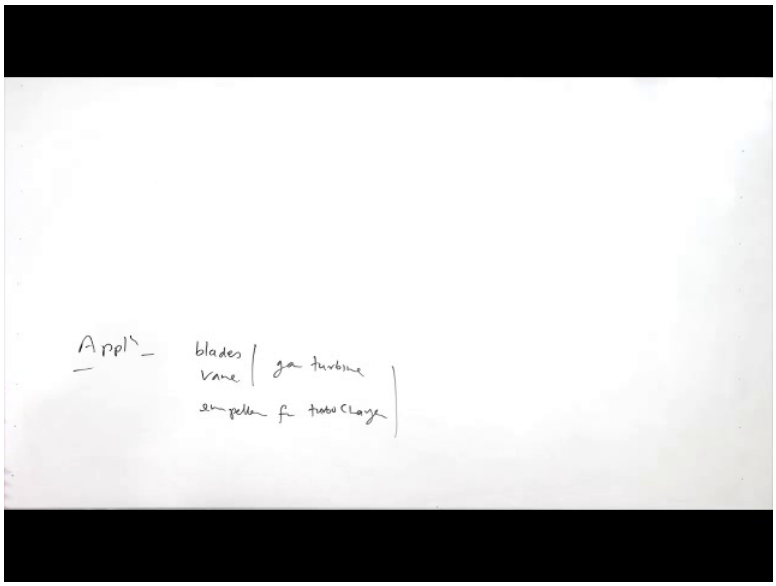

But nowadays this process is making the blades, vanes, for the gas turbines, impellers for the turbo chargers. So, wherever complex geometries with the fine details need to be produced there investment casting process is preferred.

Advantage of this process is that.

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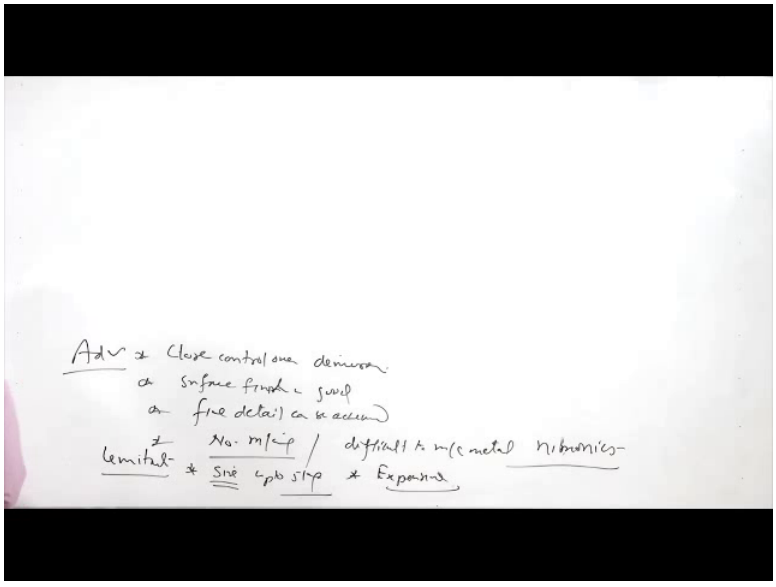

The very close control over the dimensions is achieved, surface finish is good, and very fine details can be achieved, and even the surface finish and the dimensions are so good that even no machining in the components may be needed and they can be put in directly

in to use. So, the difficult to machine metals like nimonic's or can be produced using this process because if the metals are difficult to handle by the machine then they can be produced, such kind of metals can be processed by the casting process to make the product so that they can be used directly without need of the machining.

The limitation wise the processes limited by the size: size up to say 5 kg size components. And another issue is the expensive nature: the process is expensive so for making the products which cannot otherwise be realized. So, the other casting process can be a produced using this process otherwise this process expensive, because it is completed in number of the step. First of all we have to make the metallic mould, then metallic mould will be used for preparing the wax pattern, then wax pattern will be used for the preparing the ceramic shell and then ceramic shell will be used as a mould for preparing the casting.

So, since the number of process steps are involved in the process very laver extensive that is why it is not that economical.

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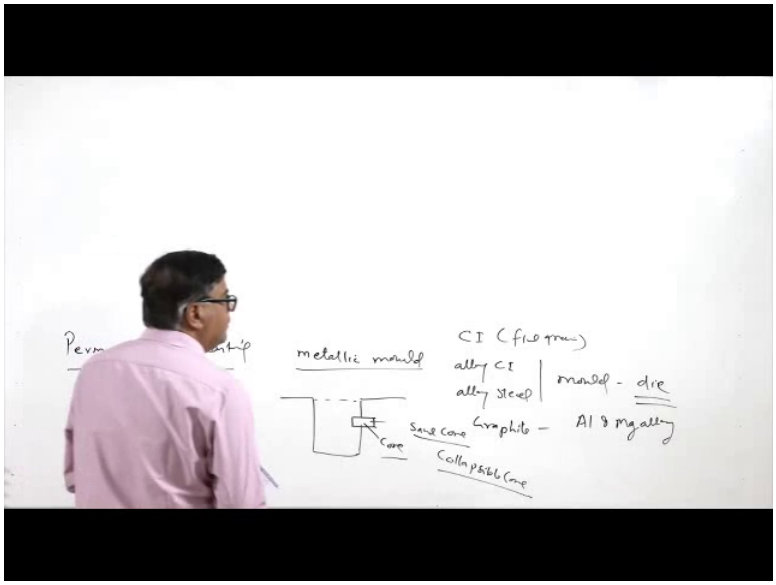

Coming to the permanent mould casting process: as name it appears it uses the mould which remains there. Means, it uses basically metallic moulds. So, metallic moulds mostly these are of the cast irons which are of the fine grade, but it can also be like alloy cast irons or alloy steels can also used for preparing the mould.

Mould basically, these are also called die. In case of the permanent mould casting, like say the mould made of the metal like this the same one can be used repeatedly for producing the a number of the components. But for producing the internal features mostly these use the collapsible cores, like say- this is the core for producing the internal feature in the casting. So, if the core is located, so the sand cores or here also called the collapsible course are used. They can be easily taken of otherwise it said difficult to make the metallic cores; metallic cores make this process complex and difficult especially the withdrawing of the core.

Another one metal which is also used for making the permanent mould is the graphite mould. Mostly the graphite mould is used for the non ferrous metal like aluminum and the magnesium alloy castings; like higher the temperature of the molten metal which is to be used lower will be the life of the mould, because mould has to handle the heat and the temperature and the metal static pressure.

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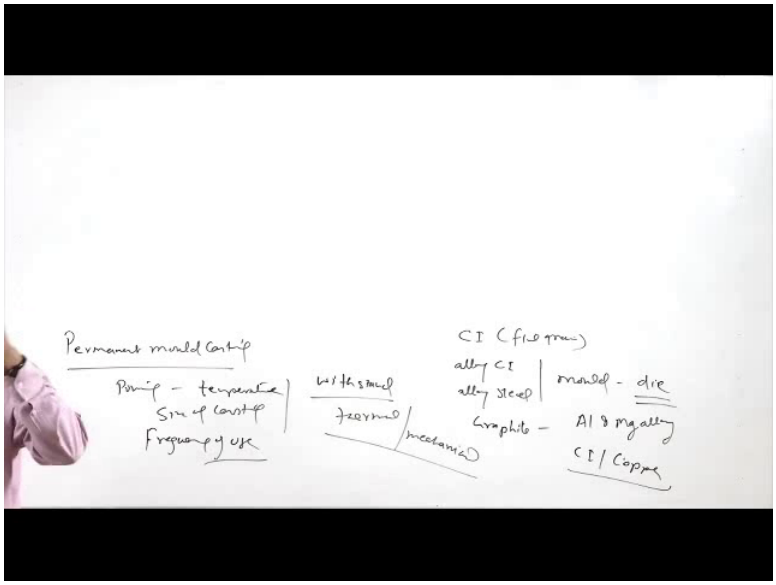

So, depending upon the temperature or you can say pouring temperature and the size of the casting the suitable metal is selected. Since these moulds will be used repeatedly again and again. So depending upon the frequency of use of the mould size of the casting and the pouring temperature suitable metal is selected so that it can with his stand basically.

The thermal and mechanical loads related with the permanent mould casting process. So, the selection becomes crucial if the selection is same proper like the cast irons and the copper alloy castings they are of the high temperature like 1100-1150 degree centigrade the molten metal is to be the poured into the a mould. And if that is to be done repeatedly then it will be adversely affecting the life of the mould and its performance. So, the metal for the permanent mould should be selected properly considering the size pouring temperature and the frequency of the use of the mould for the casting purpose.

We know that these permanent moulds are.

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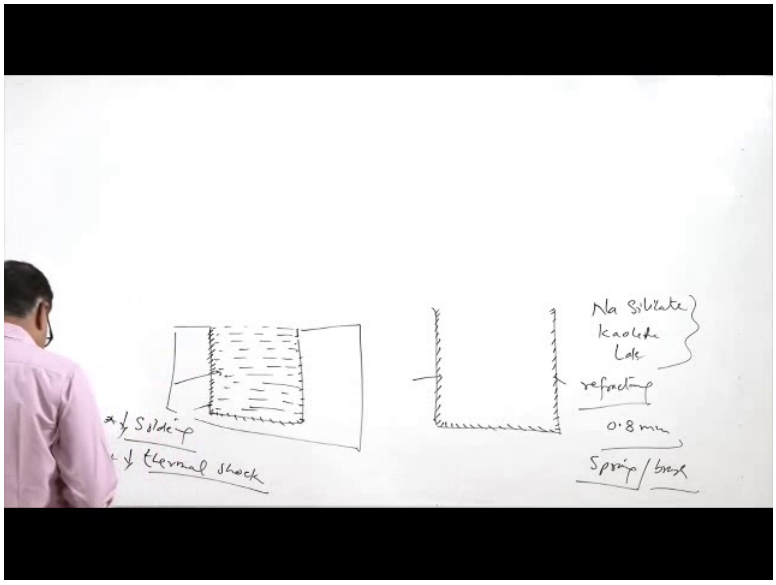

Since these are made of the metals. So, when the metal in molten state is poured into the mould it will have tendency to get a stick with. So, this is called on the solidification the molten metal on the solidification metal of the casting will have tendency to get a stick with the mould wall. This is called shouldering; shouldering of the metal of the casting with the mould wall. So, this will make the withdrawal of casting difficult. So, this is one thing shouldering needs to be reduced.

And another thing the metallic mould when poured with the molten metal it suddenly experiences lot of heat and high temperature of the molten metal. So, it lap to deal with the thermal shock related possibility. So, thermal shock tendency is to be reduced and shouldering tendency of the metal of the casting with the mould wall is to be reduced. And for this purpose the mould wall is basically coated with. So, mould wall is coated

with the suitable refractory materials. So, the refractory material is coated up to the point 8 mm thickness. This can be either applied with the help of the spray or it can be applied with the help of the brush.

And for this purpose sodium, silicate, kaolinite plus talc is used. So, mixture of these three is used for applying on the internal surface of the mould of the permanent mould so that it will reduce the thermal shock tendency as well as it will reduce the shouldering tendency of the metal of the casting with the mould wall.

Now we will talk about the advantages and the applications.

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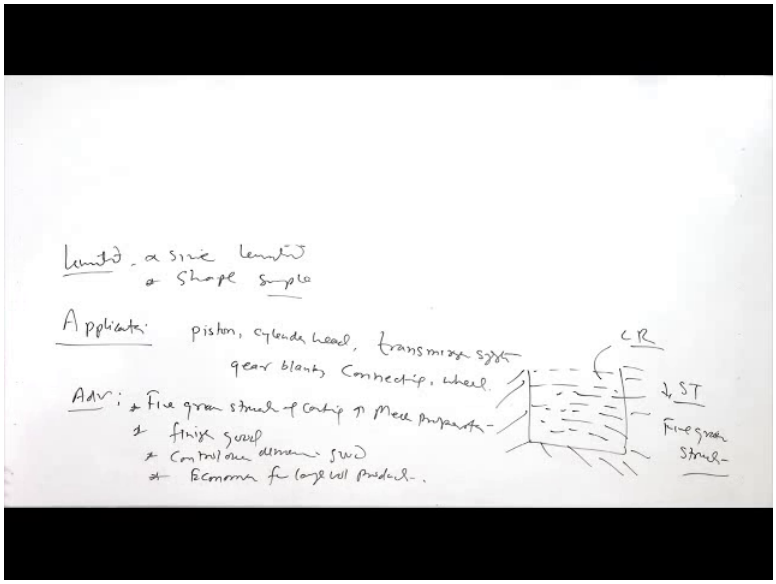

So, the applications of the permanent mould casting process includes like production of the pistons, cylinder head, and the parts of the transmission system of the automobiles, gear blanks, and connecting rods, wheels, alloy wheels; all these are commonly made with the help of the permanent mould casting. As for as the advantage is concerned: since the permanent mould are made of the metals. So, the metallic mould they offer good thermal conductivity and high rate of the heat extraction from the molten metal.

So, the cooling rate experienced by the molten metal is much higher than that is experienced in case of the shell molding or investment casting or in the sand mould casting process. So, high cooling rate reduces the solidification time and increases the

and also reduce the solidification time and the high cooling rates these lead to the fine grain structure of the casting.

So, the grain is structure which is produced by the permanent mould casting processes for the same metal is much finer as compared to those which are produced by the sand mould casting process or the shell moulding or investment casting process. So, because of the fine grain structure of castings it results in the better mechanical properties of the permanent mould casting process.

So, this is one very good advantage. And like other processes the surface finish is good, and control over the dimensions is also good, and other processes justified for the means it is economical for large volume production.

The limitation wise the process is process is good for the simple shapes as well as it is also limited by the size of the mould; so not good for the large size casting. So, limitations is of the size as well as the shape; shape has to be simple and the size has to be limited by the size of the mould which can be made. So, not very large size castings can be prepared by the permanent mould casting process.

So, now I will summarize this presentation. In this presentation I have talked about the investment casting process and the permanent mould casting process. Investment casting process is used for making the products of having the finer details, and which cannot be easily machined.

Thank you for your attention.