Principles of Casting Technology
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Lecture – 01
Introduction to Casting

Good morning dear students, welcome to this course on Principles of Casting Technology. This is a new course which is proposed we will be together to discuss about this course. In this course basically we are going to discuss about the principles of solidification, which is essential for casting to take place. Then other components of casting technology that is pattern making, mould making, core making, melting pouring, finishing, fettling and heat treatment all that. Let us proceed to the introductory lecture about principles of casting technology.

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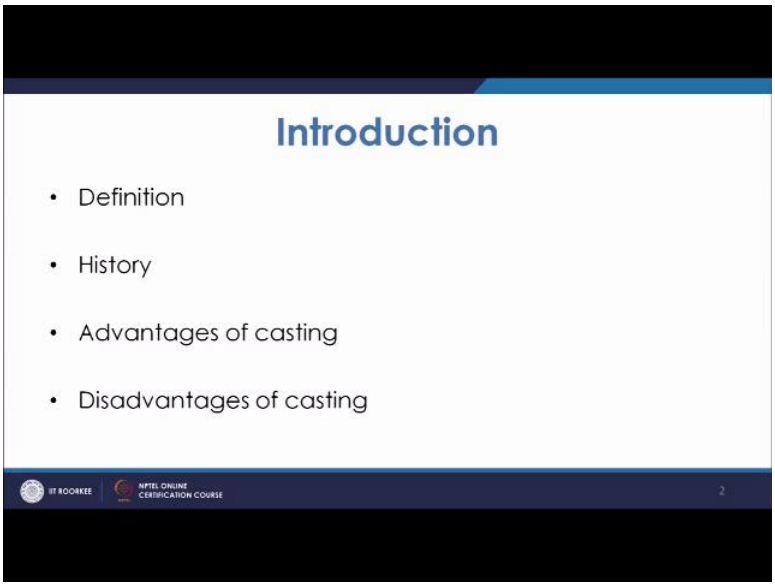

Let us see, what is casting? In a very rude way casting is nothing, but alloying molten metal to solidify in a closed cavity or even it be open the molten metal has to be poured and it will solidify. Now, why we need to study this? As you know the metals have to be shaped in different forms. Metals cannot be shaped at room temperature because it has lot of strength and because of this solid state it cannot be shaped into the shape we want. So, basically we will have to bring that metal to a state where we can shape them. For

that, we are taking this metal to a temperature where it is a liquid state, we are melting it then after melting we are basically keeping it in a cavity that cavity is known as mould.

Now, the energy which has gone inside the metal to melt it this energy has to come out. So, slowly once it is in the mould and the metal is subjected to that atmosphere it loses the heat which was put in the metal. Then it takes the shape of the cavity in which it was poured, this way after removing that mould we get the cast metal.

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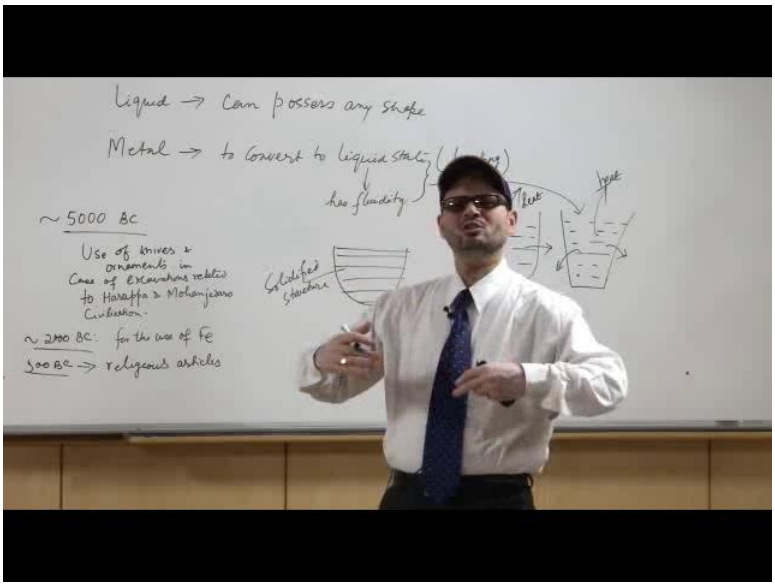

So, what we see is normally we see that a liquid, a liquid can have can possess any shape. However, for giving the metal to certain shape you will have to bring that flow ability into the metal or it has to have the fluidity. So, for metal you have to convert it, to convert to liquid state and most of the metals have their melting points above the normal temperature. So, basically you will have to give the heat to melt it, this can be done by heating.

Once you heat the metal it converts to liquid state, this liquid state has fluidity. Now, it has the characteristic to flow in any contour. Then you can pour in any shape, in any shape you can pour this, this liquid can be poured either here or this can be poured in any shape. Once this liquid goes in any cavity and you stop heating this liquid has to lose the heat so heat is lost, to surroundings heat is lost to surroundings, similarly heat will be lost to surroundings. After losing the heat to the surroundings basically a state comes when it is coming at its melting temperature that is known as an equilibrium temperature, below

which the metal will be solidified and it will come in a solid state, it will be a solidified a structure. So, basically once this liquid has lost all the heat and it has come to a temperature lower than its melting point then it has come to a solidified structure. This shape can be a complex shape; it can be a simple shape you may have to go for a number of changes to get the type of shape you want, this is how we go for casting.

If you go into the history of casting, basically in the prehistoric times or 5000 BC it is reported that casting was there in its place. Earlier the instruments or even the ornaments they were made and it has been reported in the civilization, earlier civilization that this process was there. In the earlier days basically the mould was made of either sand or even stone. So, earlier stones were used it was (Refer Time: 06:35) some portion of the tone was taken out and in that portion you were using the metal liquid metal and that it gets cast and taking the stone parts out we were getting the different types of metal and those metals were in the form of tools used for killing the animals or may be for the agriculture purposes these are reported in the history. We can have this information about the history how, chronologically this casting process has evolved that is another matter, but we must know that this is the process which was there in our earlier times and even in the modern days still advancements are going on to see that you get a good structure and good property of the cast metals.

If you look at the history of this casting process we should look at certain milestones which are considered as milestones in this field. In around 5000 BC, it has been reported that use of knives and ornaments, in case of excavations related to Harappa and Mohenjo-Daro civilization. In those days also it has been seen that this was there in its place around 2000 BC, first time the Greeks were supposed to be the users for the use of iron. This applications of this process was for the guns, for the tools, in case of other metals earlier the copper and bronze was mostly used for making either utensils or the statues, monuments all that were used I mean the most, mostly it was copper or bronze. Now, in the 500 BC they were also there was something like a revolution in the case of religious, articles like the statues of gods and goddesses they have also be reported and it gained a lot of momentum.

This is how the history in a very nutshell wave we can say that it has come since long and is still it is going on coming to the 19 century and 18 century there has been lot of

improvements and that can be found out by going into the history of the casting processes. Now, we will discuss about the advantages and disadvantages of casting.

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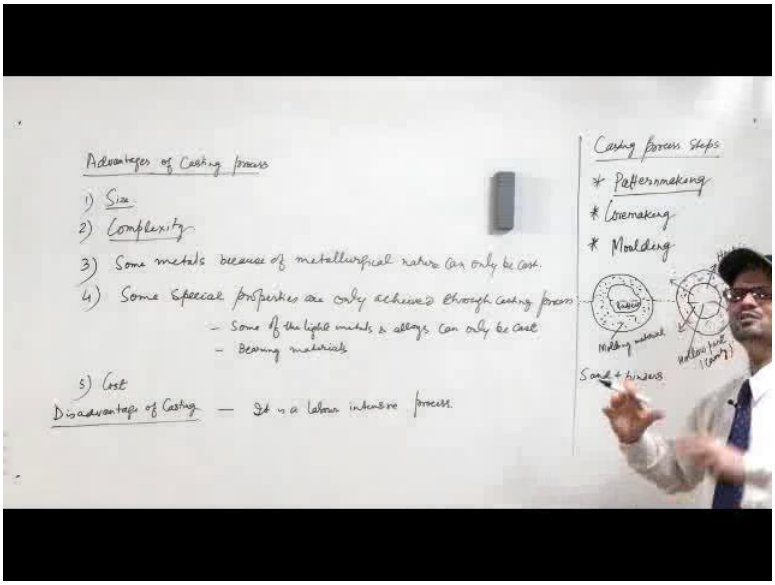

First we will discuss about the advantages of casting process. There are lots of advantages of casting process and we will discuss it one by one. First of all the size, you have the flexibility to cast a metal of even up to 200 tons or even more and you may come down to even a wire of 0.5 mm diameter. Size is a very important factor, when we talk about the casting process specially, when we talk about the larger components having the component in one go, it is only possible by casting process. Otherwise you may have to assemble a lot of other components and then you have to fabricate them you have to join them, this is a great advantage in case of casting.

Next is complexity, you can cast a metal of very simple shape to a metal of complex shape either externally or internally. So, you can have a mould of that particular shape and without the need of any further operation you can get the complex shape even in a single run that is also another advantage of casting process. Some metals because of metallurgical nature can only be cast. This is a very important advantage of casting rather we are forced to go only for casting for certain metals because they cannot be found by other processes like forming.

The typical example under this case is cast iron, when you have the metallurgical limitations like all we know that in case of cast iron basically because of the presence of

graphite in the form of flex it has a very low toughness and it cannot be found it cannot be forced. In that case, you have no option, but to only cast and we have in that case only to go for casting because cast iron for example, has a lot of advantages it has a good measuring property it has a good damping property under the when they are subjected to vibration. For these benefits you have to only adopt casting that is one advantages of casting.

Now, some of the special properties are only achieved through casting process. Basically, when we talk about certain metals some of the qualities are only achieved when we talk about the casting process only they cannot be achieved if you are making the product through (Refer Time: 15:09) root like what we discussed about cast iron. The cast iron has good machinability property or the good damping property because of the presence of carbon in terms of graphite flakes which are soft and that are why it gives a very good machinability as well as the cushioning effect gives a good damping property that is that. Another example is like you have many example of bearing metals that property is also achieved only in case of casting.

The other properties what we look at may be the toughness of the materials, some of the light metals alloys, they can only be cast. We also discussed bearing materials, the properties of bearing that comes only by casting root when we cast us get the material for that desirable properties.

The next advantage is about its cost, this is the most important aspect because with respect to other processes it is economical as we have understood that here in one go you are getting the finish product you are melting and pouring into a mold and taking out and although it is not completely finished and you may get even a finished product if you choose suitable melting material. In that case the cost of the component when we talk about making a finished product the cost through this route is minimum, when we talk about the mass production the casting is the only way to go for if we are getting specialized property then only we have to think about it and that time, the this factor is becomes very important and that way casting is a preferred process by which we get the material in the desired shape.

What is the disadvantage? Let us talk little bit about the disadvantages of casting. Although, there is not much of the disadvantage, but some of the disadvantage is that it is

a labour intensive process. Because you need the man power to go for it although in this era of automation many things are automated all the processes are mostly automated. Now, even the use of labour has been reduced also when we talk about having some specialized properties like you want to have a diaxinol property or the strength in certain particular dioxins. In that case, you will have to go for the further processing of the cast product then you get like in forging you get a fabulous structure when you are forging under the hammers or the process or you are rolling the product to get the product having specialized properties more strength is certain directions.

When we talk about the sand moulding in that case, the finishing also is not completely adequate and in that case you may have to go for the finishing processes. So, these are some of the disadvantages of casting process. Otherwise, there is not many disadvantages and that is why casting is the preferred operation for getting the proper shape of any product.

Let us move to next to the steps of casting process. What is done in a casting process? As we discussed in casting you have a mold in the mold you are pouring the liquid metal which after getting solidified has to be removed and that is your cast product. Now, for this mold you need the replica of the cast component. That replica is nothing, but a pattern and this pattern are to be made in a shop that is known as pattern making shop so, first process is pattern making.

Pattern making is nothing, but making the exact size of the cast product plus certain allowances which we will basically study in the long run. So, here this pattern is made of either wood or metal and or even plastic products nowadays, this pattern making is a separate section which makes this product which this pattern of certain material gives by considering their answers. Also it gives the provisions for supporting the course which comes later for that core prints is there and this is very important because depending upon the accuracy and depending upon the finish of the pattern you should also expect the quality of cast product.

Further there is core making. When we want to have internal features certain holes or so at that time you need to have the core and this cores are basically made in a another unit that is core making unit. Cores are normally made of sand and this is some sand of better purity. Now, for this core making you need the core boxes and for that even pattern

making unit is also in tandem, but the core making section is separate it is responsible for making the cores and keeping the cores in a proper shape and temperature. That it can be used whenever you have the mold ready and you have to place this core in the cavity.

Next come moulding, you have a moulding shop where basically you are making the cavity for which the cast component is required. So, basically you are going to pour the metal in the cavity. So, basically if suppose you have a cavity like this ultimately this will be the pattern. Now, what we do is we have to do in such a way that you are putting this moulding material here. This pattern and this is your moulding material if you talk about the common moulding material as sand we are basically having the pattern in two parts and this way in every part you are having the moulding material tagged around it, this moulding material will be there, but this pattern has to be removed. Once we remove it after removing, this is your hollow part and have outside this is the mould. So, this hollow part it is known as cavity. Once we draw this pattern from it then this becomes a cavity and this cavity in which the molten metal is to be poured. This molten metal once it goes here it will try to lose its heat to the surroundings h that is heat.

In the moulding shop what you have to see is how you have to prepare the mould the mould has to with stand the weight of the sand by which it is made the mould has to be shaped in a certain form for that it has to be first bringing to a state where it can have the cohesion. For that basically in most of the cases you are putting the binders with the sand so, sand will be used with binders. That it has the cohesive property and you can give any shape to it then this portion is kept around this pattern pressed that it gets a proper shape with proper strength and then with some tool this pattern is removed and this two boxes are joined together. So, that you get a cavity and you have the provisions to pour the metal into it then you are pouring the metal you also add additives that we will discuss later what are the functions of the binders and additives. So, basically we are putting all that, that it has a flowable property it goes around the pattern and takes all the menued a details and then this basically once you have this shape in that when the metal is poured it gives you the cast product after solidification.

In the moulding section you have different kinds of moulding boxes you have bottom top and middle moulding boxes, you have different units for basically mixing of sand you have units for the baking of sand, baking of the mould and once that is ready then when

the pattern is removed and you have baked the unit your mould is ready for the pouring part.

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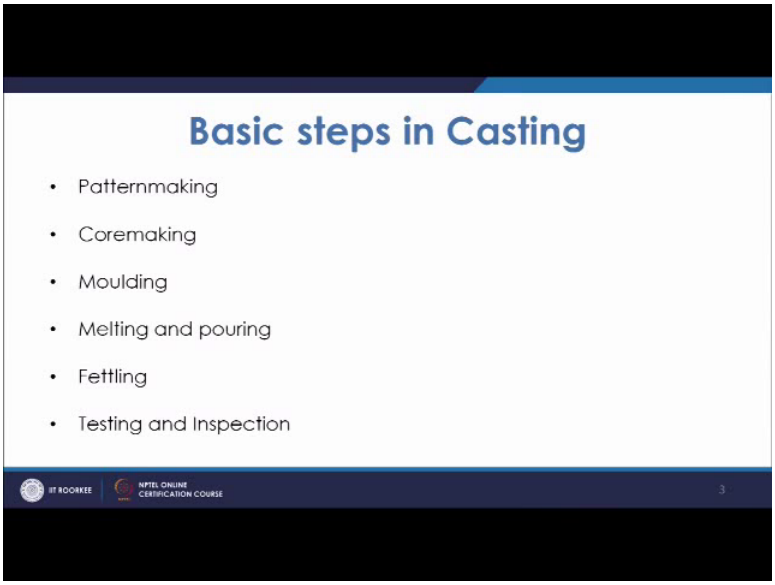

So, that way moulding section is important you have to prepare the mould the mould may be of sand or if you have we are talking about the permanent moulds we may have permanent moulds of metals, it takes care of that requirement.

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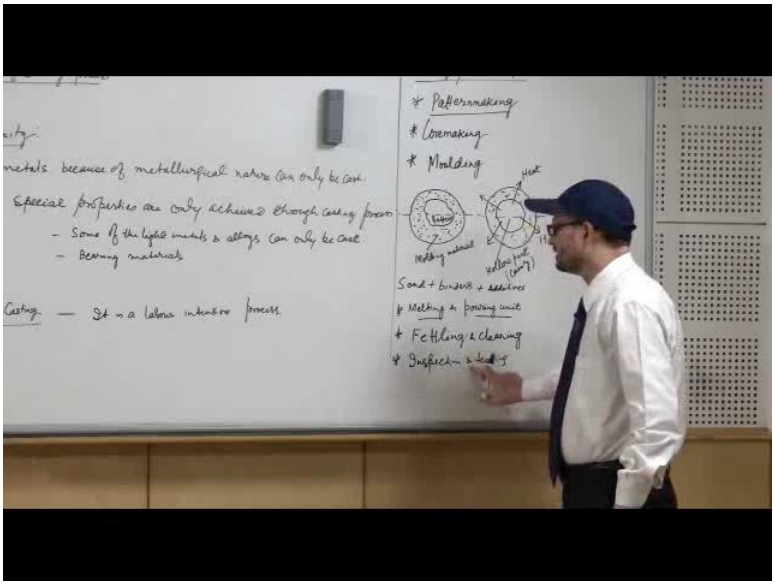

After moulding we have a melting and pouring unit. In the melting and pouring unit you have different type of furnaces and you have also the ways by which these metals from

the furnace will be transported to the place where the moulding has to take place. The furnaces may be of different type depending upon the need of requirement or requirement of the amount of metal to be melted and to be poured. So, you may have the furnaces like cupola furnace for cast iron, you may have the arc furnace, you may have the induction furnace. All these furnaces are placed in the melting unit you have from there you will have to transport these metals through cranes or by other means and then you have to bring it to the place where you have to cast it. Sometimes, if the mould is smaller it can be transported to other place, but if the mould is heavier basically in the moulding unit itself the metal is to be transported and there it is to be cast. So, this is how this melting and pouring unit surf the purpose of making the cast product.

Now, once you have poured the material into a mould as we have already discussed this material under goes solidification. Now, once the material is solidified it has to be taken out. Now, this material or this product this cast product has a lot of other sections which is out other than the original cast casting. So, you may have a mechanism for pouring the material through a funnel shaped, attachment or you may have a horizontal way to pass the liquid metal or you may have a riser which takes into account of the shrinkages all these are to be removed, that is done through the process of fettling.

Fettling is nothing but removing all the unwanted attachments or the portions which are attach to the cast product you have to basically also clean the un burnt sand you have to clean the scale all these fettling and cleaning these are done that you have to further use this material. In this case, you have the provisions for either breaking the extra attachment or you may go for cutting these attachments by flames or by electric torches for cleaning you may use the liquid solvent based agents or you may use solid particles of iron sorts they also are used, that is by short plastering you may use sand also like sand plastering. This we will discuss when we talk about the fettling and cleaning in the towards the end of the course and the purpose is to give the material a final finish or final look how the material has to be shown, how its surface roughness's, how you have to go and you have to basically packet and you have to supply it to the customer.

Before that however, you will have to go for inspection and testing. Finally, once you have clean the product and you the product is ready you will have to also ensure that the product is metallurgically, it does not have defects and we will discuss about the defects in our in the long run, but a cast product because its a face change product you have the

possibility of having different type of defects, the defects may be on the surface it may be inside it. There are different types of techniques that destructive and non destructive techniques by which we ensure that the material which you have cast has adequate properties it does not have any defect, either surface or surface defects. For that it goes to the quality control section where you have different type of testing units like you have magnetic particle testing you have use of different type of rays.

So, all these things are carried out either on all units or on the critical units and by also sampling you do this inspection and testing and finally, it is send to the customer. These are the normal steps in the casting unit and in this course we are going to study one by one about all these steps in detail, and before that we will also discuss initially the mechanism of solidification which will be the portion in the next lecture where it will be seen that why the study of solidification is important, because ultimately the transformation from the liquid to solid state is important because it involves a large amount of possibility of defects and what is underlying principle that will be studied before this, so this is how we have to be with this course.

Thank you.