Principles of Casting Technology

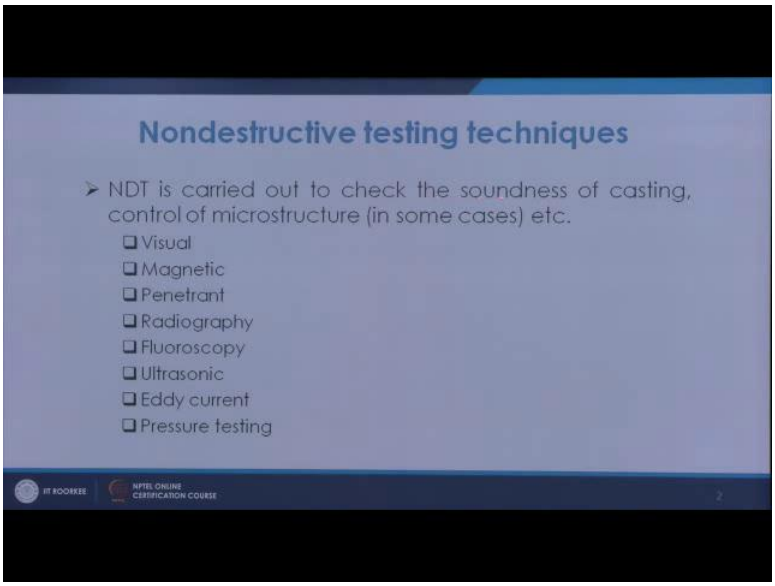
Dr. Pradeep K. Jha
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture - 40
Defects Diagnosis in Casting
Non destructive testing methods

Welcome to the lecture on Defect Diagnosis in Castings. We have so far studied about different type of molding methods, castings of different types of metals and alloys. We also discussed about the different kinds of defects which arise due to variation in parameters, because of many kind of effects like it may be because of it may be because of the molding material, it may be because of the gases, it may be because of metallurgical characteristics and so on.

The ultimate aim for any foundry is to make the defect free casting and also to ensure at the end that the product which is coming out is defect free. There are two ways, of checking whether the casting is defect, having defect one is destructive method and another is non destructive method. Destructive methods are used for finding the tinseling strength or hardness or so, but when we go for destructive methods the casting will no longer we further used. In fact, there are non destructive testing methods, which basically see and check whether casting is having any defect or it is defect free. For critical components specially, if there is any crack in the inside of the casting or if there is any kind of imperfection which cannot otherwise be seen, in that cases the non destructive testing methods are adopted.

(Refer Slide Time: 02:14)



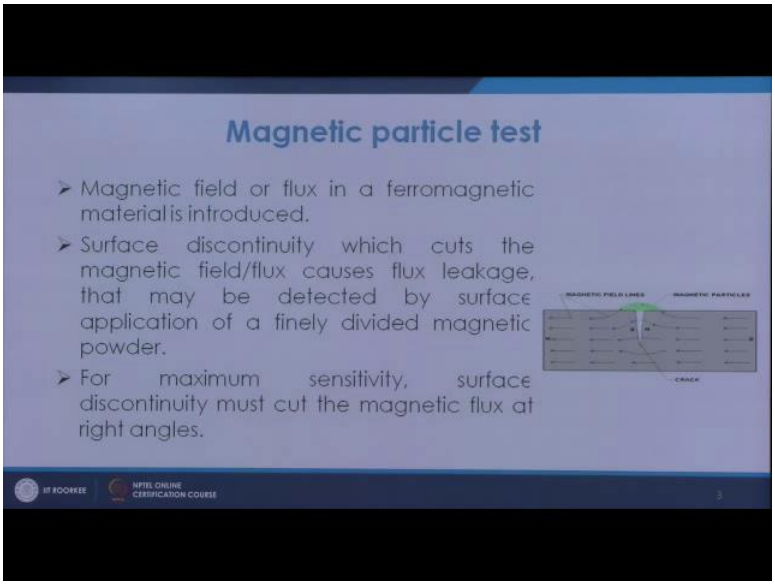
Now, non destructive testing methods are used to carry out or to check the soundness of the casting, control of microstructure in certain cases and so on like coating thickness or so. There are many ways of doing this non destructive testing and these methods are like visual methods, where you just see through the naked eye and see whether there is any discontinuity present in the casting. So, based on that if there is any (Refer Time: 02:50) or if there is any discontinuity any crack any poor surface finish, those things can be checked using the visual methods.

Certain methods are used for the surface defects like the magnetic or penetrate type of defects, which are used for checking the surface floors. If on the surface there is any kind of defects then these methods can be used to find the defect, then you have radiography test or fluoroscopy test or ultrasonic test, eddy current test or pressure testing, these things are used basically for the internal kind of defects and we will discuss one by one about the different kinds of these methods and to know what is the procedure for knowing whether the casting is defect free or having any defect, so we will go one by one. So, visual anyway visual means by looking with the naked eye or by with eye if you see that it is ok its fine.

Next is the magnetic particle test. It is basically applied for ferrous components which are basically ferromagnetic. What is done is, the magnetic field is induced in these

materials and a field will be generated and then if there is any discontinuity, then that cuts the magnetic field and that creates the flux leakage.

(Refer Slide Time: 04:23)



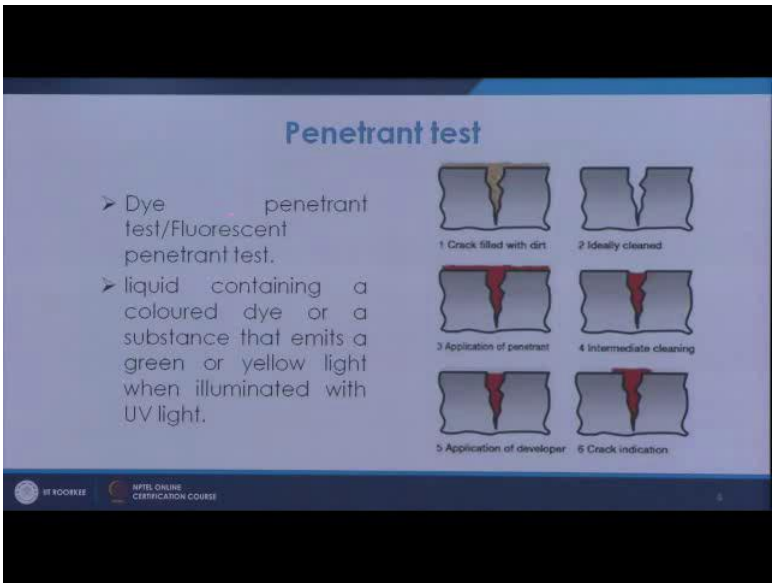
So, that can be seen, suppose you have a casting and if you induce the magnetic field you see these field lines and in the case of any kind of crack here, you can see there is a crack. In that case, there will not be continuity in these magnetic field lines. So, what you see is, they try to pass from this side to that side and there will be you can see that, what we do is normally we apply the finely divided powders magnetic powders on the casting surface, that may be dry or that may be basically in a solvent and then once you apply then you apply the magnetic field.

So, basically whenever there is a discontinuity then there will be changes because of the flux leakage, there will be change in the pattern at those points you will see that these flux lines have to pass; there is heap of this powder at this point because there is no continuity because of these cracks. As it moves you can see a visible difference in the powder which is here and this way you can say that there is some discontinuity or especially crack which is their point. For maximum sensitivity, normally the surface discontinuity must cut the magnetic flux at right angles. If the magnetic flux lines if they are in the line of this cut or crack then you cannot easily distinguish, but if they are in the right angles, then you can very much see and that is more visibly clear when this discontinuities are cutting this magnetic flux at right angles. So, that is how, that is how

you can basically visualize these cracks and use these magnetic particle test. Normally, the limitation is that it is only used for a specimen or for a custom material which is ferromagnetic, which can be magnetized.

Next is the dye penetrating test. This is penetrating test, based on the name that something penetrates into the cracks. This can be used for ferrous or non ferrous materials here there is no such limitation on what kind of material it can be applied. So here, we can use dye or that is basically a liquid is there which is containing a dye or you may have a florescent penetrate.

(Refer Slide Time: 07:36)



It basis basically, depends upon what kind of light you are exposing later on, that you have a contrast and that is seen we will discuss it. So, what is done is you apply this dye over the surface, suppose you have a crack you apply this dye on the surface. Because of its low surf extension and viscosity this dye is shipped into this crack.

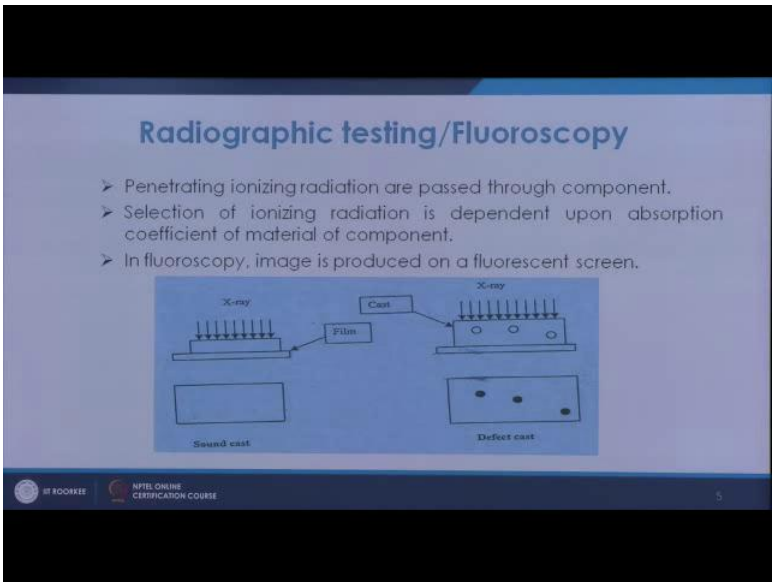
Once it goes into the crack and you ensure that this dye is basically applied fully on the surface then you wipe it off later on so, in this stays it is completely wiped off or cleaned then what you do is further you are. Here it is basically with dirt first of all the first stage is that you clean it and then you apply this penetrate and then you remove this penetrate from the surface, but penetrate which has gone into this crack is still remains here. So, this with red color you can see that this penetrate is still there in here, but from the

surface you are basically thoroughly cleaning it and as we discussed because of very low value of surf extension and viscosity the penetrate goes into this crack.

Then what you do is, you apply a developer, what developer does. This developer basically goes here and that basically has a blatting action. That basically soaks away the dye which is their inside and then it comes over the surface. When you see under the visible light this looks red, this way once there is no crack there will be no dye which is into any crack. So, you would not see any such color, but if the crack is there and if dye has penetrated into it then this developer which has the blotting action, that basically takes these dye which is into the crack and then when you see under the visible light it appears as red. If it appears as red, you assume that there is some crack because; it had got into the crack.

Similarly, if you see that under the ultra violet light you will see the color as greenish yellow. Depending upon what kind of light you use, whether it is visible light or the ultra violet light these color changes and you can see that you can detect these cracks by using these penetrate tests for ferrous or non ferrous materials. Next is radiographic testing, radiographic testing they use the kind of rays and these rays are penetrating analyzing radiations which are passed through the components.

(Refer Slide Time: 11:23)



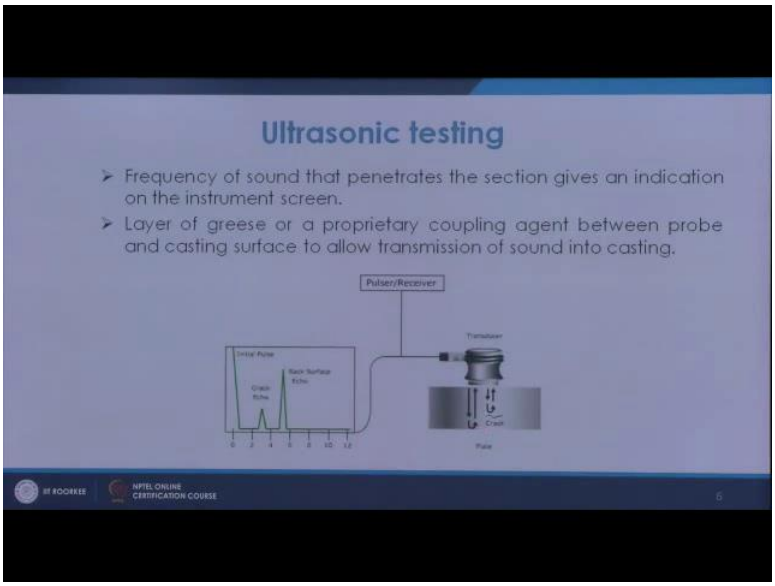
These rays are normally used for ferrous or non ferrous components and they are used to find the internal flaws, internal cracks. So, what is done is you have different kind of you

can use either the x-ray or the gamma-ray and then these radiations are basically passed through the component which is to be tested. They go and basically on any radiograph or any plate, florescent plate. So, see it you get the image the two dimensional image is formed and basically that penetrates completely, but if there is any kind of defect any kind of crack is there inside, then its shadow is created on that seat.

Once you see that seat or radiograph then you can find this here. Where you see if there is no defect in those cases, this is the caste component there is no defect you see that it is all clean, but if there is any defect here it has not been able to pass its shadow will be the dark one and that source any kind of discontinuity which is present inside the casting. So, basically it is used for finding the internal features or any defect which is internally present inside the casting. Now, you can select this analyzing radiation, based upon the absorption coefficient of material of the component. So, basically you may have the high energy radiation or low energy radiations and depending upon that the lower part will be used for materials like aluminum and if you go for materials like steel or copper brass or so, then you go for higher energy beams or radiations which are used to find that. It is one variety is that fluoroscopy in that case basically; the image that is produced that basically is projected on a florescent screen or even attached to a TV screen. You can directly see this image on the screen that is known as fluoroscopy. These methods are used for finding the internal flaws if any inside the casting.

Next is ultrasonic testing. Ultrasonic testing basically, it is basically based upon the penetration of these sound waves and they basically penetrate the section and then the eco is formed. So, based on the eco which is formed you ensure whether there is any kind of defect or not. So, what we do is initially you apply some coupling agent and that is grease or any proprietary agent is there. That is applied between the probe and the work piece and then this (Refer Time: 15:04) is there, once this emits the waves then these waves go and strike the bottom of the casting and then they come back. In that case, you can see that how much time it takes to go and come back that indication will be coming back to the machine. In case of any kind of discontinuity the wave does not is not able to go further beyond that.

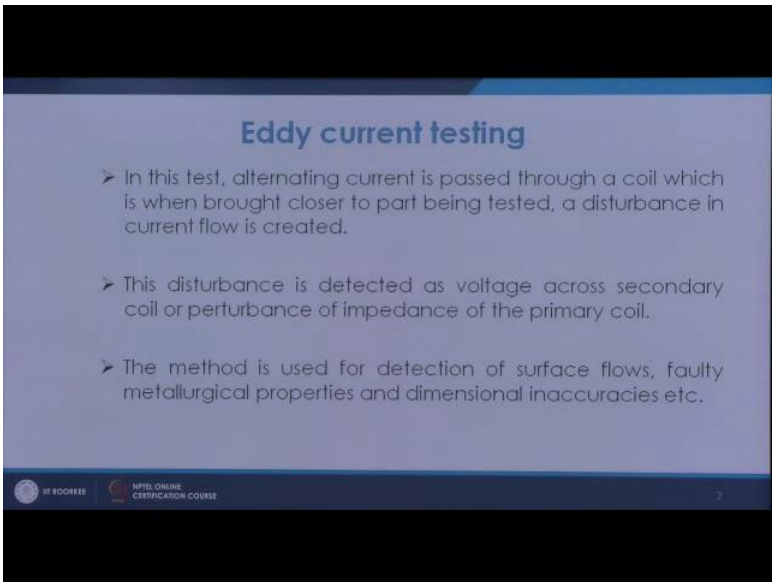
(Refer Slide Time: 15:37)



In that case, it will be removed back from there that basically produces an eco. So, what you see is had not been any crack you will find this will go smooth and then from here it will be ending, but if there is any eco any crack. In that case, because of the crack you will have this kind of crack eco. Presence of crack eco is an indication of some kind of discontinuity which is present in between. That even can tell you that where this is located depending upon that you can see that how it comes and from where the crack is located that can be found out. This method is applicable to any kind of materials ferrous or non ferrous and this is how you try to see the internal cracks in the material.

Next is eddy current testing? Now, in the case of eddy current testing what we do is the alternating current is passed, through the coil and this coil is when brought closer to the part, which is being tested a disturbance in the current flow is created.

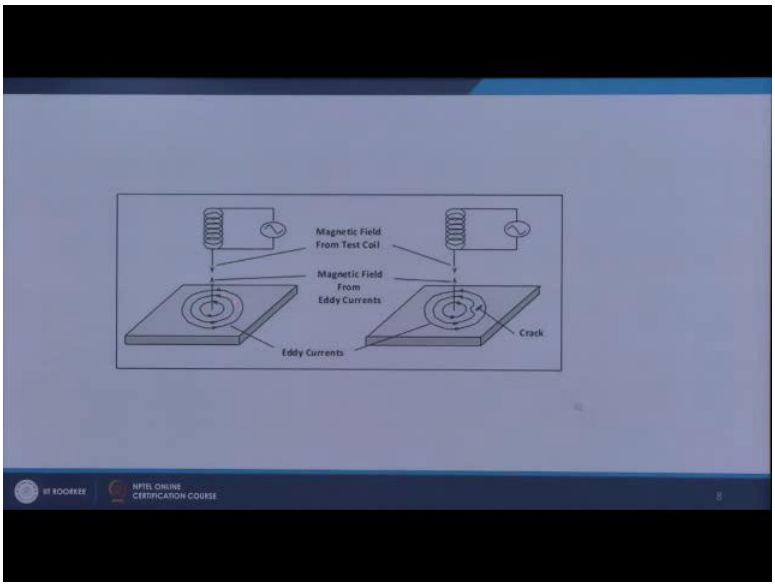
(Refer Slide Time: 17:10)



Now, what happens that you will have the primary coil and similarly when it will be brought to the cast the secondary coil is there? Now, if the there is no defect then there is no perturbance in that viscidity. However, if there is any kind of defect, then that disturbance can be seen. So, disturbance can be detected as the voltage across secondary coil or perturbance of impedance of the primary coil.

So, by that we can see we can ensure that there is some kind of disturbance and there must be something, because otherwise it will be uniform, there will not be any disturbance, there will be not any change in the voltage across the secondary coil. This is used for detection of surface flows, faulty metallurgical properties and dimensional inaccuracies. Normally even in the case of a (Refer Time: 18:28) where you have the nodules. In those cases also, you have you can use these methods. So, what we see is you see that when there is no defect, when there is no defect.

(Refer Slide Time: 18:47)



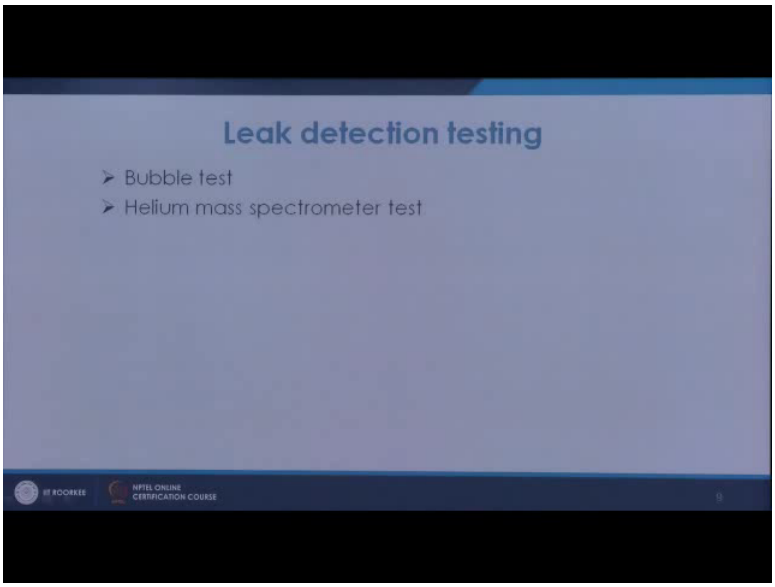
In those cases you see that there is no kind of any change. However, because of the crack as it is brought closer, if there is crack you see that there is this change which is observed. From this you can say that there is some kind of disturbance or some kind of discontinuity which is present inside the casting. This method is used for finding the surface flows or any faulty metallurgical properties or even dimensional inaccuracies and this way you can ensure whether there is any defect or not.

Eddy current testing is also useful for finding any kind of flows like the magnetic properties or the electrical properties that is how this point have been written that if there is any kind of faulty metallurgical properties, there will be variations in the eddy current pattern in the secondary coil which we see. That variation will be indicative of any change in the electrical or the magnetic property of the material. This is how this eddy current testing is carried out we discussed you have this pattern and there is no defect and in the case of defect you have the changes in the pattern, this will have changes in the voltage values by that you can find it out.

Next is the leak detection testing? So, leak detection tests are carried out under the pressurized condition to find whether there are any micro pours present inside the casting. For that there are two kinds of tests which are available, one is bubble test so what is done is the casting will be immersed in the solvent like water and then that and then if there is pressure applied on the component. Under the application of pressure if

there is any micro pour any air which is entrapped in the micro pours and if they come out they will come out as bubbles, because of the insolvability of the air which is inside the bubble and that it cannot be inside the liquid so it will try to come out and the presence of the bubble indicates that there is some micro pour or there is any porosity which is their inside the casting. So, even we use the soup solution also, that on the surface you have low surf extension and then that basically facilitates the coming of these pours through the pour I mean through the surface and then it will come into the liquid and in the form of bubble.

(Refer Slide Time: 21:44)



So, this way this bubble test is carried out, we may also use the helium or hydrogen based solvents and that basically, because they have lower surf extension. So, that also uses is used as the pressuring media and in that basically facilitates the formation of bubbles and that gives you indication of having any leak or taking the preventive measures to further see that there is no further any kind of micro porosity in the next castings.

The further modification or even the smaller kind of pours can be detected by the helium mass spectrometer test. In this case, even the smaller dimension of pours can be checked into and you can ensure that there is no pour which is their inside the casting. So, these two tests are for the finding the leak detection test and these are carried out on the systems on the castings which are to be used under pressure like in the boiler plates or

valves where you the material is always under the pressure. On those components normally we go for leak detection testing, and this ensures that there is no at all any small pour or macro porosity inside the casting.

So, this is the end of this lecture and this is also the end of the whole lecture series of the principles of casting technology where basically, we discussed about different kinds of casting processes, molding processes, then you have melting units you have production of different kinds of metals and alloys then its defects and further the defect diagnosis using these non destructive testing methods.

Hope you have enjoyed this course and good luck for knowing about this course and we will discuss more and more through the assignments and tutorials in due course.

Thank you very much.