

Metal Casting
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Module – 06
Finishing, Design And Environment
Lecture – 02
Inspection, Testing And Quality Control

Welcome friends. In this lecture let us learn about Inspection, Testing and Quality Control. First let us learn about inspection and testing then we will be learning about the quality control. Now this inspection under testing is carried out at the following stages.

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INSPECTION AND TESTING

It is carried out at the following stages.

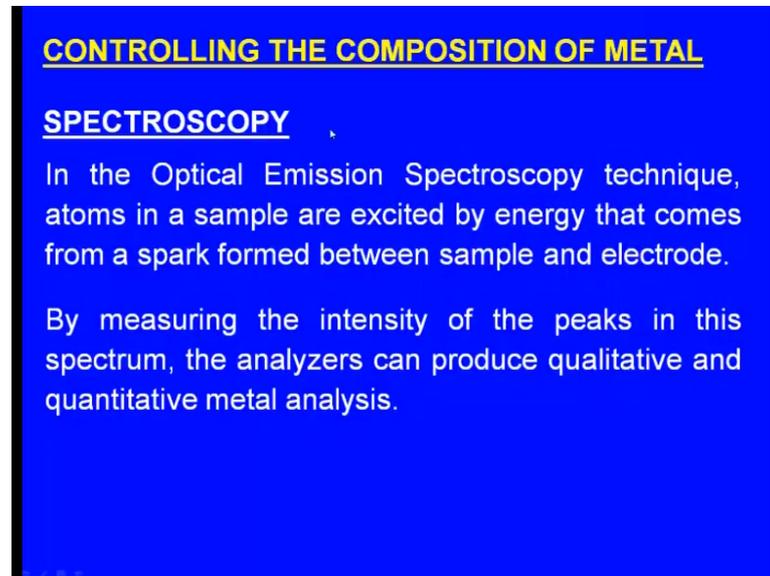
- a) Controlling the composition of metal
- b) Dimensional inspection
- c) Examination of surface quality and finish
- d) Testing of mechanical properties
- e) Non-destructive testing

The first one is controlling the composition of the metal I mean the molten metal which is poured into the metal cavity. Second one is the dimensional inspection, what are the dimensions are they as per the what say specifications of the customer. So, that is the testing of the dimensional accuracy that is the dimensional inspection.

Third one is the examination of surface quality and finish, fourth one is the testing of mechanical properties of the casting and finally, non destructive testing internal sometimes there may be internal what should defects should be there, internal cracks or blow holes and so some other defects. So, this will be what say detected using non

destructive testing, first we will see the controlling and composition of the metal. So, this controlling and composition of the metal is done using spectroscopy.

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CONTROLLING THE COMPOSITION OF METAL

SPECTROSCOPY

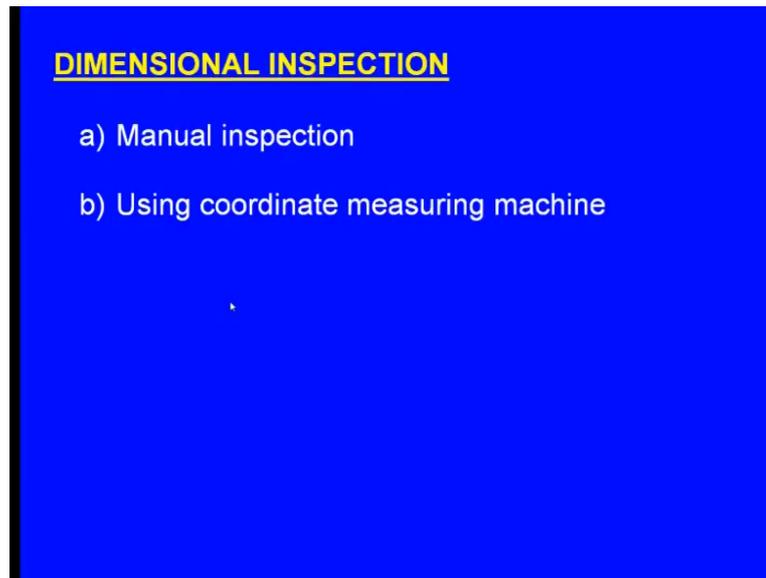
In the Optical Emission Spectroscopy technique, atoms in a sample are excited by energy that comes from a spark formed between sample and electrode.

By measuring the intensity of the peaks in this spectrum, the analyzers can produce qualitative and quantitative metal analysis.

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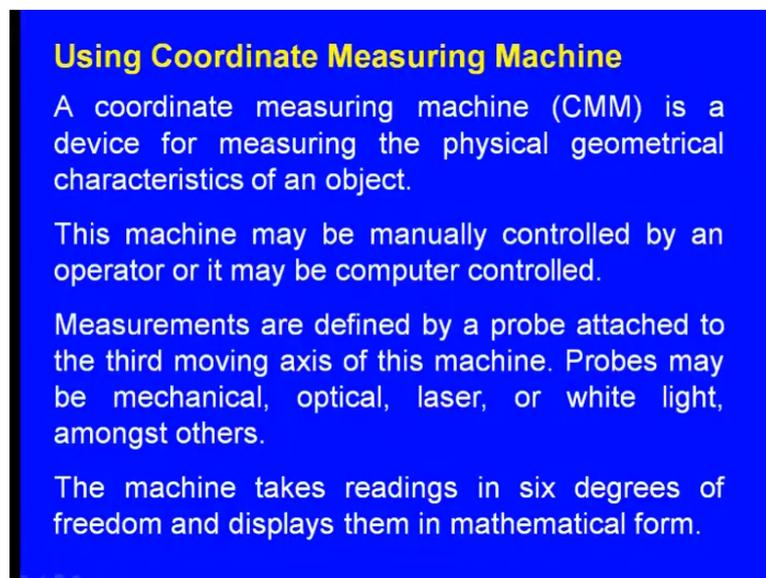
Next one let us see the dimensional inspection dimensional inspection again is carried out what say in 2 types.

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One is manual inspection and the other one is the using coordinate measuring machine, there is no what say much to learn about the manual inspection. So, let us so see little about the coordinate measured machine.

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Using coordinating what say coordinate measuring machine a coordinate measuring machine CMM is the device for measuring the physical geometrical characteristics of an object, this machine may be manually controlled by an operator and it may be computer controlled it can be manual or computer control.

Measurements are defined by a probe attached to the third moving axis of this machine. Now what about the probe probes may be mechanical optical laser or white light amongst the others, the machine takes readings in 6 degrees of freedom and displays them in mathematical form.

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So, here we can see A typical coordinate measuring machine. So, here we can see this is the probe with the probe and this is the component. So, these components dimensions are being examined. Next one examination of surface quality and finish this is carried out using a profilometer.

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EXAMINATION OF SURFACE QUALITY AND FINISH

PROFILOMETER

A profilometer is a device used to measure the roughness of a surface.

It gives the difference between the high and low point of a surface in nanometres.

- **Types of Profilometers**
 - Non - Contact Profilometers
 - Contact Profilometers

A profilometer is a device used to measure the roughness of a surface, it gives the difference between the high and low point of a surface in nanometers. There are 2 types of profilometers one is non contact profilometer and the other one is the contact profilometer. Next one testing of mechanical properties of the cast component or the cast specimen.

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TESTING OF MECHANICAL PROPERTIES

Strength – Determined through Tensile Testing
This is the load a metal can withstand without fracturing.

Ductility – Determined through Tensile Testing
Property of the metal which enables it to be drawn easily.

Hardness – Determined through Brinell Hardness Test
Measure of the metal's resistance to wear or erosion.

Impact Resistance - Determined through Impact Test
This is the measure of resistance to impact of the metals.

Elasticity - Determined through Tensile Testing
Measure of the property to regain its original condition after being subjected to a load under its yield point.

Toughness - Determined through Impact Test
Resistance to both elastic and plastic Deformation

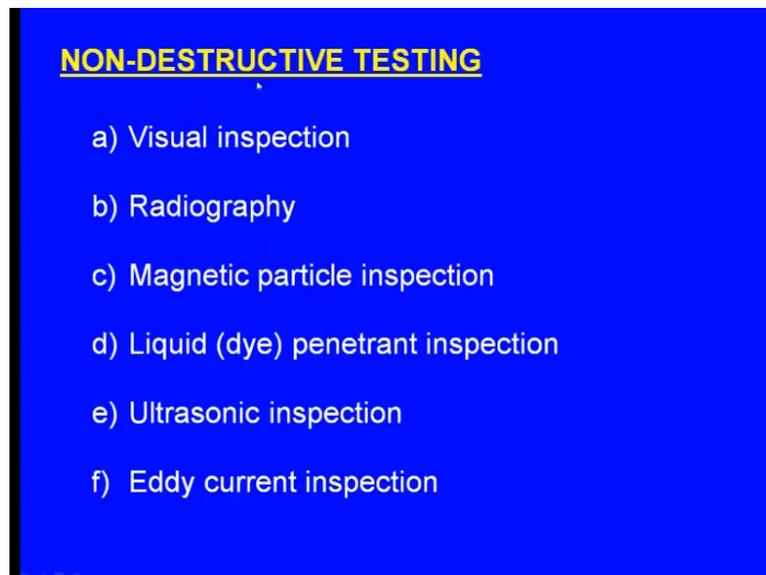
So, these are the mechanical properties that are normally measured strength, ductility, hardness, impact resistance, elasticity, toughness. Now this strength is determined

through tensile testing, this is the load a metal can withstand without fracturing this is the impact this is the maximum load it can withstand under the next property is ductility it is also determined through tensile testing.

It is the property of the metal which enables to do to be drawn into what say thin wires easily, next property hardness is determined through brinell hardness testing. It is a measure of metals resistance to wear or erosion, next property is the impact resistance and it is determined through impact test. This is the measure of resistance resistance to impact of the metals. Next property elasticity it is determined through tensile testing, it is a measure of the property of the what say material to regain, it is original condition after being subjected to a load under it is yield point and finally, the toughness it is determined through impact test.

Toughness is the resistance to both elastic and plastic deformations. So, these are the what say testing of the mechanical properties of the component or the what say specimens finally, we come to the non destructive testing it is very important.

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Non destructive testing is carried out in different ways, one is the visual inspection, second one is the radiography, third one is the magnetic particle inspection, fourth one is the liquid penetrant inspection, this is also known as dye penetrant inspection. Next one is the ultrasonic inspection finally; we have the eddy current inspection.

So, first we will see the visual inspection.

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VISUAL INSPECTION

- Visual Testing (VT) is the oldest and most widely used Nondestructive testing method.
- Mechanical or optical aids may be necessary to perform visual testing.
- The specimen should be well illuminated and its surface cleaned.
- Often visual inspection eliminates the need for further testing and the associated costs.
- **3 types of visual inspection are:** a) Direct visual testing, b) Remote visual testing and c) Translucent visual testing.

Visual Testing VT is the voltage stand most widely used non destructive testing method, mechanical or optical aids may be necessary to perform this visual testing, the specimen should be well illuminated and it is a surface cleaned often visual inspection eliminates the need for the testing and the associated costs. There are 3 types of visual inspections one is the direct visual testing, second one is the remote visual testing, and the third one is translucent visual testing.

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Direct Visual Testing

Direct visual testing may usually be made when access is sufficient to place the eye within 600 mm of the surface to be examined.

The visual angle between plane of vision and surface being tested shall not be less than 30°.

Mirrors may be utilized to improve the angle of vision.

First one let us see the Direct visual testing; direct visual testing may usually be made when access is sufficient to place the eye within 600 mm of the surface to be examined, means when the cash what say object to be examined is closed within 600 mm then only we can use this technique direct visual testing, the visual angle between the plane of vision and surface being tested shall not be less than 30 degrees mirrors may be utilized to improve the angle of vision.

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Remote Visual Testing

In some cases, remote visual examination may have to be substituted for direct examination.

Remote visual examination may use visual aids such as mirrors, telescopes, fiber optics, cameras, or other suitable instruments.

Remote visual testing personnel shall demonstrate Snellen 20/20 vision or better.

Next one remote visual testing; in some cases remote visual examination may have to be substituted for direct examination. Remote visual examination may use visual aids such as mirrors telescopes fiber optics cameras or other suitable instruments, remote visual testing personnel shall demonstrate Snellen 20 by 20 vision or better means the operator should have a good vision to carry out this testing.

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Translucent Visual Testing

It is a supplement of direct visual examination. The method uses the aid of artificial lighting, which can be contained in an illuminator that produces directional lighting.

The illuminator shall provide light of an intensity that will illuminate and diffuse the light evenly through the area or the region under examination.

The ambient lighting must be so arranged that there are no surface glares or reflections from the surface under examination.

Next one translucent visual testing it is a supplement of direct visual examination; the method uses the aid of artificial lighting which can be contained in an illuminator that produces directional lighting.

The illuminator shall provide light of an intensity that will illuminate and diffuse the light evenly through the area or the region under examination the ambient lighting must be. So, arranged that there are no surface glares or reflections from the surface under examination, what are the advantages of visual inspection.

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Advantages of Visual Inspection

1. Inexpensive
2. Highly portable
3. Immediate results
4. Minimum training
5. Minimum part preparation

It is inexpensive it is highly portable we can get the results immediately there is no question of analysis and so on. Next one it can be done with minimum training, next one this can be what say done where the it does not require what say is so much of parts preparation with minimum part preparation we can carry out this inspection.

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Disadvantages of Visual Inspection

1. The accuracy of visual inspection depends largely on the experience and knowledge of the inspector.
2. Visual inspection is limited to detection of surface discontinuities.
3. Only large discontinuities can be detected.
4. Possibility for misinterpretation of scratches as cracks.

Now, these are the disadvantages or the drawbacks of the visual inspection the accuracy of visual inspection depends largely on the experience and knowledge of the inspector. So, the inspector should have enough knowledge and experience. Next one the visual inspection is limited to detection of surface discontinuities, one is surface detect what say this discontinuities can be detected what about the internal cracks are internal blow holes those cannot be detected using visual inspection naturally, next one only large discontinuities can be detected if there are discontinuities which are very small in nature that may go undetected.

Possibility of misinterpretation of scratches as cracks sometimes there will be some scratches will be there and the operator and if he does not have sufficient experience he may think that these scratches are the cracks. So, in the non destructive testing we have completed the visual inspection. Now let us see the radiography this technique is suitable for the detection of internal defects in ferrous and non ferrous metals and other materials.

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RADIOGRAPHY

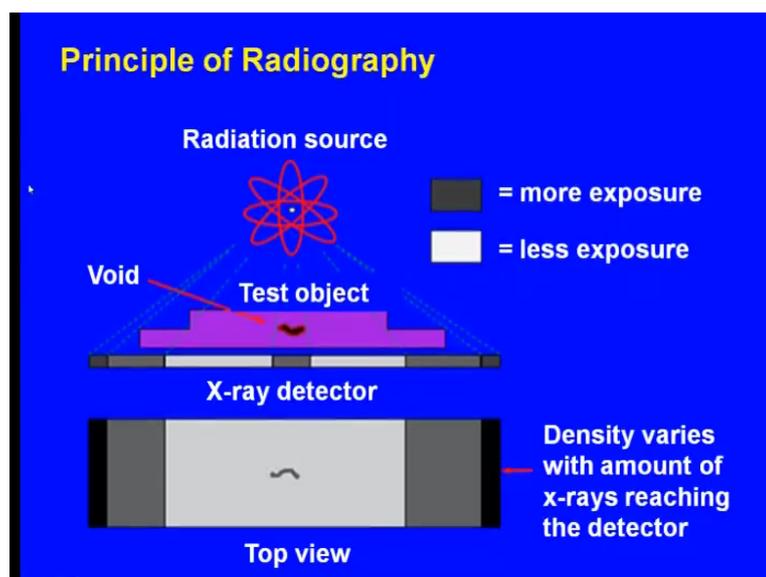
This technique is suitable for the detection of internal defects in ferrous and nonferrous metals and other materials.

X-ray and gamma ray radiographic inspection are the two most common forms of this inspection technique.

X-ray and gamma ray radiographic inspection are the 2 most common forms of this inspection technique.

So, in this radiography we use the x-ray and gamma rays for the examination of the materials.

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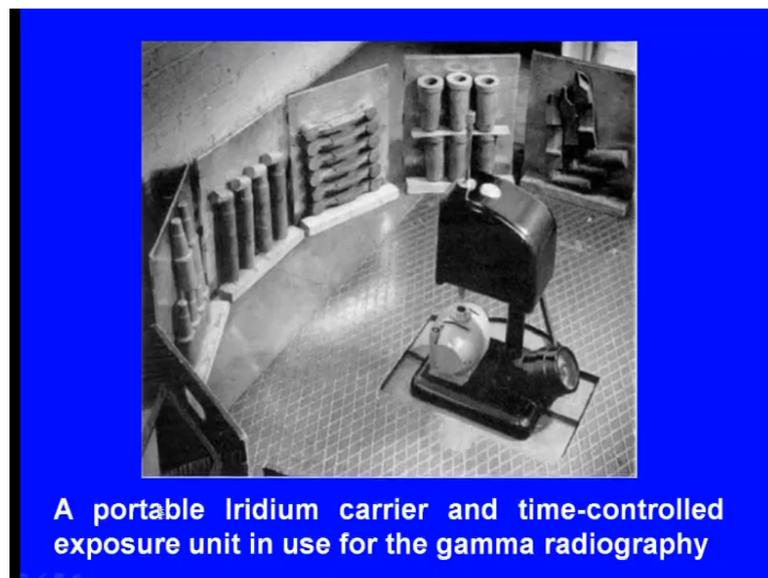


Now, this is the principle of the radiography and here we can see this is the radiation source from here what say either x-rays or gamma rays will be emitting. Now this is the

what say component to be examined, now you can see here this component is having at internal crack here, now this is the what say film this is the what say film x-ray film and this is the top view of that film and here we can see and here what happens. So, white means it is let us exposure black means, dark means more exposure and here we can see the whole film there is less exposure that is why it is appearing as white.

But here we can see where there is a crack there is more exposure. So, once there is a what say any what say a place if we see more exposure means we can presume there is a defect or a crack. So, here density varies with amount of X-rays reaching the detector. So, that is how the what say defects are the crack can be easily what say found out on the X-ray film. So, this is the principle of the radiography.

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And here we can see A portable iridium carrier and time controlled exposure unit in use for the gamma radiography and here we can see gamma ray what say they are exposed and these are all the components and behind the components there is X-ray film. So, what is the advantage of this gamma ray inspection at a time several components can be examined with one source of the gamma ray.

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Advantages of Radiography

- Surface defects as well as internal defects can be detected.
- Information is presented pictorially.
- Suitable for any material.
- Can inspect assembled components intact (like a full suitcase).
- Minimum surface preparation required.
- Sensitive to changes in thickness and density.
- A permanent record of the result is obtained.

Now, these are the advantages of the radiography surface detects as well as internal defects can be detected, information is presented pictorially suitable for any material ferrous materials, non ferrous materials, even non metals can be examined. Can inspect assembled components intact like a full suitcase no need to separate the parts, minimum surface preparation is required, sensitive to changes in thickness and density a permanent record of the result is obtained, because it is exposed on the film.

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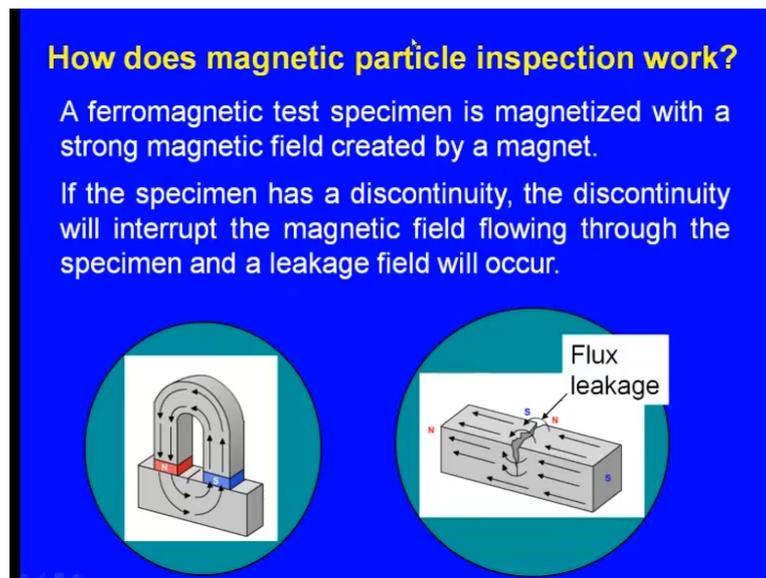
Disadvantages of Radiography

- Many safety precautions required.
- Orientation between incident x-ray and flaw is critical.
- Many hours of technician training prior to use.
- Film processing and viewing facilities are necessary - expensive and time consuming.
- Determining flaw depth is impossible without additional angled exposures.
- Expensive initial equipment cost.

Now these are the Disadvantages of Radiography; many safety precautions are to be taken if the precautions are not taken these radiations can go on harm human, orientation between incident x ray and flaw is critical otherwise sometimes that crack or the defect may go undetected next one many hours of technician training prior to use.

The technician must be given rigorous training prior to the actual application, next one film processing and viewing facilities are necessary and these are expensive and time consuming, next one determining flaw depth is impossible without additional angled exposure, next one inexpensive initial expensive initial equipment cost the equipment is very costly that is how the initial what say cost will be very high. So, we have completed visual inspection and radiography, next one is the magnetic particle inspection.

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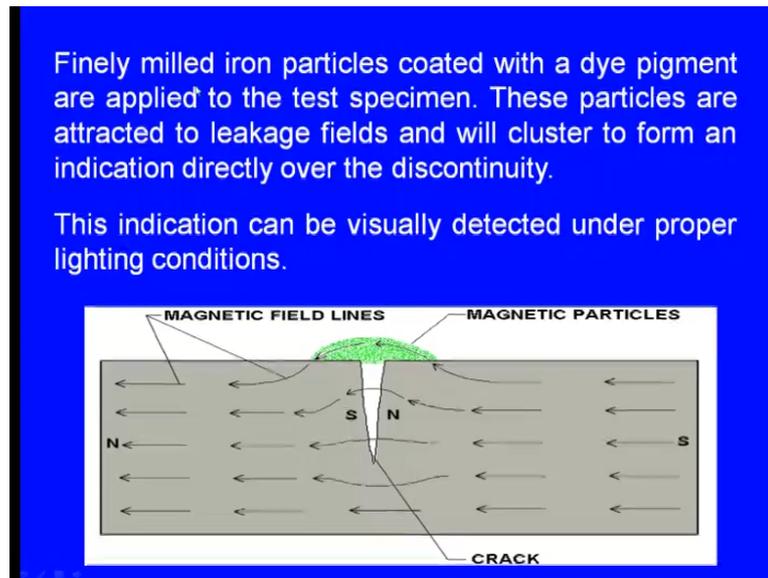


How does magnetic particle inspection work a ferromagnetic test specimen is magnetized within a strong magnetic field created by a magnet, a ferromagnetic what say component are a material is the one which can be magnetized easily under the influence of a magnet.

Now, this ferromagnetic specimen is magnetized with a strong magnetic field created by a magnet, now if the specimen has a discontinuity the discontinuity will interrupt the magnetic field flowing through this specimen and leakage field will occur. Now this here we can see this is the specimen if the specimen within the specimen if there is no crack if

there is no defect and here we can see there are the 2 poles here, this is the south pole and these are these are the north pole, on the other hand if there is a discontinuity if whether it is external discontinuity or internal discontinuity what will happen here also where there is a disconnect there also north pole and south pole will be created then what we will do find milled iron particles coated with dye pigment are applied to the test specimen.

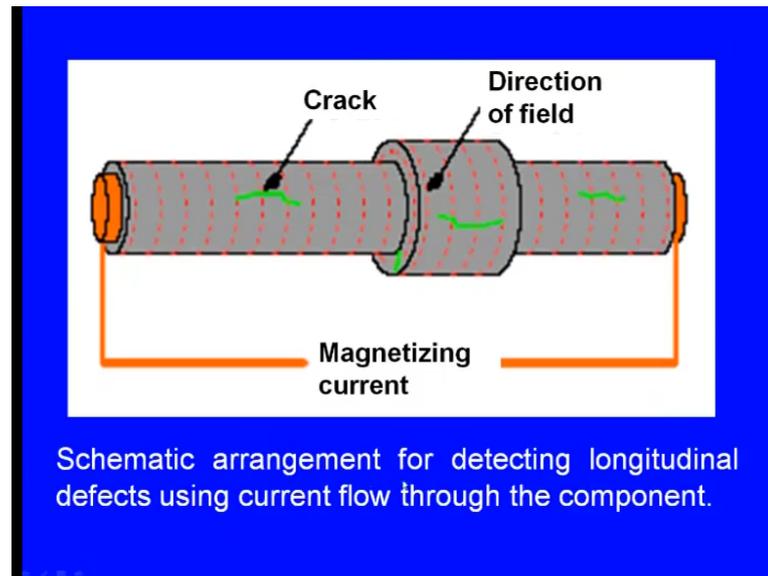
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Now, these particles are attracted to leakage fields and will cluster to form an indication directly over the discontinuity. So, when we what say a port or we when we sprinkle finely milled iron particles over the cached component or the specimen. So, no doubt here is the south pole and here is the north pole, on the poles are over the poles there will be more attraction of the this iron powder, but if there is a discontinuity where there is a discontinuity there also this iron powder will be attracted. These particles are attracted to leakages fields and with cluster to form an indication directly over the discontinuity.

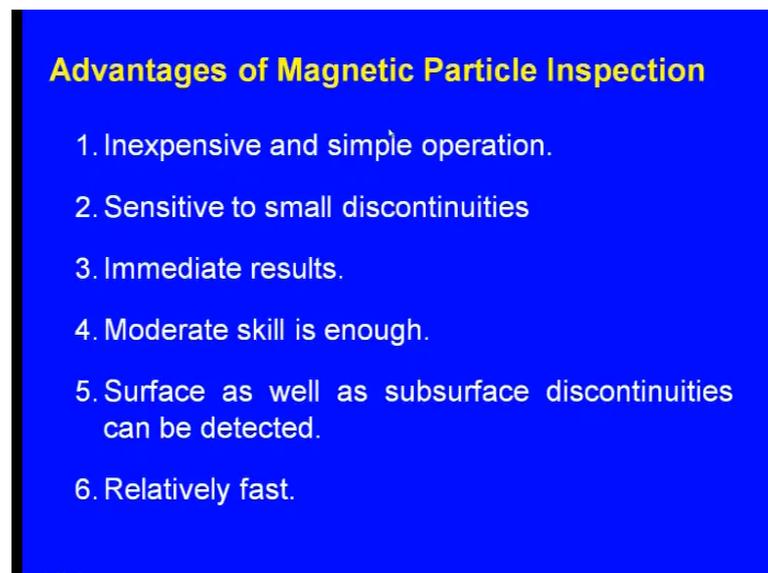
Here we can see again iron powder is sticking here where there is discontinuity this indication can be visually detected under proper lighting conditions.

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And this is the schematic arrangement for detecting longitudinal defects using current flow through the component, next one schematic arrangement for a detecting circumferential and transverse defects using encircling coil. Now these are the advantages of magnetic particle inspection.

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Inexpensive and the simple operation, sensitive to small discontinuities, immediate results, moderate scale is enough not as in the case of the what say X-ray are the radiography moderate skill is enough.

Next one surface as well as the subsurface discontinuities can be detected, if the discontinuities are on the surface or even internally, if they are existing these can be detected using the magnetic particle inspection, next one relatively fast.

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Disadvantages of Magnetic Particle Inspection

1. Surface must be accessible.
2. Rough surfaces interfere with test.
3. Part preparation is required.
4. Ferro-magnetic components only can be examined.
5. Components must be demagnetized after the inspection.

Now these are the disadvantages of magnetic particle inspection surface must be accessible, otherwise how can we go under sprinkle the what say iron powder, next one rough surface interfere with the test path preparation is required, ferromagnetic particle components only can be examined why because only ferromagnetic components can be magnetized under the influence of a magnetic.

Components must be demagnetized after the inspection. So, this is time consuming. So, we have completed the first 3 what say ndts methods, next one is the liquid penetrant inspection this is also known as dye penetrant inspection.

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LIQUID (DYE) PENETRANT INSPECTION

The dye penetrant inspection process detects surface connected cracks and other flaws, such as laps and pores in all metals, as well as in most plastics and ceramics.

Important steps involved are:

- Clean the surface
- Apply dye penetrant
- Remove excess dye penetrant
- Apply developer
- Inspect the surface

What is the principle, the dye penetrant inspection process detects surface what say connected cracks or other flux such as laps are pores in all the metal as well as in most plastics and ceramics. Now important steps involved are what say clean the surface, next one apply dye penetrant, remove excess dye penetrant, apply developer, inspect the surface.

So, in this method we use 3 reagents one is the what say penetrant, second one is the what say remover, and next one is the developer. First one dipenetrant, next one cleaner and third one is the developer so how to use 3 reagents on the 3 liquid so we will see now.

First step is the Clean the part thoroughly using a suitable cleaner acetone aqueous degreasing and so on.

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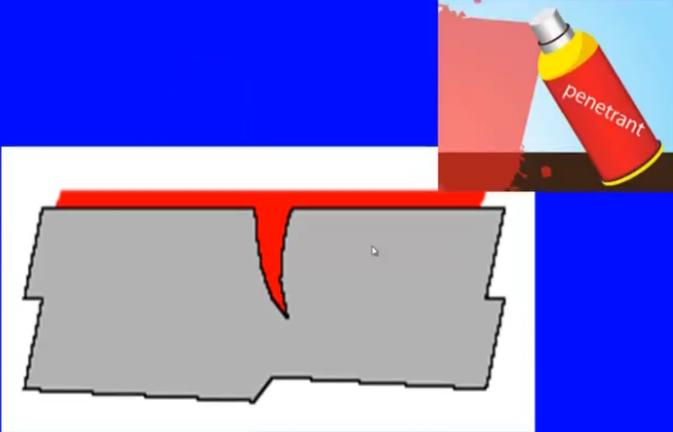
1. Clean the part thoroughly using a suitable cleaner, acetone, aqueous degreasing, etc.

The image shows two cleaning containers. On the left is a white plastic jug with a brown cap and a large orange label that says "degreasing". To its right is a smaller white plastic bottle with a black cap and a pinkish-red liquid inside, with a white label that says "acetone".

So, this up the what say what say reagent which are used to clean the surface very cleanly no duck should be there on the component.

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2. Apply the penetrant to the surface being inspected.

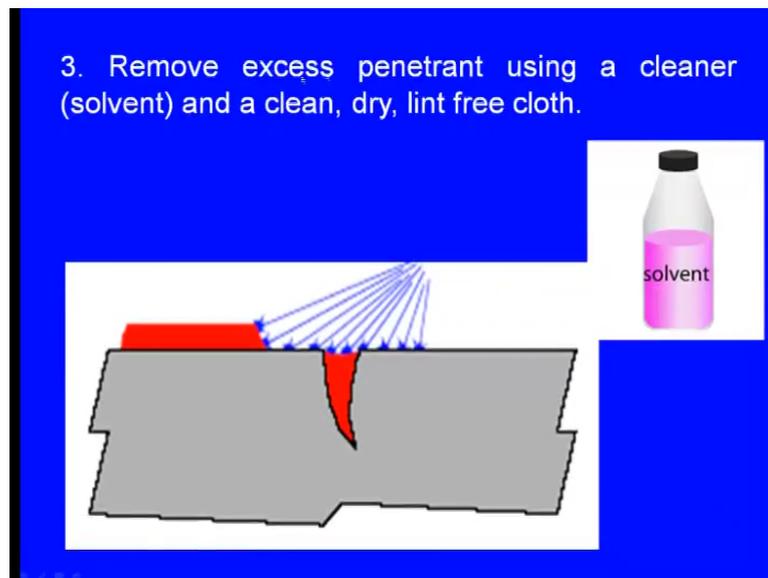
The image contains two parts. The top part is a close-up of a red spray can labeled "penetrant" being applied to a surface. The bottom part is a diagram of a grey component with a V-shaped crack. A red liquid is shown filling the crack, representing the application of the penetrant.

Second one apply the penetrant to the surface being inspected we have seen that we will be using trill 3 liquids which are available in some containers, one is the penetrant, second one is the cleaner, and the third one is the developer. Now we are taking the first reagent or the first 2 liquid that is the penetrance, apply the penetrant to the surface being

inspected. So, this is the component and here there might be a what is a external what is a defect or cracking is there, but it is invisible to the naked eye.

Now what we have done is we are applying the dispenetrant on the surface of the cached component. So, the penetrant will be flowing all over the surface of the cast component, now there is a crack now to this into this crack also this penetrant is going inside means it is penetrating through the leaks or the cracks.

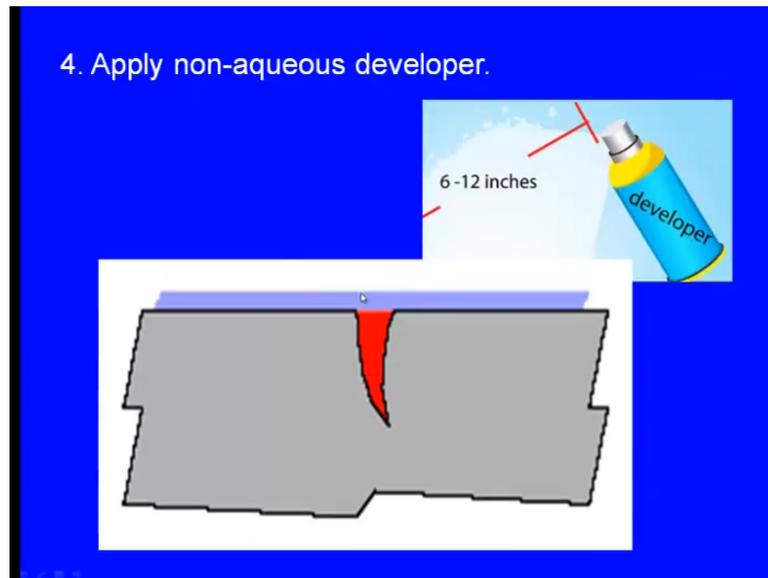
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Third step remove excess penetrant using a cleaner and clean dry what is a lint free cloth, now here we can see this is the surface of the component the excess what is a penetrant which is their everywhere must be cleaned and it must be removed.

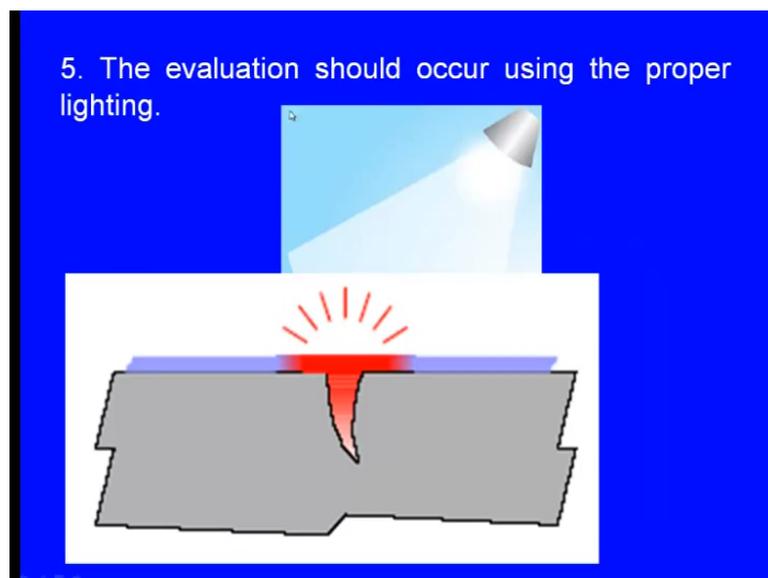
Now, what about this crack the crack which is not visible to the naked human eyes it has trapped the penetrant. Now this penetrant here you see.

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Next step apply non aqueous developer. So, this is the second reagent we will be using; now this is the third reagent we will be using; now you can see here this developer is falling on the surface of the component and there must be a distance of 6 to 12 inches from the developer can to the surface of the casting, then what will happen the evaluation should occur using proper lighting, now lighting is applied.

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Once this developer falls on these what say this penetrant it will be illuminating you see under the light it will be until now it is invisible this is penetrant has gone inside the

crack, but it is not visible once we put this developer it is visible outside. So, that is the principle of the liquid penetrant inspection.

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Advantages of Liquid Penetrant Inspection

1. Highly portable.
2. Inexpensive.
3. Sensitive to very small discontinuities.
4. Inspection can be completed in less than 30 minutes.
5. Moderate skill is enough.

Now, what are the advantages of the liquid penetrant examination one is it is highly portable what are the equipments only 3 reagents or the 3 liquids; one is the developer, second one is the cleaner. So, sorry first one is the penetrant first one is the penetrant, second one is the cleaner, third one is the developer. Only 3 reagents and they are available in this kind of size cans. So, we can take them anywhere in the plant. So, that way this process is highly portable.

Next one inexpensive these reagents are not very costly, it since due to small discontinuities, even a small discontinuity can be examined using this inspection. Inspection can be completed in less than 30 minutes, now moderate still is enough highly skilled what is a personnel are not required to carry out this inspection.

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Disadvantages of Liquid Penetrant Inspection

1. Only surface defects can be detected.
2. Rough or porous surfaces interfere with the test.
3. Part preparation is required.
4. High degree of cleanliness is required.

Now what are the disadvantages of liquid penetrant inspection only surface defects can be detected, what about the internal defects internal cracks now they cannot be examined using liquid penetrant testing.

Next one rough or porous surfaces interfere with the test part preparation is required it must be cleaned very thoroughly very clean, next one high degree of cleanliness is required now let us see the ultrasonic inspection.

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ULTRASONIC INSPECTION

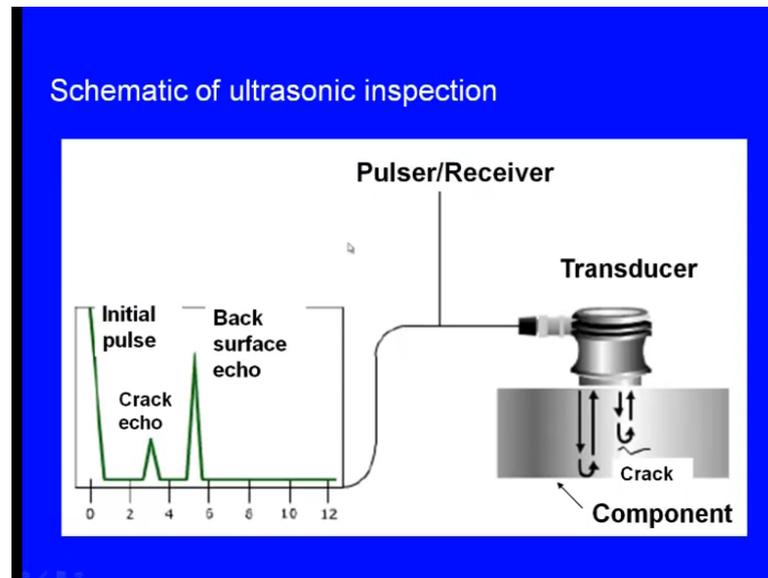
The principle is in some respects similar to echo sounding.

A short pulse of ultrasound is generated by applying an electric charge to a piezo electric crystal.

These sound waves have the ability to travel a considerable distance in many metals.

The principle is in some respects similar to the echo sounding, a short pulse of ultrasound is generated by applying an electric charge to a piezoelectric crystal the sound waves have the ability to travel a considerable distance in many metals.

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And here we can see this is a schematic of the ultrasonic inspection. So, this is the transducer your piezoelectric transducer means what does it mean? So, it generates the electric pulse. So, this is the component.

So, we generate the what is pulses and ultrasonic waves will be coming and they will be passing through the component. So, if the a normal what is a ultrasonic wave will be coming and it will go up to the extreme surface end of the cast component and it will be coming back. Now here we can see this is the initial pulse and after the wave ultrasonic wave comes back. So, this is the back surface echo this one this one. Now it is possible that at this somewhere there is a crack. So, this is the crack that be the case what will happen the wave will return little earlier than the original wave. So, here we can see this is the crack echo. So, a sound what is the specimen will be examined initially and how much time it is taking for the for a return of the wave it will be recorded how many seconds or how many what is a milliseconds it is taking.

Now, once there is a component will be or say change changing from time to time it is examined one after other, now if there is any crack in a particular component we get the

echo what is a crack echo very quickly. So, this is how the ultrasonic inspection is carried out.

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Advantages of Ultrasonic Inspection

- It is sensitive to both surface and subsurface discontinuities.
- Lengths up to 10 meters can be inspected.
- No consumables required – less running cost.
- Only single-sided access is needed.
- Minimal part preparation is required.
- It provides instantaneous results.
- Capable of being fully automated.
- It is non-hazardous to operators or nearby personnel.
- Its equipment can be highly portable or highly automated.

Now, what are the advantages of ultrasonic inspection it is sensitive to both surface and subsurface discontinuities lengths up to 10 meters can be examined no consumables required and the less running cost. Naturally even in the liquid penetrant testing we were using 3 types of what is a liquids and they are consumables, that is how the process is not so what is a highly chip it is little expensive, but here the running cost is almost 0, no consumables required- less running cost, only single sided access is needed both the sides we do not have to access the component.

Minimal part preparation is required, next one it provides instantaneous results, now it is capable of being fully automated, it is non hazardous to operators or nearby personal. So, this is one of the what is a good what is a merits of this process. In the case of the what is a radiographic examination are the dye penetrant testing what happens. So, the radiographic race the X-rays are the gamma rays are harmful to the human operators, even in the case of the liquid penetration testing. So, these reagents cause streams to the human hands or to the workers. So, that way it is non hazardous to the operators or nearby personal, it is equipment can be highly portable or highly automated it is highly what is a portable.

Now, these are the disadvantages of ultrasonic inspection.

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Disadvantages of Ultrasonic Inspection

- Surface must be accessible to transmit ultrasound.
- Skill & training is more extensive.
- It normally requires a coupling medium to promote the transfer of sound energy into the test specimen.
- Materials that are rough, irregular in shape, very small, or not homogeneous are difficult to inspect.
- Cast iron and other coarse grained materials are difficult to inspect due to low sound transmission.
- Linear defects oriented parallel to the sound beam may go undetected.
- Calibration of equipment and the characterization of flaws is required.

Surface must be accessible to transmit ultrasound, next one skill and training is more extensive sometimes it is very different to what is a discriminate the crack wave are the original wave. So, only a highly experienced person can differentiate between the what is a cracked wave and the original wave, it normally requires a coupling medium to promote the transfer of sound energy into the test specimen. Materials that are rough irregular in shape very small or not homogenous or difficult to inspect, sometimes if the material is not homogenous let us say what will happen at some place the density is less at some place at a particular place the density is very high.

Then what will happen at that place where the density is very high it will take more time to penetrate and you to take more time for the return that is how it causes the operator to get confused. Next one cast iron and other coarse grain materials are difficult to inspect due to low sound transmission, next one linear defects oriented parallel to the sound beam may go undetected, calibration of equipment and the characterization of flaws is required initially the equipment has to be what is a calibrated otherwise it is very difficult to discriminate or to what is they assess the flaws.

So, now let us come to the last one that is the Eddy current inspection.

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EDDY CURRENT INSPECTION

Eddy currents can be produced in any electrically conducting material that is subjected to an alternating magnetic field.

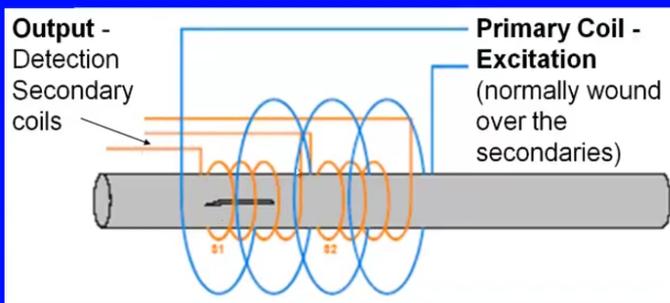
The magnitude of the eddy currents generated in the product is dependent on conductivity, permeability and the set up geometry.

Any change in the material or geometry can be detected by the excitation coil as a change in the coil impedance.

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Typical Eddy Current Inspection Setup



Now here we can see the principle of the generation of the eddy current, now this is the what is a cast specimen, now this is the primary coil the blue colored one is the primary coil.

Normally wound over the secondaries, now here is the secondary coil, the red one is the secondary coil. So, in this setup we see there are 2 types of coils; one is the primary coil and the other one is the secondary coil. And through the primary coil we will be passing the current we will be passing the current, then what will happen when this current passes through the primary coil eddy currents are generated that is the electromagnetic induction. So, because of the electromagnetic induction eddy currents are generated and these eddy currents will be passing through the secondary coils.

So, this is the principle of the what is a eddy current inspections what is a method, now how that what is a defect will be examined, now if let us assume there is no crack there is no defect internally for the casted specimen then what will happen as we send certain amount of primary current through the primary coil a what is a proportionate amount of eddy current will be generated for a sound cast specimen. Now as long as the we change the what is a what is a specimens as long as there is no what is a defect inside the cast component the same amount of secondary eddy current has to be generated. So, that is the principle.

Now, if there is any crack in a particular specimen then what will happen there will be change in the secondary current secondary eddy current that is how we can measure or we can detect the defect or a crack internal crack inside a cast specimen? So, this is the simple principle of the eddy current inspection.

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Advantages of Eddy Current Inspection

1. Extremely compact and portable units are available.
2. Suitable for the determination of a wide range of conditions of conducting materials, such as defect detection, composition, hardness, conductivity, permeability etc. Surface as well as subsurface defects can be detected.
3. No consumables (except probes – which can sometimes be acquired).
4. Immediate results
5. Sensitive to small discontinuities

Now, what are the advantages of the eddy current inspection, extremely compact and portable units are available this is very what is a compact there is no heavy machinery involved.

Next one suitable for the determination of a wide range of conditions of conducting materials, such as defect in detection, composition, hardness, conductivity, permeability and so on. Surface as well as subsurface defects can be detected, now this is the most interesting feature of this inspections what are that interesting feature not only that we can detect the cracks, now composition, now this generation of the eddy current will be depending on the composition. In a particular casts specimen if there is a change of extreme change in the composition even then in such a case also the what say output of the eddy current will be different, then we can know that there is a change in the composition and also when the hardness is changing abruptly changing at a particular place then also the amount of eddy current that is flowing through the secondary coil will be different.

Now, again depends upon the conductivity the secondary eddy current will be depending on the conductivity permeability and so on. So, the secondary eddy current you will be showing so many parameters. So, these are all the parameters which we can assess using the secondary eddy current, now surface as well as the surface subsurface defects so can be detected, no consumables you see no consumables are used as in the case of the liquid

penetrant testing, except probes which is sometimes can be are to be changed. So, these probes are semi consumers maybe once in a while we have to change them otherwise the running cost is almost 0.

Next one results we get immediately there is no question of processing if it is the you take for example, you the radiographic examination initially we expose the a what is a radiographic waves are the rays, the X-rays are the gamma rays on the photographic film and this photographic film has to be processed. So, the text sometime, at least few hours, but here we get the results immediately. Next one sensitive to small discontinuities also not only long discontinuities can be examined even a very small discontinuities can be examined using eddy current inspection.

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Disadvantages of Eddy Current Inspection

1. Surface must be accessible
2. Rough surface interfere with test
3. Only electrically conductive components can be inspected.
4. Highly skilled persons are required.
5. The signal from a required parameter (e.g. crack) can be masked by an unwanted parameter (e.g. hardness change).
6. Requires considerably more time.

Next one these are the disadvantages of eddy current inspection surface must be accessible; next one rough surface interferes with the test only electrically conductive components can be inspected. So, that is the drawback. Highly skilled of persons are required because sometimes there will be small what is a variation in the output what is a secondary eddy current. So, that time the operator must be any position to what is a assist the change and we must be in a position to tell what is the reason for that is it in internal crack are changing the composition are changing the hardness and so on. The must be in a position to interpret, the signal from a required parameter example crack can be masked by a an unwanted parameter hardness and so on. That is possible hardness

because of the hardness there is a variation in the output eddy current, but it is possible that the operator may mistake that it is due to a crack that is that is how that is how a highly experienced person is required to conduct this what is the eddy current inspection.

Now, this requires considerably more time now let us see the quality control.

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Quality control is carried out at the following stages.

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Quality control in pattern making and mold making, quality control in melting of the metal, quality control in heat treatment, quality control in fettling and cleaning quality control in final inspection. In all these cases the quality control has to be done. So, what is this quality control is the hat's a molten metal is as per the required composition are not. Next one is the heat treatment is proper or not and next one what about the fettling and cleaning is it proper and next one final inspection, does the cast is what is a component has the required surface finish, does the cast component have the required surface finish.

So, these are all the what is a things to be examined end of the under the quality control, first let us see the quality control in pattern making and mold making what is this how it is done.

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Quality Control in Pattern and Mould Making

1. The patterns should be checked for dimensions and other pattern allowances.
2. The dovetail pins of the moulding boxes should be checked against wear.
3. Moulding sand should be tested for different mould properties before ramming.
4. Core oven temperatures should be controlled carefully.
5. Cores should be positioned carefully.

That patterns should be checked for dimensions and other pattern allowances does the pattern have the required dimensions or not does the pattern have the required pattern allowances like the machining allowance, shrinkage allowance, draft allowance, taper allowance and what is a wrapping allowance. So, all this what is allowances are to be given to the pattern. So, does the pattern have all these allowances or not. So, that is to be checked.

Next one that dovetail pins of the molding boxes should be checked against wear, now generally we use the 2 molding boxes the cope the upper one and they drag the lower 1. So, these 2 must be aligned properly these 2 boxes will have brackets at the middle, now through the brackets we insert a dovetail pin and the dovetail pin must go and exactly through the 2 brackets of the 2 boxes and when we insert the dovetail pin there must not be any gap between the bracket hole and the dovetail pin.

Sometimes it is possible that when we use these pins for several what is a components then what will happen these pins will undergo wear, if there is a wear of one mm then what will happen the molding boxes can displace by 1 mm, that be the case there will be a what is the misalignment between drag and the cope that is why we always have to check whether the dovetail pins are in good condition or they are worn out.

If they have already worn out we must replace them. So, that is the quality control in the maintaining of the molding boxes and the molding what say dovetail pins, next one molding sand should be tested for different mold properties before ramming, different tests must be conducted what is the moisture content, what is the active clay content, what is the permeability, what is the hardness, what is the green compression strength, what is the dry compression strength. So, likewise we have to conduct different what is tests before the molding sand is rammed into the modeling boxes core oven temperature should be controlled carefully.

Next one cores should be positioned carefully. So, these are all the what say quality control what see in pattern and mold making.

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Quality Control in Melting

1. Metal charge should be melted in an appropriate furnace.
2. Metal charge should be clean and dry.
3. Fluxes and other additives should be dry.
4. Fluidity temperatures should be carried out.
5. Online analysis of molten metal should be carried out.
6. Molten metal should be degassed.

Next one quality control in melting; metal charge should be melted in an appropriate furnace there are different furnaces are available we have already seen and an appropriate furnace should be taken. Next one metal charge should be clean and dry, sometimes it is possible that people take this scrap and they used to dump in the furnace and this may this scrap may contain what say unwanted what say oils lubricants and so on, then the composition will be changing our hydrogen will be evolving because of the carbons are the hydrocarbons present on the surface of the what is a scrap.

So, the metal charge should be clean and dry fluxes and other additives should be dry if the moisture is present it must be a what is a dried out before they are used. Next one fluidity temperatures should be carried out; next one online analysis of molten metal should be carried out means as the molten metal is being melted. So, parallelly we must examine it is the composition what is the composition does it process all they required what say elements allowing elements or not molten metal should be degassed using different degassing techniques.

So, these are the what is say different what is say features of the quality control in melting.

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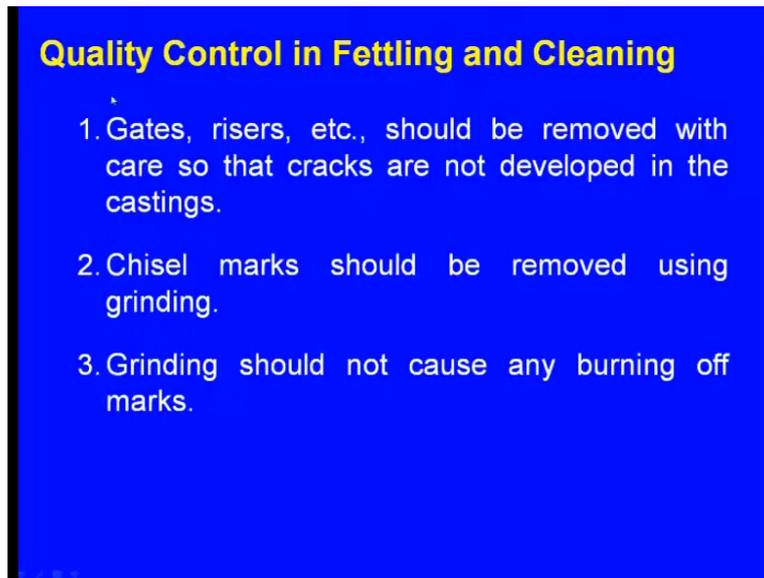
Quality Control in Heat Treatment

1. Heat treatment should be carried out at correct temperatures.
2. Rate heating should be controlled to prevent crack formation.
3. Rate of cooling of castings should be controlled carefully.

Next one control in heat treatment the heat treatment is carried out to the cast component after it is taken out from the molten metal, next one then heat treatment should be carried out at correct temperature rate of heating should be controlled to prevent crack formation sometimes if this what is say temperature is not maintained properly during this heat treatment to cycle the cached component can undergo cracking. So, that is why it should be controlled to prevent crack formation.

Rate of cooling of casting should be controlled carefully if they can what is a casting is cooled abruptly again there will be cracking.

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Quality Control in Fettling and Cleaning

1. Gates, risers, etc., should be removed with care so that cracks are not developed in the castings.
2. Chisel marks should be removed using grinding.
3. Grinding should not cause any burning off marks.

Next one quality control in fettling and cleaning what is this Fettling? Fettling means we take the what is say we break this sand take the casting outside then what will happen the casting will have what is the gating system the riser the sprue everything will be there these are not the parts of parts of the casting we do not want this. So, these prove there is a runner the gating system must be riser must be removed from the casting.

So, that operation is known as the fettling gates riser etcetera should be removed with care. So, that cracks are not developed in the casting, sometimes it is possible that as we are trying to crack the riser gating system the casting the actual casting can undergo cracking that should not happen, next one chisel marks should be removed using grinding as we are what is say cutting them sometimes there will be unwanted chisel marks will be there on the casting. So, they must be removed using grinding.

Next one grinding should not cause any burning of the burning off marks. So, the this is the quality control in fettling and cleaning.

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Quality Control in Final Inspection

1. The appearance and dimensions of the finished castings are to be checked as per the drawing.
2. After the tests, the surfaces of the casting may be given a preservative or electroplating coating to prevent rusting.

Next one Quality control in final inspection the appearance and dimensions of the finished castings are to be checked as per the drawing. So, does the casting possess the required dimensions as for the specifications given by the customer? So, that is the what is a final checking as per the drawing, next one after the tests the surface of the casting may be given a preservative or a electroplating coating to prevent rusting. So, this is very important after the casting has the required surface finish and they required what say geometrical tolerances then it must be given the preservative or a an electroplating coating to prevent the rusting otherwise it will be of no use.

So, very soon it will be resting before it is shift to the customer it will become useless. So, friends in this lecture we have seen the inspection and testing and also the quality control and in the inspection and testing we have learned different ways of inspection and testing that those are the controlling the composition of the metal we have seen. Next one how to what say inspect the dimensional inspection we have seen, next one examination of surface quality and finished that also we have seen, next one testing of different mechanical properties we have seen, next we have seen non destructive testing like visual inspection radiographic inspection magnetic inspection ultrasonic inspection liquid penetrant inspection eddy current inspection we have seen.

So, with this we are we have completed the inspection and testing finally, we have learnt about the quality control quality; control is carried out at different stages quality control

in pattern on mold making quality control in melting, quality control in heat treatment, quality control in fettling and cleaning quality control in final inspection. So, with this we are completing this lecture.

Thank you.