

# The electromagnetic testing: the eddy current testing



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In modern NDT methods electromagnetic testing plays an important role. Electromagnetism is a part of ndt process. It is a process based on inducing magnetic field. The process of inducing an electric current and magnetic field or both inside a test material. Then observe the magnetic flux induced in the material. This method is based on the electromagnetism. Electromagnetism is the property of a material to get magnetic effect while an electric field applied. The main factor of this test is that the material should be a conductor. These methods give more benefits and advantages than other tests. The major tests coming under the electromagnetic testing are,

Eddy current testing

Flux leakage testing

Alternating current field testing

Remote field testing

Among these techniques my topics are

Eddy current testing

Flux leakage testing

## **EDDY CURRENT TESTING**

Eddy current testing is relatively applicable in small materials. It gives good measurements on ferromagnetic materials. The basic principles of eddy current testing are electromagnetism and permeability. More details about eddy current testing is shown in the coming pages.

## **FLUX LEAKAGE TESTING**

Flux leakage is another electromagnetic testing. It is widely used.

Electromagnetism is the basic principle of flux leakage testing. This method is most commonly used in pipe lines and storage tanks. After inducing magnetic field we are able to analyzing the defects through instruments.

Other electromagnetic techniques are,

## **ALTERNATING CURRENT FIELD MEASUREMENT**

ACFM methods are used to detect surface breaking cracks. This method can be applied to both magnetic and nonmagnetic materials. ACFM method is based on the electromagnetism and these entirely different from eddy current method. ACFM method gives us more benefit than other methods. It does not need the removal of paintings and coating. ACFM technique is more advanced testing than dye penetrant testing and magnetic particle testing.

The main advantages of ACFM testings are

Able to work on coatings

No need to cleaning more

Does not require equipment shut down

High speed inspection

## **REMOTE FIELD SENSING METHOD**

RFT is the commonly used electromagnetic method in ndt. Remote field testing method also joined with eddy current testing is named as remote field eddy current testing. But in practically there are many difference shows

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between eddy current testing and remote field testing. RFT technique is mainly used to find out the thickness of the ferromagnetic material tube walls. Here RFT shows more sensitivity than eddy current testing. The main principle of RFT is the electromagnetism. In RFT, the probe contains transmitter zone and receiver zone. The remote field shows more coupling to the exciter coil and receiver coil. The main advantages of RFT are,

High sensitivity

Give accurate measurements from sheets and plates.

Ability to inform internal defects

Detect defects from the ferromagnetic tubes

## **EDDY CURRENT TESTING**

Eddy current testing is used in a variety of industries to find defects and also measurements. Major use of eddy current testing is for defect detection when the nature of the defect is well understood. Naturally the method is used to test relatively small area and the probe design and test parameters must be established with a good understanding of the flaw that is to be detected. Eddy current testing only used to detect surface and near surface defects.

In thin materials such as plates and sheets, eddy currents can be used to measure the thickness of the material. This shows eddy current is useful for detecting corrosion damage and other damage that causes a thinning of the material. The method is used to make corrosion thinning measurements on

aircraft skins and in the walls of tubing used in assemblies such as heat exchangers. Eddy current method is also used to find the thickness of paints and other coatings.

Eddy currents are varied with respect to the electrical conductivity and magnetic permeability of materials. So eddy current testing can be used to arrange materials and also find which heat treatment applied to the material. It is the main advantage and use of eddy current testing method.

In Eddy current testing different probes or transducers are used. Compare to other testing methods eddy current testing shows many advantages and applications. Transducers used in eddy current testing is depend upon the properties and size of the material.

## **PRINCIPLES**

In eddy current testing the major principles are,

Electromagnetism

Permeability

## **ELECTROMAGNETISM**

The main principle of eddy current testing is the 'electromagnetism'.

This states that when an electron is passing through a conductor, a magnetic field induced on the conductor perpendicular to the axis. The same effect happens in a copper wire while alternating current passing through it.

When the alternating current expands then the magnetic field also expands.

The magnetic field obtained through electro magnetism is similar to the bar magnet.

## **PERMEABILITY**

Permeability is also relating to the electromagnetism. It is also called as magnetic permeability. Permeability is ability to permeable. It is a constant of proportionality exists magnetic induction and magnetic field intensity.

Permeability of some materials has been change according to the temperature changes and magnetic induction.

## **PRINCIPLE OF EDDY CURRENT TESTING**

IMAGE-1

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## **PRACTICAL METHOD**

Eddy current testing is used in different sectors for fin out the thickness and used to check the material losses in different materials. The cause of material loss is corrosion. It mainly used in thin sheets, plates and also in aircraft components. On the impedance plane, thickness variations exhibit on the eddy current signal response as a subsurface defect. Except that the signal represents a void of different size and depth. Due to this the phase rotation should be same and the amplitude should be greater.

In the device the lift-off curves for different areas of taper wedge can be produced by nulling the probe in the air and touching it to the various surfaces at various locations of thee tapered wedge. A comma shaped curve is formed while a line is drawn between the end points of the lift-off curves.

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In the second stage the comma shaped curve path is traced on the screen when the probe is scanned down the length of the tapered wedge. So that the entire range of thickness values are measured.

The important thing is that the depth of penetration of the eddy currents must cover the range of thickness being measured. Then a frequency is selected that produces standard depth of penetration at maximum thickness. Lower frequency is needed for getting high penetration. Due to the probe impedance is more sensitive to changes in electrical conductivity. So electrical conductivity cannot be phased out and is important to verify the conductivity of below the region of low level.

If testing need more penetration single coil probe, reflection type probe and transformer probes are used based on configuration. Small diameter probe coils has the efficiencies to give very high sensitivity.

## **EDDY CURRENT TESTING ON A BORE**

IMAGE-2

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## **EDDY CURRENT INSTRUMENTS**

In industries various eddy current instruments are used. Analog and digital display instruments are mainly used. Classification of eddy current instruments is based on the display used for presenting the data. The main display types are,

Analog meter

Digital readout

Impedance plane

Time vs. signal amplitude

## **PROBES USED**

In eddy current testing a variety of probes or transducers are used. The probe classification is based on the configuration and mode of operation. The main probes are,

Absolute probe

Differential probes

Reflection probes

Hybrid probes

Surface probes

Bolt hole probes

Bobbin probes

Encircling coils

## **WORKING OF A PROBE**

IMAGE-3

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## **CODES AND STANDARDS USED IN ECT**

### **BRITISH STANDARD**

BS 3683(PART 5) = Eddy current flaw detection glossary.

BS 3889 (PART20) = Automatic eddy current testing of wrought steel tubes.

BS 3889(PART213) = Eddy current testing of nonferrous tubes.

BS 5411(PART3) = Eddy current method for measuring coating thickness of conductive coatings on nonmagnetic base materials.

### **AMERICAN STANDARD**

ASTME 243= Eddy current testing of seamless copper and copper alloy tubes.

ASTME 309= Eddy current examination of steel tubular products using magnetic saturation.

ASTME 1033= Eddy current examination of type F continuously.

**The main advantages and disadvantages are,**

### **ADVANTAGES**

Ability to detect small cracks

Find surface and near surface cracks

High sensitivity

Equipment is portable

High accuracy

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Able to inspect on irregular shapes

Economically adjustable

## **DISADVANTAGES**

The material should be a conductor The

Skilled and trained person needed

Depth of penetration has some

## **APPLICATIONS & USES**

Eddy current testing is applicable in different sectors. The main applications are,

Crack detection

Material thickness measurement

Coating thickness measurement

Conductivity measurement

Material identification

Hest damage detection

## **2. ELECTROMAGNETIC FLUX LEAKAGE TESTING**

Magnetic flux leakage is an important method in NDT process. Magnetic flux leakage method can be used to detect the circumferential cracks on the stainless steel and metal losses in ferromagnetic materials. It is widely used

in tubes and heat exchangers for find out the discontinuities. The major principle of magnetic flux leakage testing is the electromagnetism. During MFL inspection a magnetic field induced on the material. This property of material is termed as electromagnetism.

MFL tools consist of two or more bodies while inspecting tubes and complicated material models. The main body is named as magnetizer with magnets and others are batteries and electronics. MFL tool is able to find sensor readings based on either the distance of tool travelled or on increment time. In flux leakage examination of tubular parts three types of defects can be detected. They are longitudinally oriented, transversely oriented, silvers.

Magnetic flux leakage testing has some limitations in sizing the capacity of defects. In compare with eddy current testing magnetic flux leakage testing shows more sensitivity and advantages. In magnetic flux leakage testing method of tubular products both outside and inside diameter defects can be detected but generally they cannot be distinguished.

## **WORKING PRINCIPLE**

The main principles of electromagnetic flux leakage are,

## **ELECTROMAGNETISM**

The main principle of MFL is that electro magnetism. This states that when electron is passing through a material a magnetic flux induced on the conductor. The magnetic field should be perpendicular to the axis. An

electromagnet is an object, which acts like a magnet and its magnetic effect created and controlled by electricity.

## **HALL EFFECT**

Some Hall Effect sensors are used in electromagnetic flux leakage testing.

Hall Effect is the production of a voltage difference across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current.

## **PERMEABILITY**

Permeability is also related to the electromagnetic field. It is the ability to become permeable. Permeability changes occur in some material with temperature changes and magnetic induction.

## **PRACTICAL METHOD**

Magnetic flux leakage testing was used earlier because eddy current cannot detect subsurface defects in ferromagnetic test material. In such a situation a common technique using encircling coils but them sometimes inconvenient while using in internal coils. Flux leakage testing is used at steel mills and fuel mills for getting correct measurements without errors.

When ferromagnetic material that is free from defects is magnetized, then an unbroken flux field flows through the object material. The magnetic flux flows through between its poles. Next the flux density decreases towards the outer material surfaces and a detector of flux leakage testing would pick up a very weak signal from the surfaces.

However, if the surface is interrupted by a discontinuity, poles are formed at opposite sides of the resulting gap. Then the flux lines flow externally from the north to South Pole. The flux leakage lines are detected by a transducer or probe passing over the discontinuity and signal is displayed. Disturbance of the materials original flux lines also extends under the discontinuity and if the material wall is thin itself, a discontinuity on wall surface may be detected from the opposite wall.

After getting the signals from the detector we have to find out the length, thickness and measurement about the defect through monitoring. MFL gives us to the ability to detect the surface and subsurface defects.

## **FLAW DETECTION USING FLUX LEAKAGE**

IMAGE-4

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## **CODES AND STANDARDS USED IN MFL**

### **BRITISH STANDARD**

BS 6072 = Magnetic particle flaw detection.

BS 4489 = Automatic black light measurement.

BS 5044 (PART) = Forged and stamped crank shafts.

### **AMERICAN STANDARD**

ASTME 709= Magnetic particle inspection practice.

ASTME 1251= Indications in ferrous castings.

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ASTME 570= Flux leakage examination of ferromagnetic steel tubular products

## **ADVANTAGES OF MFL**

1. Able to detect surface and subsurface defects
2. It is a simple method
3. High sensitivity
4. Easy measurement
5. No need to remove the coatings

## **DISADVANTAGES OF MFL**

1. Surface contamination not detectable.
2. Works only with ferromagnetic materials.
3. Difficult to measure deep depts.
4. Skilled and trained person needed.

## **APPLICATIONS OF MFL**

1. Bars transverse and tilted effects.
2. Tubes longitudinal defects.
3. Pressure vessels
4. Heat exchangers

## 5. Power plants

# CONCLUSION

## EDDY CURRENT TESTING

In this project contains an explanation of eddy current testing. The main concept is the understanding of basic theories and working methods of eddy current testing. The second thing is to describe the advantages and disadvantages and also describe the applications. This method is used in different industry sectors for getting accurate measurements and to find out the discontinuities for increasing the safety and production. So eddy current testing is a method which gives good sensitivity and accurate measurements.

## ELECTROMAGNETIC MFLUX MLEAKAGE

the performance of MFL testings. MFL testing can be carried out only in ferromagnetic materials. It can be applicable in coated and non coated ferromagnetic materials. MFL is used in the inspection of tube and piping to find unwelded areas of longitudinal joints. It also a most useful method in plate materials, storage tanks and also to find other forms of degradation

In this project also describes the magnetic flux leakage testing in NDT. This study is used to understand.

## REFERENCE

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