

ME 8097

Non Destructive Testing & Evaluation

UNIT I

1. What do you mean by Non-Destructive Testing(NDT)?

Inspecting or testing the materials and components in such a way that allows the materials or components without changing or destroying their usefulness.

2. What is purpose of NDT inspection?

It is used to find out the size and locate surface and surface flaws and defects.

3. Give the importance of using NDT.

Material or parts which fails to achieve the design requirements or projected life due to undetected defects may require expensive repair or early replacements.

4. Give the reason for using NDT methods for inspection.

1. Accident prevention and reduce costs.
2. To improve product reliability.
3. To determine the acceptance to a given requirement.
4. To give the information on repair criteria.

5. List out the merits of NDT methods.

100% testing on actual components are possible. 2.Repeated checks over a period of time is possible. 3.Very little preparation is sufficient. 4.Most test methods are rapid.

6. List out limitations of NDT methods.

1. Measurements are indirect. 2. Usually qualitative measurements. 3. Skilled judgement and experience is required.

7. What are the tests to be mechanically conducted for material.

Impact Test, Hardness Test, Toughness test, Load Test, Brittleness Test, Fatigue Test. 8. Give the basic elements requirement for NDT

1. A probing medium.

2. Modification of probing medium.

3. A sensitive detector.

4. A means of indicating or recording or the detector's signal.

8. What are the common NDT methods usually involved?

1. Visual Test. 2. Liquid penetrant test 3. Magnetic particle test 4. Eddy current test 5. Ultrasonic test 6. Radiographic test.

9. List out the scientific techniques available for enabling material characterization.

1. Macroscopic Observation.

2. Microscopic Observation.

3. Optical microscopy.

4. Electron microscopy.

5. Diffraction technique (X-ray)

6. Spectroscopic techniques.

10. What are the defects that can be detected by Unaided visual inspection

1. General condition of the components. 2. The response of crack. 3. The surface porosity. 4. To magnify the defect that can not be detected by unaided eye.

5. Potential source of mechanical weakness. (Sharp notches, misalignments)

11. Give any two reasons for using Optical Aids for visual inspection.

To permit visual checks or areas not accessible to the unaided eye.

12. Describe the function of Microscope:

An optical microscope is a combination of lenses used to magnify the image of a small object.

The object is placed close to the lens to obtain as high a magnification as possible.

13. Describe the function of Boroscope:

To inspect the inside of a narrow bore, tube or chamber.

It consists of a precision built in illumination system having a complex arrangement of prism and plain lenses through which light is passed to the observer with maximum efficiency.

14. Describe the function of Endoscope:

It is like a boroscope except that it has a superior optical system and a high intensity light source, various viewing angles can be used.

It is available in diameter down to 1.7mm and length from 100 to 1500mm.

15. Describe the function of Telescope:

It is used to obtain magnified images of objects at considerable distance from the eye. It is particularly useful for providing visual examination of the surface which is otherwise in accessible.

16. List out the application of NDT.

1. Inspecting plant system / components for any leakage.
2. Misalignment of parts in the equipment.
3. For inspecting the weldments, repaired weldments.
4. Minute discontinuities with the help of optical aids.

17. List out the advantages of NDT methods.

1. In expensive.

2. Highly portable. 3.Immediate results.
- 4.Minimum skill is required.
- 5.Minimum part preparation.

18. What are the disadvantages of using NDT methods?

- 1.Surface discontinuities only
- 2.Misinterpretation of surfaces

1. What are the principal methods available in Penetrant Tests?

1. Water washable method.
2. PostEmulsifiable method
3. Solvent Removal method.

2. Give the properties of Penetrants:

1. Spread over the surface easily.
2. Should remain in the defect but remove easily from the surface.

3. List the types of Penetrants:

1. Visual Penetrant Test.
2. Fluorescent Penetrants.

4. What do you mean by visible Penetrants?

It contains a red dye that provides high contrast against the white developer background.

5. What do you mean by Fluorescent Penetrants?

It contains dye or several dyes that fluoresce when exposed to UV radiation

6. What is the role of developers in LPT?

The role is to pull the trapped penetrant material out of the defects and spread it out on the surface of the part.

7. How do you classify the Developers:

1. Dry powder.
2. Water suspendable.
3. Non aqueous type (visible type)

4. Non aqueous type (Fluorescent type)

5. Water soluble type.

8. Give the merits and demerits of Dry Developers:

Merits: 1. Indication tends to remain bright.

2. Easy to apply.

Demerits: 1. Does not form contrast background.

2. Difficult to assure entire part surface has been coated.

9. Give the merits and demerits of Suspendable

Developers: **Merits:** 1. Ease of coating entire part.

2. Indications are bright.

3. White coating of good contrast can be produced.

Demerits: Indications weaken and become diffused after some time.

10. Give the merit and demerits of Non aqueous Developers: Merits:

1. Easy to apply.

2. White coating of good contrast can be produced.

3. Indications show up rapidly.

4. Provides highest sensitivity.

11. What do you mean by Magnetic Particle Test?

It uses magnetic fields and small magnetic particles (Iron filings) to detect flaws in parts. The part must be a ferromagnetic material.

12. Define Magnetism:

The concept of magnetism centers around the magnetic field and known as a dipole.

The term magnetic field describes a volume of space where there is a change in energy within that volume.

13. List out the Magnetisation Methods:

1. Magnetisation using a magnet.
2. Magnetisation using an Electromagnet.
3. Contact current flow method.
4. Using a threading bar.

The object is placed close to the lens to obtain as high a magnification as possible.

14. What are the properties of Magnetic particles?

1. High magnetic permeability – More attracts.
2. Low retentivity- Easy removal.

15. How do you classify magnetic particles?

1. Dry magnetic particles.
2. Wet magnetic particles.

16. How the demagnetization is carried out for the parts after inspection?

1. By heating the part approximately to 700deg.
2. The part is placed in the field of an AC coil and withdrawn slowly to about 1.2

to 2m away.

17. List out the advantages Particle of Magnetic Testing:

1.Sensitive to small discontinuities. 2.Minimum surface preparation. 3.Immediate results can be obtained. 4.Low cost.

5.Moderate skill is enough.

6.Indications are produced directly on the surface.

18. List out the advantages of Magnetic particle Testing:

1.Only surface defects can be detected.

2.Part preparation is required.

3. Relatively small area can be inspected at a time.4.Only applicable to ferromagnetic materials.

5.Parts requires demagnetization after conducting tests.

1. Define Thermography.

It is a method of inspecting Electrical and Mechanical equipment by obtaining heat distribution pictures.

2. Give the application of Thermography.

Inspection of Electrical equipments. Inspection of Mechanical equipments. Inspection of Refractory lined structures.

3. Give the application of Thermography in Electrical systems.

Fault findings in Fuse boards, Distribution boards, Bus bar systems, Control panels, High and Low voltage systems, UPS, Battery systems, PLC, Motor controls and Transformers.

4. Give the application of Thermography in Mechanical systems.

Fault findings in Misalignment and component looseness, Bearing defects, Cracks, Internal Flaws, Improper Lubrication, Refractory and Insulation faults.

5. What are the advantages of Non Contact Thermal measurements?

--Target in Motion, Target electrically hot, Current conducting Equipments, Component present in Hazard to personnel, Target Fragile, Target temperature changing, Target remote.

6. What are the methods available for checking in Thermography? Contact : Liquid Crystal Thermography.

Remote : Infrared Thermography. Remote :

Radio Thermography.

6. What is meant by Infrared Thermography?

Infrared Thermography is equipment or method which detects infrared energy emitted from object, converts it into temperatures and displays images of temperature distributions.

7. What do you mean by contact Infrared Thermography?

It is the method which is based on the properties of liquid crystals to change the colour depending upon the temperature.

8. List out the advantages of Infrared Thermography. It is a non contact type technique.

Fast, reliable and accurate output.

**A large surface area can be scanned in less time.
Capable of catching moving targets in real time.
Presented in visual and digital form.**

**Require very little skill for monitoring.
Used to detect objects in dark area.**

Used to measure or observe in inaccessible or hazardous for other methods.

9. What do you mean by Liquid Crystal Thermography (LCT) ?

Thermographic Liquid Crystals (TLC) are materials that change their reflected colour as a function of temperature when illuminated by white light.

11. List out the Liquid Crystal types.

Liquid Crystal types are 1. Encapsulated 2. Unencapsulated.

12. List out the characteristics of Infrared.

It is not visible as its wave length is longer than the visible light.

It has a characteristic of heating an object. Therefore it is called as Heat Ray. It can travel through vacuum.

13. What are the measurements carried out by using Infrared?

Temperature Measurements, Stress measurements, Moisture measurements, Film thickness measurements.

14. Give the principle of Eddy Current Testing.

An electric current is made to flow in a coil produces an alternating magnetic field around it. This coil when brought close to the electrically conducting surface of a metallic material to be tested induces an eddy current flow in the material due to electromagnetic induction. The presence of any defect or discontinuity in the material disturbs the eddy current flow which will be detected.

15. What are the different types of Probes used in Eddy Current Testing?

Focused Pencil type, Spring loaded absolute probe, Deflection type, Encircling probe, Bobbin type.

16. What are the different type of Instrumentation system available in ECT?

Step function excitation at constant voltage of a single absolute coil.

Two-part reflection type.

17. What are the applications of ECT?

To scan the open surface cracks on welds and heat affected zones.

To detect and quantify corrosion on the inside of thin metal such as aluminium air craft skin.

To check the discontinuities (Cracks, Inclusions and Flaws) To check the thickness of coatings.

On line testing of Wires, Rods and Tubes. To check the strength and Hardness.

18. What are the advantages of using ECT? Sensitivity to surface defects.

Can detect defects in multilayer structures upto 14 layers. Accurate conductivity measurements.

Inspection is rapid.

**Most suitable for automated plants manufacturing uniform parts.
Portability. Equipment is very small and light weight less than 2 kgs.**

19. What are the limitations of ECT?

Only electrically conductive materials can be inspected.

It will not detect, defects parallel to surfaces. (The flow of eddy current is parallel to the surfaces)

Signal interpretation is required. Careful interpretation of signal is needed to distinguish between relevant and non-relevant indications. No permanent record, unless it is automated.

UNIT IV

1. What do you mean by Ultrasonic Test (UT) ?

Ultrasonic test uses high frequency sound waves to conduct examinations and make measurements.

2. Give the principles of Ultrasonic Tests:

A pulse echo UT inspection system consists of several functional units such as Pulser, Receiver, Transducer and a display device. The sound energy is introduced and propagates through the material in the form of waves. When there is a discontinuity in the wave path, a part of the energy will be reflected from the flaw surface and it is displayed.

3. Classify the types of waves in UT Tests:

Longitudinal waves and Shear waves and Surface waves.

4. Give the properties of Acoustic waves:

The wave length is directly proportional to the velocity of the wave. Inversely proportional to the frequency of the wave.

5. Write down the meaning of Attenuation:

The combined effect of scattering and absorption of waves is called attenuation.

6. What is meant by Couplant?

A couplant is a material (usually liquid) that facilitates the transmission of Ultrasonic energy from the transducer into the test specimen.

7. List out the UT methods used for Inspection and measurements:

Normal Beam Pulse-echo method, Normal Beam through Transmission, Angle Beam Pulse-echo method and Angle Beam through Transmission.

8. Write the common formats available for the Data Transmission in

UT tests: The common formats are A Scan, B Scan and C Scan presentations.

9. Name the Standard calibration blocks used for UT: IIW – International Institute of Welding.

AWS – American Welding Society.

10. List the applications of UT:

1. Weldment Testing.

2. Bar, Rods, Sheets, Pipes and Rails Testing. 3. Crack detection and Corrosion Testing.

4.Plant and Machinery checking.

11. List out the advantages of UT.

Sensitive to both surface and sub surface discontinuities.

The depth penetration for flaw detection superior to other NDT methods. It is highly accurate.

Minimum part preparation is required.

Instantaneous results can be obtained.

Detailed images can be produced without automated system.

Non hazardous to operators. Highly portable.

12. List out the disadvantages of UT:

Surface must be accessible to transmit sound. Skill required than other methods.

Materials that are rough, irregular shape are difficult to inspect.

Cast iron and other coarse grained materials are difficult to inspect due to low sound transmission and high signal noise.

13. Define Acoustic Emission Test:

Acoustic Emission is defined as the class of phenomenon whereby transient elastic waves are generated by the rapid release of energy from localized source.

**14. List out the common ways in which AE signals can be processed:
Counting, Energy analysis, Amplitude analysis and Frequency analysis.**

15. Give the applications of AE tests:

1. Inspection during proof testing and on line monitoring of pressure vessels.
2. Leakage detection and locations.
3. Investigating process like fatigue, stress and corrosion.
4. Monitoring underground pipelines and on line weld monitoring.

UNIT V

1. Give the properties of X rays and Gamma rays:

They are not detected by human senses (can not be heard, seen, felt etc) They travel in straight line at the speed of the light.

Their path can not be changed by electrical or magnetic fields.

They pass through matter until they have a change to encounter with an atomic particle. They have enough energy to ionize matter and can damage or destroy living cells.

2. Illustrate the principles of Radiography:

This technique make use of the ability of short wave length of electromagnetic radiations such as X ray and Gamma rays to penetrate objects. The shorter the wave length the greater is the penetrating power. The radiation that entersthrough the material, some being absorbed in the material itself and amount of absorption is a function of the density and thickness of the materials.

3. What do you mean by attenuation?

When X ray or Gamma rays are directed into an object, some of the photons interact with the particles of the matter and their energy can be absorbed or scattered. This absorption and scattering is called Attenuation.

4. What do you understand by Radiographic film?

It is a similar to photographic film. In that there is a central carrier called the film base that is made of a thin sheet of polyester type material. This is normally transparent and serves only as the carrier for the chemically reactive material that form emulsion.

When radiation strikes the emulsion a change takes place in the emulsion. This change is referred to as the latent image. Latent simply means “not available or hidden”

5. List out the various class of films and its characteristics:

Various classes are Class	I	Extra fine grain, High contrast, Slowspeed.
Class	II	Fine grain, High contrast, Mediumspeed.
ClassIII		High speed
ClassIV		Fluorescent screens

6. What is meant by intensifying screens?

The use of thin screen/foils made out of heavier material has been found to produce intensification. When films X or Gamma rays radiation of 70 kv and above. The screen helps to cut down the exposure time by utilizing more effectively the radiation reaching the film.

7. List out the general rules for optimum results in Radiography?

Source or focal spot size should be as small as practicable. Ideal source will be a point source.

Source to object distance should be as large as possible. The film should be in close contact with the object.

Source location should be such that radiation passes through the object thickness.

8. Define Radiographic Image Density: After taking a radiographic image of a part and processing the film, the resulting darkness of the film will vary according to the amount of radiation that has reached the film through the test object. The darker areas indicate more exposure and lighter areas indicate less exposure. The term Radiographic Image Density is a measure of the degree of film darkening.

9. What do you understand by Radiographic contrast?

Radiographic contrast is the differences in photographic density in a radiograph. It has two main contributors. One is the Subject contrast and another one is Film contrast.

10. What do you mean by Penetrameter?

A Penetrameter or Image Quality Indicator (IQI) is a gauge used to establish radiographic technique or quality level. To get this, IQI must be made up of material radiographically similar to the material being radiographed. The identifying number in the penetrameter are in thousands of an inch.

11. List out the types of Penetrameters:

The variety of penetrameter designs have suggested, some of the most common are Step type, Wire type and Plaque type.

12. Give short notes on Step type penetrameter

This type of penetrameter is essentially a step wedge having 4 or 5 steps. The

thickness of these steps increases either in geometric or arithmetic progression. The following are the some of the pentrameter uses 1. Bureau of Indian Standard – BIS 3657. 2.ANFOR – FRNCH - IQI – 304 and 3.ISO (Similar to ANFOR)

13. Give short notes on Wire type Pentrameter:

Among the Wire type penetrameters. DIN wire type penetrameter are most common. These are available in two types.

- 1. DIN – 54109 – It consists of a series of equidistance parallel wire whose diameter increases in geometric progression.**
- 2. DIN – 54110 – It consists of 4 indicators each having series of equidistance parallel wire whose diameter increases in arithmetic progression.**

14. What do you mean by Fluoroscopy?

The term Fluoroscopy is synonymous with real time radiography and electron radiography.

Basic equipment for conventional fluoroscopy consists of a source of radiation, a fluoroscopic conversion screen, mirror and a viewing port,

To get the basic real time image an object is placed between the source of radiation and fluoroscopic screen that converts the transmitted radiation into visible lights.

15 List out the advantages of Radiography:

Both surface and internal discontinuities can be detected.

Significant variations in composition can be detected.

It has a very few material limitations. Can be used for inspecting hidden areas.

Very minimal or no part preparation is required. Permanent test record is obtained.

Good portability especially for Gamma ray sources.

16 List out the disadvantages of Radiography:

Hazardous to operator and other nearby personnel. High degree of skill is required.

The equipment is relatively costly. The process is generally slow.

Depth of discontinuity is not indicated.

17 What are factors involved in health safety issues in Radiography?

Type of radiation involved.

Size of dose received.

Rate at which the dose received.

Part of the body exposed.

The age of the individuals.