

Non destructive testing

N.D.T.- Testing of materials without destroying them, and testing of components without affecting their serviceability. Also it is a powerful tool for reducing costs, improve product quality and maintaining products quality level.

Methods of N.D.T.--

- 1) Liquid Penetration Inspection (L. P. I.)
- 2) Magnetic Particle Inspection (M. P. I.)
- 3) Radiographic inspection.
- 4) Ultrasonic Inspection.
- 5) Eddy current (E. C.)
- 6) Hardness
- 7) Leak test
- 8) Chemical spot test etc.

TESTING OF MATERIALS

It is mandatory to test any material prior to taking into use for engineering purpose or other uses; whether it meets the laid down requirement as per standard specification or not to help in financial saving and prevent failure in service.

The testing is of three types:

- a) Visual observation
- b) Destructive Testing
- c) Non- Destructive Testing.

Visual observation :-Before processing for other tests the material should be visually observed for external surface perfection, dimensional accuracy and other required parameters. This is applicable in all the testing methods.

Destructive Testing :- Destructive testing is conducted to judge the chemical metallurgical and engineering properties of the material under test by destroying the material. The sample is taken as per given specification and after visual observation the same is processed for further tests. The tests conducted may be any one or more of the following.

- i) Chemical composition.
- ii) Physical /Engineering Properties.
 - 1) Hardness Test
 - 2) Tensile Test
- iii) Metallographic Examination
 - 1) Macro Examination
 - 2) Micro Examination

c) Non –Destructive Testing : This method provides information on the quality of a material or component without any alteration or damaging the component assemblies under test.

It is most important in this method of test that no mechanical working on the subject to be tested be done .The surface must be free from scales, water ,oil ,grease or any other dirty, paints etc.

Some N. D. T. methods are as tabulated below:-

<u>Method</u>	<u>Features</u>	<u>Applicability</u>
LIQUID PENETRATION	Detection of surface defects which break the surface.	Can be used for any Metal, many plastics, Glass and glozed ceramics.
MAGNETIC PARTICLE	Detection of surface defects which break the surface and Sub-surface defects.	can only be used for ferro-magnetic materials.
ELECTRICAL METHOD (EDDY CURRENT)	Detection of surface defects and sub-surface defects. Can. also be used to measure the thickness of non-conducting Coating,such as paints on metal.	can be used for any metal.

Description of NON- DESTRUCTIVE method

Liquid Penetration Inspection (L.P.I.)

It is the technique which can be used to detect defects in wide range of components, provided that the defect breaks the surface of the material.

The principle is that a liquid is drawn by capillary attraction into the defect and after subsequent development, any surface breaking defects may be rendered visible to human eye. In order to achieve detection i.e. defect visibility, the penetrating liquid be either coloured with a bright and persistent dye or else contain fluorescent compound. In the former type the dye is generally red and the developed surface can be viewed in natural or artificial light, but in the later case the component must be viewed under *ULTRA-VIOLET* light if indication of defects are to be seen.

There are five essential steps in L. P. I. method.

a) Surface preparation, b) Application of penetrant, c) Removal of excess penetrant, d) Development, e) Observation and inspection.

There are three types of L.P.I. method.

a) Chalk test, b) Dye Penetration Test, c) Zyglo test.

CHALK TEST:- This is a very old process and it is applicable in those fields where D.P.I. or zyglo is not available.

In this process chalk solution is applied on the surface cleaned by K. Oil. After chalk coating dries up component is lightly hammered. The K.Oil which has gone in the discontinuity due to capillary action oozes out and indicates the location and size of flaw.

DYE-PENETRATION INSPECTION (D.P. I.) :- In this process three chemicals are used. 1) Cleaner, 2) Penetrant, 3) Developer.

The surface under test must be nicely cleaned. Then cleaner is applied to dissolve the residual oil, grease etc and wiped off with a clean cloth. Subsequently, penetrant, normally red in colour for observation in day light is applied and a certain dwelling time is allowed. Then the excess penetrant is wiped off and white developer is applied to give a clear contrast of the surface discontinuities. This method is applied preferably for heavy static components only as this is a costly method and bulk and rapid testing is not possible. Both ferrous and non ferrous component can be tested. In case of fluorescent type penetrant the observation is made under U.V.lamp.

ZYGLO Test:- This is an exhaustive form of D. P. I. and small ferrous and non ferrous components can be processed in bulk for test. In this process the observation is made exclusively under ultraviolet light. The penetrant used is water washable fluorescent type . This has got fluorescent compound to develop the phenomenon of chemical- fluorescence.

PENETRANT TYPES

DYE PENETRANTS: The liquids are colored so that they provide good contrast against the developer. The liquids are as a rule red with white developer.

FLUORESCENT PENETRANTS: The liquid contains fluorescent material which glows under ultraviolet light.

WATER WASHABLE PENETRANTS: The liquid contains an emulsifier which allows surface penetrant to be removed using water.

POST- EMULSIFIABLE PENETRANT: After the liquid has been applied, an emulsifier must be applied to the excess surface penetrant to make it water(washable) soluble..

SOLVENT REMOVABLE PENETRANT : The penetrant can only be removed fully from the surface by means of an appropriate organic solvent.

DEVELOPER TYPES

Dry powder developers.

Water based wet developers.

Non water based wet developers.

Limitations

Components with porous surface can not be tested.

The crack must be opened to the surface.

MAGNETIC PARTICAL EXAMINATION

PRINCIPLE: The technique is well suited to the detection of surface defects such as cracks, lack of fusion and laminations etc. ferromagnetic materials.

A surface defect in a magnetized ferromagnetic item will disturb the magnetic field in the object of the test. The defect will cause some of the lines of magnetic field to depart from the surface and thus to form a magnetic leak field. This leak field can be found by placing fine iron particles on the surface. The leakage field will hold the magnetic particles in a ridge on top of the crack..

PROCEDURE: As per sequence the steps are as under.

1. Clean the surface .
2. Magnetize the object using either permanent magnet or electromagnet
3. Spray magnetic liquid over the object.
4. Inspect for indication of defects.
5. Repeat the above test in perpendicular direction.

ADVANTAGES:

1. The method is most dependable and sensitive for finding surface defects.
2. It is first, simple and less expensive.
3. The indications are directly visible on the surface of the object.
4. Simple and durable equipment.

LIMITATIONS:

1. The method can only be applied to ferromagnetic materials.
2. Defects below the surface will not always be indicated.
3. The direction of magnetic field has an important bearing upon the result of the examination.
4. Certain objects must be demagnetized before and after the examination.

RADIOGRAPHY

In industrial radiography, X-rays and Gamma rays are used to detect the internal defects of any material right from raw material to assemblies.

PRINCIPLE : In order to examine an object it is irradiated with X-rays or gamma radiation. The radiation will be absorbed in the object to varying degree depending upon the thickness of the object, the composition of the material and the wave length of the radiation.

The portion of the radiation which penetrates the object can be registered by recording it on a film. The more radiation penetrating the object and striking the film, the darker the film appears when developed.

PROCEDURE

Take the radiograph using penetrometer.

Develop the film.

Inspect radiograph for indication of defect and compare with standard radiographs.

LIMITATIONS

X- radiation and gama radiation are health hazards.

Maximum penetration about 150 mm of steel.

Uses of X- rays

Surgery, Radiotherapy, Engineering, Detective department, Industry, Art, Scientific research. etc.

ULTRASONICS

Ultrasonic testing of materials makes use of high frequency sound waves. The high frequency sound waves which are commonly used in Ultrasonic testing of materials are of the following types.

1. Longitudinal waves.
2. Transverse or shear wave.
3. Surface waves.

Properties of sound waves:

The important properties of sound waves are :-

1. Reflection 2. Refraction , 3. Diffraction, 4. Absorption, 5. Scattering.

PRINCIPLE : A series of ultrasonic waves each lasting for a few micro-seconds are introduced in the material under test through a coupling medium. These pulses propagate in the material in a very narrow beam until they strike an interface such as the opposite surface of the test object or an internal defect. The pulses are entirely or partly reflected back to the transmitter, which now functions as a receiver. The receiving probe converts the ultrasonic waves to the electrical energy, which is amplified and displayed on a CRT in such a manner as to indicate the time difference between the transmitted pulses and reflected pulses. The horizontal scale of CRT is calibrated in terms of distance , hence position of flaw peak on horizontal scale tells the location of the flaw. The vertical scale of CRT is calibrated with a standard test piece having artificial flaws of known size hence the height of the flaw peak tells about the size of the flaw.

PROCEDURE :

1. Calibrate the horizontal scale of the UFD for required depth range.
2. Calibrate the vertical scale using standard block having artificial flaws of known size.
3. Scan the component using suitable transducer.
4. Compare the trace pattern with the trace pattern from standard block..
5. Follow the rejection criteria as specified.

ADVANTAGES :

1. Most widely used and accepted method for **detecting internal flaws.**
2. **Can scan up to 10 m. long steel components.**

3. Quick result.
4. Location as well as size of the defect can be measured.
5. IN-SITU Adaptability.

LIMITATIONS:

1. Not suitable for components having complex geometry.
2. Difficult to test coarse-grain material.
3. Defects having orientation parallel to the direction of beam propagation are difficult to be detected.

Scanning Techniques: Three basic scanning techniques are employed for ultrasonic testing of Axles.

1. Far- End scan- Through scanning of the whole length of the Axle.
2. Near End low angle scan –Scanning from the Axle end into the nearer Wheel seat.
3. High angle scan – Scanning across the diameter.