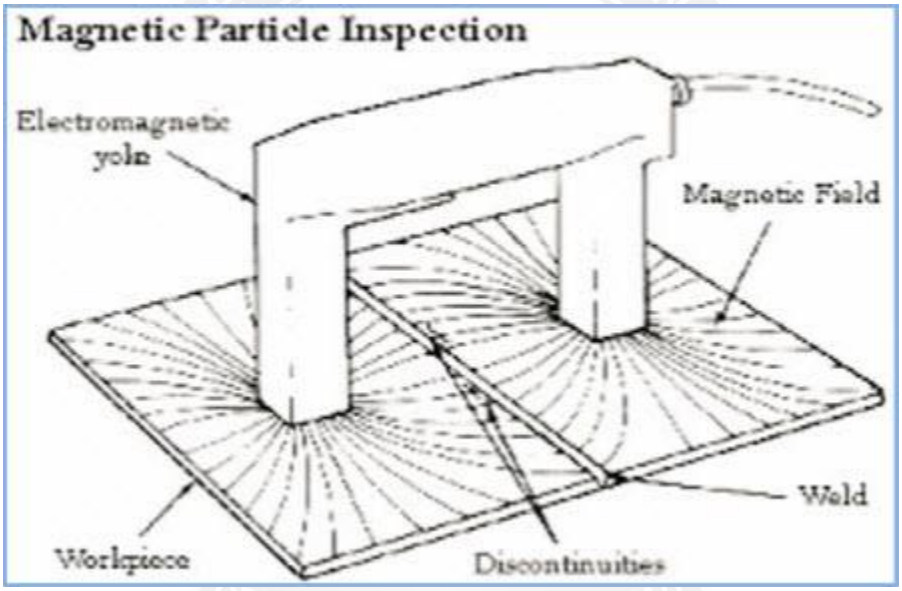
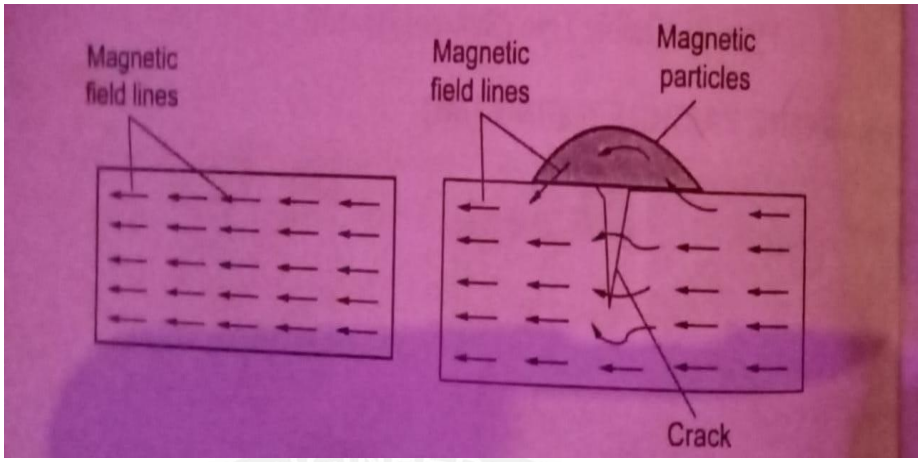
3.4 MAGNETIC PARTICLE TESTING (MT)

- A magnetic field is established in a component made from ferromagnetic material. The magnetic lines of force travel through the material and exit and reenter the material at the poles.
- Defects such as crack or voids cannot support as much flux, and fo some of the flux outside of the part.
- Magnetic particles distributed over the component will be attracted areas of flux leakage and produce a visible indication.



1. PRINCIPLE

- ❖ This NDT process uses magnetic fields to find discontinuities at or t the surface of ferromagnetic materials. The magnetic field can be with a permanent magnet or an electromagnet, which requires a current be applied.
- ❖ The magnetic field will highlight any discontinuities as the magnetic field lines produce leakage, which can be seen by using magnetic particles are drawn into the discontinuity.



Principle of working

2. MAGNETIC PROPERTIES OF MATERIALS

(a) HYSTERESIS LOOP

- A hysteresis loop shows the relationship between the induced magnetic flux density B and the magnetizing force H. It is often referred to as the B H loop.
- From the hysteresis loop, a number of primary magnetic properties of material can be determined.
- Retentivity, Residual Magnetism or Residual Flux, Coercive For Permeability and Reluctance.

(b) PERMEABILITY

- Permeability describes how easily a material can be magnetized; a material with a high permeability is easier to magnetise than a material with a low permeability.
- A material's permeability is determined by dividing the magnetising force applied to a material into the magnetic flux density achieved in the material -permeability has no units.
- There are three material categories that are related to permeability: diamagnetic .paramagnetic and ferromagnetic.

(a) Diamagnetic materials: It have a permeability value slightly less. It will slightly repel a magnetic field.

(b) Paramagnetic materials: It have a permeability value slightly greater It is slightly easier for the magnetic flux to pass through the paramagnetic material than to travel through the vacuum.

(c) Ferromagnetic materials: It have a permeability value much higher, that it is much easier for the magnetic flux to pass through the ferromagnetic material than to pass through the vacuum. Ferromagnetic materials are very strongly attracted by a magnetic field.

3. COMPONENTS IN MAGNETIC PARTICLE INSPECTION (MPI)

(a) Permanent magnet
(b) Electromagnetic Yoke
(c) Current flow probes
(d) Flexible coil
(e) Adiscent cable

(a) Permanent magnets

- Permanent magnets are sometimes used for magnetic porticleinspectin the source of magnetism. The two primary types of permanent magnets are bar magnets and horseshoe (yoke) magnets

(b) Electromagnetic Yoke

- An electromagnetic yoke is a very common piece of equipment that is used to establish a magnetic field. It is basically made by wrapping an electrical coil around a piece of soft ferromagnetic steel.

(c) Current flow probes

- Probes are handheld electrodes that are pressed against the surface of the component being inspected to make contact for passing electrical current through the metal.

(d) Adjacent cable

- Coils and conductive cables are used to establish a longitudinal magnetic field within a component. When a preformed coil is used, the component is placed

against the inside surface on the coil. Coils typically have three or five turns of a copper cable within the molded frame.

(e) Portable Power Supplies

- Portable power supplies are used to provide the necessary electricity to the prods, coils or cables. Power supplies are commercially available in a variety of sizes.

4. WORKING OF MAGNETIC PARTICLE TESTING

(a) Pretreatment

- The surface must be free of grease, oil or other moisture that could keep particles from moving freely.
- A thin layer of paint, rust or scale will reduce test sensitivity but can sometimes be left in place with adequate results.

(b) Apply the magnetizing force (magnetic particle)

- Use permanent magnets, an electromagnetic yoke, prods, means to establish the necessary magnetic flux.

(c) Dust on the dry magnetic particles

- Dust on a light layer of magnetic particles.

(d) Gently blow off the excess powder

- With the magnetizing force still applied, remove the excess powder the surface with a few gentle puffs of dry air.
- The force of the air needs to be strong enough to remove the particles but not strong enough to dislodge particles held by flux leakage field. Non Destructive Testing.

(e) Detect the defects

- Look for areas where the magnetic particles are clustered with the help of visual aids like illuminating light, microscope, naked eyes and magnifying glass etc.

(f) Post Treatment

- The surface of material should be demagnetized (or) cleaned using demagnetizer (or) demagnetizing equipment.

6. ADVANTAGES

- Can find both surface and near sub-surface defects.
- This inspection formats are extremely portable and low cost.
- Rapid inspection with immediate results.
- Indications are visible to the inspector directly on the specimen surface.
- Can detect defects that have been smeared over.
- Can inspect parts with irregular shapes (external splines, crankshafts connecting rods, etc.).
- The method can be adapted for site or workshop use.
- It is inexpensive compared to radiography.
- Large or small objects can be examined.

7. LIMITATIONS

- The specimen must be ferromagnetic (e.g. steel, cast iron)
- Paint thicker than about 0.005" must be removed before inspection
- Post cleaning and post demagnetization is often necessary
- Maximum depth sensitivity is typically adopted as 0.100" (deeper under perfect conditions)
- Alignment between magnetic flux and defect is important
- Insensitive to internal defects
- Require magnetization and demagnetization of materials to be inspected
- Require power supply for magnetization
- Coating may mask indication
- Material may be burned during magnetization

8. APPLICATIONS

- Magnetic particle testing or inspection (MT or MPI testing) quality control and materials testing in all major industries. This castings, forgings, plates, extruded components, weld joints, electrics electronic component

manufacturing, production of steel, pressure ships, bridges, motor vehicles, machinery and jet engines.

- ❖ The flaws to be detected include cracks, inclusions, pipe, lami bursts and flakes.
- ❖ Testing effective in detecting fatigue cracks during in-service maintenance inspection of power plants, cement plants, sugar plants, petroleum refinery machinery components and structures.

Mainly used to find,

- Fatigue Cracks Grinding Cracks
- Inclusions in aerospace blooms, billets, and bars
- Quenching Cracks Shrink Cracks
- Stress Corrosion Cracking → Welding Defects