Magnetic Particle Inspection

- Fluorescent Magnetic Particles
- Colored Magnetic Particles
- Carrier Fluids
- Contrast Paints
The Importance of Magnetic Particle Inspection

Magnetic particle inspection (MPI) is a nondestructive testing (NDT) method that does not harm the parts being inspected. MPI is a cost-effective and reliable testing method commonly used to identify surface and slightly subsurface discontinuities in ferromagnetic materials. The process is used on machined parts, iron and steel castings, forgings, welds, parts that undergo heat treatment, and several other applications that will be placed into service or already are in service and require maintenance. MPI is often used to locate defects in mechanical parts in the aerospace, automotive, oil & gas, welding and power generation industries.

The process of magnetic particle inspection involves generating a magnetic field and applying magnetic particles, visible or fluorescent, to a part being inspected. After applying magnetization, if an indication is present, the particles will accumulate directly over the discontinuity at the magnetic flux leakage fields. The indication can then be visually detected under proper lighting conditions. The part may be accepted, rejected, or repaired according to industry specifications.

Immediate results
Magnetic particle inspection is fast and relatively easy to apply, making it one of the most widely utilized nondestructive testing methods.

Detects surface and sub-surface discontinuities
Magnetic particle inspection is an ideal method for detecting surface and subsurface defects in ferromagnetic materials.

Detection through coatings
Magnetic particle inspection may detect discontinuities through thin nonconductive coatings, such as paint (on the order of 1 to 2 mil or 0.02 to 0.05 mm) and does not require the removal of the coating which can save time and money during the inspection process.

Determining Inspection Method
The primary considerations when deciding between visible or fluorescent inspection are the type of indication on the part, and where you will be physically inspecting the part.

Visible Color Inspection
This method is ideal for locating large surface defects. Visible inspection may be performed indoors or outdoors with portable applications under white light.

Fluorescent Inspection
This method is ideal for locating very fine discontinuities at or just below the surface. Fluorescent inspection must be done in a dark room with a maximum white light intensity of 2 fc (22 lux) and performed under ultraviolet light.

Determining Application Method
Magnetic particles can be applied to a part as either a powder (dry method) or suspended in a liquid (wet method) such as an oil- or water-based carrier.

Dry Method Visible
This method is ideal for low to medium sensitivity inspections, and works on most ferrous metal surfaces. It is commonly used in field testing and yoke inspection when working with rough cast or forged parts.

Products Needed
- Dry powders
- Magnetic yoke or power pack

Wet Method Visible
This method is ideal for high sensitivity inspections on parts with varying shapes and sizes. It is commonly used for detecting shallow and fine surface cracks in outdoor testing environments.

Products Needed
- Black particle
- White contrast paint
- Magnetic yoke or power pack

Wet Method Fluorescent
This method is ideal for high volume, high sensitivity inspections on parts. Quickly and easily coat the parts with an even layer of magnetic particle bath.

Products Needed
- Powder, premix, or concentrate particles
- Carrier oil or water
- Wet bench or power pack
Common Terms

**Background** – The surface of the test part against which the indication is viewed.

**Defect** – A material or component that does not meet the specified acceptance criteria and is rejectable.

**Demagnetization** – A process through which magnetism is removed from a test part.

**Ferromagnetic** – A metal with a chemical composition largely iron and a high susceptibility to magnetization.

**Inspection** – Visual examination of the test part after completion of the magnetic particle testing processing steps.

**Magnetic flux leakage** – The magnetic field of a test part will exit and re-enter at the location of the discontinuity producing a visible indication as a result of magnetic particles collection.

**Magnetic Particle Testing** – A nondestructive test that uses magnetic particles to detect discontinuities located at or near the surface in ferromagnetic materials.

**Precleaning** – The removal of surface contaminants from the test part so that they will not interfere with the examination process.

**Magnetic Yoke** – Portable device for detecting surface and sub-surface cracking in any ferromagnetic material.

**Ultraviolet Lamps** – Black lights that are designed for use with fluorescent magnetic particle and liquid penetrant inspection.

**Common Applications**

- **Aerospace** processes commonly use fluorescent magnetic particles and NDT-approved carrier oils for safety critical ferrous parts including steel alloy landing gear.

- **Automotive** processes commonly use fluorescent or visible magnetic particles to inspect ferrous components such as crank shafts and engine heads.

- **Oil & Gas** commonly use fluorescent or visible magnetic particles to inspect ferrous parts such as tubular goods, couplings, or bottom hole assembly.

**Fluorescent**

1. Prepare
   - Clean the part or test area with SKC-S cleaner.

2. Position yoke or prods on the part or test area.
   - Switch on the magnetizing current.

3. Mount the part to be tested.
   - Select current type and output.
   - Start the particle suspension flow.

4. Inspect the part or test area for indications under UV-A light.

5. Demagnetize
   - Switch off the current.
   - Check the part for residual magnetism.

**Visible Dry**

1. Prepare
   - Clean the part or test area with SKC-S cleaner.

2. Apply contrast paint to the part or test area.
   - Position yoke, prods, cable, or coil on the part or test area.
   - Switch on the magnetizing current.

3. Apply suspension to all test surfaces.
   - Stop the particle suspension flow.
   - Trigger mag shot on equipment.

4. Inspect the part or test area for indications under UV-A light.

5. Demagnetize
   - Switch off the current.
   - Check the part for residual magnetism.

**Visible Wet**

1. Prepare
   - Clean the part or test area with SKC-S cleaner.

2. Position yoke, prod, cable, or coil on the part or test area.
   - Switch on the magnetizing current.

3. Apply the magnetic particles.
   - Switch off the current.

4. Inspect the part or test area for indications in a well lit environment.

5. Demagnetize
   - Switch off the current.
   - Check the part for residual magnetism.

**Technical Info**

- **Background** – The surface of the test part against which the indication is viewed.
- **Defect** – A material or component that does not meet the specified acceptance criteria and is rejectable.
- **Demagnetization** – A process through which magnetism is removed from a test part.
- **Ferromagnetic** – A metal with a chemical composition largely iron and a high susceptibility to magnetization.
- **Inspection** – Visual examination of the test part after completion of the magnetic particle testing processing steps.
- **Magnetic flux leakage** – The magnetic field of a test part will exit and re-enter at the location of the discontinuity producing a visible indication as a result of magnetic particles collection.
- **Magnetic Particle Testing** – A nondestructive test that uses magnetic particles to detect discontinuities located at or near the surface in ferromagnetic materials.
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   - Switch on the magnetizing current.

3. Mount the part to be tested.
   - Select current type and output.
   - Start the particle suspension flow.

4. Inspect the part or test area for indications under UV-A light.

5. Demagnetize
   - Switch off the current.
   - Check the part for residual magnetism.

**Visible Dry**

1. Prepare
   - Clean the part or test area with SKC-S cleaner.

2. Position yoke, prod, cable, or coil on the part or test area.
   - Switch on the magnetizing current.

3. Apply the magnetic particles.
   - Switch off the current.

4. Inspect the part or test area for indications in a well lit environment.

5. Demagnetize
   - Switch off the current.
   - Check the part for residual magnetism.

**Visible Wet**

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   - Clean the part or test area with SKC-S cleaner.

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**Product Selection**

1. **Select Method Type**
   - UV - Fluorescent Wet
   - Visible Wet
   - Visible Dry

2. **Select Magnetic Particles**
   - H4A
     - Powder: Carrier II or Water
     - Form: Liquid
     - Part Numbers: 1 lb jar: 01-0179-71, 15 lb pail: 01-0179-70
   - H4AM
     - Ready-to-use liquid & aerosol: Carrier II, Aerosol case (12), 5 gal: 01-0145-70
   - H4A Redi-Bath
     - Concentrated liquid: Water
     - Part Numbers: 27 fl oz bottle: 01-0130-44, 1 gal jug case: 01-0130-36
   - 20B
     - Powder premix: Water
     - Part Numbers: 1 lb jar: 01-0179-71, 15 lb pail: 01-0179-70

3. **Select Carrier or Contrast Paint**
   - 14A
     - Fluorescent Wet Particles: Carrier II with WA-2B
     - Part Numbers: 1 lb jar (6): 01-0130-71, 20 lb pail: 01-0130-75
   - 14AM
     - Ready-to-use liquid & aerosol: Carrier II Aerosol case (12)
     - Part Numbers: 5 gal: 01-0145-70
   - 14A Aqua-Glo
     - Ready-to-use liquid: Water
     - Part Numbers: 1 gal jug case: 01-0145-78
   - 14A Redi-Bath
     - Ready-to-use liquid: Water
     - Part Numbers: 1 gal jug case: 01-0145-40
   - 7C Black
     - Visible Wet Powder: Carrier II or Water
     - Part Numbers: 1 lb jar: 01-0179-71, 10 lb jar: 01-0179-70
   - 7EF
     - Visible Wet Aerosol: Oil
     - Part Numbers: Aerosol case (12): 01-0160-76
   - MV-740
     - Visible Wet Ready-to-use liquid: Water
     - Part Numbers: 1 gal jug case: 01-0140-35
   - #1 Gray
     - Visible Dry Powder: Carried II or Water
     - Part Numbers: 10 lb: 01-1716-69, 45 lb: 01-1716-87
   - #2 Yellow
     - Visible Dry Powder: Carried II or Water
     - Part Numbers: 10 lb: 01-1732-69, 45 lb: 01-1732-87
   - #8A Red
     - Visible Dry Powder: Carried II or Water
     - Part Numbers: 10 lb: 01-1780-69, 45 lb: 01-1780-87

4. **Select Equipment**
   - Wet Bench
     - A-Series
       - A-2030: AC 3,000
     - AD-Series
       - AD-2045: AC 4,000
     - ADH-2045: AC 4,000
     - HWDC: 5,000
   - D-Series
     - D-2060: PWDC 3-phase 6,000
     - D-2100: PWDC 3-phase 10,000
   - MD-Series
     - MD-2030: AC 2,500
     - MD-2050: AC 5,000
     - MD3-2060: PWDC 3-phase 6,000
   - CD-Series
     - CD-2100: PWDC 3-phase 10,000
   - CMO-Series
     - CMD-2060: PWDC 3-phase 6,000
     - CMD3-2060: PWDC 3-phase 6,000
   - CSV-Series
     - CSV-10: PWDC 3-phase 10,000
     - CSV-20: PWDC 3-phase 20,000
   - Portable Power Packs
     - P-Series
       - P-70: AC/HWDC 750
       - P-1500: AC/HWDC 1,500
   - M-Series
     - M-2030: AC/HWDC 3,000
     - M-2040: AC/HWDC 4,000
     - M-2060: AC/HWDC 6,000

5. **Defect Location**
   - Y-2 Yoke: Surface AC 628554
   - Y-7 Yoke: Surface and subsurface AC/DC 625643
   - #8 Yoke: Subsurface (and some surface) DC 628994