

MAGNETIC PARTICLES TESTING

Magnetic particle Inspection (MPI) is a non-destructive testing (NDT) process for detecting surface and shallow subsurface discontinuities in ferromagnetic materials such as iron, nickel, cobalt, and some of their alloys. The process puts a magnetic field into the part. The piece can be magnetized by direct or indirect magnetization. Direct magnetization occurs when the electric current is passed through the test object and a magnetic field is formed in the material. Indirect magnetization occurs when no electric current is passed through the test object, but a magnetic field is applied from an outside source.

The magnetic lines of force are perpendicular to the direction of the electric current, which may be either alternating current (AC) or some form of direct current (DC) (rectified AC).

The presence of a surface or subsurface discontinuity in the material allows the magnetic flux to leak since air cannot support as much magnetic field per unit volume as metals.

To identify a leak, ferrous particles, either dry or in a wet suspension, are applied to a part. These are attracted to an area of flux leakage and form what is known as an indication, which is evaluated to determine its nature, cause, and course of action, if any.

Magnetic Particle Testing uses one or more magnetic fields to locate surface and near-surface discontinuities in ferromagnetic materials. The magnetic field can be applied with a permanent magnet or an electromagnet. When using an electromagnet, the field is present only when the current is being applied. When the magnetic field encounters a discontinuity transverse to the direction of the magnetic field, the flux lines produce a magnetic flux leakage field of their own as shown in Figure 1.

Because magnetic flux lines don't travel well in air, when very fine colored ferromagnetic particles ("magnetic particles") are applied to the surface of the part the particles will be drawn into the discontinuity, reducing the air gap and producing a visible indication on the surface of the part. The magnetic particles may be a dry powder or suspended in a liquid solution, and they may be colored with a visible dye or a fluorescent dye that fluoresces under an ultraviolet ("black") light.

Relevant norms

ASTM A275

AD-HP5/3

DIN EN 1369

DIN EN ISO 17638

DIN EN 10228-1

Test method

Surface cleaning

The surfaces to be inspected must be cleaned to remove adhering films of dirt, grease and loose particles.

Magnetization procedure

To find both longitudinal and transverse cracks, in general two inspection steps are required with magnetic fields disposed at 90° to each other.

When testing with a hand magnet, the magnet must be brought into contact with the component twice, using two orientations of the magnet disposed at 90° to each other.

When testing with devices like “Ferrotest 2000” or “Portaflux 6000”, there are two possible procedures:

- a) Flow and induction procedure
- b) Induction coil turned at 60°, so that the longitudinal and transverse cracks can be detected in a single operation.

The defects that are indicated are those whose longitudinal axis corresponds to the direction of the coil or the flow direction.

Depending on the shape of the workpiece, the production process, and the experience of the inspector, it may be possible to reduce the amount of testing.

Measuring magnetic field strength and direction

The magnetic saturation in the inspection zone is measured with a field strength measuring instrument. According to AD-HP5/3, the minimum permissible saturation is 25 Oersted, that is equal to 2.0 kA/m.

For complex geometries, the field strength must be measured section by section. In addition. The direction of the magnetic field is to be determined using a Berthold’s test body.

Test media

Fluorescing under UV light, or
Fluorescing under daylight or artificial light.

Depending on the test medium, inspection must be carried out in daylight, artificial light or using UV light.

Acceptance criteria

Cast parts:	according to DIN EN 1369, according to the quality class
Weld seams:	according to AD-HP5/3 – no cracks permissible according to DIN EN ISO 17638 to acceptability limit 1
Forged parts:	according to DIN EN 10228-1 or ASTM A275
Sealing surfaces:	no indication permissible

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