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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

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Non-destructive testing - Magnetic particle testing - Part 1: General principles

无损检测 磁粉检测 第1部分：总则

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1 Scope

The document lays down the general principles of magnetic particle testing of ferromagnetic materials. Magnetic particle testing is used mainly to detect discontinuities open to the surface, cracks above all; it can also detect near-surface discontinuities, but its sensitivity falls away quickly as the depth increases.

The document lays down the surface preparation of the workpiece under test, the magnetization techniques, the requirements for the detection media and their application, and the recording and interpretation of the test results. It does not deal with acceptance criteria. Additional requirements for the magnetic particle testing of particular workpieces are laid down by the product standard.

The document does not apply to the residual field technique.

2 Normative references

The following documents are referred to normatively: ISO 3059, Non-destructive testing - Penetrant testing and magnetic particle testing - Viewing conditions; ISO 9934-2, Non-destructive testing - Magnetic particle testing - Part 2: Detection media; ISO 9934-3, Non-destructive testing - Magnetic particle testing - Part 3: Equipment; ISO 12707, Non-destructive testing - Magnetic particle testing - Vocabulary; EN 1330-1, Non-destructive testing - Terminology - Part 1: General terms; and EN 1330-2, Non-destructive testing - Terminology - Part 2: Terms common to non-destructive testing methods.

Notes give the identical Chinese adoptions of the first four: GB/T 5097-2020 for ISO 3059:2012, GB/T 15822.2-2024 for ISO 9934-2:2015, GB/T 15822.3-2024 for ISO 9934-3:2015 and GB/T 12604.5-2020 for ISO 12707:2016.

3 Terms and definitions

The terms and definitions given in ISO 12707, EN 1330-1 and EN 1330-2 apply to the document.

4 Qualification and certification of personnel

Magnetic particle testing shall be carried out by personnel who are competent and who hold a qualification certificate. It is recommended that personnel be certified in accordance with ISO 9712 or another equivalent document.

5 Safety and environment

National and, or, local regulations on health, safety and the environment shall be complied with.

Magnetic particle testing normally produces a strong magnetic field near the workpiece under test and near the magnetizing equipment; devices sensitive to magnetic fields should be kept outside that area.

6 Testing procedure

Where the enquiry or the order so requires, magnetic particle testing shall be carried out to a written testing procedure.

The testing procedure takes the form of a concise technical data sheet whose content includes the reference to this document or to the other applicable documents. The procedure should set out the testing parameters in enough detail to make the test repeatable.

All testing shall be carried out in accordance with an approved written testing procedure or with reference to the relevant product standard.

7 Surface preparation

The surface under test shall be free of dirt, scale, loose rust, weld spatter, grease, oil and any other foreign matter liable to affect the sensitivity of the test.

The surface quality required depends on the size and the orientation of the discontinuities being sought. Surface preparation shall be carried out so that relevant indications are clearly distinguishable from false indications.

A non-ferromagnetic coating not thicker than 50 µm, such as an unbroken and tightly adhering paint layer, does not generally reduce the sensitivity of the test. A thicker coating does reduce it, and in that case the sensitivity shall be verified.

There shall be a marked visual contrast between the indication and the surface under test. For non-fluorescent techniques a thin, uniform layer of an approved contrast enhancing agent may be applied.

8.1 Magnetization - General requirements

The minimum magnetic flux density B suitable for testing is 1 T. In low-alloy and low-carbon steels the magnetic field strength H that has to be applied to reach that value is governed by the relative permeability of the material. Relative permeability varies with the material, with the temperature and with the applied field, so no explicit requirement is placed on the

applied field strength; the tangential field strength is usually about 2 kA/m.

Where the field is produced by a time-varying current, control of the crest factor of the waveform and of the method of current measurement is very important if the technique is to be repeatable. The usual methods measure the peak value and the root-mean-square value, and the measured value is affected by the response of the instrument. Only instruments that respond directly to the waveform shall therefore be used, such as a true root-mean-square meter able to measure the root-mean-square value accurately with a suitable crest factor. Instruments that derive the peak or the root-mean-square value by theoretical calculation from another quantity shall not be used. The same applies to equipment for measuring the magnetic field.

A smooth waveform has a low crest factor and the smallest difference between peak and root-mean-square value, and is the preferred waveform for magnetic particle testing. Unless the effectiveness of the technique is proved by documentation, waveforms with a crest factor, that is a peak to root-mean-square ratio, greater than 3 shall not be used.

Where a multidirectional magnetization technique is used, a pure sinusoidal current or a phase-controlled current shall be used, and the phase control shall not exceed 90°. The effectiveness of the technique in each direction shall be verified, for example with a workpiece or a test piece carrying known defects.

Provided the permeability is within the normal range and the method of current measurement is controlled as required above, a calculation based on 2 kA/m gives a useful way of preparing the technique. If the crest factor is known, the use of the peak current or of the root-mean-square current is acceptable. It is best for the complete waveform of the magnetizing current to be known; where the crest factor is known, a good practical approximation can also be obtained. The relationships between the peak, mean and root-mean-square values of a pure sine wave are given in Annex A. A technique based on calculation shall be verified before use.

Note 1 states that steels of low permeability may require a higher tangential field strength to be selected, and that too high a magnetization may produce false background indications that mask relevant ones.

Where cracks or other linear discontinuities are very likely to lie in one particular direction, the magnetic lines of force shall be perpendicular to that direction.