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Low-frequency Magnetic Current Features

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Abstract:

Using the alternating electricity as magnetizing current has some disadvantages: if it's in the residual magnetic method, the residual magnetism is not stable due to it's related to the phase current breaker. Due to the skin effect, the detection depth is not so long, which is not good for the defects under the surface. Using the direct current electricity as magnetizing current, without the skin effect, the magnetic field is in deep penetration, but even harder to the magnetic field elimination. The low-frequency alternating current is with the merits of alternating current, direct current, rectified current, impulse current. Based on the skin effect theory, the magnetic degree is in reverse ratio with the current frequency. The low-frequency detection could nearly reach the same depth of direct current, which is a kind of impulse current that could vibrate the magnetic powder slightly to form the trace, while it has got the features of alternating current, no necessary of magnetic elimination. Low-frequency magnetic current is a new method of magnetic detector, which has made a breakthrough in the limitation of present magnetic power detection on the metal surface, and made up of the difficulties in the thin metal piece Ultra-test detection. Deep detection length, high sensitivity, no need of smoothing the parts surface, test available, no necessary to getting rid of the magnetic force after detection, fast speed, small dimension, light weight, energy and electric savings.

Keywords: Low-frequency; magnetic detection

1. Summarization

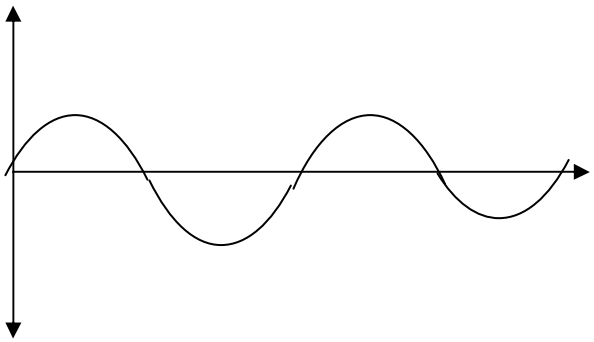
Current used for the magnetic field caused around the work piece is named the magnetic current. In magnetic powder detection, the types of current are alternating current, direct current, rectified current, impulse current and low-frequency alternating current, etc..

1.1 Alternating current

The relationships between the effective value I, peak value I_m and the average value $I_{d\,of}$ sinusoidal alternating current are:

$$I \approx 0.707 I_m$$
$$I_d \approx 0.637 I_m$$

As for the mobile or portable magnetic powder detector with Si-controlled alternating voltage, the output current is changed into non sinusoidal alternating current with load (it's not $\sqrt{}2$ relationship between the peak value and effective value)



In the magnetic powder detection, the alternating current is extensively used with such features:

① Due to the skin effect, high sensitivity to the surface defects.

② The magnetic field is on the work piece surface, easily getting rid of.

③ Complex and induction current magnetizing

④ Due to the changes of current directions, it could prompt the magnetic powder moving.

⑤ Proper for the tapered work piece magnetized.

⑥ Simple structure of the alternating magnetic powder detector

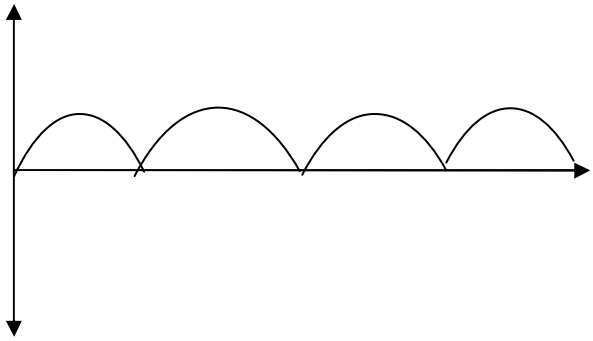
Using the alternating electricity as magnetizing current has some disadvantages:

① If it’s in the residual magnetic method, the residual magnetism is not stable due to it’s related to the phase current breaker.

② Due to the skin effect, the detection depth is not so long, which is not good for the defects under the surface.

1.2 Rectified current

The rectified current is by alternating current rectified, which is in those types: single-phase half-wave, single-phase full wave, three-phase half-wave, and three-phase full wave.



[Pic.1] Peak value/average value of the rectified current

Types of rectified current	single-phase half-wave	single-phase full wave	three-phase half-wave	three-phase full wave
Peak value/ average value	3.14	1.57	1.21	1.05

The rectified current is commonly used in magnetic powder detection with such features:

① With both the alternating and direct currents features, from the single-phase half-wave, single-phase full wave, three-phase half-wave, and three-phase full wave, the pulsating degree is lower and lower, and the penetration degree is deeper and deeper, and the deep defect is more testable; reversely, the pulsating degree (or current component) is increasing, good to the magnetic powder moving.

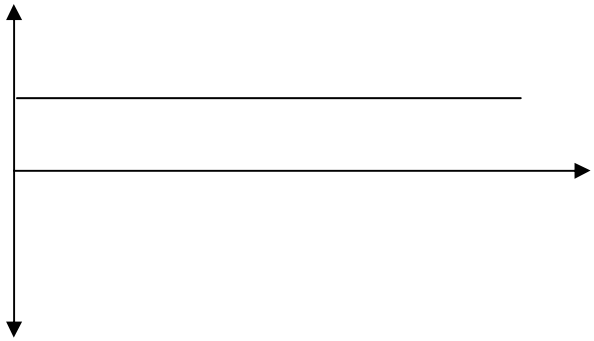
② The residual magnetism could keep stable.

③ Hard to get rid of magnetism, and large field is necessary.

④ As for the tapered work piece, the magnetizing is not average.

1.3 Direct current

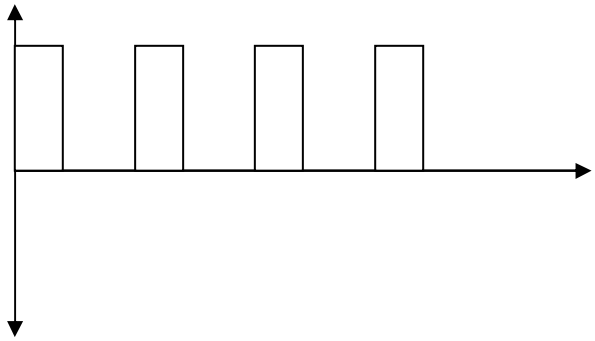
The direct current and its direction are not changed by the time. Without the skin effect, the magnetic field is in deep penetration, but even harder to the magnetic field elimination.



[Pic.2] Average value of the direct current

1.4 Impulse current

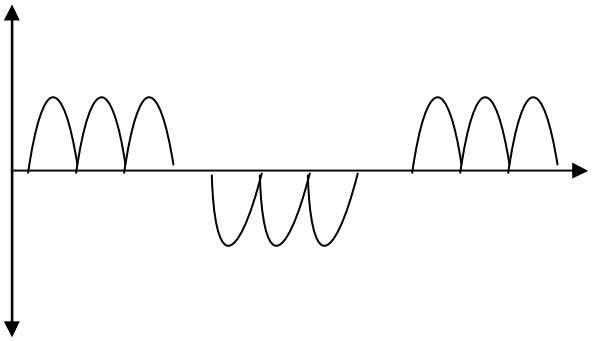
The impulse current is by the capacitor charging or releasing. Large current (1～2×10^4A), short time through, just for the residual magnetic method.



[Pic.3] Peak value/average value of the impulse current

1.5 Low-frequency alternating current

The low-frequency alternating current is with the merits of alternating current, direct current, rectified current, impulse current. Based on the skin effect theory, the magnetic degree is in reverse ratio with the current frequency. The low-frequency detection could nearly reach the same depth of direct current, which is a kind of impulse current that could vibrate the magnetic powder slightly to form the trace, while it has got the features of alternating current, no necessary of magnetic elimination.



[Pic.4] Peak value/average value of the low-frequency alternation current

2. Selecting the magnetic current

As selecting the magnetic current, consider those factors:

① Alternating current magnetizing could test sensitively the surface defects.

② Rectified or direct current magnetizing could test the surface or subsurface defects.

③ The more alternating current in the rectified, the less able to test the surface defects.

④ Alternating current for the residual magnetic method, the residual magnetism is not stable, if necessary added with the phase controller current breaker.

⑤ Direct or rectified current for the residual magnetic method, it's stable.

⑥ The impulse current is just for the residual magnetic method.

3. Low-frequency magnetizing current features:

（1）The penetration degree is high, which could find the 6mm split（0.1×2×30mm）under the surface.

（2） High sensitivity, A type performance could indicate clearly.

（3） The magnetic powder is energetic, easily absorbed on the defect place.

（4） No need of magnetic elimination.

（5） No need of smoothing the surface of work piece, straightly detecting.

（6）Low-frequency could save the energy, especially for the batteries, Li battery could work three times more than the direct current does.

Reference

[1]. Xi'an Thermal Power Research Institute: Technical manual of thermal power 1989