Magnetizing Current

As seen in the previous pages, electric current is often used to establish the magnetic field in components during magnetic particle inspection. Alternating current and direct current are the two basic types of current commonly used. Current from single phase 110 volts, to three phase 440 volts, are used when generating an electric field in a component. Current flow is often modified to provide the appropriate field within the part. The type of current used can have an effect on the inspection results, so the types of currents commonly used will be briefly reviewed.

Direct Current

Direct current (DC) flows continuously in one direction at a constant voltage. A battery is the most common source of direct current. As previously mentioned, current is said to flow from the positive to the negative terminal. In actuality, the electrons flow in the opposite direction. DC is very desirable when inspecting for subsurface defects because DC generates a magnetic field that penetrates deeper into the material. In ferromagnetic materials, the magnetic field produced by DC generally penetrates the entire cross-section of the component. Conversely, the field produced using alternating current is concentrated in a thin layer at the surface of the component.

Alternating Current

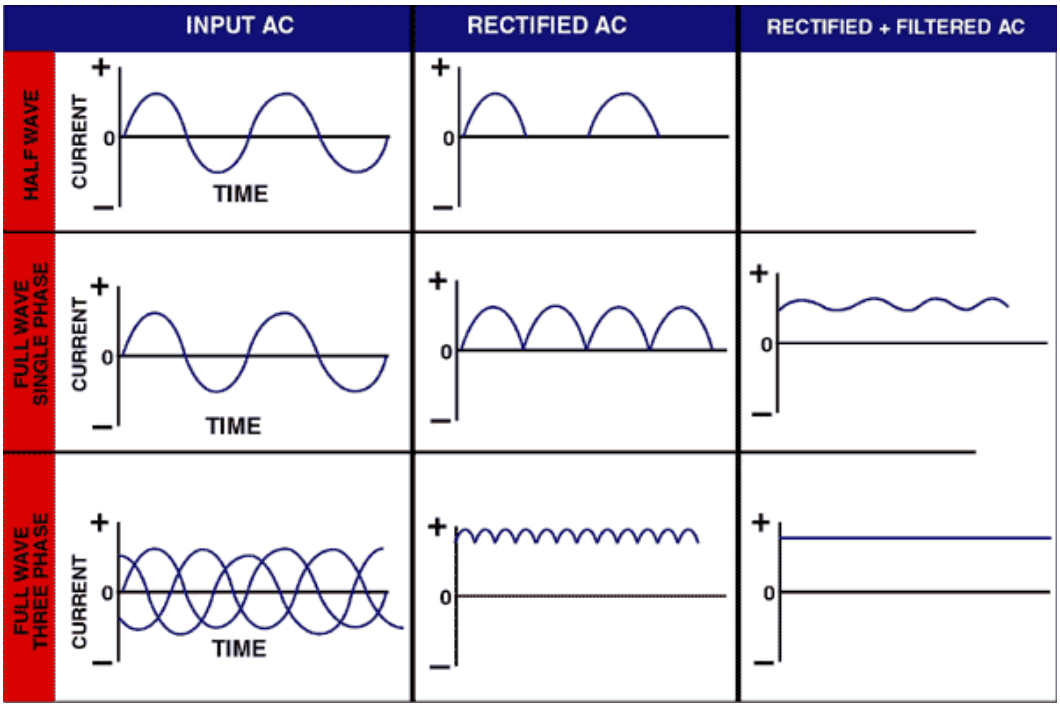
Alternating current (AC) reverses in direction at a rate of 50 or 60 cycles per second. In the United States, 60 cycle current is the commercial norm but 50 cycle current is common in many countries. Since AC is readily available in most facilities, it is convenient to make use of it for magnetic particle inspection. However, when AC is used to induce a magnetic field in ferromagnetic materials, the magnetic field will be limited to narrow region at the surface of the component. This phenomenon is known as the "skin effect" and occurs because the changing magnetic field generates eddy currents in the test object. The eddy currents produce a magnetic field that opposes the primary field, thus reducing the net magnetic flux below the surface. Therefore, it is recommended that AC be used only when the inspection is limited to surface defects.

View a short video on the AC versus DC. (195 KB mov)

Rectified Alternating Current

Clearly, the skin effect limits the use of AC since many inspection applications call for the detection of subsurface defects. However, the convenient access to AC, drives its use beyond surface flaw inspections. Luckily, AC can be converted to current that is very much like DC through the process of rectification. With the use of rectifiers, the reversing AC can

be converted to a one directional current. The three commonly used types of rectified current are described below.



Half Wave Rectified Alternating Current (HWAC)
When single phase alternating current is passed through a rectifier, current is allowed to flow in only one direction. The reverse half of each cycle is blocked out so that a one directional, pulsating current is produced. The current rises from zero to a maximum and then returns to zero. No current flows during the time when the reverse cycle is blocked out. The HWAC repeats at same rate as the unrectified current (60 hertz typical). Since half of the current is blocked out, the amperage is half of the unaltered AC.

This type of current is often referred to as half wave DC or pulsating DC. The pulsation of the HWAC helps magnetic particle indications form by vibrating the particles and giving them added mobility. This added mobility is especially important when using dry particles. The pulsation is reported to significantly improve inspection sensitivity. HWAC is most often used to power electromagnetic yokes.

Full Wave Rectified Alternating Current (FWAC) (Single Phase)
Full wave rectification inverts the negative current to positive current rather than blocking it out. This produces a pulsating DC with no interval between the pulses. Filtering is usually performed to soften the sharp polarity switching in the rectified current. While particle mobility is not as good as half-wave AC due to the reduction in pulsation, the depth of the subsurface magnetic field is improved.

Three Phase Full Wave Rectified Alternating Current
Three phase current is often used to power industrial equipment because it has more favorable power transmission and line loading characteristics. This type of electrical current is also highly desirable for magnetic particle

testing because when it is rectified and filtered, the resulting current very closely resembles direct current. Stationary magnetic particle equipment wired with three phase AC will usually have the ability to magnetize with AC or DC (three phase full wave rectified), providing the inspector with the advantages of each current form.

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