1.1.19. NUMERICAL INVESTIGATION OF LOCAL CIRCULAR MAGNETIZATION OF ROUND ROLLED METAL IN MAGNETIC TESTING

Halchenko V.Ya., Ostapuschenko D.L., Vorobyov M.A.,
Luhansk state medical university, Luhansk, Ukraine

One of the difficulties arising under development of magnetic testing devices is design of devices for test object circular magnetization in machine unit. A circular magnetization is required for robust detection of axial cracks that often appear in such production. Usually stationary object circular magnetization is created by an electric current passing along an object axis. This technique is not applicable for nonstop moving test object magnetization due difficulties in ensuring a contact to pass an electric current. That is why in such objects testing one applies a pole magnetization with an electrical magnet as alternative. It is necessary to create same magnetization in any point of a cross-section perimeter for complete object testing. In case of nonstop moving of the test object, e.g. in case of rolled metal, there arise difficulties connected with the necessity of insuring of the effective contact while connecting to the electric current. There may be used other magnetization technique by a system of magnetic poles of alternative polarity situated near a test object surface among cross-section perimeter. Between neighboring poles a magnetization is very close to circular one. In these regions an axial crack prevents from magnetic flux passing essentially. But near poles magnetic flux lines are perpendicular to an object surface. This may result in poor quality of crack detection. To avoid this the non-destructive testing device magnetic system should contain several identical units that are oriented such way to provide overlap of local circular magnetization regions. There are different implementations of such systems, e.g. a multipole electrical magnet, a system of attachable solenoids with a saddle-like form, etc. In the article [1] the toroidal magnetic system containing thin rectangular coils situated on a toroid surface in regular manner is proposed. But a ferromagnetic test object was not taken into account in field analysis. With other words a research goal [1] is creation of magnetic field with prescribed properties, but object magnetization is not considered.

Magnetic field of non-destructive testing devices may be calculated using software designed by authors [2 – 4]. The software takes into account a geometrical form of test object, nonlinear material properties and configuration of field for magnetization. This software is based on spatial integral equations method allow also taking into account peculiarities of testing problems: nonuniform nonlinear magnetic properties of ferromagnetic material, multiconnected regions with ferromagnetic object, cracks of different forms and sizes situated on an object surface or inside. Simulation results can be used for non-destructive testing devices development to increase their efficiency.

Two cases of a cylindrical test object magnetization were investigated. Calculations results of toroidal system have shown that centers of regions with local circular magnetization are situated near coils of magnetic system. Also size of these regions is very small. This results in cracks detection efficiency decreasing and difficulties of registering devices placement in testing region. According to multipole electrical magnet calculation results magnetic flux lines are perpendicular to an object surface near poles. Local circular magnetization regions are between neighboring poles. Registering devices may be placed in these regions. Size of the regions relate to poles sizes, their number and spatial orientation.

Thus, use of multipole magnetization systems in magnetic testing of round rolled metal is more effective. This is proven with numerical simulation results.

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