Numerical Modeling of Eddy Current Defectoscopy Probe

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Abstract **Investigation of pulsed eddy current non-destructive testing of bodies made of conductive materials is presented. For the purpose of development of suitable probes, the numerical model was stated. The investigated eddy current probe is a differential type consisting of one excitation and two sensing coils with a ferrite magnetic circuit. The numerical solution was carried out in the COMSOL Multiphysics using Magnetic field and Electrical circuit modules. The model was verified performing laboratory experiment.**

Keywords **non-destructive testing, eddy current defectoscopy, magnetic field, COMSOL Multiphysics, differential probe**

I. Introduction

There is often important to detect faults in metal object. One of the method revealing surface or subsurface defects is the eddy current non-destructive testing. At first, the eddy current probe produces a non-stationary magnetic field, which induces eddy currents in the examined body. The magnetic field generated by eddy currents superpose with the original magnetic field. In this approach, we are concerned with a differential reflection eddy current probe which consist of one excitation coil and two sensing coils. Excitation coil generates non-stationary magnetic field which induces eddy currents in the examined body. In case of inhomogeneity in proximity of one of the sensing coil, the output signals will be different [1]-[3].

II. Continuous Mathematical Model

The magnetic field is described by the partial differential equation

$$\mathrm{curl}\ \frac{1}{\mu}\mathrm{curl}\ \boldsymbol{A} + \gamma\frac{\partial \boldsymbol{A}}{\partial t} = \boldsymbol{J} \quad (1)$$

where $\boldsymbol{A}$ stands for magnetic potential and $\boldsymbol{J}$ is current density.

III. Illustrative Example

A. Numerical Solution

Mathematical model is solved numerically in COMSOL Multiphysics software with use of Magnetic field module and Electrical circuit module. Model is solved in four areas, as you can see in Fig. 1. The dimensions of the cross section of the artificial defect in the plate are 2 x 2 mm. Electric circuit module

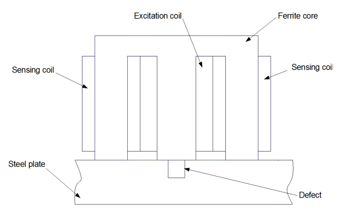

Fig. 1. Numerical solution arrangement

was used to generate input pulse to excitation coil and to emulate properties of osciloscope probe in measuring circuit. In Fig. 2 there is differential voltage output of numerical solution at the proximity of the defect.

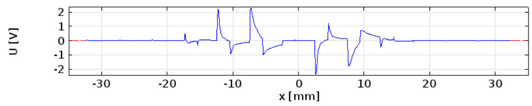

Fig. 2. Differential voltage output

B. Experimental verification

Results of numerical solution were verified by the measuring device moved stepwise above a wide steel plate with an artificial defect. The signals picked up by the sensing coils were measured by a digital oscilloscope. In Fig. 3 you can see comparison of numerical model and measured data.

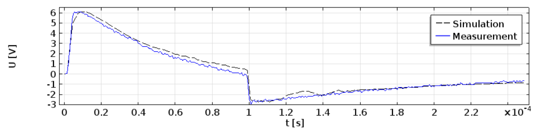

Fig. 3. Output voltage of single sensing coil

IV. Conclusion

Having reliable numerical model, we can now optimize the shape of the magnetic circuit of the probe and the parameters of coils without necessity of making the new prototypes.

V. Acknowledgements

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