1.1.26. METHODS OF SELECTION OF FREQUENCY FOR ELECTROMAGNETIC FIELD OF EDDY-CURRENT TRANSFORMER WITH U-TYPE CORE BY ITS INTERACTION WITH A TESTED FERROMAGNETIC SPECIMEN

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The work contains results of theoretical and experimental research in eddy-current defectoscopy the interaction of U-type eddy-current transformer with a tested ferromagnetic specimen. A laying–on ECT (eddy-current transformer) is traditionally used for defectoscopy when testing metal products with anisotropy.

ECT is viewed as a non-linear inductance coil with parameters changing under influence of eddy currents emerging in the tested specimen by its interaction with ECT. When receiving expressions for calculating parameters of a coil sequential equivalent circuit, we assume, that magnetic loss (power loss) in a volume unit of core material and the tested specimen is determined by ellipse area (its area equals the area of core material and tested specimen hysteresis loop).

By known magnetic loss and the size of the core and the tested area, we receive the expressions for determining active resistance for ECT equivalent circuit in the absence and under presence of the tested specimen (with or without the tested specimen). The expression for active resistance in the absence of the tested specimen has one component. By ECT interaction with the specimen there appears in the expression one more component stipulated by magnetic loss in the tested specimen. We receive the expression for determining ECT reactance by using connection between active resistance and reactance through the magnetic loss-angle tangent. Active resistance and reactance of ECT equivalent circuit depend on relative magnetic permeability, frequency and power loss-angle tangent of core materials and the tested specimen.

The received expressions for determining ECT active resistance and reactance were used for calculating these parameters by interacting with the tested specimen. Relative magnetic permeability of ECT core material necessary for calculation was determined through known ECT active resistance and reactance in the absence of the tested specimen. Core material relative magnetic permeability is not a constant but depends on frequency. Relative magnetic permeability for tested specimen material was of the same value as the one for core material.

Theoretical results were compared to experimental results in the frequency range from 0.1 to 200 kHz. The difference between theoretical and experimental results is caused, in our opinion, by the fact, that the pre-assigned values for relative magnetic permeability differ from their precise values and by the fact, that magnetic flux on all sections was considered to be equal.

However, as show the diagrams of frequency dependencies experimentally received values of ECT parameters (fig. 1a) and theoretically calculated parameters – reactance (fig. 1b), the obtained expressions may be used for calculating parameters for ECT equivalent circuit.

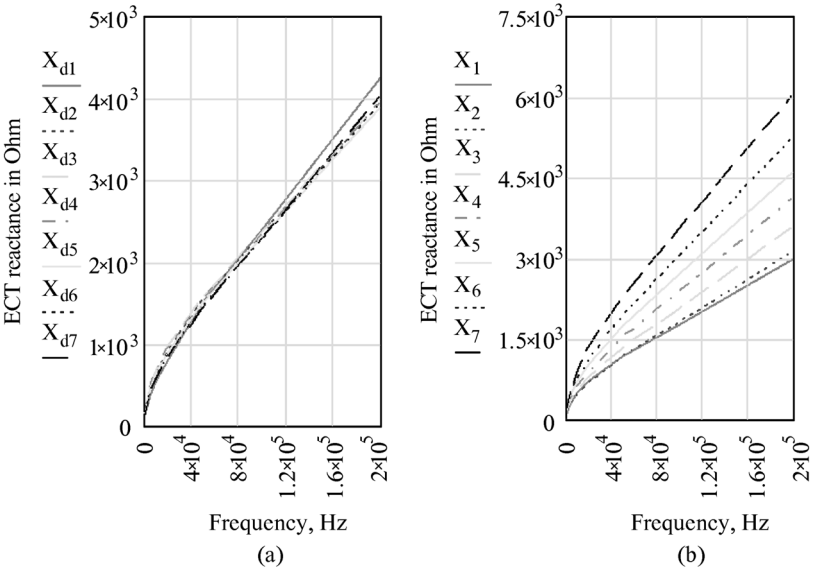

Fig. 1. Graph of dependencies ECT reactance:
(a) – experimentally received; (b) – theoretically calculated

It is proposed that working frequency for ECT should be selected graphically allowing for electromagnetic wave penetration depth into the tested ferromagnetic material when carrying out eddy-current testing. To do this we should build frequency dependencies curve for ECT active resistance and reactance which are calculated by received expressions. Then on these curves we should select areas with the biggest slope of curve for these values. As is seen on these curves, working frequency values lies within limits of 50 – 150 kHz subject to thickness of the tested specimen (electromagnetic wave penetration depth into the specimen).