1.1.32. MAGNETO-DYNAMIC METHOD OF SEPARATE CONTROL OF A THICKNESS OF DOUBLE-SIDE CERAMIC-METAL COATINGS

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The way of the separate control of a thickness of double-side low-magnetic coatings on non magnetic basis is offered. Considered the common case when depth of informative band is more than the thickness of non magnetic basis on which from two sides the low-magnetic coating is deposit. The task was solved by computer simulation. The calculations be lead on a finite element method with reference to method implementation in magneto-dynamic thickness gage of MTG type [1 – 4]. An informative signal of the gage not include a component caused by the primary magnetizing field that provides a wide range of measured thickness and high resolution of a method.

Ceramic-metal coatings are the composition of small (up to 7 microns) particles of nickel and non magnetic ceramics and also are a low-magnetic material with the magnetic permeability defined by concentration of nickel. Usually in practice a thickness of the basis d and a weighting composition of a coating (therefore – permeability) are known. Therefore informative signal we will present in the form of function of a thickness of coatings h_1 and h_2, and a thickness of the basis and permeability of a coating will be parameters. For such system thickness coatings is calculated influence for the value of an informative signal for a different thickness of the basis.

For the case $h_1 = h_2$ it is received that absolute amount of a signal is decreases with increase a thickness of the basis and will increase with growth of a thickness and permeability of a coating. Relative change of an informative signal for $d > 2$ mm practically does not depend on h and decreases with growth d. Thus all dependences are close to the linear.

For a case $h_1 \neq h_2$ the informative signal depends on what side the transducer is installed. For a case then transducer installed on the side with the coating of the thickness h_1, the value of an informative signal F_{12} we will present in shape: $F_{12} = F(h_1) + F(d, h_{12}) + F(d, h_2) + F(d, h_{21})$ where $F(h_1)$ – the contribution to the informative signal brought by a coating of the thickness h_1 for lack of a coating of the thickness h_2; $F(d, h_{12})$ – the contribution to the informative signal brought by change of magnetization of a coating of the thickness h_1 by magnetic field a coating of the thickness h_2; $F(d, h_2)$ – the contribution to the informative signal brought by a coating of the thickness h_2 for lack of a coating of the thickness h_1; $F(d, h_{21})$ – the contribution to the informative signal brought by change of magnetization of a coating of the thickness h_2 by magnetic field a coating of the thickness h_1. Similarly, for the transducer installed on the side with the coating thickness h_2: $F_{21} = F(h_2) + F(d, h_{21}) + F(d, h_1) + F(d, h_{12})$.

Whence follows that, $F(h_1,d,h_2) \neq F(h_1,d,h_2|_{\mu=1}) + F(h_1|_{\mu=1},d,h_2)$. As show calculations, this distinction makes 2-3 %, depending on a relation between thickness of coatings h_1 and h_2, and $F(h_1,d,h_2) < F(h_1,d,h_2|_{\mu=1}) + F(h_1|_{\mu=1},d,h_2)$. Physically it is linked by that the thickness h_1 and h_2 of coatings is many times less than depth of informative band, therefore occurs mutual demagnetization: coating of the thickness h_1 at the expense of a tangential component of the field H_R of a coating of the thickness h_2 and on the contrary.

For definition h_1 and h_2 also we use a graduation method on standard samples. We will place the converter in turn on coatings in the thickness h_1 and h_2, accordingly we have two signals $F_{12} = f_1(h_1,h_2)\big|_{d,\mu}$ and $F_{21} = f_2(h_1,h_2)\big|_{d,\mu}$. Let $F_{12} = f(F_{21})$, then in a co-ordinate system F_{12}, F_{21} we will receive the calibration grid with quadrangular cells. For each cells of this grid nodes are defined by the value of informative signals F_{12} and F_{21}, and the sides – the thickness (h_1 , h_2) one of a coatings. Having such graduation and results of measurements F_{12}^x and F_{21}^x on the object, we define values of a thickness of coatings h_1^x and h_2^x on each of the sides. For this purpose we define a cell to which the point T gets with co-ordinates F_{12}^x , F_{21}^x. For all cells we calculate the distance $D_i = \sum_{j=1}^{4} \sqrt{\left(F_{12}^j - F_{12}^x\right)^2 + \left(F_{21}^j - F_{21}^x\right)^2}$, its minimum value specifies a cell with number i which results of measurements on the control object concern. Having defined a cell to which the point T(F_{12}^x , F_{21}^x) gets, we find values of the thickness h_1^x and h_2^x of a coatings on algorithm:

– on co-ordinates of nodes of a cell we find the equations of its sides, to take their segments of straight lines;

– draw through a point T(F_{12}^x , F_{21}^x) two intersected straight lines ($h_1 =$ const and $h_2 =$ const), parallel to the cell sides;

– we define co-ordinates of points M and N, L and K intersections of straight lines with the cell sides;

– knowing co-ordinates of cross points of straight lines with the cell sides, we find length of segments MN and LK, and as segments MT and LT;

– believing linear change of a thickness of a coating in a cell and existence of direct proportionality between this change and change of an appropriate signal within a cell, we receive formulas for calculation of a thickness of a coating from each side:

$$h_1^x = h_1(M) + TM / MN\left[h_1(N) - h_1(M)\right]; \quad h_2^x = h_2(K) + TK / KL\left[h_2(L) - h_2(K)\right].$$

If the coating is one-sided the point inevitably gets on one of grid outer sides and if coatings from that and other side are identical on a thickness – that on the main diagonal of a grid. Therefore, the received graduation covers all variants of possible relations between thickness of coatings on opposite sides.

As transducer signals depend on a thickness of the basis and magnetic permeability of coatings at the big assortment of objects of the control, such graduation are necessary for having for a various thickness of the basis and magnetic properties of coatings.

The number of standard samples for graduation can be reduced approximately twice if for every thickness of a coating h_1 the condition is satisfied $h_2 \leq h_1$. In this case calibration dependence will be limited by a triangle.

It is obvious that the offered method of graduation and measurement of a thickness of double-side coatings has universal enough character and can be used at other quality monitoring.

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