

COMPARATIVE ANALYSIS OF THE METHODS FOR THE MAGNETIC
CURIE TEMPERATURE DETERMINATION BY ALTERNATING
CURRENT CIRCUITS

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Being very precise the methods for measuring magnetic permeability are often used for the determination of Curie temperature of magnetic materials|1,2|. These measurements are done by the use of the inductance and induction methods|3,4|. The first group of methods is a more precise one. These measurements are performed by means of the alternating current bridges.

The basic problem in determining Curie temperature by means of the above mentioned methods is that in using bridge methods the measurements consist of balancing of signal ("zero"-method) whose magnitude and change during the transition to a weak magnetic phase become very weak and difficult to measure. This problem has not been paid enough attention in literature.

The above difficulty can be avoided by means of the maximum voltage method|5|, which is successfully used for the determination of Curie temperature of ferrites and ferromagnetic metals|6|, as well as in the study of the temperature magnetic hysteresis|7|. The principle of the method is illustrated in Fig. 1. A constant resistor R_M is connected in a series with the coil which contains the examined sample (equivalent scheme $R_S + jX_S$), and in parallel with the resistance of a voltmeter. This measuring circuit is connected to the alternating voltage source of a constant maximum value. With the change of magnetic permeability (μ) and magnetic losses ($\text{tg}\delta$) due to the change of temperature (T), the voltage on the ends of measuring coil is changed and consequently

that of the resistor R_M , too. With the increase in temperature near T_C , both μ and $\text{tg}\delta$ decrease while the voltage U_M increases and reaches its maximum at the temperature T_C .

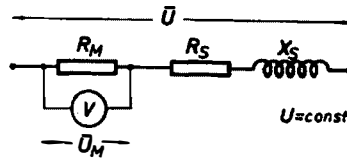


fig.1

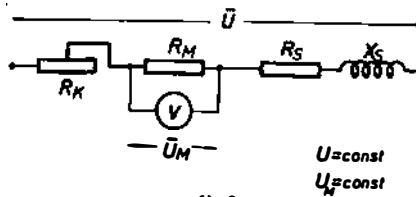


fig.2

This method of measurement can also be realized in a little more elaborate version (Fig.2) by adding the variable resistance R_K to the simple measuring circuit from Fig. 1. During measurements the U_M changes are compensated by regulating R_K , so that the determination of T_C is performed at a constant maximum current, i.e. at a constant maximum magnetic field strength. Unchangeability of the magnetizing regime is a special characteristic of this method.

In the theory of alternating current bridges [8,9] that analysis of the accuracy of bridge methods is given and their sensitivity calculated. It is not difficult to prove that with the measuring circuits from Figs.1 and 2 the accuracy corresponding to that of the bridges can be obtained. On the other hand, voltage sensitivity of the

measuring circuits from Figs. 1 and 2 is found to be

$$S_u = \frac{\delta U_M}{\delta Z_S} = U \frac{R_M}{Z_{tot}^2}$$

where Z_S is the modulus of coil impedance and Z_{tot} the modulus of total circuit impedance. This expression for sensitivity in form and meaning equals the expression for sensitivity of Maxwell bridge [8,9], the only bridge that allows for balancing by means of change in ohmic resistances. Nevertheless, we should have in mind that the expression for bridge sensitivity is derived assuming either the voltage at the ends of the bridge, or the magnitude of the current passing through the sample to be constant [8,9], both of them being impossible in practice [9].

This analysis points out to the advantages of the maximum voltage method which is corroborated by laboratory experiments.

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