DIFFERENTIAL TRANSFORMER TRANSDUCER FOR MONITORING MECHANICAL STRESSES IN METAL PRODUCTS

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Control of mechanical stresses in mechanical engineering requires non-contact, accurate, and reliable methods. Traditional absolute electromagnetic methods have limited sensitivity to changes in ferromagnetic materials under mechanical loading [1].

A model of a differential transformer-type electromagnetic transducer (TEMP) has been developed in this study for non-contact monitoring of torsional moments in cylindrical ferromagnetic components.

The transformer-type electromagnetic transducer (TEMP) consists of two pairs of identical transformers. The first pair is mounted on both sides of the test specimen subjected to a torsional moment, while the second pair is symmetrically positioned relative to an unloaded specimen. All four magnetizing windings are connected in series with coordinated polarity and are powered by a sinusoidal current generator. The measuring windings within each pair are also connected in series with matching polarity, whereas the two pairs are interconnected in series but in opposite phase (differential connection).

The study presents experimental research on the non-contact monitoring of mechanical loading in cylindrical ferromagnetic products using a surface-mounted differential transformer-type electromagnetic transducer (EMT). The monitoring was carried out based on the variable-frequency method under the condition of a fixed value of the generalized parameter, which made it possible to assess the sensitivity and effectiveness of detecting changes in the state of the controlled object.

A laboratory setup was developed and used to investigate the dependence of the output signal of a surface-mounted differential electromagnetic transformer transducer (EMTT) on the magnitude of the torsional moment applied to a cylindrical ferromagnetic specimen. A cylindrical shaft subjected to mechanical deformation under the action of a torsional load was selected as the test object.

Experimental results confirmed the high efficiency of the variable-frequency control method, which demonstrates the highest resolution – up to 25 Hz/MPa – compared to the amplitude and phase methods. The approaches proposed in the study for the simultaneous determination of magnetic permeability (μ_r) and electrical resistivity (ρ) make it possible to establish functional dependencies of the form $\mu_r = f(\sigma_m)$ and $\rho = f(\sigma_m)$, as well as to determine their relative sensitivities, which amount to 10% and 5%, respectively.

References:

1. Paton B.Ye., Troitsky V.A., Posypayko Yu.M. Non-Destructive Quality Control in Ukraine // Non-Destructive Testing and Technical Diagnostics: Scientific and Technical Conference, May 19–23, 2003: Conference Proceedings. Kyiv, 2003. Pp. 11–14.