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Measurement Technologies for Advanced Characterization of Magnetic Materials Used in Electric Drives and Automotive Applications

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Abstract : Due to the high complexity of the magnetization in electrical machines and influence of the manufacturing processes on the magnetic properties of their components, the assessment and prediction of hysteresis and eddy current losses has remained a challenge. In the design process of electric motors and generators, the power losses of stators and rotors are calculated based on the material supplier's data from standard magnetic measurements. This type of data does not include the additional loss from non-sinusoidal multi-harmonic motor excitation nor the detrimental effects of residual stress remaining in the motor laminations after manufacturing processes, such as punching, housing shrink fitting and winding. Moreover, in production, considerable attention is given to the measurements of mechanical dimensions of stator and rotor cores, whereas verification of their magnetic properties is typically neglected, which can lead to inconsistent efficiency of assembled motors. Therefore, to enable a comprehensive characterization of motor materials and components, Brockhaus Measurements developed a range of in-line and offline measurement technologies for testing their magnetic properties under actual motor operating conditions. Multiple sets of experimental data were obtained to evaluate the influence of various factors, such as elevated temperature, applied and residual stress, and arbitrary magnetization on the magnetic properties of different grades of non-oriented steel. Measured power loss for tested samples and stator cores varied significantly, by more than 100%, comparing to standard measurement conditions. Quantitative effects of each of the applied measurement were analyzed. This research and applied Brockhaus measurement methodologies emphasized the requirement for advanced characterization of magnetic materials used in electric drives and automotive applications.

Keywords : magnetic materials, measurement technologies, permanent magnets, stator and rotor cores
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