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# Measurement of Magnetic Properties of Grainoriented Electrical Steels at Low and High Fields Using a Novel Single

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**Abstract :** Magnetic characteristics of grain-oriented electrical steel (GOES) are usually measured at high flux densities suitable for its typical applications in power transformers. There are limited magnetic data at low flux densities which are relevant for the characterization of GOES for applications in metering instrument transformers and low frequency magnetic shielding in magnetic resonance imaging medical scanners. Magnetic properties such as coercivity, B-H loop, AC relative permeability and specific power loss of conventional grain oriented (CGO) and high permeability grain oriented (HGO) electrical steels were measured and compared at high and low flux densities at power magnetising frequency. 40 strips comprising 20 CGO and 20 HGO, 305 mm x 30 mm x 0.27 mm from a supplier were tested. The HGO and CGO strips had average grain sizes of 9 mm and 4 mm respectively. Each strip was singly magnetised under sinusoidal peak flux density from 8.0 mT to 1.5 T at a magnetising frequency of 50 Hz. The novel single sheet tester comprises a personal computer in which LabVIEW version 8.5 from National Instruments (NI) was installed, a NI 4461 data acquisition (DAQ) card, an impedance matching transformer, to match the 600 □ minimum load impedance of the DAQ card with the 5 to 20 □ low impedance of the magnetising circuit, and a 4.7 Ω shunt resistor. A double vertical yoke made of GOES which is 290 mm long and 32 mm wide is used. A 500-turn secondary winding, about 80 mm in length, was wound around a plastic former, 270 mm x 40 mm, housing the sample, while a 100-turn primary winding, covering the entire length of the plastic former was wound over the secondary winding. A standard Epstein strip to be tested is placed between the yokes. The magnetising voltage was generated by the LabVIEW program through a voltage output from the DAQ card. The voltage drop across the shunt resistor and the secondary voltage were acquired by the card for calculation of magnetic field strength and flux density respectively. A feedback control system implemented in LabVIEW was used to control the flux density and to make the induced secondary voltage waveforms sinusoidal to have repeatable and comparable measurements. The low noise NI4461 card with 24 bit resolution and a sampling rate of 204.8 KHz and 92 KHz bandwidth were chosen to take the measurements to minimize the influence of thermal noise. In order to reduce environmental noise, the yokes, sample and search coil carrier were placed in a noise shielding chamber. HGO was found to have better magnetic properties at both high and low magnetisation regimes. This is because of the higher grain size of HGO and higher grain-grain misorientation of CGO. HGO is better CGO in both low and high magnetic field applications.

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