

Data Sets of Interlaboratory Comparison of Alternating and Rotational Loss Measurements in Non-oriented Fe-Si Sheets

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We report on a comparison performed by four European laboratories [INRIM (Torino), Ampère Lab (Lyon), Politecnico di Torino, and SATIE Lab (Paris Saclay)] regarding the measurement of the magnetic energy losses in non-oriented Fe–Si sheets (physical parameters reported in Table I) under alternating and rotational fields. The laboratories used different Rotational Single Sheet Testers (RSSTs) with independently developed hardware and software tools and methods. Both open and closed magnetic circuits were employed, using circular, cross-shaped, and single-strip samples. The effective field across the measuring region was measured in all the RSST setups using calibrated tangential coils.

The measurements were performed under alternating and circular flux, in the frequency interval $5 \text{ Hz} \leq f \leq 200 \text{ Hz}$, and with peak polarization values $1.0 \text{ T} \leq J_p \leq 1.5 \text{ T}$. The alternating RSST values were traced to reference ones obtained by an Epstein frame, according to the IEC 60404-2 standard and by localized B -coils and tangential H -coils. The whole data set files are enclosed with this paper.

The laboratory-averaged RSST alternating loss figures differ from the reference values around $\pm 5 \%$. These discrepancies and their trend with J_p descend from the inhomogeneity of the effective field, the difference between applied and demagnetizing fields, across the sensing area. The RSST measurement reproducibility is consequently affected, and the ensuing overall dispersion of the laboratories' best estimates is quantified by the empirical standard deviations $s = 4.5 \%$ and $s = 3.6 \%$ for the alternating and rotational loss figures, respectively (Tab. II). These figures are significantly reduced with respect to a previous international comparison launched in the '90s. This research was carried out in the framework of the 19ENG06 HEFMAG project, funded by the EMPIR program, and co-financed by the Participating States and the European Union's Horizon 2020 research and innovation program.

TABLE I
Physical parameters of the investigated
non-oriented Fe-(3.5 wt%)Si sheets.

Thickness (mm)	Resistivity (Ωm)	Density (kg/m^3)	Saturation polarization J_s (T)
0.30	$56.9 \cdot 10^{-8}$	7600	1.98

TABLE II

Best estimates of the energy loss values generated in the comparison. They are obtained by averaging the loss figures provided by the participating labs for each J_p and f pair. The RSST alternating loss $\langle W^{(ALT)} \rangle_{LAB}$ is paralleled by the reference loss figure W_{ref} . These quantities and the rotational loss $\langle W^{(ROT)} \rangle_{LAB}$ are expressed in mJ/kg.

f (Hz)		J_p (T)			
		1	1.25	1.4	1.5
5	W_{ref}	14.45	22.22	29.8	34.66
	$\langle W^{(ALT)} \rangle_{LAB}$	15.19	22.07	27.56	32.69
	$\langle W^{(ROT)} \rangle_{LAB}$	25.72	32.43	39.10	43.70
50	W_{ref}	17.65	27.10	36.06	42.00
	$\langle W^{(ALT)} \rangle_{LAB}$	18.44	26.77	33.51	40.36
	$\langle W^{(ROT)} \rangle_{LAB}$	31.56	40.71	49.36	55.45
200	W_{ref}	25.58	39.58	52.25	61.26
	$\langle W^{(ALT)} \rangle_{LAB}$	26.97	39.34	48.84	59.36
	$\langle W^{(ROT)} \rangle_{LAB}$	47.76	63.71	78.25	88.80