BROCKHAUS ACADEMY

Calculating of magnetic properties

Field strength:

$$H(t) = \frac{N_1}{R_n \cdot l_m} \cdot u_1(t) \Rightarrow \underline{H_i = \frac{N_1}{R_n \cdot l_m} \cdot u_{1_i}}$$

Induction:

$$\frac{dJ}{dt} = -\frac{u_2(t)}{N_2 \cdot A_m} \Rightarrow J(t) = -\frac{1}{N_2 \cdot A_m} \cdot \int_0^t u_2(t)dt$$

H_{eff}:

$$H_{eff} = \frac{N_1}{R_n \cdot l_m} \cdot \sqrt{\frac{1}{T} \cdot \int_0^t u_1^2(t)dt}$$

J_{eff}:

$$J_{eff} = + \frac{\delta \cdot l}{N_2 \cdot m} \cdot \sqrt{\frac{1}{T} \cdot \int_0^t u_2^2(t)dt}$$

Power loss:

$$P_s = \frac{f}{\delta} \oint HdJ = \frac{f}{\delta} \oint JdH$$

with $H(t) = \frac{N_1}{R_n \cdot l_m} \cdot u_1(t)$

N_1= Windings primary

R_n=Resistance shunt

l_m=magnetic length

$u_1(t)$=Measured voltage shunt

Apparent power:

$$S_s = \frac{N_1 \cdot U_{1_{eff}} \cdot U_{2_{eff}}}{N_2 \cdot R_n \cdot \delta \cdot l_m \cdot A_m} = \frac{N_1 \cdot U_{1_{eff}} \cdot U_{2_{eff}} \cdot l}{N_2 \cdot R_n \cdot l_m \cdot m} \; with \, A_m = \frac{m}{\delta \cdot l}$$

Form factor:

$FF = \frac{U_{eff}}{|\overline{u}|}$, with $|\overline{u}| = \frac{1}{T}\int_0^T |u(t)|dt$

Permeability:

$\mu_r = \frac{J_{max_{mittel}}}{\mu_0 \cdot H_{max_{mittel}}} + 1$ with $H_{max_{mittel}} = (H_{max}^{+} - H_{max}^{-})/2$

Remanence:

$$J_R = \frac{J_+(H=0) - J_-(H=0)}{2}$$

Coercitive field strength:

$$H_C = \frac{H_+(J=0) - H_-(J=0)}{2}$$

Offset:

$$DC[\%] = -100 \cdot \frac{H_{max} + H_{min}}{(H_{max} - H_{min}) \cdot 2}$$

Power loss separation

Due to the fact, that the hysteresis loss increases linear, but the eddy loss square, you can separate the two parts, if you measure at two different frequencies. You have to devide the power loss by the frequency and extrapolate the result to 0Hz. The extrapolated value is the hysteresis loss. Eddy loss is the difference of power loss and hysteresis loss. The residual loss is ignored in this case because of it's small influence.

$$P_H = \frac{P(f_1)}{f_1} + b \cdot f_1 with b = \frac{\frac{P(f_2)}{f_2} - \frac{P(f_1)}{f_1}}{f_1 - f_2}\ (gradient)$$

$$P_W = P_{tot} - P_H$$

P_H = Hysteresis loss
P_W = Eddy loss
P_{tot} = total Power loss
f_1 = upper frequency
f_2 = lower frequency
$P(f_1)$ = power loss at f_1
$P(f_2)$ = power loss at f_2