Magnetostriction as a function of the vector course of time *B*(*t*) of rotational magnetization

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Magnetostriction is the most significant source for power transformer no-load noise. In the last years, increasing energy demand brings transformers closer to residential centers, hence the importance of noise approaches that of losses.

It is well known that the magnitude of the magnetostrictive-strain depends on the type of material, the intensity of the applied magnetic field, and the type of the magnetization, i.e. alternating magnetization (AM) or rotational magnetization (RM). For RM, the peak-to-peak strain λ shows strong increases with rising axis ratio $a = B_{TD} / B_{RD}$ (with B_{TD} the induction peak value in transverse direction and B_{RD} in rolling direction, respectively) [1]. However, earlier studies [2] have revealed that distortion and DC-bias are further impact factors in the case of AM, yielding increases of harmonics and intensity of $\lambda(t)$.

In our own recent work, we investigated if analogous mechanisms arise for RM. We studied the influence of several characteristics of the course of time ***B***(*t*) comprising (i) the shape of pattern, (ii) the dynamics and (iii) possible DC-bias (compare Fig.1).

Magnetization patterns ***B***(*t*) were simulated by a 3-phase excited rotational single sheet tester. According to practical cases in T-joints of transformer cores, focus was put on lancet-like patterns according to Fig.1. As a typical phenomenon, the induction vector ***B*** passes from hard direction HD1 to HD2 with high maximum angular velocity ω_{max}. Further, bias is given in transverse direction (TD).

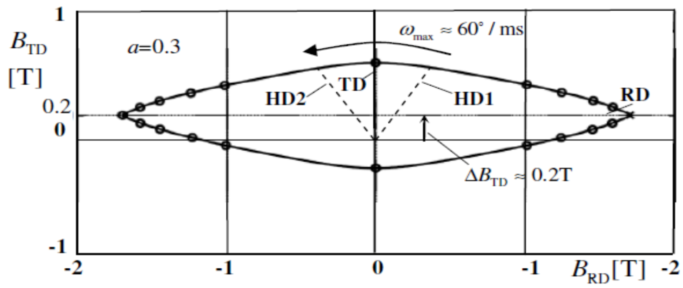

Fig.1. Example of a RM-pattern of rhombic-like shape which is characterized by high dynamics as revealed by the strongly uneven spacing of the 20 instantaneous positions of the induction vector ***B*** (with time spacing of 1 ms). Further, DC-bias is given in TD is indicated in a schematic way.

The results of measurement reveal the following tendencies:

(i) The shape of pattern has insignificant influence on λ, rhombic-like and elliptic patterns - as frequently reported in literature - yielding very similar results.

(ii) Increased dynamics - e.g. doubling of ω_{max} - yielded distinct increase of the harmonic lines for 200 Hz and 300 Hz.

(iii) DC-bias tends to increase the peak-to-peak value of λ, especially for the rolling direction (RD). E.g. for a = 0,3, a DC/AC-ratio r_{DC} = 0,2 in RD yields an increase of about 30%.

As a conclusion for practice, the usual modelling with almost even angular velocity of ***B*** tends to under-estimate the harmonics of strain which have major physiological acoustic relevance. Further, DC-bias yields enhanced magnetostriction in agreement with enhanced audible noise of DC-affected transformers.

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