Analysis of Natural Frequencies in the Transformer Core

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Abstract **This paper presents results of natural frequency analysis of the 3D numerical model of transformer. The goal is to map structural dynamics and vibrations of its selected parts with respect of the mechanical resonance. The model taking into account the real arrangement of the transformer core with winding is solved numerically by the finite element method.**

Keywords **Eigenfrequency, Mechanical Resonance, Numerical Analysis, Finite Element Method, Structural Analysis, Transformer Core**

I. Introduction

The prerequisite for evaluation of vibrations, noise, and life expectancy of electric machines is represented by structural analysis. The papers on the topic are still rare [1], [2]. The first step in structural dynamics is analysis of natural frequencies, which must be confronted with all sources of vibrations that needs to be taken into account during the design of the device.In case of transformer core are critical values around the typical electric working frequency range.

II. Illustrative example

The arrangement and dimensions of considered one-phase shell transformer without tank is depicted in Fig. 1. The transformer is composed of steel sheets and all supports of the copper winding and magnetic core are made of wooden structures. The natural frequencies were computed using Solidworks with the add-on Simulation aimed for the structural mechanics.
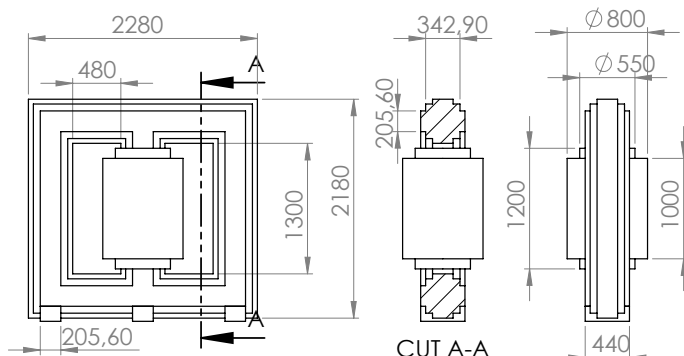

Fig. 1. Dimensions of the considered one phase transformer (in mm) including magnetic core, support points and winding

III. Conclusion

This paper presents the first step towards solving the problems of the design of low-noise transformers, that is the analysis of natural mechanical resonance that may cause acoustic interference on specified frequencies. The results of first five resonance frequencies for selected transformer are given in Table I and the distribution of deformation at selected frequency is depicted in Fig. 2. It is evident, that some modes are strongly dependent on the number of fixed points and on the whole

TABLE I
NATURAL RESONANCE FREQUENCIES OF TRANSFORMER FOR 3 AND 2 SUPPORT POINTS (REMOVED UNDER MIDDLE COLUMN)

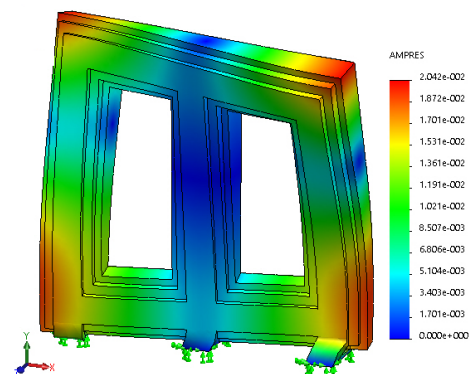| Mode	3 supports	3 supports winding	2 supports	2 supports winding
1st	16.28 Hz	15.08 Hz	13.34 Hz	12.29 Hz
2nd	71.75 Hz	65.82 Hz	66.60 Hz	60.93 Hz
3th	75.22 Hz	75.239 Hz	75.15 Hz	75.17 Hz
4th	187.54 Hz	171.39 Hz	150.81 Hz	135.43 Hz
5th	208.00 Hz	183.45 Hz	161.23 Hz	139.88 Hz

Fig. 2. Distribution of deformation inside the transformer core without winding at the frequency of 255.27 Hz (8th mode of natural frequency)

geometry. Next research in this field will be aimed at the problem of magnetostriction and impact of dynamic forces on the transformer winding.

IV. Acknowledgements

References

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