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ACOUSTIC PRESSURE LEVEL MECHANICAL VIBRATION ANALYSIS OF A TRANSFORMER MODEL

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ABSTRACT

The paper presents the results of vibration acoustic investigations and the measurements of the acoustic pressure measurment (noise) of a transformer model. The analyses were taken at a full transformer load in following operation steps: at a producer packeted core and at unpacketed core. Unpacketing consisted in loosing the screws pressing the particular core plates. Mechanical vibrations were observed and the acoustic pressure level was identify and measured. The vibration acoustic analysis results are presented in the form of frequency spectrum and the results of the acoustic analysis of the transformer under study are shown by determining corrected values of the acoustic pressure level and by a frequency analysis.

Key words: PACS numbers: 43.58.Wc, 43.58.Fm

INTRODUCTION

Modern approach of electric power enterprises to the management of the network assets accumulated, especially power transformers, is based on a multi--parameter analysis of the units under study [1{4]. An overall assessment of a transformer may be carried out based on several parameters, including its current signi¯cance in an electric power system and its impact on environment. Trans-former operation is more and more often connected with the problem of an ex-cessive emission of noise into environment. This phenomenon becomes even more valid if a transformer station is located in the vicinity of living quarters. The problems with exceeding allowable values of acoustic power around a transformer usually refer to the units of older constructions. The sources of sound are not only magnetostriction phenomena taking place in the core or cooler spinning fans but also windings which vibrate due to electrodynamic forces and operation of the pumps forcing oil ° ow. The paper presents the results of vibroacoustic investigations and measure-ments of the acoustic pressure level around a dry transformer model, in which core damage, consisting in its partial unpacketing, was modelled.

CHARACTERISTICS OF THE MEASURING SETUP

The measurements were taken on the transformer model, the view of which is shown in Fig. 1. The transformer under study was characteristic of the following nominal data:

| type: ET3S-20,
| power: 20 kVA,
| rated voltage GN: 3 £ 400 V,
| rated voltage DN: 3 £ 20 V,
| rated current GN: 17.1 A,
| rated current DN: 333 A,
| type of work: S1.

Fig. 1. Low-voltage transformer model under study.

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Mechanical vibrations of the transformer model were measured with an ac-celerometer type 752-10 by Endevko company, which was attached to the core with a magnet and the view of which is shown in Fig. 2a. Sensitivity of the measuring transducer was 1.021 mV/(m s^2) (for 100 Hz). The signal received by the trans-ducer was passed onto the input of a low-noise measuring ampli¯er from Nexus 2693 family by the ¯rm BrÄuel &Kj½r, shown in Fig. 2b. In order to get separated from disturbances transferred by the low-voltage net 230 V, the amplifying system was supplied from the internal battery source during the measurements. A com-puter equipped with a measuring card type CH 3160 by the ¯rm Acquitek and specialized AcquiFlex software were used for observation and registration of the vibration signals.The measurements of the acoustic pressure level were taken with a meter type 945A by the ¯rm SVAN. This appliance is used for taking measurements of

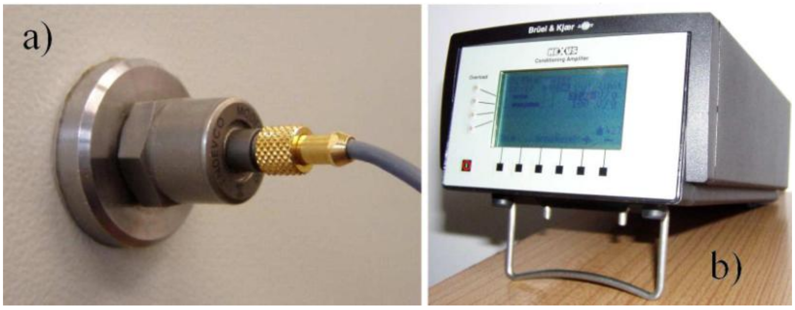

Fig. 2. View of the transducer (a) and the measuring ampli¯er (b).

the sound level with accuracy corresponding to class 1 and the frequency analysis of the acoustic signals in the band 1 Hz{20 kHz. The measuring tool makes it also possible to perform: the tone analysis, volume measurement, octave and tierce analysis, fast Fourier transform (FFT) analysis and detecting discrete tones of the acoustic signal measured. Figure 3 shows the appearance of the meter used.

Fig. 3. View of the meter of the acoustic pressure level.

3. METHODOLOGY OF MEASUREMENT TAKING

During the measurements, the transformer under study was loaded with rated current using a water resistance making adjustment of the current values in the range from 0 to 340 A possible. The investigation was carried out in the stages: the ¯rst stage contained analyses of the transformer vibrations and the acoustic pressure level at a packeted core, and the second stage referred to measurements at an unpacketed core. Mechanical vibrations were registered with a transducer placed on the core, and the acoustic pressure level was measured in the distance of 1 m away from the transformer under study.

4. ANALYSIS OF THE RESULTS OBTAINED

In the result of the measurements taken, the values of the corrected acoustic pressure levels for two operation conditions of the transformer under study were determined, which are shown in Table I.Operation of a transformer with a properly pressed core is characteristic of the value of the acoustic pressure level lower by 12.2 dB than in the case when

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TABLE

Mean level of the acoustic pressure registered around transformers with packeted and unpacketed cores.

Mean level of acoustic pressure in dB	
packeted core	unpacketed core
51.6	63.8

the core has become loose. This di®erence in the values obtained indicates a signi¯cant in°uence of the construction and proper packeting of the transformer core on the noise emitted into surrounding. In order to examine the in°uence of the modelled core damage on the participation of the particular frequency components, the measurement of the acoustic pressure level was supplemented by an analysis in the frequency domain, which was carried out by using a FFT and an octave analysis [5, 6]. The results of the frequency analysis are shown in Figs. 4 and 5.

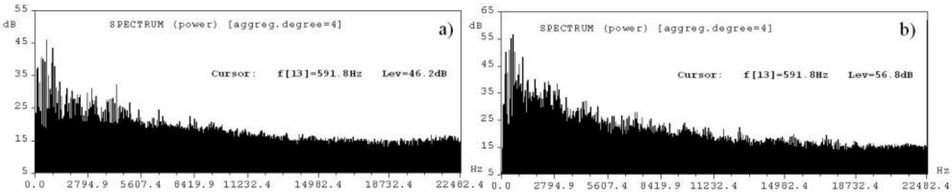

Fig. 4. The results of the FFT analysis of the acoustic pressure level around the transformer: (a) with the packeted core, (b) with the unpacketed core.

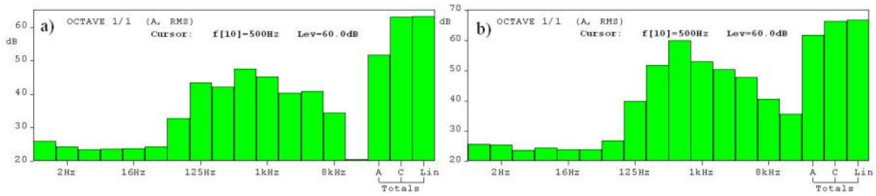

Fig. 5. The results of the octave analysis of the acoustic pressure level around the transformer: (a) with the packeted core, (b) with the unpacketed core.

Analyzing the runs of the frequency spectra as well as the column diagrams showing the results of the octave analysis, it can be observed that participations of the particular frequencies are relatively constant and do not depend on the modelled core damage. Signi¯cant di®erences can be observed analyzing amplitude values of the particular frequency components. Bigger amplitudes correspond to the results determined for the transformer with the loose core. In order to determine frequency ranges, based on which it is possible to discover core damage in a transformer, it is necessary to carry out vibroacoustic investigations. The

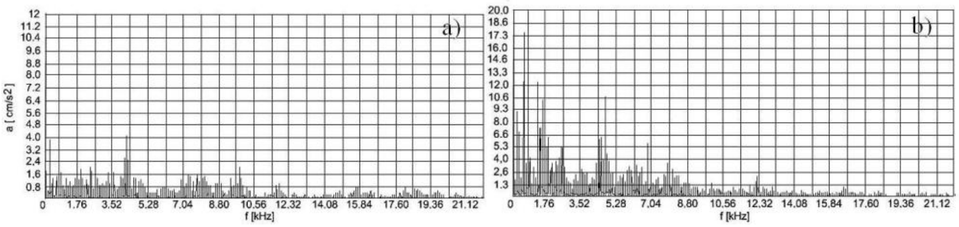

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Fig. 6. Frequency spectra of transformer vibrations: (a) packeted core, (b) unpacketed core.

Amplitude values, determined based on the measurement of the vibration acceleration, di®er both in the range of dominant frequencies and in amplitude. In the case of the loose core, a signi¯cant participation of components for frequencies from the range from 0 to about 5 kHz can be observed.measurement results of the mechanic vibrations of the transformer under study are shown in Fig. 6.

5. SUMMARY

An excessive value of the acoustic pressure level occurring around transform-ers is a signi¯cant problem for both professional power engineering and services involved in environment protection [7, 8]. Over the years the level of the acoustic pressure emitted by power transformers into environment is not constant but is subject to changes. This can be caused either by a signi¯cant wear of cooling appli-ances or changes taking place in a transformer core. The works on noise reduction presently concentrate on seeking new technical solutions, the aim of which is lim-iting the value of the acoustic pressure level emitted by such appliances as pumps or coolers. Increasing the noise level above the values provided at the stage of a transformer construction can be the cause of non-compliance with environmen-tal standards. Therefore it is vital that the acoustic pressure level be monitored during periodical check-ups, especially around high-power transformers.The research results presented in this paper indicate a signi¯cant in°uence of the core construction on the value of the acoustic pressure level occurring around a transformer. These results prove that the assessment of the transformer core condition should be an indispensable element of a transformer diagnostics as po-tential failures can in°uence not only technical parameters but also increase the noise level emitted into surrounding.

References

[1] Carlson, J. Fuhr, G. Schemel, F. Wegscheider, *ABB | Testing of Power Trans-formers*, Pro Print, DÄusseldorf 2003.

[2] 2 T. Boczar, S. Borucki, A. Cicho¶n, M. Lorenc: in *Proc. 37th Int. Conf. and Exhibition, Defektoskopie 2007, Praha 2007*, Eds. M. Ko·renska, P. Mazal, Brno University of Technology, Brno 2008, p. 45.

[3] T. Boczar, M. Lorenc, D. ZmarzÃly, in: *Proc. 14th Int. Congress on Sound Vibra-tion, Cairns (Australia) 2007*, 1{8, Abstract 316, p. 1.

[4] T. Boczar, S. Borucki, A. Cicho¶n, *Arch. Acoust.* 32 (Supplement), 291 (2007).

[5] T. Boczar, S. Borucki, A. Cicho¶n, *Mol. Quant. Acoust.* 28, 13 (2007).

[6] EE Standards, *Test Core for Liquid-Immersed Distribution*, Power and Regu-lating Transformers, IEEE Std. 57.12.90 (1999).

[7] *Order of Environment Ministry since 29.07.2004* (Dz. U. since 13.08.2004) (in Polish)T. Boczar, S. Borucki, A. Cicho¶n, M. Lorenc, *Mol. Quant*