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Experimental Application of Leakage Flux to the Detection of Insulation Faults on Disc-Type Winding Transformers

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Abstract. Interturn faults may be considered as one of the more likely root causes of breakdown in high voltage power transformers. Since transformers are essential components of the electrical power systems, their perfect operation determines the quality of power supply.
This paper presents an experimental study carried out on a disc-type winding transformer. Although several industrial methods exist for the on-line and off-line monitoring of power transformers, all of them are expensive and complex, and require the use of specific electronic instrumentation. In this paper, an on-line analysis of transformer leakage flux is tested as an efficient alternative procedure for detecting insulating failures during their earliest stages. A power transformer was specifically manufactured for the study (Fig. 1).

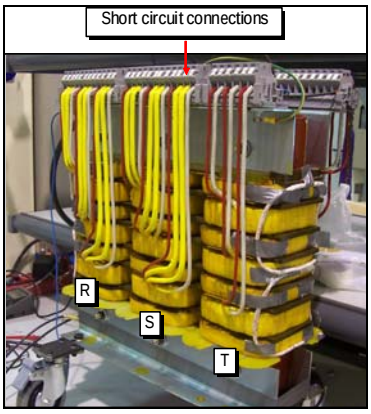

Fig. 1. External appearance of the transformer

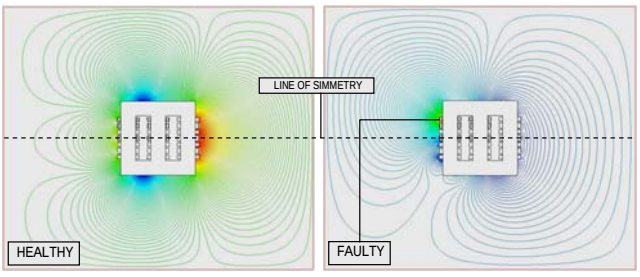

Fig. 2. Leakage flux lines. Left: healthy machine. Right machine with a shorted turn.

A finite element model of the machine was designed to obtain the transient distribution of leakage flux lines in the machine's transversal section under normal operating conditions and when shorted turns are intentionally produced (Fig. 2).
Very cheap, simple sensors, based on air core coils, were built in order to measure the leakage flux of the transformer, and non-destructive tests were also applied to the machine in order to analyse pre- and post-failure voltages induced in the coils (Fig. 3).

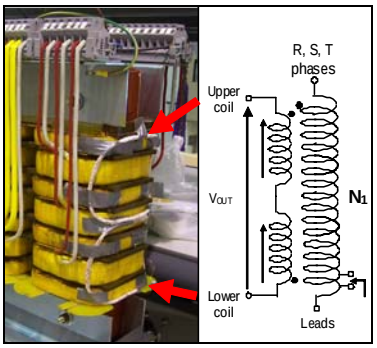

Fig. 3. Air core coils attached to the surface of the transformer windings

Results point to the ability to detect very early stages of failure. The asymmetry produced by the failure generates an indicator (induced EMF in the coils) that can be easily distinguished from the one obtained for the healthy machine. In fact, diagnosis can be perfectly achieved in spite of the variation of such an indicator (V_{OUT}) with load (Fig. 4).

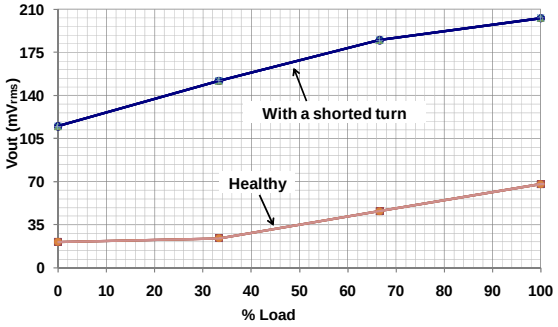

Fig. 4. V_{OUT} rms value vs. load level in the cases of the healthy transformer and with an interturn short circuit