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Title Signal Processing Tools to Enhance Interpretation of Impulse Tests on Power Transformers

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ABSTRACT

Insulation is still the single major cause for most of the failures in power transformers Due to its enormous cost, power utilities increasingly use monitoring and diagnostics as possible ways of determining its actual status to enable preventive or corrective measures in time Impulse test after manufacture is an accepted way of assessing insulation integrity of transformers This procedure is straightforward when the apparatus has a major fault, but rather difficult when only a minor fault (say a sparkover between adjacent coils/turns lasting for a few microseconds) occurs However, early detection of such minor faults can prevent apparatus damage, and newer methods capable of accomplishing them are continually being explored

With introduction of inexpensive A/D converters and computers in impulse testing, the relevant signals are available in digital form, thus enabling post-processing A direct consequence of this was the development of the transfer function (TF) approach for fault diagnosis Practical experience in transformer testing has indicated many problems in the TF method, with regard to it being independent of the applied voltage, chopping time, etc In addition, computation of a unique transfer function is possible only when both input and output signals are represented exactly (ideal signals) In practice, these signals are far from ideal due to various reasons Perhaps due to these deficiencies, this approach has not yet been accepted as a standard for purposes of fault detection These were the motivating factors that initiated this research work

TF computation using digital signals for the entire frequency range is mathematically ill-posed Non-ideal nature of digital signals causes excessively high and erratic values of TF in the higher frequency zones Due to this reason, TF is considered only up to 1-2 MHz in practice In this context, a couple of popular frequency domain de-noising methods, namely compensation method and Nahman method have been suitably adopted to de-noise and arrive at a reasonably good estimate of TF Essentially, these methods iteratively converge to a filter function which was used to avoid the situation of division by a quantity close to zero Details of the two methods are briefly described, followed by the implementation aspects Results obtained from simulation studies are compared with analytical responses, which reveal the need to de-noise TF and the potential of the proposed methods

It is well recognized that TF approach has problems in identifying minor faults The second part of the thesis precisely addresses this problem and proposes a new method for directly processing the neutral current for detecting minor faults, based on the principle of joint time-frequency analysis Short-time Fourier transform, wavelet transform and multiresolution signal decomposition have been used Here, the neutral current is considered as a non-stationary signal whose properties change or evolve with time, when there is a fault Details about the underlying principle of each of these methods and implementation issues are described followed by results and discussion It was found that the proposed time-frequency tools are robust and far superior to the TF approach in identifying minor faults

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