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2016-10-11

http://hdl.handle.net/10539/21153

Bokoro, Pitshou Ntambu (2016) Degradation analysis of metal oxide varistors under harmonic distortion conditions, University of Witwatersrand, Johannesburg, <http://wiredspace.wits.ac.za/handle/10539/21153>

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Abstract

Doctor of Philosophy

Degradation Analysis of Metal Oxide Varistors under Harmonic Distortion Conditions

by Pitshou BOKORO

Modern electrical networks provide an opportunity for inevitable interaction between metal oxide arresters and power system harmonics. Therefore, these arrester devices are continuously exposed to the combined effect of distorted system voltage and environmental thermal stresses. Recent studies supported by field experiments have shown significant rise in the leakage current through these surge arrester devices when exposed to ac voltage with harmonics. However, the major shortcoming in the current knowledge and applications of varistor arresters resides on the reliability and the electrical stability of these overvoltage protection units, when subjected to long-term and continuous distorted ac voltage and thermal stresses from the environment.

Commercially-sourced ZnO arresters of similar size and electrical properties are tested using standard ac accelerated degradation procedure or electro-thermal ageing test; the $V - I$ characteristic measurement and the high-frequency impulse tests. The times to degradation. the coefficient of non-linearity, the reference voltages. as well as the clamping voltage measured are used to analyse the reliability and the electrical stability of the metal oxide-based arrester samples. The resistive component of the leakage current is extracted from the measured total leakage current. The three-parameter Weibull probability model is invoked in order to analyse the degradation phenomenon.

The results obtained indicate that for respective increase of 4.4%, 3.1% and 5.7% in the 3^{rd}, the 5^{th} and the 7^{th} harmonic content, the resistive current is increased by 92.67%. The mean life of the arrester samples is reduced by 40.91%, and the probability of accelerated time to degradation is found to be 58.93%. The accelerated loss of stability is proven by 81.71% reduction in the coefficient of non-linearity and 43.75% drop in the reference voltage, which both indicate the shift of the $V - I$ characteristic curve towards the high conduction region.