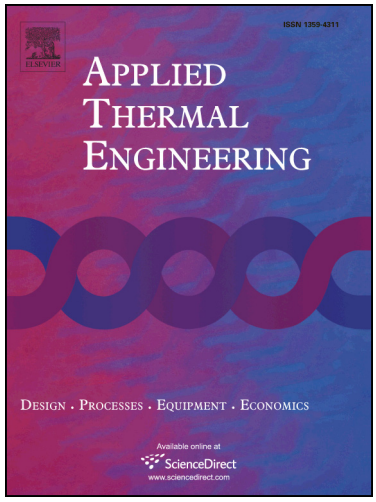

Thermal Response and Failure Mode Evaluation of a Dry-Type Transformer

Pelayo E. Blanco Alonso, Andrés Meana-Fernández, Jesús M. Fernández Oro

PII: S1359-4311(16)33121-0
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2017.04.007
Reference: ATE 10154

To appear in: *Applied Thermal Engineering*

Please cite this article as: P.E. Blanco Alonso, A. Meana-Fernández, J.M. Fernández Oro, Thermal Response and Failure Mode Evaluation of a Dry-Type Transformer, *Applied Thermal Engineering* (2017), doi: http://dx.doi.org/10.1016/j.applthermaleng.2017.04.007

Thermal Response and Failure Mode Evaluation of a Dry-Type Transformer

Pelayo E. Blanco Alonso, Andrés Meana-Fernández*, Jesús M. Fernández Oro

Fluid Mechanics Area, Department of Energy, University of Oviedo
C/Wifredo Ricart s/n Gijón Asturias 33203 Spain

Abstract

In this work, the safe working limits of a 10 kVA dry-type transformer with H-class insulation are determined by modeling its thermal response in different scenarios using numerical simulations (CFD). A numerical model of the heat transfer from the transformer to its surroundings by natural convection has been developed. Firstly, a steady regime with the transformer working at full load at an ambient temperature of 300 K is studied in order to gain insight into the heat transmission mechanisms. Then, a series of 32 steady simulations with different load and ambient conditions is performed to characterize insulation aging due to overheating. Finally, a second group of 9 transient simulations is employed to assess the transformer failure time under an overload situation. The results show a coupling between the thermal and flow fields. The hot spot temperatures obtained by the model are consistent with previous experimental observations and the time that the transformer resists an overload has been calculated. The results obtained allow the prediction of the thermal behavior of a transformer under different scenarios, reducing the need for instrumentation, as well as experimental tests which result in the loss of the testing transformer.

Keywords: numerical analysis; electrothermal effects; power transformer losses; power transformer insulation; failure analysis.

Nomenclature

α	Steinmetz equation exponent, thermal expansion coefficient $[1/K]$
β	coefficient for the equation of state for air, air volumetric expansion coefficient $[1/K]$
$\dot{Q}$	rate of heat transfer $[W]$
$\dot{Q}_{in}$	heat entering the system $[W]$

*Corresponding author: meanaandres@uniovi.es