SIMULATIONS PREVENT COSTLY FAILURES

CASE STUDY 1: CONVERTER TRANSFORMER LOAD LOSSES

Through simulation, high losses and hot spot areas can be identified at the design stage saving money and time. The actual behavior of transformers in service (considering harmonics of converters) can be studied only by means of simulations.

SUMMARY

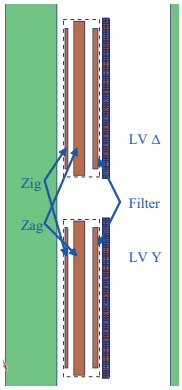
Locally the LV-winding had very high losses, causing conductors to overheat with consequent turn to turn failure. Because of the small amount of cellulose being degraded, the Dissolved Gas Analyses (DGA) may not alert the end user about the imminent failure.

The simulation provided an excellent match with the observed failure (burnt paper at middle axial height of LV-winding). It allowed the OEM to understand the nature of the failure and take proper corrective actions. If the simulation had been used to validate the original design, the failure would have note occurred!

DESCRIPTION

Transformer data:

- 55 MVA, 124/22/1 kV
- HV: 2 Zig Zag windings in parallel
- Filter: 2 windings in series
- LV: Δ and Y windings, made up of double disks in parallel
- The 12 pulse (network side) rectifier injects in the LV windings:
  - Harmonic 1, 11, 13, 23 etc. in phase
  - Harmonic 5, 7, 17, 19 etc. in phase opposition



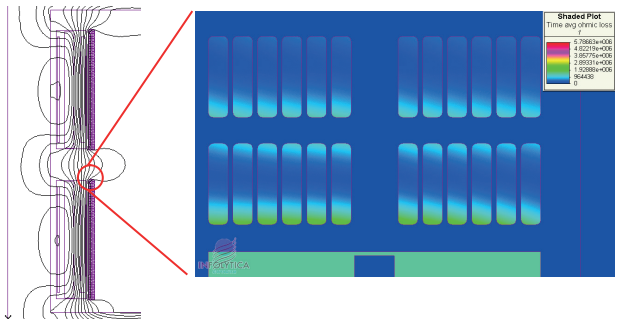
TECHNICAL CHALLENGE

In order to compute the correct current distribution in the windings it was necessary to take into account all the three phases and the filter circuit (coupling a complex circuit with FEM).

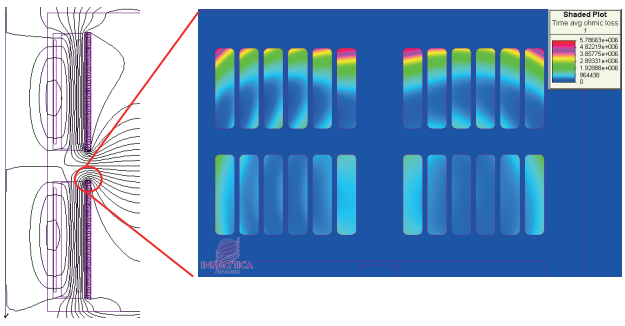
The loss calculation has taken into account (for each harmonic current):

- Uneven current sharing
  - among the double disks in parallel
  - among mechanical conductors in parallel inside each disk.
- Uneven current density distribution inside each conductor because of eddy currents.

RESULTS



1st, 11th, 13th harmonic leakage flux with loss density of the affected double disks



5th, 7th harmonic leakage flux with loss density of the affected double disks

CONCLUSIONS

Simulations allow OEMs to identify critical spots in the windings, to understand the nature of the problem and to validate corrective actions, for example change of:

- type and number of conductors
- number, shape and relative position of elementary windings making up the LV windings (to improve current sharing).

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