Simulations for innovative designs

The reasons of very high losses in the LV winding can not be explained but through simulations. Finite Element Analysis allows finding an optimized solution at the same cost of the original one.

Case Study 5: LV Losses

1. Summary

Very high load losses in the LV winding have been observed. The LV winding was built following the "classical" design rules for the transposition of conductors in parallel. However, only simulations can verify the validity of the "classical solution" for each specific design.

Simulations show that the flux leakage pattern is not symmetrical and with significant radial components. The radial transpositions in the LV winding, determined by means of classical rules are not sufficient to keep circulating currents under control. The axial positioning of transpositions minimizing the losses without additional costs for the winding is determined.

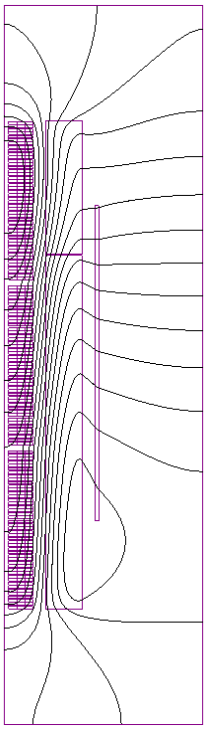
2. Description

A 126 star/16 delta kV, 165 MVA transformer with 13 taps. LV Windings made of CTC cables.

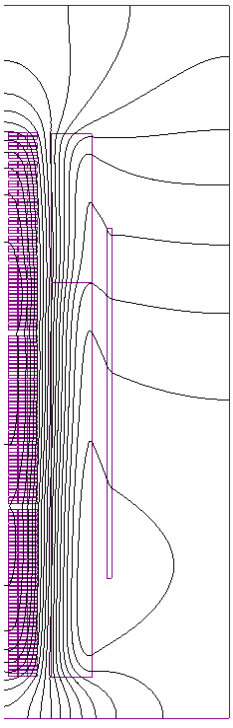
3. Technical Challenge

- Circulating currents among the CTC cables have to be taken into account in order to compute the losses in the LV winding.
- Determine the optimal positions of transpositions in order to minimize circulating currents among the CTC cables.

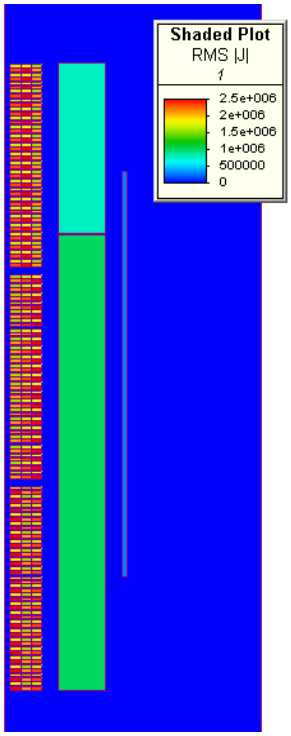
4. Results



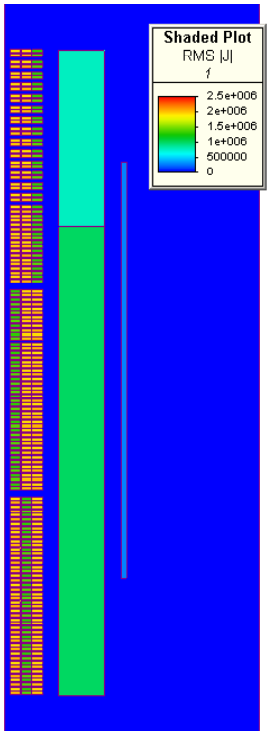
Flux plot – original transposition



Flux plot – modified transposition



Current density plot [A/m^2] - original transposition



Current density plot [A/m^2] - modified transposition

5. Conclusions

In the original design, due to the inadequate type of transposition (not balancing uneven radial leakage flux) and the uneven amp-turn distribution in the HV winding, circulating currents lead to a 40% increase in LV load losses. Simulations allow us to determine the LV turn axial distribution that matches the HV ampere turns distribution, minimizing the losses.