Paris Session 2022

Simulations in Short circuit evaluation

Study committee A2: Transformers and Reactors

Preferential Subject nº 3+ question 3.8

Considering the technical difficulties to apply short-circuit testing, but also manufacturing tolerances, and unknown parameters of the transformer design and materials, is it possible to rely only on numerical simulation to assess the short-circuit withstand ability?

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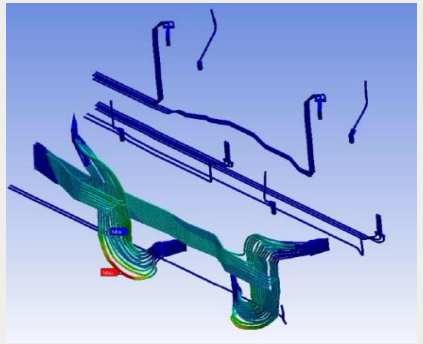
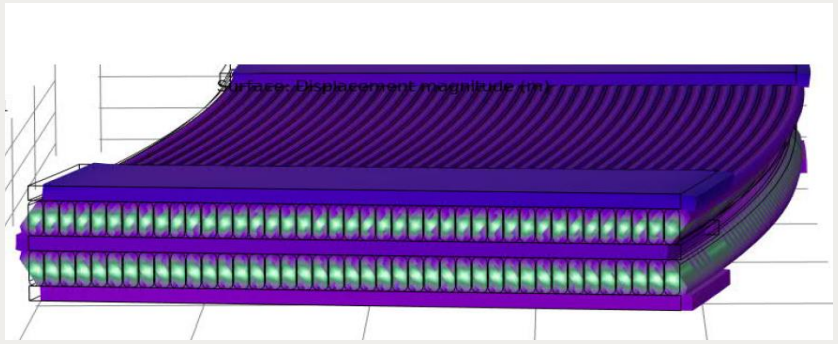
HITACHI Inspire the Next

Numerical simulations to access short-circuit withstand capability

- Use of numerical simulations as only method for short-circuit evaluations is not the most reliable approach since a failure may be caused by poor manufacturing quality.
- Advanced numerical simulations can:
  - improve prediction of mechanical stresses and strength
  - estimate effects of manufacturing tolerances and winding clamping pressures
  - together with the comparison with full-scale tests and manufacturing quality checks help to ensure that the transformer is designed properly.
- This decreases the risk of short-circuit failure.





Numerical simulations to access short-circuit withstand capability

- Short circuit design rules in transformers are historically based on:
  - 2D FEM magnetic simulations
  - analytical calculations and,
  - comparisons with full-scale tests on transformers or laboratory models.
- This approach can be improved by using more sophisticated simulations tools:
  - 3D FEM magnetic simulations
    - ➢ to see effects of different boundary conditions, winding pitches etc.
  - Nonlinear dynamic FEM mechanical simulations
    - ➢ to see effects of structural resonances, clamping pressure etc.
  - 3D mechanical simulations
    - ➢ to analyze the behavior of certain components on the active part such us cleat & leads, clamping system, common insulation parts, winding end supports, etc.
    - ➢ to determine critical loads for elastic instability phenomena, such as winding buckling and tilting of conductors etc.