Paris Session 2022

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For power system expertise

Innovative Resilient Transformers

SC A2 – PS2 – Q2.5

There seem to be conflicting opinions concerning the use of some alternative transformer technologies at higher temperatures, especially ester-immersed transformers. What is the experience of using alternative transformer technologies at higher temperatures? What further work is needed on this subject?

A. O'MALLEY – US, R. SZEWCZYK - PL, J.-C. DUART – FR,
K. KAINEDER - AT, R. MAYER - AT, E. SCHWEIGER - DE

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Experience of using alternative transformer technologies at higher temperatures applied in resilient transformers

- Challenges for operating at higher temperatures
  - Limitation of traditional material (e.g. insulation) and components
  - Calculation and design tools need to be adapted considering new materials and combinations

- Approach to be chosen
  - New technologies and materials undergo upfront testing to ensure compatibility in the transformer
  - Design tools updating and verification via tests of transformers of various sizes
  - Sophisticated electrical and mechanical tool landscape capable of optimizing the transformer design within the given constraints

- Solutions applied in transformers
  - Use of aramid material for insulation components (e.g. cylinders and end-insulation structure like stress rings, molded caps, collars, snouts, spacer blocks or clamping plates.)
  - Hybrid insulation systems (combination of newly developed materials and solutions with traditional ones)

Experience of using alternative transformer technologies at higher temperatures applied in resilient transformers

- **Achievements** (case study A2 11022 2022)

– Maximum operating flexibility, fast-deployable, lighter-weight, fit in an existing tight substation space

– Plug-and-play features like plug-in bushings and cables for shortest possible installation time. Fast deployment (less than a week)

– HV: 132 and 65 kV, LV: 13.8, 28 and 35 kV with LTC @LV and a narrow impedance band → up to 8 individual windings per phase

– DETC for changeover of voltage levels and avoiding handling of liquid during deployment Design includes 4xDETCs and one OLTC

– Up to 93 MVA and high overload capacity of up to 200%

– Highly efficient routing of the lead structure essential to accommodate the heating effects from stray flux

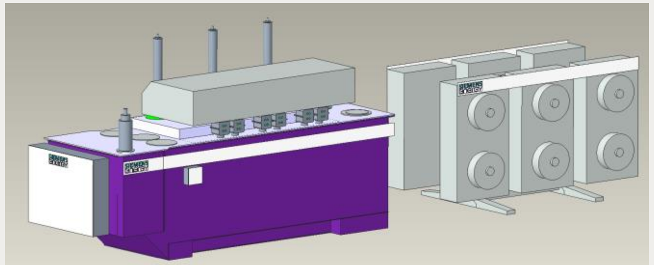
– Quiet operation → massive core of low-noise, grain-oriented magnetic steel with cooling ducts of a high-thermal class material

– Maximum transport weight of 200 000 lbs. (91 t)

– Filled with synthetic ester liquid, Midel® 7131

References (excerpts)

- 83.3 MVA, 1 ph, multi-ratio resilience GSU, each, total weight 97 tons
- 93 MVA,132 kV – 2022
- 65 MVA, 132 kV – 2018
- 58 MVA, 65 kV – (2023)
- Further A2 11022 2022 / D1 302 2021



Experience of using alternative transformer technologies at higher temperatures applied in resilient transformers

- Further work
  - Investigations and upgrading of materials/components (e.g. OLTC, bushings, accessories)
  - Longer term / aging investigation for very high temperatures
  - Updated thermal models for utility transformer rating calculations
  - On going development of full aramid insulation system for transformer active part
  - Educating regulatory agencies