Paris Session 2022

Reliability of dry-type transformers 72.5 kV and above

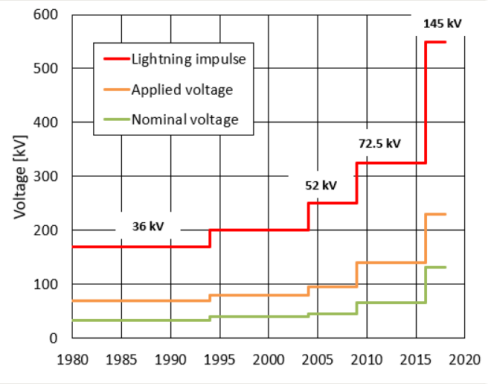
A2-PS2-Question 2: What is the experience of reliability in service of alternative transformer technologies, especially for demanding applications? Is there any significant difference from the reliability of conventional oil-immersed transformers?

Carlos Roy (Spain)

Hitachi Energy

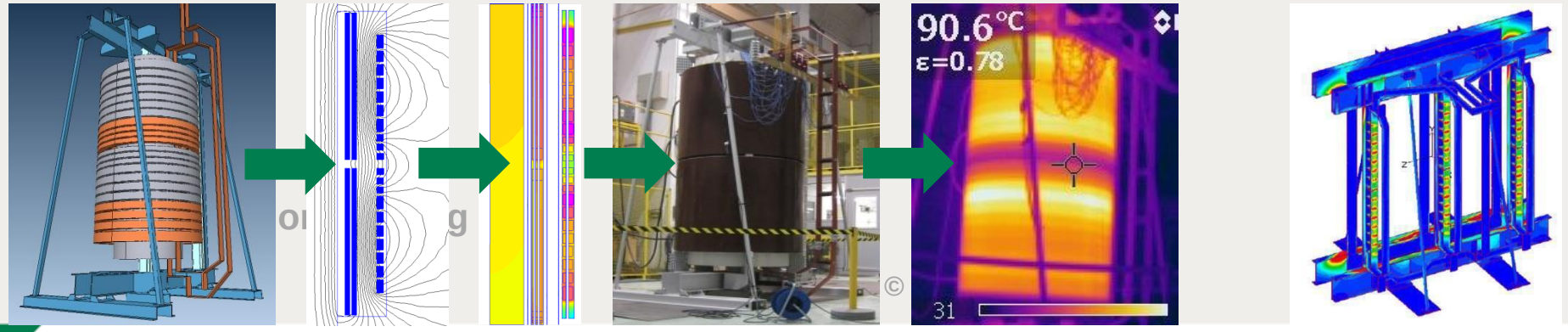
Reliability of dry-type transformers 72.5 kV and above

- Historically, dry-type transformers had been limited up to a voltage level of 36 kV
- Only since the year 2009 we are having in service experience with the level 72.5 kV and since 2020 with 145 kV
- By now 30 units are in service without problems, among them:
  - 4 x 31.5 MVA - 72.5 kV with OLTC for an urban substation (Spain)
  - 2 x 25 MVA - 72.5 kV with OLTC in a soccer stadium (Brazil)
  - 3 MVA - 145 kV in a hydro power plant in USA
- The main issues that may affect its reliability are:
  - Ageing of the insulation caused by hot spots
  - Breakdown of the insulation caused by over-voltages



Reliability of dry-type transformers 72.5 kV and above

- 72.5 kV transformers have higher ratings than distribution units and typically have an OLTC with a wide tapping range
- This can lead to high eddy losses and local hot spots
- Both are controlled by means of:
  - Combination of disk with different cross-sections and aluminium/cooper in the same HV winding
  - Coupled magnetic-thermal Finite Element Method (FEM) simulations for an accurate result



Reliability of dry-type transformers 72.5 kV and above

- Dry-type transformers withstand the same high frequency insulation surges than oil-filled ones. The demanding 550 kV lighting impulse has been proved with enough safety margin
- Electric stress in the insulating air controlled by means of technology adapted from oil transformers:
  - Insulating collars
  - Grading rings in the windings
  - Optimized number of barriers between windings
  - Conductive shielding for the clamps and yokes
- Precise knowledge of the electric stress in the solid insulation by means of an in-house developed FEM simulation tool