Paris Session 2022

Temperature Rise Test and Simulation

SC A3 - PS2 - Q9 - There are conflicting reports on temperature rise performance of SF_6 alternatives – experts to shed some light on the various influential factors and how they are controlled

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Temperature Rise Factors

WG A3.36

- Heat generation
  - Power loss
    - Contact resistance
    - Bulk resistance
    - Skin effect
    - Proximity effect
- Heat dissipation
  - Conduction
  - Radiation
  - Convection

$$P = RI_r^2$$

$$R_{cont} = \frac{\rho_1 + \rho_2}{4a}$$

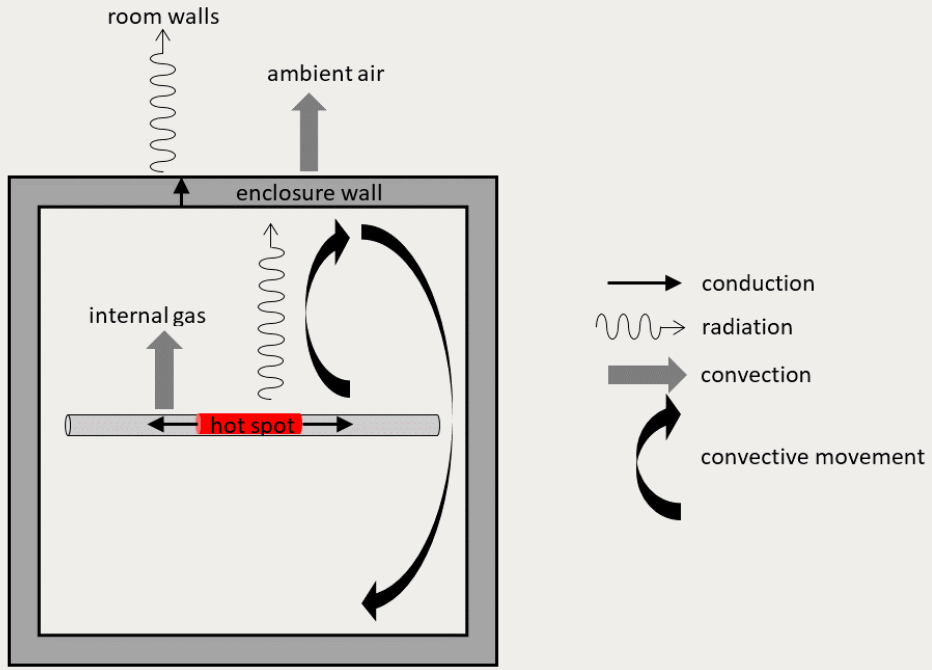
$$R_{bulk} = \rho \frac{l}{A_{cc}}(1 + \alpha\Delta T)$$

$$\delta = \sqrt{\frac{2\rho}{\mu\omega}}$$

$$P_{cond} = -kA_{cc}\nabla T$$

$$P_{rad} = \varepsilon\sigma_s A_{surf}(T_s^4 - T_0^4)$$

$$P_{conv} = hA_{surf}(T_s - T_0)$$



Convection is the only parameter that depends on the gas; all other parameters depend on the design

Temperature Rise Test and Simulation

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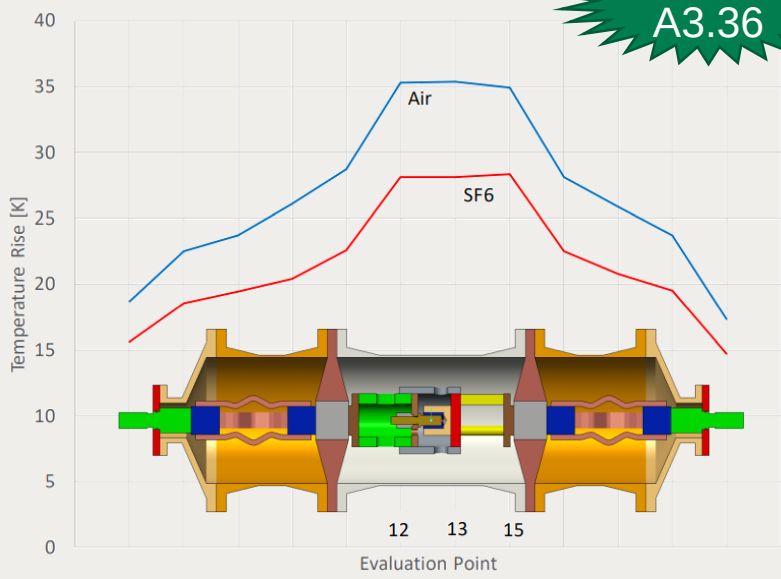
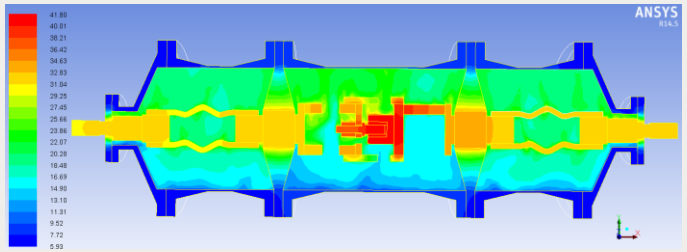
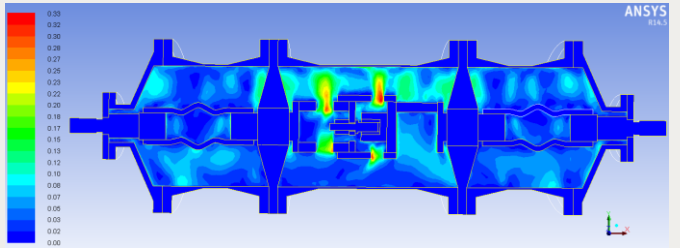
- Benchmark
  - Filling pressure: p_{abs} = 1.5 bar; 4 bar; 5 bar
  - Test current: I_{rms} = 1250 A; 2000 A; 2500 A
  - Insulating gas: SF_6; synthetic air (80% N_2, 20% O_2)
- Result
  - Gas: difference in temperature rise between SF_6 and synthetic air is about 7 K (at 4bar, 2000A)
  - Design: Contact resistances have big impact on temperature rise (simulation)







Performance prediction of a temperature rise simulation can be done when the simulation model is calibrated

Conflicting Reports?

- 10658 C4-FN gas mixture compared to SF_6
  increased pressure and no design changes – still higher temperature rise – additional small design change – same performance expected
- 10657 Air only in a pressurized air insulated cable
  no comparison possible - Pressurized air insulated cable, no comparison included
- 10126 C4-FN gas mixture compared to SF_6
  increased pressure and additional small design changes – same performance

No conflict in the reports seen when analyzing the impact of the influencing factors (gas properties, filling pressure and design)

Higher temperature rise with C4-FN gas mixtures compared to SF_6 can be compensated by higher filling pressure and small design changes.