Paris Session 2022

MV HEAT RISE FACTORS FOR C4-FN MIXTURES IN NORTH AMERICA

A3 PS2: Decarbonization of T&D equipment

Q9: There are conflicting reports on temperature rise performance of SF6 alternatives. Can specialists shed some light on the various influential factors and how they are controlled?

Andres Laso, USA
Foster Pyle, USA

Engineered to order. Built to last.

MV HEAT RISE FACTORS FOR C4-FN MIXTURES IN NORTH AMERICA

APPLICATION AND DESIGN

Requirements for MV gas insulated switchgear in North America

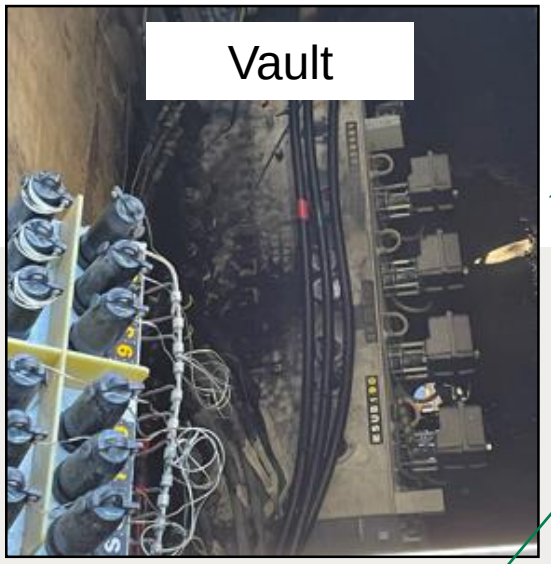
→ Compactness
→ Customization
→ Environmental exposure
→ <2bar

Design variables

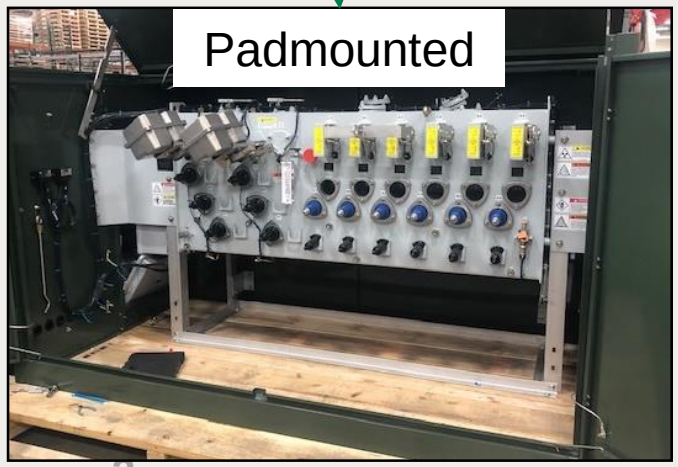
→ Heat dissipation
→ Conductor size, materials and shape
→ Contact resistance
→ Gas media

Limits of temperature and temperature rise

→ Based on IEEE C37.74-2014, Table 5 or IEC 62271-111



Environmental requirements may change greatly for different applications



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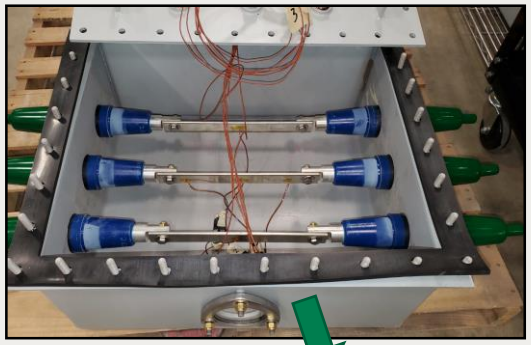
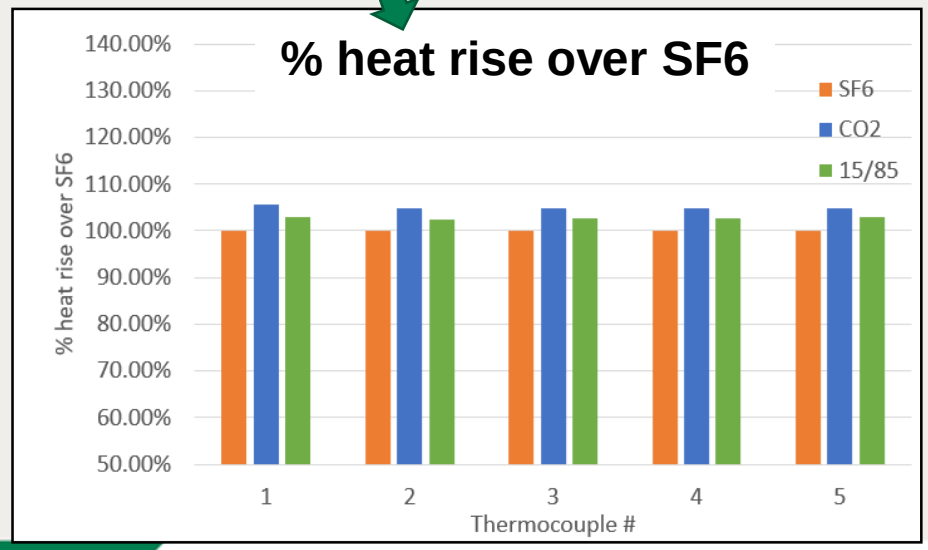
TEST 1: SIMPLE BUSBAR

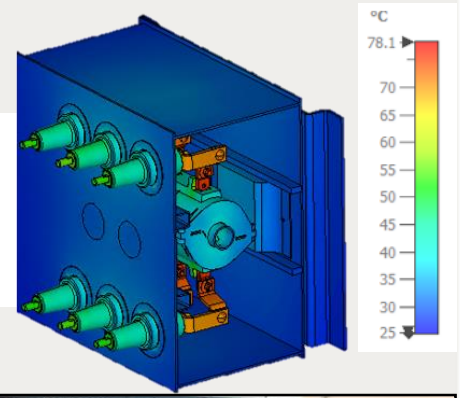
- 630A, single and three-phase system
- 3 gases: **SF6, CO_2 and 15/85 C4-FN/CO_2 mix**
- 1.7bar absolute

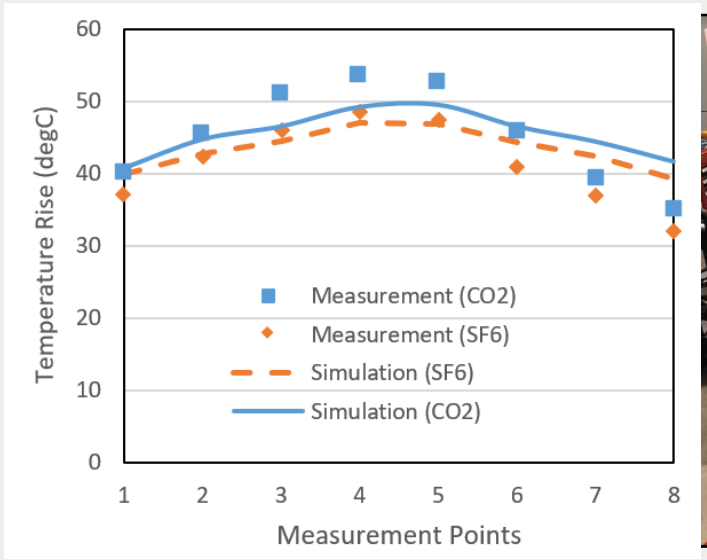




TEST 2: ROTARY SWITCH

- 630A
- 2 gases: **SF6 and CO_2**
- 1.7bar absolute





- CFD performed for all arrangements.
- Analysis and test data were compared.
- Values correlate with gas properties.

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CONCLUSIONS

Gas media effects

→ Pure **CO_2** perform the worst with a **5 to 10%** temperature increase higher than SF6 for the same configuration and pressure.

→ C4-FN mixed with CO_2 at **15/85** mol ratio it's a middle ground, with temperature rise between **2 to 5%** for the same configuration and pressure.

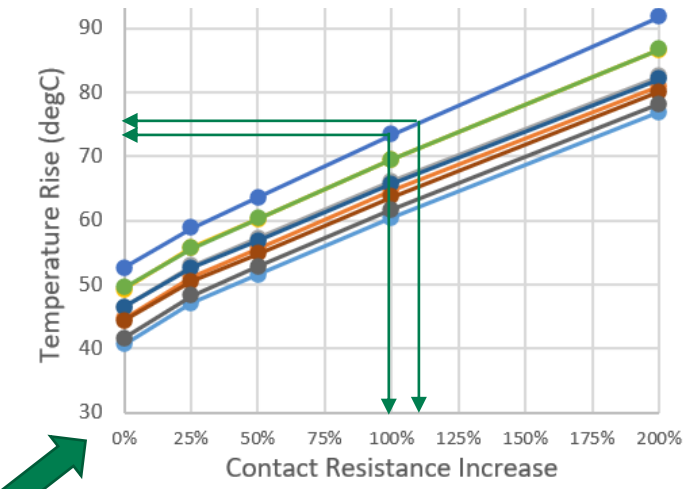
Design impact

→ Compared to other design parameters, heat-rise may require minor changes.

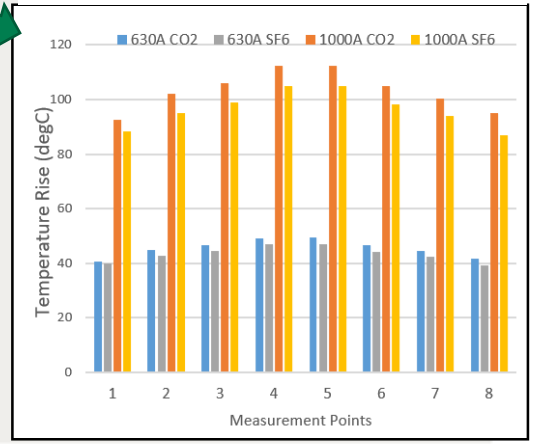
Simulated values

→ Heat-rise was successfully calculated for changes in the contact resistance and for higher current.

Simulated heat-rise increase for % contact resistance



Simulated heat-rise increase for 1000A



Summary

- Gas alternatives register higher temperatures for same pressure than SF6.
- CFD and heat-rise test show a ~10% error.
- Impact depends on design margins of previous SF6 gear.