

Long term stability of SF₆ alternative gas mixtures

SC D1 - Materials and emerging test techniques

PS 2 - Q2.03

Is there any experience concerning
decomposition of low-GWP gases available?

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Long term stability of SF₆ alternative gas mixtures

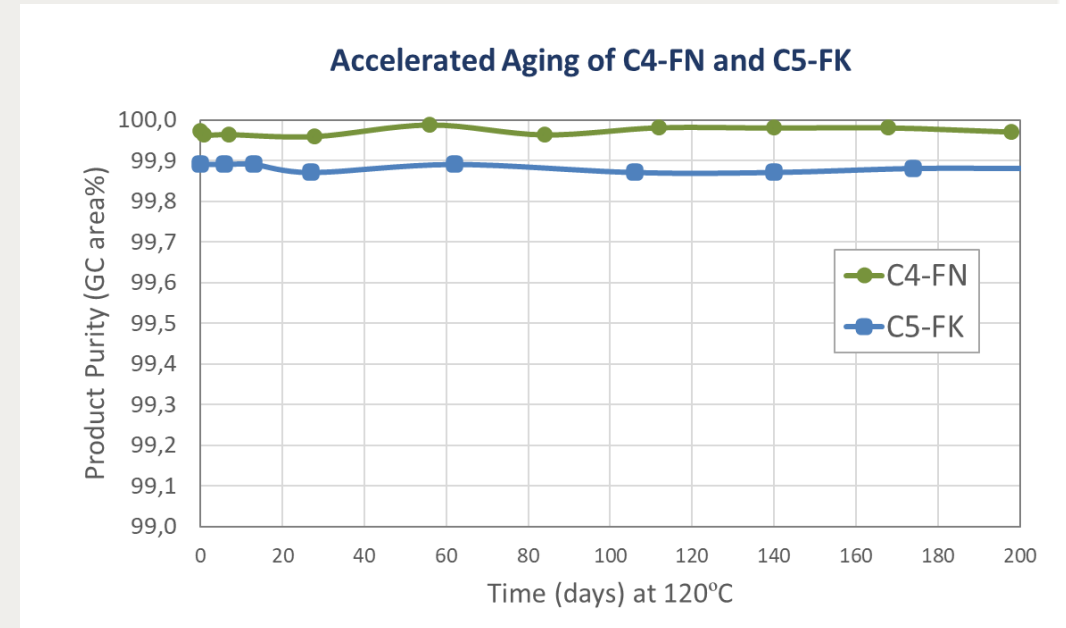
Focus materials: C4-FN and C5-FK

→ Need to consider the pure gas as well as the stability of gas mixtures

Stability of pure C4-FN and C5-FK

- Both gases have been assessed using accelerated aging studies to predict the condition of the materials.
- The heat aging tests exhibited little change in chemical composition of the materials and remained consistent with the minimum purity requirements specified.
- Based on the van't Hoff principle this would simulate more than 50 years of aging at room temperature

Group Discussion Meeting



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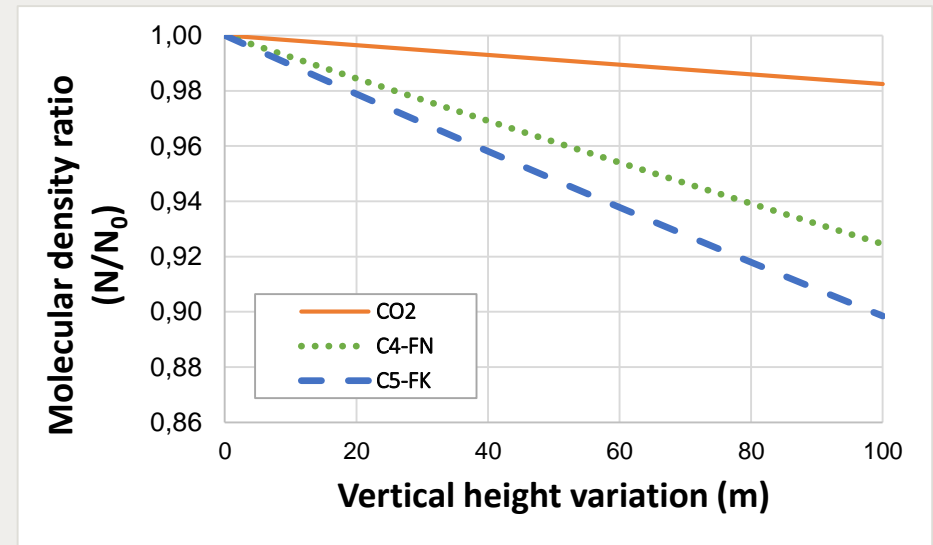
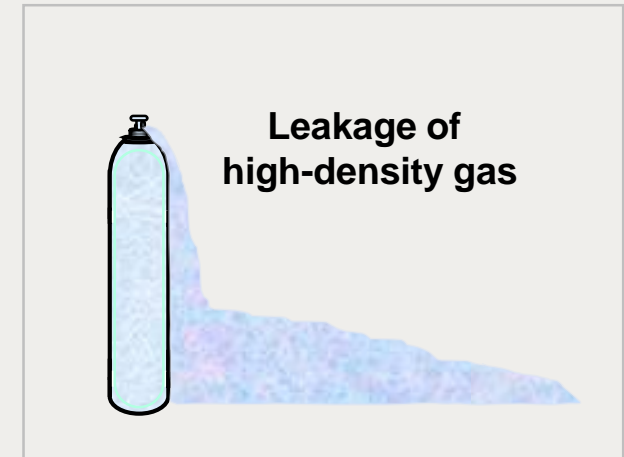
Focus materials: C4-FN and C5-FK

Stability of C4-FN and C5-FK gas mixtures – Potential of demixture

- Potential of demixture is an often-arising question
→ no separation will occur!
(in the absence of condensation via lower temperature
or lower pressure)

Although the overall gas density will vary with height

- The column of pressure exerted on any molecule is created by the entire mixture not the individual components.
- Therefore, since the forces on each molecule are the same, the composition does not change with height.



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Stability of C4-FN and C5-FK gas mixtures – Formation of by-products

Has been assessed in multiple papers. E.g CIGRE TB 871⁽¹⁾ concludes:

- “This ‘gas wear mechanism’ is numerically compared with the wear of arcing contacts and nozzle (as usual in SF₆ breakers). With the knowledge so far, it is concluded that gas decomposition in properly designed equipment is not a lifetime limiting factor compared to other degradation mechanisms”
- Regarding health & safety aspects of the by-products: “...the by-products created by arcing fall in the same acute toxicity classification as arced SF₆.”
- Key conclusion: “The operability, performance, maintenance and lifetime of alternative gases appear to be similar to SF₆.”

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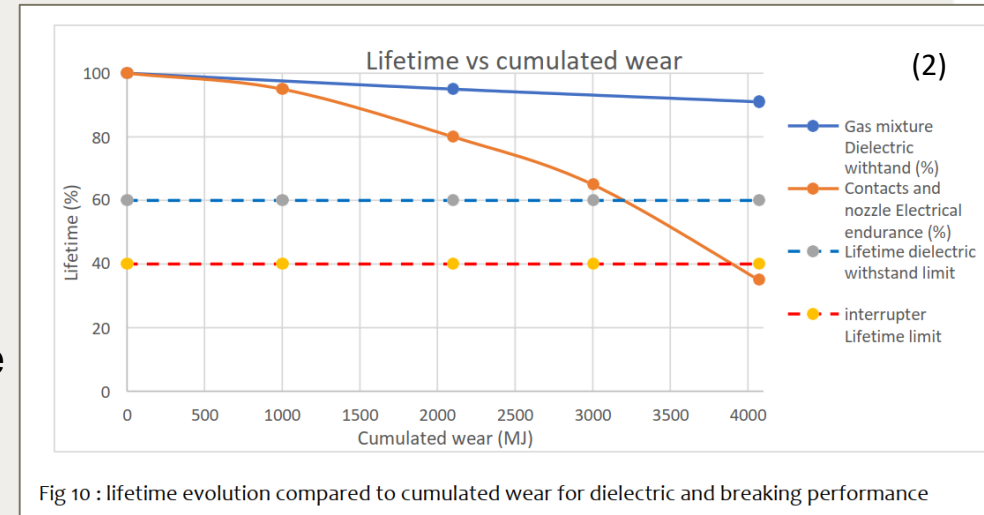
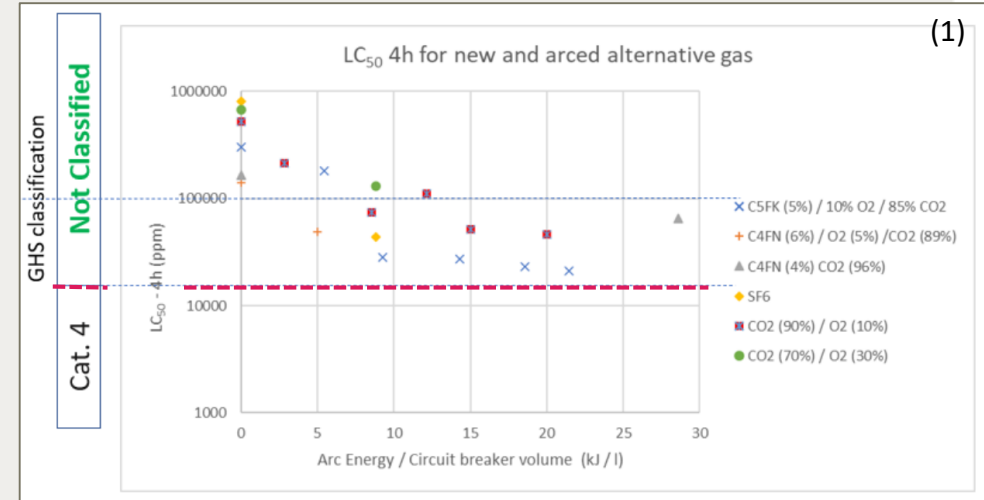


Fig 10 : lifetime evolution compared to cumulated wear for dielectric and breaking performance



References:

(1) CIGRE TB 87: Current Interruption in SF₆-free Switchgear

(2) CIGRE 2020, A3-117:

Return of experience of the SF₆-free solution by the use of Fluoronitrile gas mixture and progress on coverage of full range of transmission equipment