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High filling pressure trend of potential SF_6 alternative gases and its measures

B3

Pref. Subject 2 Question PS2.2

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Question PS2.2

- Much development has taken place to reduce SF_6 impact on the environment from utility application for electrical insulating and interrupting equipment. What are likely to be the enduring **initiatives to** prevent SF_6 gas leaks and **find a possible alternative to SF_6 for GIS applications?**

Answer

- **SF_6 alternatives:** Two main streams (Dry air + VCB, New F-gas mixtures)
- **Challenge for potential alternatives:** High filling pressure, especially at EHV equipment
- **A topic of study:** Lifetime evaluation of EPDM O-ring in high-pressure dry air

  ->> **Enough lifetime** considering annual equivalent temperature

Typical measures for high filling pressure (Fig.1) reported in literatures

- Improvements of gas monitoring system
- Safety against internal arc, including pressure relief device
- Insulators reinforcement, and safety pressure reduction of the adjacent gas compartments
- Interface compatibility, e.g. cable boxes, bushings / transformer connections
- Lifetime of gasket against high oxidation
- Measures against abnormal gas leakage from EHS viewpoints

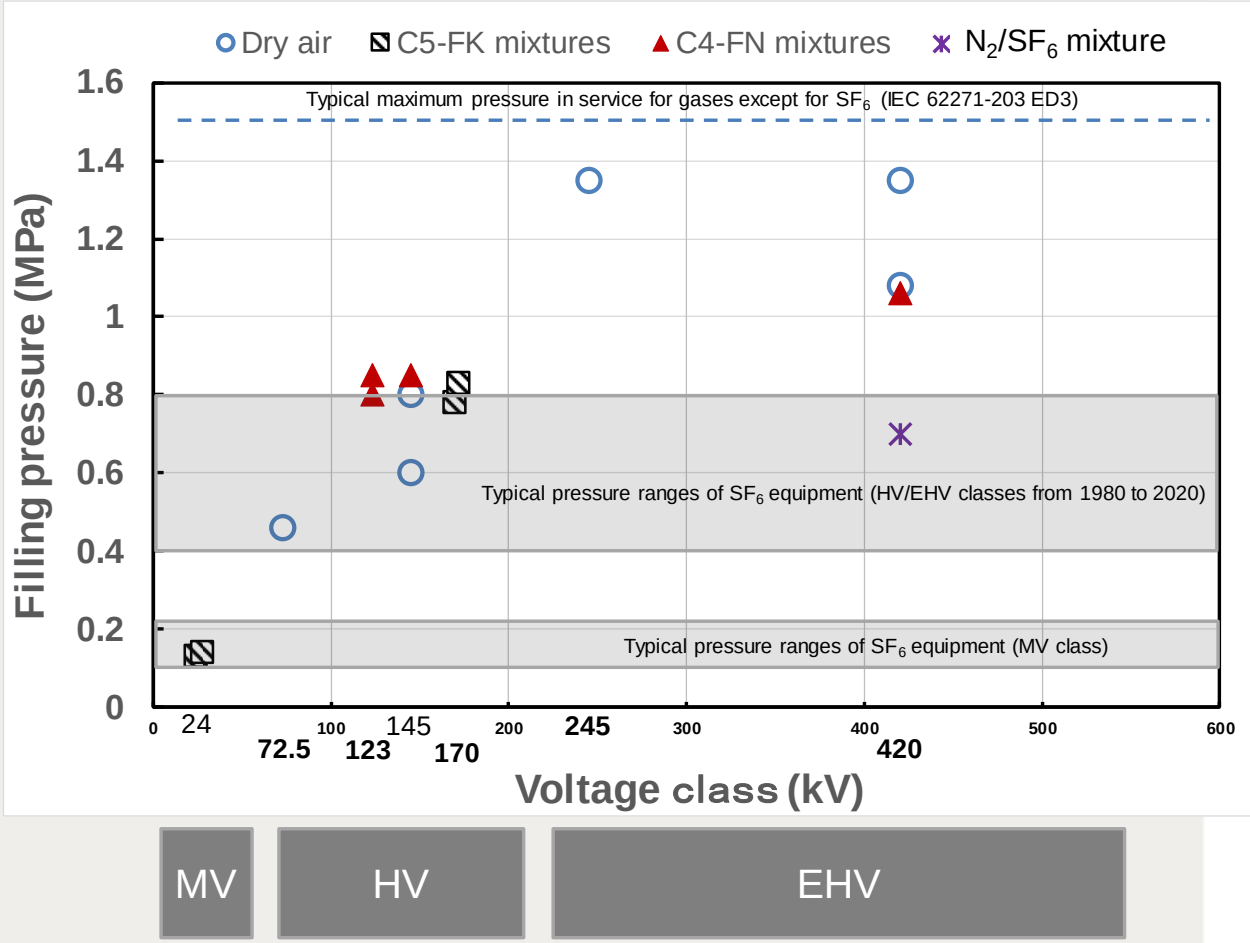

Figure 1: Filling pressure vs. voltage class of equipment. Equipment at 245 kV and 420 kV is GIL and voltage transformers, while the others are GIS.

Lifetime of EPDM O-ring - A topic of study (for high filling pressure)

- **Test conditions / measurements** (Fig. 2)
  - ✓ Gasket: EPDM O-ring (to investigate oxidative degradation of EPDM O-ring in high-pressure dry air)
  - ✓ Dry air pressure: 0.8 MPa

  ->> Accelerated tests on compression set was done at three temperature levels.

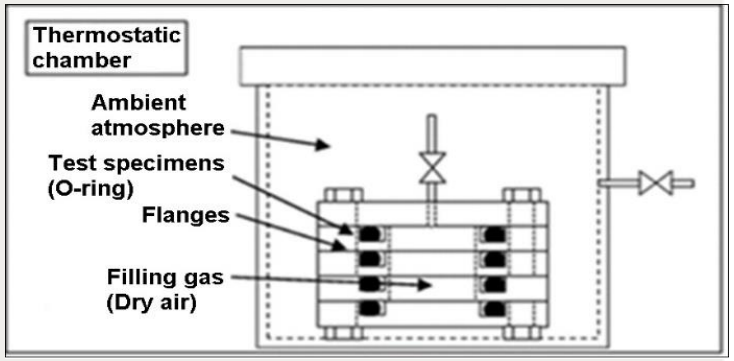

Figure 2: Test facility for O-ring ageing test.

- **Results / discussions**
  - ✓ Lifetime: evaluated by 80% compression set (Fig. 3)
  - ✓ Annual equivalent temperature T_{eq} was applied, considering annual temperature change at the O-ring (temperature rise by load current = 40K).

  ->> T_{eq} : 64.2…66.3 °C (at 3 typical regions in Japan)

  ->> Lifetime: over 100 years (Fig. 3)

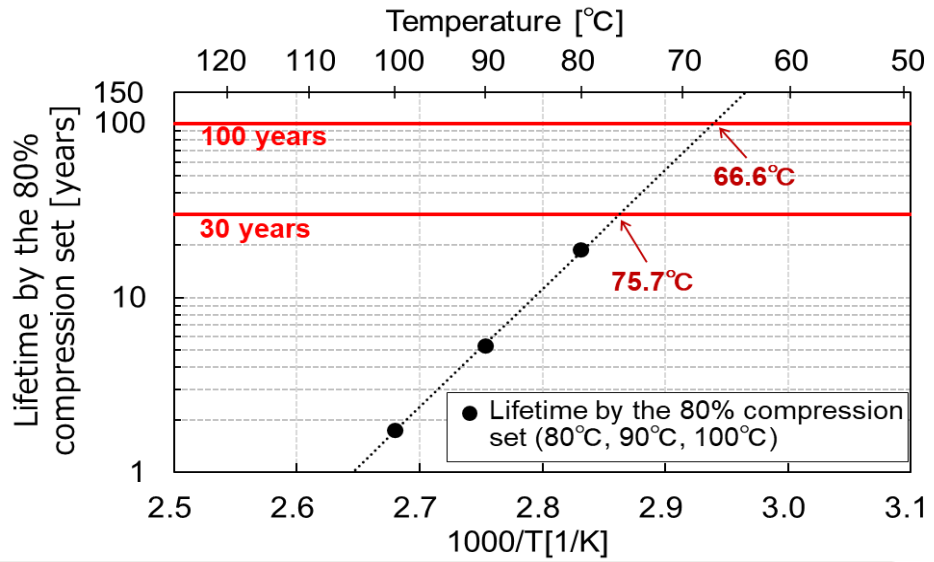

Figure 3: Arrhenius plot of O-ring lifetime by 80% compression set

Summary: Challenges for potential SF_6 alternatives
(dry air + VCB, new F-gas mixtures)

- **Measures for high filling pressures are necessary.**

  ✓Gas monitoring system, safety against internal arc, safety pressure reduction, interface compatibility, EHS against abnormal leakage were already reported.

  ✓**As a topic of study**, oxidative degradation of EPDM O-ring in high-pressure dry air was investigated by using annual equivalent temperature.

  ->> Acceptable **lifetime** was found at the three typical regions in Japan.