MV C4-FN MIXTURE HARMINIZATION IN NORTH AMERICA

North America distribution switchgear it's usually required to be exposed to ambient climate without thermal protection or external heating. Rather than having a electric room, switchgear is installed as a stand-alone instrument. The ambient temperature while in service can then vary depending on the location from +65C/-30C to +50C/-40C.

Switchgear is required to require minimum service during commissioning and service. Due to utilities and transportation regulations, pressure must be bellow 2bar absolute. At the same time, it's common to require the same size and ratings as SF6 switchgear.

The application of the gas media can be used as insulation media for circuit breakers making use of vacuum breakers, or for load break where the gas media is used for the interruption of load current and fault making.

Low temperature testing

Under the requirements listed above, C4-FN mixtures were identified as the ideal media to replace SF6 that could englobe all the applications.

We analyzed the dielectric performance of 5%, 10% and 15% mol C4-FN gas mixtures with CO2 as a carrier gas. The pressure was 1.7bar absolute at 20C.

The evaluation was performed using simple geometries of flat to rod electrodes across different temperatures (20C, -20C, -25C and -30C) for which partial liquification didn't occur.

The results show that gases show a consistent performance through the range of temperatures. The performance of C4-FN was inferior to SF6 by 20 to 30%.

Although 15% C4-FN performed the best of the alternative gas mixtures, even a 5% C4-FN greatly increases the dielectric performance.

Partial liquification dynamics and dielectrics

In order to analyze the liquification dynamics, we introduced a switch device in a temperature chamber and exposed it to temperatures that would cause the mixture to liquify. The device was filled at 1.7bar absolute of a 13/87 C4-FN/CO2 ratio. Interestingly, no mist or fog was observed during the ramp up or ramp down of temperature (10C/h). The gas mixture drift was recorded for -45C and -50C to be 11.4% and 8.8% respectively. The homogenization was recorded to happen in approximately 24h under -40C. The mixture homogenizes from the bottom up.

Conclusion

The device passed power frequency test at 80% of the power frequency voltage (48kV) during the transition from -50C to 20C (homogenization). The device's gas mixture homogenized after 24h from 32% partial liquification.

Partial liquification should be avoided as it's not clear how the homogenization dynamics may work for different geometries. However, device it's functional up to 80% of the rated power frequency voltage.

Gas mixture used C4-FN/CO2 at a 13/87 ratio with 4.4kg/m3 density it's stable in gas phase for temperatures lower than -40C. From other works, O2 is not required for load break and insulation applications. The gas mixture has been harmonized with another MV manufacturer as 13/87 mol ratio.