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Insulation characteristics of eco-friendly insulating gas with potential to replace SF_6 at equivalent pressure

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SF_6 gas has been widely used in high-voltage gas insulated electrical equipment[1]. As SF_6 gas has the highest global warming potential(GWP) and it is hard to be degraded, searching for eco-friendly insulated gas becomes a hot point[2]. When replacing SF_6 gas with eco-friendly gas in high-voltage equipment, the gas pressure is often increased to meet insulation requirements, such as C_4F_7N mixed gas and dry air[3-4]. High pressure also increases the cost of equipment manufacturing, operation and maintenance. So it is necessary to find eco-friendly gases that can be used at the same pressure with SF_6, which requires finding a gas with higher insulation strength and lower liquefaction temperature.

In this work, we will propose a new type of insulated gas mixture that can replace SF_6 at equal pressure of 0.5 MPa, and its liquefaction temperature is as low as -25℃. The insulation and liquefaction performance of the proposed gas is better than C_4F_7N mixed gas. It has great potential for use in practical devices.

A rod-plate electrode is used to simulate slightly nonuniform electric field. The radius of rod electrode is 5 mm, and the diameter of the plate electrode is 25 mm. The gap distance is 5 mm. The electrode material is tungsten copper, which is resistant to ablation. The rod electrode is connected to high voltage and the plate electrode is grounded.

The experimental results in Figure 1 show that the breakdown voltages of $CF_3SO_2F/C_4F_7N/N_2$ and $CF_3SO_2F/C_4F_7N/CO_2$ are both comparible to SF_6 at 0.5 MPa. The calculation results of liquefaction temperature indicate that it can be used at a minimum of -25 ℃. This result is better than the current C_4F_7N binary mixture gas, as the ternary gas significantly reduces the pressure. The GWP calculation results indicate that the GWP of CF_3SO_2F ternary gases can be reduced to below 2000 with appropriate ratios. These results indicate that CF_3SO_2F ternary gases have certain substitution potential.

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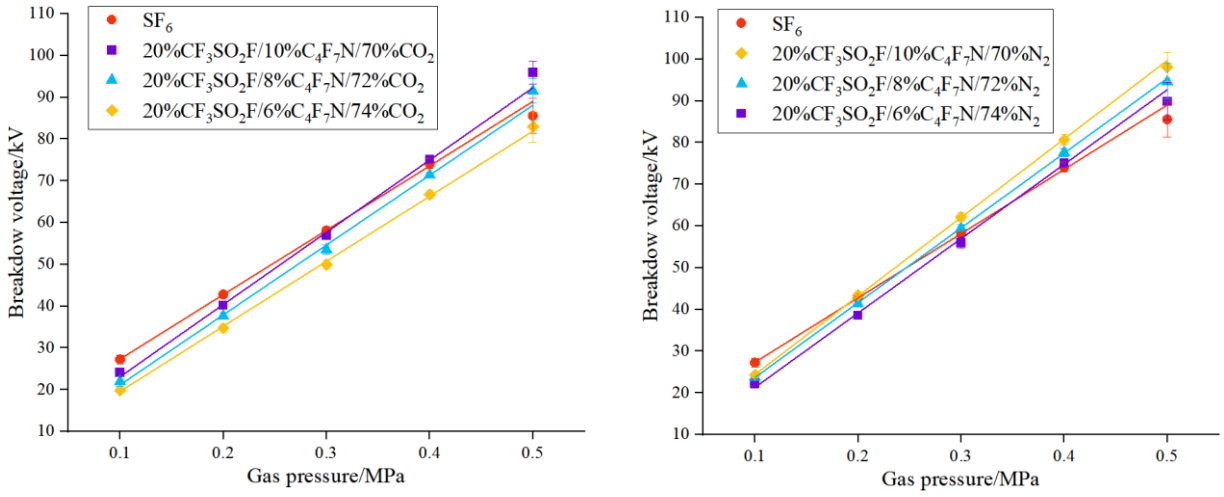

Figure 1. Breakdown characteristics of CF_3SO_2F ternary mixtures that are potential to replace SF_6 at equivalent pressures. (a) is the $CF_3SO_2F/C_4F_7N/CO_2$ ternary gas mixtures and (b) is the $CF_3SO_2F/C_4F_7N/N_2$ ternary gas mixtures.