https://doi.org/10.69646/aob241119

Electrical Breakdown in trans-1,3,3,3-Tetrafluoropropene HFO1234ze(E)

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Hydrofluoroolefins, unsaturated organic compounds developed as "fourth generation" refrigerants, possess only 0.1% of the Global Warming Potential (GWP) of hydrofluorocarbons (HFCs) and have negligible Ozone Depletion Potential (ODP). Their excellent eco-friendly properties make them suitable for use in air conditioning systems and they are also considered to be potential replacements for SF_6 in dielectric applications. In recent years, trans-1,3,3,3-Tetrafluoropropene (HFO1234ze(E)) has garnered the research community's interest due to its applications in medium and high voltage gas-insulated transmission and distribution equipment (HV and MV GIE), as well as in RPC particle detectors (Koch and Franck 2015, Hosl et al. 2020, Chachereau et al. 2016, Preve et al. 2017). The improvement of existing applications relies on relevant and reliable data, which can be obtained from breakdown measurements. Here, we present the results from our measurements of dc breakdown in trans-1,3,3,3-tetrafluoropropene. Our measurements are done in a centimeter-sized plan-parallel electrode system (Sivoš et al. 2020), under swarm conditions at low currents (~ 1 μA) and low pressures (~ 0.05 – 3 Torr). In Figure 1, we present breakdown results for trans-1,3,3,3-Tetrafluoropropene (HFO1234ze(E), $C_3H_2F_4$) in comparison with sulfur hexafluoride (SF_6). Paschen curve of HFO1234ze(E) is recorded for electrode distance of 1 cm. The minimum breakdown voltage of 482 V occurs at pd = 0.25 Torrcm (p – pressure, d – electrode distance). The discharge ignites and operates stably at low-currents up to ~ 0.8 Torrcm, but above this value discharge ignites into periodic relaxation oscillations (Kuschel et al. 2011). The breakdown voltage values for HFO1234ze (E) are slightly lower than those for SF_6 around the Paschen minimum and on the right-hand side of the Paschen curve.

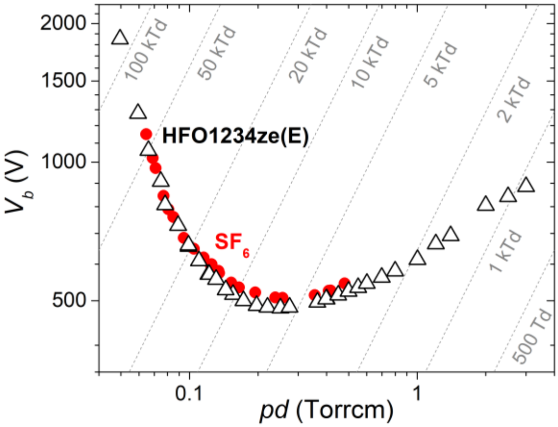

Fig. 1. Comparison of Paschen curves for trans-1,3,3,3-Tetrafluoropropene (HFO1234ze(E)) (black open triangles) and sulfur hexafluoride (SF_6) (red solid circles) (Stefanović 1998, Marić et al. 2014). Curves have been obtained for an electrode distance of 1 cm.

On the other hand, at lower pressures, the breakdown voltage of HFO1234ze(E) increases steeply and becomes nearly equal to SF_6. Although HFO1234ze(E) shows significant insulation potential, it is not sufficient as a standalone substitute for SF_6.

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia, Grant No. 7749560, project EGWIn. Zoran Lj. Petrović is grateful to the SASA project F155.

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