Research and Findings on Alternatives to Pure SF_6

Loucas G. Christophorou
National Institute of Standards and Technology
Gaithersburg, MD

The best response to the concerns regarding the possible impact of SF_6 on global warming is to prevent the release of SF_6 into the environment. A way to achieve this goal is to use alternative, environmentally more acceptable gaseous dielectrics.

The search for SF_6 substitutes traces back many years. Its aim has recently been shifted from finding gases/mixtures "superior" to SF_6 to finding gases/mixtures that are comparable in dielectric strength and performance to SF_6, but are environmentally acceptable.

To have a high dielectric strength, a gas has to be electronegative; that is, it has to be able to remove electrons from the gaseous medium by electron attachment [1,2,3]. Although many electronegative gases have been identified to perform better than SF_6 [1-5], these are not without problems. Non-electronegative gases that are benign and environmentally ideal, such as N_2, normally have low dielectric strengths and lack the fundamental properties to be used by themselves in certain important areas such as circuit breakers. Nonetheless, such environmentally friendly gases might be used by themselves at higher pressures, or at comparatively lower pressures as the main component in mixtures with electronegative gases (e. g., c-C_4F_8), including SF_6. The dielectric strength of many such mixtures has been shown to be synergistically enhanced—that is, to exceed the partial-pressure-weighted average of the dielectric strengths of the component gases [1,2,3].

Based on the work of a recent study, high-pressure (_1 MPa) N_2 and low-concentration (< 20% SF_6) in SF_6/N_2 mixtures can be used for electrical insulation [3]. Higher SF_6 concentrations (40% to 50%) in N_2 can be used for arc quenching, current interruption, and transformers.

Although the need for alternatives to SF_6 is pressing, regrettably, there is presently no program looking *systematically* for substitutes. The establishment of such a program is urged.

Possible components of such a program may be:

- An in-depth investigation of the overall properties of SF_6/N_2 mixtures, with full characterization of their behavior at high pressures (0.6-1.2 MPa), and their discharge/arc decomposition products and reactions (some recent results on SF_6/N_2 mixtures can be found in Refs. 6 and 7).

- An investigation at high pressure (1.0-1.5 MPa) of *non-electron attaching* gases (e. g., N_2) and *weakly electron attaching* (e.g., CO_2) gases.

- An effort to identify good dielectric gases with an infrared window.

New substitute gases need to be looked at in combination with the use of new equipment, and not just for use in existing equipment designed for pure SF_6.

The need for alternative gases to SF_6 will be magnified if the use of gaseous dielectrics is greatly expanded, for instance, by wider use of long transmission lines.

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