Flammability Properties of Partially Fluorinated Hydrocarbons

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The need to replace nonflammable chlorofluorocarbon refrigerants for protection of stratospheric ozone has raised concern about flammability of proposed alternatives. This need has increased interest in studying refrigerant flammability in recent years and has resulted in several reviews and investigations of methods used for flammability measurements. Nevertheless, the questions of how experimental data obtained in a small scale experiment will carry over to the appraisal of a fire hazard in real large-scale application and how isomeric structure will affect the flammability limits still remain. In this work, in order to investigate these two questions, lower flammability limits of 1,1,1-trifluoroethane (R-143a) and 1,1,2-trifluoroethane (R-143) are measured at 21 ºC using 3, 5, 12, and 20 L vessels by using ASTM E 681 method. A spark ignition source is used with the voltage adjusted to the value where dielectric breakdown just begins to occur (approximately 7–12 kV). The results demonstrated a higher concentration for the lower flammability limit for the vessels smaller than 5 L, suggesting that wall effects quench the flame propagation. The lower flammability limits for vessels with a 5 L or greater volume are in good agreement with those obtained in earlier investigations. For 5 L and larger vessels the lower flammability limits systematically shift to higher concentrations of both R-143a and R-143 with increasing vessel size, which is consistent with a percolation model for spatial flame propagation. Results also indicate that more polar isomeric structure will have a higher lower flammability limit, which is consistent with percolation theory.