Thermodynamic Properties of Binary Mixtures Containing of Hydrofluorocarbons and Hydrofluorolefins: New Data and Modelling

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Hydrofluorolefins (HFOs) are a new class of more environmentally-friendly refrigerant with zero ozone depletion potential, low global warming potentials, and low flammability. In this work, thermophysical property data for equimolar mixtures of HFOs (specifically R1234yf and R1234ze(E)) and hydrofluorocarbons (R32, R125, R134a, R143a, and R152a) are presented. The following properties were measured:

- Vapor-liquid equilibria (VLE) of five equimolar binary mixtures: R1234ze(E) + [R125, R134a, R143a, R1234yf] and R1234yf + R32 by the analytic method (sampling with gas chromatograph analysis) at temperatures of (273, 293 and 343) K and pressures from (280 to 2600) kPa. The standard uncertainties in the measured mole fractions were approximately 0.02·*x* or smaller.
- Liquid and vapor densities of eight equimolar mixtures: R1234ze(E) + [R125, R134a, R143a, R1234yf]; R1234yf + [R125, R134a, R143a]; and R125 + R152a measured by vibrating tube densimetry at temperatures between (252 and 403) K and pressures from (540 to 4200) kPa. The standard uncertainty in the density measurements were about 0.1 % for the liquid phase and about 3 $kg.m^{-3}$ for the vapor phase.
- Liquid isobaric heat capacities of seven equimolar binary mixtures: R1234ze(E) + [R125, R134a, R143a, R1234yf]; R1234yf + [R125, R143a]; and R125 + R152a and pure R1234yf and R1234ze(E) by differential scanning calorimetry at temperatures between (283 and 313) K and pressures between (570 and 3100) kPa. The standard uncertainty in heat capacity was about 1 %.

Our measurements were combined with literature data available for these binary mixtures to optimize the mixture parameters in the models used in NIST REPFROP 9.1 and thereby improve thermodynamic property predictions for mixtures of HFO and HFC refrigerants. Significant improvements in the predicted properties were achieved, particularly for the density where, for the example of (R143a + R1234yf), the deviation of the model from the data was reduced from over 1 % to 0.06 %. The measurements and modelling conducted in this work should allow the more accurate simulation of refrigeration processes using mixtures of these refrigerants.