Thermodynamic Properties of the Mixtures R23/R744 and R41/R744 and their Efficiency as Refrigerants

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Mixtures of refrigerants are widely used as working substances for refrigerating plants. Among them, mixtures of ozone-safe and natural refrigerants, in particular R23/R744 and R41/R744, are important. For calculating their thermodynamic properties, we compiled equations of state on the basis of the method in [1]. According to this reference, the equation of state for a mixture is presented as a combination of Helmholtz free energies of the components and an interaction function. For determination of the coefficients of these functions on the basis of experimental data on thermal properties, a stepwise regression analysis method was used. By means of compiled equations, tables of thermodynamic properties at temperatures 240 - 400 K and pressures 0.05 - 6 MPa for R23/R744 and 220 - 420 K and 0.05 - 35 MPa for R41/R744 were calculated. As a result of comparison with experimental data and with data calculated by the system REFPROP [2], an estimation of errors in the obtained values of mixtures' properties was determined. For the majority of values of density, enthalpy, and entropy, these errors do not exceed 0.4 %, 4 kJ/kg, and 0.01 kJ/(kg·K). Therefore the accuracy of the obtained values of properties is acceptable for engineering calculations. The thermodynamic behavior of both mixtures at phase equilibrium was investigated. It is established that the difference of temperatures of saturated vapor and liquid on isobars for these mixtures does not exceed 2 K. Values of the refrigerating coefficient ε and the volumetric cooling capacity q_{0v} of a one-stage refrigerating plant were calculated using the investigated mixtures as refrigerants, their components, and R22. The compiled equations of state are included in the automated information system for calculation thermophysical properties of refrigerants developed by us.

1. Lemmon E.W., Jacobsen R.T. A generalized model for the thermodynamic properties of mixtures, International Journal of Thermophysics, Vol. 20, No. 3, 1999.
2. Lemmon E.W., McLinden M.O., and Huber M.L. REFPROP, Thermodynamic and Transport Properties of Refrigerants and Refrigerant Mixtures. Standard Reference Database 23 –Version 7.0, NIST, USA, 2002.