An Automated System for Calculating Thermophysical Properties of Natural and Ozone-Safe Refrigerants and Their Mixtures

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An automated system for calculating thermophysical properties of technically important natural and ozone-safe refrigerants has been created. It allows us to calculate properties of monatomic gases, nitrogen, oxygen, hydrogen, air, carbon dioxide, ammonia, some hydrocarbons (methane, ethane, ethylene, propane, n butane) and ozone-safe refrigerants (R23, R32, R125, R134a, R143a). The properties of mixtures of ozone-safe refrigerants and of ozone-safe and natural refrigerants (propane and carbon dioxide) can be calculated also.

The system provides calculation of temperature, pressure, density, enthalpy, entropy, isochoric and isobaric specific heat, speed of sound, Joule-Thomson coefficient, heat of vaporization, fugacity, viscosity, thermal conductivity, Prandtl number and some other properties. These data can be determined in the single-phase and two-phase regions and on the phase-equilibrium lines at temperatures from the triple point up to 1500 K and pressures up to 100 MPa at twelve combinations of independent variables: T, ρ; T, v; T, p; T, s; T, h; T, x; p, ρ; p, v; p, s; p, h; p, x and h, s. The calculations are fulfilled by method of iterations, which ensures good agreement of data, calculated at different independent variables. The software works in dialogue regime; therefore the chosen combination of the variables and their values are indicated by the user during the calculations.

For calculating thermodynamic properties in wide intervals of density and temperature, unified equations of state for gas and liquid are used. In some cases for greater reliability the user can calculate properties by means of equations compiled by different authors and compare obtained results. For determination of transport properties the dependences of viscosity and thermal conductivity on temperature and density are used.

The software of the system has a modular structure and permits an increase in the number of substances, properties, and independent variables. The system is effectively used for obtaining data on thermodynamic and transport properties, necessary for calculating the processes and cycles of cryogenic and refrigerating plants.