Wide-Ranging Speed of Sound Measurements in Supercritical Helium at High Pressures

Tobias Dietl[1, S] and Karsten Meier[1, C]

[1]*Institut für Thermodynamik, Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg, Hamburg, Germany*
karsten.meier@hsu-hh.de

Helium is used in many industrial, scientific, and metrological applications. However, its thermophysical properties in large temperature and pressure ranges are not accurately known. To fill a part of this gap, we performed comprehensive and accurate measurements of the speed of sound in supercritical helium between 80 K and 200 K at pressures up to 100 MPa with a double-path-length pulse-echo technique. To cover temperatures in this range, a cryogenic thermostat arrangement cooled with liquid nitrogen was used. The expanded (k=2) uncertainties are 2.5 mK in temperature, 0.005 % in pressure, and 0.015 % in speed of sound. We compare our data with experimental data of other authors from the literature, the current reference equation of state for helium, and a first-principles virial equation of state. Our new data are useful for developing an improved reference equation of state for helium, for assessing the region of convergence of the virial equation of state, and for validating results of molecular simulations.