The Speed of Sound and Derived Thermodynamic Properties of Para-Xylene at Temperatures between the Melting Temperature and 423 K and at Pressures between Saturation and 65 MPa

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Two independent, double-path, pulse-echo instruments (at UWA and NIST) were used to measure the speed of sound of para-xylene (p-xylene) from just above the melting temperature to 423 K at pressures from saturation to 65 MPa. The ultrasonic cells were calibrated in water at a reference temperature and a pressure of 0.1 MPa against the speed of sound given by the IAPWS-95 which, for that state point, has an uncertainty of 0.005 %. Corrections for the effects of temperature and pressure on the path length difference were included. The speed of sound at saturation conditions was obtained by extrapolation of the sound-speed data with respect to pressure at each experimental temperature. The experimental data were compared with the Helmholtz equation of state (EOS) of Zhou et al. for p-xylene, which is stated to have an uncertainty in sound speed of 0.3 % in the liquid region. Relative deviations between experiments and the EOS of up to 1 % were observed, especially at high temperatures and low pressures. Deviations between the two instruments, however, averaged just 0.05 %. The density and isobaric specific heat capacity of p-xylene were then obtained in the temperature range (306 to 423) K at pressures up to 65 MPa by thermodynamic integration of the sound-speed data. The maximum estimated expanded relative uncertainty of the speed of sound determined in this work is shown to be less than 0.08 % at a confidence level of 95 %, taking into consideration temperature and pressure stabilities. The present work suggests that the current Helmholtz model should be refit using the new experimental data.