Speed of Sound Measurements of Deuterium Oxide (D_2O) in the Temperature Range from (278.15 to 353.15) K at Pressures up to 20 MPa

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The speed of sound of deuterium oxide (heavy water, D_2O) was measured over the temperature range of (278.15 to 353.15) K with pressures up to 20 MPa utilizing the double-path length pulse-echo technique. The sound waves were propagated by a piezo transducer operated at high frequency, which was used both as emitter and receiver. Measurements were carried out using a single-burst method, whereby the echo signals were recorded with a digital oscilloscope and then loaded to a computer. Subsequently, the first echo signal of each path length was identified and processed by a special software data analysis tool, and the time of flight was computed. This single-burst method in conjunction with the new data analysis tool helped us to improve the reproducibility of the measurements and thus decreased the overall experimental uncertainty. The speed of sound system was calibrated with pure water at temperatures between T = (274.15 and 353.15) K and ambient pressure. The reference equation of state for ordinary water represents the calibration data within the uncertainty of the equation of 0.005 %. The relative combined expanded uncertainty (k = 2) in speed of sound for the measurements with deuterium oxide was 0.02 % over the entire temperature and pressure range. Comparisons of the measured sound speed data with other experimental data from literature and values calculated from a new reference equation of state for heavy water will be presented.