Measurements of Sound Speed in Gaseous Ethane by a Spherical Resonator for Determination of Reliable Virial Coefficients

M. Yasui and S. Yamamoto[S]
Graduate School of Science and Technology, Keio University, Yokohama, Japan

H. Sato[C]
Department of System Design Engineering, Faculty of Science and Technology, Keio University, Yokohama, Japan
hsato@sd.keio.ac.jp

The key for representing the reliable thermodynamic properties of real gases is to determine the second and third virial coefficients, which would be determined with the smallest uncertainty from accurate sound speed measurements. The spherical resonator method would be the best way to determine the speed of sound in the gaseous phase with the highest accuracy.

Accurate speeds of sound are useful for determining not only the thermodynamic properties, but also the transport properties. The thermodynamic properties, including the ideal-gas heat capacities, for refrigerants R32, R125, R134a, R143a, and R152a, were consistently determined by our group from the sound speed measurements, with an uncertainty of 72 ppm, using a spherical resonator. Simultaneously, we have consistently pointed it out that specific heat behavior near saturation cannot be correctly represented by many Helmholtz equations of state, because their second and third virial coefficients do not behave correctly. Astina and Adachi, from our group, have already established new Helmholtz equations of state for all of the important refrigerants whose specific heats behave reasonably near saturation. We also investigate to determine both thermodynamic and transport properties from the intermolecular potential models with parameters based on our speed-sound measurements.

In this report, we focus on our results for the establishment of a way to determine the second and third virial coefficients from our sound-speed measurements using a spherical resonator. For this purpose, we measured the speed of sound in gaseous ethane, because the temperature range of measurements seems to be important for the determination of virial coefficients. We will also study each factor included in the uncertainties of our measurements, such as the different sound speed values among different modes, and assess the virial coefficient values through measurements for ethane, C_2H_6.