Sound Speed and Ideal Gas Heat Capacity Data of Selected Siloxanes from Acoustic Measurements: $[SiO(CH_3)_2]_4$, $[SiO(CH_3)_2]_5$ and $[SiO(CH_3)_2]_6$

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Siloxanes are a class of organic fluids composed of molecules containing alternate silicon and oxygen atoms in either a linear or cyclic arrangement, usually with one or two methyl groups attached to each silicon atom. Due to favorable characteristics of these fluids, i.e. non-toxicity, good thermal stability, limited flammability, and good thermodynamic properties regarding cycle design, they are used as working media in Organic Rankine Cycles and heat transfer equipment. A possible future application includes the use of siloxanes in high-temperature heat-pumps. Recently, using the Stryjeck-Vera modified Peng-Robinson Equation of State and the Harrison-Seaton zeroth order group contribution method for estimating the ideal gas isobaric heat capacity (ICP), it has been demonstrated that some of the heavy linear and cyclic siloxanes are Bethe-Zel'dovich-Thompson (BZT) fluids, i.e., these specific siloxanes may exhibit nonclassical gas dynamic behavior in a certain single phase thermodynamic region close to the critical point (approx. at reduced pressures between 0.7 and 1 with respect to the critical pressure and reduced temperatures between 0.95 and 1 with respect to the critical temperature). For the investigation on BZT fluids currently ongoing at the Process and Energy Technology Department of the Delft University of Technology, accurate ICP data are required. Unfortunately, these data are unavailable for the fluids of interest, namely octamethylcyclotetrasiloxane, decamethylcyclo-pentasiloxane and dodecamethylcyclohexasiloxane, and need to be estimated using the previously mentioned estimation technique. The Harrison-Seaton method allows for estimation of ICP data with an uncertainty on the order of 25 %. To reduce the uncertainty in estimated ICP values, the well-established acoustic resonance technique has been employed to measure low-pressure speed-of-sound data from which the ICP at a certain temperature can be deduced. The measurements were done at NIST using a cylindrical acoustic resonator. The cylindrical resonator allows for measuring the speed-of-sound with an uncertainty of xx % and of ICP data with an uncertainty of yy %. Results indicate that the speeds-of-sound data are measured with an uncertainty of less than xx % for all three siloxanes and the extrapolated ICP data have an uncertainty of at most yy %. Although the obtained ICP data have an uncertainty greater than what is common for measurements in the cylindrical resonator, the obtained sound speed and ICP data in the low-pressure gas phase are the only experimental data available. The comparatively larger uncertainties are a consequence of the molecular complexity of the three cyclic siloxanes under investigation, which posed additional experimental problems.