

Progress in the Determination of Dielectric and Density Virial Coefficients of Argon

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The realization and development of new gas-based temperature and pressure standards is relying on accurately determined gas properties. Calculating these properties by *ab initio* methods with lower uncertainties than experimentally achievable is currently only possible for helium which has the drawback that the desired measurement effect itself is comparably small. While the molar polarizability of argon is about eight times higher making it more suitable for these applications, the potential of theoretical calculations is here limited by the complex electron structure. To allow the application of argon on a metrological level and to provide comparative values for calculations, an innovative apparatus for the experimental determination of dielectric and density virial coefficients has been built up at PTB [1]. First sums of virial coefficients and the molar polarizability are determined by dielectric-constant gas thermometry. In the second step the dielectric and density virial coefficients are extracted separately from the capacitance and pressure ratios obtained by expansion experiments. The combination of these two methods grants cross validated measurements with low uncertainties in the temperature range (-40 - 90) °C for pressures up to 7 MPa. The key component of the device are four measurement cells equipped with cylindrical capacitors which are connected by a symmetric ultra-high purity gas handling system that allows to expand gas from any one into any other cell. The benefits of this special design are presented together with the main sources of uncertainty like dead volumes, temperature gradients, volume expansion of the measurement cells and compression of the capacitor electrodes under gas pressure. Experimental progress and latest results for the dielectric and density virial coefficients from isothermal measurements with argon are shown and compared to the available literature values.

References:

- [1] C. Guenz, C.Gaiser, M.Richter., Meas. Sci. Technol. **28**, 027002 (2017)