Density and Dielectric Virial Coefficients of Argon for Applications in Gas Metrology

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As a result of the redefinition of the international system of units in 2019, different primary gas-based thermometers were incorporated in the MeP-K. They are now approved methods for the realization of the base unit kelvin. Competitive uncertainties and working ranges of these and other gas-based methods (for instance in the field of optical pressure measurement) critically depend on the knowledge of thermophysical properties of the used measuring gas. While typically helium is used, Argon has a measuring effect which is eight times higher because of the higher molar polarizability. Unlike helium its properties cannot be calculated with the required uncertainties yet. Therefore, innovative and automated combined DCGT and expansion experiments were performed at PTB to obtain the density and dielectric virial coefficients as well as their combinations in form of the DCGT virial coefficients. The previously presented apparatus [1] was revised and equipped with a smaller expansion chamber. This allowed to obtain 16 measurement points within one isothermal measurement between 1 MPa and 7 MPa enabling the application of required higher fit orders. Novel working equations taking into account dead volumes at different temperatures and the deformation of the measuring cells were derived and will be presented together with the dominating sources of uncertainty. Key results will be presented for the temperatures 253 K, 273 K, 296 K and 303 K in form of the second and third density virial coefficients. Furthermore, for the first time in three decades values for the small second dielectric virial coefficient of argon will be presented.

References

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