First Results of Density and Dielectric Virial Coefficients of Hydrogen

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In the wake of climate change, green hydrogen has gained popularity as a possible sustainable source of energy over the last years. Generally, not only pure hydrogen, e.g., for fuel cell applications, but also binary mixtures, e.g., with methane for power to gas applications and transport in the existing natural gas pipeline grid, are of interest. To fully utilize hydrogen and its mixtures as a large-scale fuel source, accurate knowledge of the thermodynamic properties is essential. However, the underlying data of the current reference fundamental equation of state for pure hydrogen by Leachman *et al.* (2009) often dates back to the 1960s, hence verification and improvement is required [1]. We used dielectric-constant gas thermometry (DCGT) to determine the molar polarizability as well as combinations of density and dielectric virial coefficients, the so-called DCGT virial coefficients. The experimental setup allows performing additional Burnett expansions. The measured pressure and capacitance ratios can be used for the separate determination of the density and dielectric virial coefficients. Knowledge of the absolute density of the gas is not required. The setup used for these experiments was described in detail in Ref. [2]. An improved setup is currently being developed and will be used in the future to verify the results and measure hydrogen-methane mixtures. Both setups consist of four measurement chambers, each equipped with a cylindrical capacitator and interlinked with a gas-handling system to enable the expansions. The first measurements were performed in the temperature range from 253 K to ambient temperature. The results will be compared to literaturer data of other authors. The temperature range will be extended up to 350 K to complement the Burnett data measured by Sakoda *et al.* for temperatures between 353 K and 473 K in 2012 [3]. Furthermore, experimental details and the key improvements of the new experimental setup as well as difficulties and setbacks regarding the handling of hydrogen will be discussed.

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