Binary Diffusion Coefficients of Argon-Neon Mixtures Derived from Refractive Index Measurements in a Loschmidt Cell Combined with Holographic Interferometry

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A new variant of the Loschmidt-cell technique combined with holographic interferometry has been developed to perform measurements of the binary diffusion coefficients of gases in a temperature range from 10 to 80 °C and between 1 bar and 10 bar with an uncertainty of ±1% almost over the complete range of mole fractions. The newly designed Loschmidt cell is distinguished from usual shear cells. Its two half cells have rectangular cross sections and are mounted stationary one upon the other. The half cells can be connected and separated by using a slide which belongs to the upper cell. The half cells are sealed against each other during the filling process with the gases by using an elastomeric seal operated pneumatically. The measuring temperature is controlled using a thermostat whose liquid circulates through a specially designed housing surrounding the Loschmidt cell.

To gain the dependence of the diffusion coefficient over the whole mole fraction, the concentration is determined continuously and simultaneously in both half cells using a separate optical system for holographic interferometry. During the diffusion process, a vertical concentration gradient occurs in the measuring cell. This leads to a change of the refractive index and to an interference pattern recorded with a CCD camera as a function of time. Information about the density dependence of the refractive indices of the pure gases is needed for the further evaluation. For that purpose, the first refractivity virial coefficients for argon and neon have been determined with the same apparatus.
The performance of the experimental equipment is proven by measurements on the model system argon-neon. The resulting diffusion coefficients are compared with data from the literature and with theoretical values calculated in our working group using the kinetic theory of gases.