Universität Rostock Traditio et Innovatio

Book of Abstracts

2nd Symposium on Thermophysical properties for Technical Thermodynamics

Institute of Technical Thermodynamics

University of Rostock,

Rostock, Germany

March 27 – 28, 2013

MEASUREMENTS ON N- AND ISOBUTANE USING A VIBRATING-WIRE VISCOMETER AND CORRELATIONS OF THEIR VISCOSITY SURFACES USING A STRUCTURE-OPTIMISATION METHOD

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The exact knowledge of thermophysical properties of fluids with industrial importance is needed for a more accurate basic design of compressors, gas turbines, and gas pipelines. In contrast to the thermodynamic properties, the transport properties of n-butane and isobutane, particularly in the region near to the critical point, are not sufficiently well-known. The current viscosity-surface correlations are characterized by uncertainties of up to 6% in some regions.

New viscosity measurements were performed on n-butane and isobutane using a specially designed vibrating-wire viscometer together with a single-sinker densimeter and with precise measuring devices for temperature and pressure. Isothermal series of measurements were carried out between 298 K and 448 K for n-butane and between 298 K and 498 K for isobutane and at pressures up to 95% of the saturation pressure of the respective isotherm or up to 30 MPa for both fluids. The viscosity measurements are characterized by an uncertainty of (0.25-0.4)% increasing with temperature. The uncertainty of the density determination is estimated to be less than 0.1%, and is increased in the near critical region as well as in the low-density range due to the single-sinker method. The reproducibility of the measurements amounts to 0.05%, for both viscosity and density.

Consequently, the new experimental viscosity data are considered to be primary values. In addition, the density data obtained simultaneously with the viscosity data can be used to refine the current equations of state for n-butane and isobutane [Bücker and Wagner (2006)], which are characterized by uncertainties of 0.5% in pressure in the near critical region due to the experimental data available in the literature when the equations were developed.

The results of our measurements were compared with viscosity values obtained from the surface correlations by Vogel et al. (1999 and 2000) and with density values calculated from the equations of state by Bücker and Wagner (2006) as well as with the best experimental data available in the literature.

New viscosity-surface correlations for n-butane and isobutane were generated using the structure-optimisation method by Setzmann and Wagner (1989). The bank of terms comprises expressions for different regions: the limit of zero density, the moderately dense fluid, the dense liquid phase, and the near critical region. The results are compared to the primary data sets from the literature and from this work which were used in the development of the correlations.