Measurement and Modeling of Thermodynamic Properties for Various Hydrogen Carriers

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Hydrogen is a very promising material for capturing, gathering, and storing renewable energy. For the worldwide transportation of hydrogen, various hydrogen carriers have recently been suggested. We aim to support the development and control in hydrogen reforming processes from these hydrogen carriers, based on precise measurements and modeling of the thermodynamic properties of these substances and their mixtures. In our presentation, the current situation of the thermodynamic property models for toluene, cis-decalin, and methylcyclohexane, which are the main components in hydrogen reforming processes, will be reported.

To obtain measurements in the temperature range of the hydrogenation and dehydrogenation processes of the hydrogen carriers (commonly higher than 573 K), we use a modified metal-bellows volumometer at temperatures below 600 K. The expanded uncertainties (k=2) in the temperature, pressure, and density measurements of the apparatus are estimated to be less than 5 mK, 0.02 MPa, and 0.88 kg/m3 (T≤423 K, p<100 MPa), 0.76 kg/m3 (T≤423 K, p≥100 MPa), 0.76 kg/m3 (T>423 K, p<100 MPa), and 2.94 kg/m3 (T>423 K, p≥100 MPa), respectively. Throughout the fitting process of the present Helmholtz-type equations of state, we adopted the most up-to-date constraints to obtain the best coefficients and exponents of the equations of state and appropriate extrapolation behavior of various derived properties, for example, residual isochoric heat capacities and Phase Identification Parameters to assure thermodynamic consistency over the entire fluid-phase region.