PVT Property Measurements of Hydrogen at High Temperatures and High Pressures up to 773 K and 100 MPa

Naoya Sakoda C, S
Kyushu University, International Research Center for Hydrogen Energy, Fukuoka, Japan
sakoda@mech.kyushu-u.ac.jp

Koichi Motomura, Supriatno and Keisuke Kubo
Kyushu University, Department of Mechanical Engineering, Fukuoka, Japan

Kan’ei Shinzato
National Institute of Advanced Industrial Science and Technology (AIST), HYDROGENIUS, Fukuoka, Japan

Masamichi Kohno and Yasuyuki Takata
Kyushu University, Department of Mechanical Engineering, Fukuoka, Japan

Motoo Fujii
National Institute of Advanced Industrial Science and Technology (AIST), HYDROGENIUS, Fukuoka, Japan

Hydrogen is expected to be a next-generation clean energy carrier. However, the currently available thermodynamic property data are insufficient at high temperatures and high pressures, and new accurate data are required. Recently, we measured the PVT properties of hydrogen in the temperature range from 353 K to 473 K and at pressures up to 100 MPa by the Burnett method and developed a virial equation of state (EOS) based on the measured data. In the present work, a PVT property measurement apparatus was developed by the isochoric method to farther extend the temperature range up to 773 K. In the isochoric method, the sample cell (250 cc) is filled with a sample fluid, and the P-T relations along isochores are obtained by measuring the pressures at the temperatures to be studied. However, due to very low hydrogen density, it is difficult to measure the mass in the sample cell accurately. Using the apparatus, we then prepare an expansion cell that has a large volume (2500 cc) and combine with the gas expansion method to determine the densities of the isochores. Nitrogen was measured from 473 K to 773 K and up to 100 MPa. The obtained data are in good agreement with a reference EOS within 0.1 %. Finally, we measured the PVT properties of hydrogen from 473 K to 773 K and up to 100 MPa. The present data at 473 K agree with the data obtained by the Burnett method and the latest EOS within 0.1 %. As the temperature increases, the deviations between the present data and the EOS become larger and 0.3 % at 773 K.