IAPWS Certified Research Need
ICRN #6

Thermophysical Properties of Ammonia-Water Mixtures

ICRN Re-issue Date: September 1997
ICRN Expiration Date: September 2000

Closure Document

In consideration of the expiration of this ICRN and in accordance with the guidance of the EC (item 7.12 from the Minutes of 2001), the Working Groups on the Thermophysical Properties of Water and Steam and Physical Chemistry of Aqueous Solutions jointly recommend this closing statement.

Background:

An ICRN on the Thermophysical Properties of Ammonia-Water Mixtures was first issued in 1994 and extended (with minor revision) in 1997. During this period extensive work on the thermodynamic properties of the mixture has been completed.

Results Achieved:

The Guideline on the *IAPWS Formulation 2000 for the Thermodynamic Properties of Ammonia-Water Mixtures* was adopted in 2001; this document is available on at http://www.iapws.org. Experimental, modeling, and bibliographic studies were completed in several IAPWS member countries including Britain and Ireland; the Czech Republic; Denmark; Germany; Japan; and the United States. We list a few key reports and publications on work related to the subject of this ICRN, although we emphasize that this should not be considered a complete reference list:

F. Maršik and P. Šafařik, “Some Remarks on Critical Behaviour of Ammonia-Water Mixture,” presented at TPWS/PCAS Joint Session, IAPWS Annual Meeting, Prague (2000).

K. Oguchi, H. Kitamura, H. Ishii, and H. Saito, “Examination of the PVTx Properties for NH_3-H_2O Mixtures near the Maximum Density, presented at TPWS/PCAS Joint Session, IAPWS Annual Meeting, Prague (2000).

J. Suzuki and M. Uematsu, “Equation of State for Fluid Mixtures Based on the Principle of Corresponding States with a Two-Fluid Model: Application to Fluid Mixtures of Water + Ammonia,” Heat Trans. Asian Res. **31**, 320 (2002).

K. Thomsen and P. Rasmussen, in *Steam, Water and Hydrothermal Systems: Physics and Chemistry Meeting the Needs of Industry, Proc. 13th Int. Conf. on the Properties of Water and Steam*, P.R. Tremaine, P.G. Hill, D.E. Irish, and P.V. Balakrishnan, eds., NRC Research Press, Ottawa (2000); pp. 118-125.

R. Tillner-Roth and D.G. Friend, “A Helmholtz Free Energy Formulation of the Thermodynamic Properties of the Mixture {Water + Ammonia},” J. Phys. Chem. Ref. Data **27**, 63 (1998).

R. Tillner-Roth and D.G. Friend, “Survey and Assessment of Available Measurements on Thermodynamic Properties of the Mixture {Water + Ammonia},” J. Phys. Chem. Ref. Data **27**, 45 (1998).

C.J. Wormald and B. Wurzberger, “Second virial cross coefficients for (ammonia + water) derived from gas phase excess enthalpy measurements,” J. Chem. Thermodyn. **33**, 1193 (2001).

M. Uematsu, “Comparison of the Density Values in the Liquid Phase for Ammonia-Water Mixtures between the IAPWS Formulation 2000 and Experimental Data,” presented at TPWS/PCAS Joint Session, IAPWS Annual Meeting, Gaithersburg, MD (2001).

Conclusion:

Although a significant amount of work has now been completed on the ammonia-water systems, including the first IAPWS document describing a full thermodynamic surface for a mixture, additional work on this system would seem to be warranted. In particular, there are still essentially no results for the key transport properties (viscosity, thermal conductivity, and diffusion) for the ammonia-water mixture. Further, the IAPWS Guideline is recognized as a preliminary formulation, as it “can be expected to need revision as new measurements are made or new equations become available.” In particular, data were very limited in the important supercritical regions, the uncertainties could be reduced with new data, the locus of density maxima near the melting line is not well described by the formulation, and chemical speciation was not explicitly incorporated. For these reasons, a follow-on ICRN will be considered.