IAPWS Certified Research Need – ICRN

Thermal Conductivity of H_2O at Low Pressures and High Temperatures

Closing Statement

In 2009, the IAPWS Working Group "Thermophysical Properties of Water and Steam" examined the published work concerning the thermal conductivity of ordinary water near the dilute-gas limit. It was observed that the best theoretical calculations then available [1] differed significantly (by several percent) from available experimental data (see [2] for a summary of experimental data) at temperatures above roughly 500 K. This discrepancy led to the formulation of ICRN-24, Thermal Conductivity of H_2O at Low Pressures and High Temperatures. The ICRN encouraged new experimental and theoretical work to resolve this discrepancy. ICRN-24 was approved in September 2009 and revised and reissued in October 2012. At the IAPWS annual meeting in Stockholm in July 2015, it was decided to let this ICRN expire.

While we are not aware of any new experimental work during the period of the ICRN, there was new theoretical work that has mostly resolved the discrepancy. Hellmann and Bich [3] improved their kinetic theory calculations to better take into account the effects of internal degrees of freedom on the thermal conductivity, and found that this correction was important for polar molecules such as water. They published new calculated values of the dilute-gas thermal conductivity that are in much better agreement with experimental data. Agreement with the latest IAPWS formulation [2] is also improved.

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References

[1] Hellmann, R., Bich, E., Vogel, E., Dickinson, A.S., and Vesovic, V., Calculation of the transport and relaxation properties of dilute water vapor, *J. Chem. Phys.* **131**, 014303 (2009).

[2] Huber, M.L., Perkins, R.A., Friend, D.G., Sengers, J.V., Assael, M.J., Metaxa, I.N., Miyagawa, K, Hellmann, R., and Vogel, E., New International Formulation for the Thermal Conductivity of H_2O, *J. Phys. Chem. Ref. Data* **41**, 033102 (2012).

[3] Hellmann, R., and Bich, E., An improved kinetic theory approach for calculating the thermal conductivity of polyatomic gases, *Mol. Phys.* **113**, 176-183 (2015).