German National Committee to IAPWS

Research Activities on the Thermodynamic Properties of Water and Steam

Report "Research in Progress 2016"

Baltic Sea Research Institute, Warnemuende
Dr. Rainer Feistel

Projects

1. Development of a draft Advisory Note No. 6: "Relationship between Various IAPWS Documents and the International Thermodynamic Equation of Seawater – 2010 (TEOS-10)"
2. Preparation of a paper about Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air to be submitted to Int. J. Thermophys.
3. Preparation of a paper about unleashing empirical equations using nonlinear fitting & GUM tree calculator to be submitted to Int. J. Thermophys.
4. Preparation of a paper toward a fundamental definition on relative humidity to be submitted to Int. J. Thermophys.

Recent Publications

- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air.
  Int. J. Thermophys. (2016), in preparation.
- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Digital Supplement to "Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air".
  Int. J. Thermophys. (2016), in preparation.
- Lovell-Smith, J. W.; Saunders, P.; Feistel, R.:
  Unleashing empirical equations using nonlinear fitting & GUM tree calculator.
  Int. J. Thermophys. (2016), in preparation.
- Lovell-Smith, J. W.; Feistel, R.; (and others):
  Toward a fundamental definition on relative humidity.
  Int. J. Thermophys. (2016), in preparation.
- Feistel, R.; Lovell-Smith, J. W.; Saunders, P.; Seitz, S.:
  Uncertainty of Empirical Correlation Equations.
  Metrologia 53 (2016), pp. 1079-1090, doi: 10.1088/0026-1394/53/4/1079.
- Feistel, R.; Wielgosz, R.; Bell, S. A.; Camões, M. F.; Cooper, J. R.; Dexter, P.; Dickson, A. G.; Fisicaro, P.; Harvey, A. H.; Heinonen, M.; Hellmuth, O.; Kretzschmar, H.-J.; Lovell-Smith, J. W.; McDougall, T. J.; Pawlowicz, R.; Ridout, P.; Seitz, S.; Spitzer, P.; Stoica, D.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables: Oceanic salinity and pH, and atmospheric humidity. Part 1: Overview.
  Metrologia 53 (2016), pp. R1-R11, doi: 10.1088/0026-1394/53/1/R1.
- Pawlowicz, R.; Feistel, R.; McDougall, T. J.; Ridout, P.; Seitz, S.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables Part 2: Oceanic salinity.
  Metrologia 53 (2016), pp. R12-R25, doi: 10.1088/0026-1394/53/1/R12.

- Dickson, A. G.; Camões, M. F.; Spitzer, P.; Fisicaro, P.; Stoica, D.; Pawlowicz, R.; Feistel, R.:
  Metrological challenges for measurements of key climatological observables. Part 3: Seawater pH.
  Metrologia 53 (2016), pp. R26-R39, doi: 10.1088/0026-1394/53/1/R26.
- Lovell-Smith, J. W.; Feistel, R.; Harvey, A. H.; Hellmuth, O.; Bell, S. A.; Heinonen, M.; Cooper, J. R.:
  Metrological challenges for measurements of key climatological observables. Part 4: Atmospheric relative humidity.
  Metrologia 53 (2016), pp. R40-R59, doi: 10.1088/0026-1394/53/1/R40.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O. (Proposers):
  Guideline on a Virial Equation for the Fugacity of H2O in Humid Air.
  The International Association for the Properties of Water and Steam.
  Stockholm, Sweden, July 2015. Available at www.iapws.org.
- Feistel, R.:
  Salinity and relative humidity: climatological relevance and metrological needs.
  Acta Imeko 4, No. 4 (2015), 57-61.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O.:
  Virial Equation for the Fugacity of Water in Humid Air.
  Int. J. Thermophys. 36 (2015), pp. 44-68.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O.:
  Erratum to: Virial Approximation of the TEOS-10 Equation for the Fugacity of Water in Humid Air.
  Int. J. Thermophys. 36 (2015), p. 204.
- Kretzschmar, H.-J.; Herrmann, S.; Feistel, R.; Wagner, W.:
  The International IAPWS Formulation for the Thermodynamic Properties of Seawater for Desalination Processes.
  The International Desalination Association World Congress on Desalination and Water Reuse, San Diego, CA, USA (2015), doi: 10.13140/RG.2.1.4734.7444.
- Kretzschmar, H.-J.; Feistel, R.; Wagner, W.; Miyagawa, K.; Harvey, A. H.; Cooper, J. R.; Hiegemann, M.; Blangetti, F. L.; Orlov, K. A.; Weber, I.; Singh, A.; Herrmann, S.:
  The IAPWS Industrial Formulation for the Thermodynamic Properties of Seawater.
  Desalination and Water Treatment 55 (2015), pp. 1177-1199,
  doi: 10.1080/19443994.2014.925838.

German Aerospace Center (DLR), Cologne
Institute of Propulsion Technology
Prof. Dr. Francesca di Mare

Project

1. Implementation of the Fast Steam Property Algorithms Based on Spline Interpolation into the CFD Code TRACE
   - The draft “IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using the Spline-Based Table Look-Up Method (SBTL)” has been implemented into the CFD code TRACE.
   - On this basis the implementation has been further improved, especially regarding the software architecture, solution algorithm and boundary treatment.
   - The capability of the SBTL-method has been tested on Laval-nozzle and Cascade test cases. The calculation of a real steam engine configuration is targeted next.

Recent Publications

- Kunick, M.; Kretzschmar, H.-J.; Gampe, U.; di Mare, F.; Hrubý, J.; Duška, M.; Vinš, V.; Singh, A.; Miyagawa, K.; Weber, I.; Pawellek, R.; Novi, A.; Blangetti, F.; Friend, D. G.; Harvey, A.H.:
  Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL),
  J. Eng. Gas Turbines Power (2016), in preparation.

Leibniz Institute for Tropospheric Research, Leipzig
Dr. Olaf Hellmuth

Projects

1. Investigation on Virial Approximation for Humid Air
2. Preparation of a paper about Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air

Recent Publications

- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air.
  Int. J. Thermophys. (2016), in preparation.
- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Digital Supplement to "Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air".
  Int. J. Thermophys. (2016), in preparation.
- Feistel, R.; Wielgosz, R.; Bell, S. A.; Camões, M. F.; Cooper, J. R.; Dexter, P.; Dickson, A. G.; Fisicaro, P.; Harvey, A. H.; Heinonen, M.; Hellmuth, O.; Kretzschmar, H.-J.; Lovell-Smith, J. W.; McDougall, T. J.; Pawlowicz, R.; Ridout, P.; Seitz, S.; Spitzer, P.; Stoica, D.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables: Oceanic salinity and pH, and atmospheric humidity. Part 1: Overview.
  Metrologia 53 (2016), pp. R1-R11, doi: 10.1088/0026-1394/53/1/R1.
- Pawlowicz, R.; Feistel, R.; McDougall, T. J.; Ridout, P.; Seitz, S.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables Part 2: Oceanic salinity.
  Metrologia 53 (2016), pp. R12-R25, doi: 10.1088/0026-1394/53/1/R12.
- Lovell-Smith, J. W.; Feistel, R.; Harvey, A. H.; Hellmuth, O.; Bell, S. A.; Heinonen, M.; Cooper, J. R.:
  Metrological challenges for measurements of key climatological observables. Part 4: Atmospheric relative humidity.
  Metrologia 53 (2016), pp. R40-R59, doi: 10.1088/0026-1394/53/1/R40.
- Hellmuth, O.:
  Selected Aspects of New Particle Formation in the Earth Atmosphere: Phenomenology and Mechanistic Description.
  In: Schmelzer, J. W. P.; Hellmuth, O. (eds.): Nucleation Theory and Applications. Special Issues. Review Series on Selected Topics of Atmospheric Sol Formation: Volume 2. Joint Institute for Nuclear Research, Dubna, Russia (2016), in technical revision.

- Hellmuth, O.:
  Selected Aspects of New Particle Formation in the Earth Atmosphere: Organic Aerosol Formation and Pre-Nucleation Molecular Clustering.
  In: Schmelzer, J. W. P.; Hellmuth, O. (eds.): Nucleation Theory and Applications. Special Issues. Review Series on Selected Topics of Atmospheric Sol Formation: Volume 3. Joint Institute for Nuclear Research, Dubna, Russia (2016), in technical revision.
- Hellmuth, O.:
  Selected Aspects of New Particle Formation in the Earth Atmosphere: Ion-Mediated Aerosol Formation.
  In: Schmelzer, J. W. P.; Hellmuth, O. (eds.): Nucleation Theory and Applications. Special Issues. Review Series on Selected Topics of Atmospheric Sol Formation: Volume 4. Joint Institute for Nuclear Research, Dubna, Russia (2016), in technical revision.
- Lovell-Smith, J. W.; Feistel, R.; Hellmuth, O.:
  Toward a fundamental definition of relative humidity.
  TEMPMEKO 2016, XIII International Symposium on Temperature and Thermal Measurements in Industry and Science, June 26-July 1, 2016.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O.:
  Virial Approximation of the TEOS-10 Equation for the Fugacity of Water in Humid Air.
  Int. J. Thermophys. 36 (2015), pp. 44-68.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O.:
  Erratum to: Virial Approximation of the TEOS-10 Equation for the Fugacity of Water in Humid Air.
  Int. J. Thermophys. 36 (2015), p. 204.
- Hellmuth, O.; Shchekin, A. K.:
  Determination of interfacial parameters of a soluble particle in a nonideal solution from measured deliquescence and efflorescence humidities.
  Atmos. Chem. Phys. 15 (2015), pp. 3851-3871.
- Hellmuth, O.; Shchekin, A. K.:
  Supplement of "Determination of interfacial parameters of a soluble particle in a nonideal solution from measured deliquescence and efflorescence humidities".
  Supplement of Atmos. Chem. Phys. 15 (2015), pp. 3851-3871.
- Feistel, R.; Lovell-Smith, J. W.; Hellmuth, O. (Proposers):
  Guideline on a Virial Equation for the Fugacity of H2O in Humid Air.
  The International Association for the Properties of Water and Steam.
  Stockholm, Sweden, July 2015. Available at www.iapws.org.

Physikalisch-Technische Bundesanstalt Braunschweig und Berlin, Braunschweig
Dr. Henning Wolf

Recent Publications

- Schmidt, H.; Wolf, H.; Hassel, E.:
  A method to measure the density of seawater accurately to the level of 10^{-6}.
  Metrologia 53 (2016), pp. 770–786, doi: 10.1088/0026-1394/53/2/770.
- Feistel, R.; Wielgosz, R.; Bell, S. A.; Camões, M. F.; Cooper, J. R.; Dexter, P.; Dickson, A. G.; Fisicaro, P.; Harvey, A. H.; Heinonen, M.; Hellmuth, O.; Kretzschmar, H.-J.; Lovell-Smith, J. W.; McDougall, T. J.; Pawlowicz, R.; Ridout, P.; Seitz, S.; Spitzer, P.; Stoica, D.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables: Oceanic salinity and pH, and atmospheric humidity. Part 1: Overview.
  Metrologia 53 (2016), pp. R1–R11.

- Pawlowicz, R.; Feistel, R.; McDougall, T. J.; Ridout, P.; Seitz, S.; Wolf, H.:
  Metrological challenges for measurements of key climatological observables Part 2: Oceanic salinity.
  Metrologia 53 (2016), pp. R12-R25, doi: 10.1088/0026-1394/53/1/R12.

Ruhr University Bochum
Faculty of Mechanical Engineering, Department of Thermodynamics
Prof. Dr. Roland Span

Projects:

1. The first version of a new standard property model for CCS relevant mixtures was published by Gernert and Span (2016). This work is especially focused on humid mixtures, since existing models from the GERG-2008 package for natural gases are not designed for higher concentrations of water. The published version of the CCS mixture model will continuously be extended to further components. The current (still unpublished) status of the model enables a description of mixtures containing carbon dioxide, water, carbon monoxide, nitrogen, argon, oxygen, methane, hydrogen, hydrogen sulfide, sulfur dioxide, hydrogen chloride, chlorine, mono-, and diethanolamine. The proceeding development of this mixture model includes the generalized description of binary systems with a very limited data base as well as fitting binary-specific functions for well investigated systems (e.g. water + methane). All models are implemented in the software package TREND by Span et al. (2015), which is already used by more than 50 groups in academia and industry.
2. The work on models describing hydrate formation has been continued in cooperation with Dr. V. Vinš, Dr. J. Hrubý and Dr. A. Jäger. Dr. Jäger has changed to TU Dresden after completing his Ph.D. and is involving the thermodynamics group led by Prof. Dr. C. Breitkopf into the work on hydrates now as well. Three journal articles describing the status of the hydrate model in detail have been submitted. Two are available in print by now, one is still under revision (see literature). S. Hielscher will continue this work at RUB. The current (still unpublished) status of the hydrate model allows for a description of first mixed hydrates as well; to extend this status to further hydrate forming components is ongoing work. Funding for this important project has been granted by the German Science Foundation (DFG). A follow up proposal is currently under preparation.
3. The development of a new reference equation of state for heavy water is ongoing. This work is linked to an IAPWS grant awarded in 2012 and to a close cooperation with Dr. A. H. Harvey and Dr. E. W. Lemmon at NIST in Boulder. Current work is focused on improving the description of 2^{nd} virial coefficient data that became available in 2015. For the final equation of state a careful evaluation of the experimental uncertainties of all published data sets is carried out to ensure the most consistent description of the whole fluid region. New data for the 3^{rd} virial coefficient and the heat capacity of the ideal gas will be provided by other IAPWS groups to enhance the fitting process.

Recent Publications

- Gernert, J.; Span, R.:
  EOS-CG: A Helmholtz energy mixture model for humid gases and CCS mixtures.
  J. Chem. Thermodyn. 93 (2016), pp. 274-293.
- Vinš, V.; Jäger, A.; Span, R.; Hrubý, J.:
  Model for gas hydrates applied to CCS systems part I. Parameter study of the van der Waals and Platteeuw model.
  Fluid Phase Equilib. 427 (2016), pp. 268-281.
- Jäger, A.; Vinš, V.; Span, R.; Hrubý; J.:
  Model for gas hydrates applied to CCS systems part III. Results and implementation in TREND.
  Fluid Phase Equilib. 429 (2016), pp. 55-66.

- Vinš, V.; Jäger, A.; Span, R.; Hrubý, J.:
  Model for gas hydrates applied to CCS systems part II. Fitting of the model parameters.
  Fluid Phase Equilib. (2016), submitted.
- Span, R.; Eckermann, T.; Herrig, S.; Hielscher, S.; Jäger, A.; Thol, M.:
  TREND. Thermodynamic Reference and Engineering Data 2.0.1.
  Lehrstuhl für Thermodynamik, Ruhr-Universität Bochum, Bochum, Germany (2015).

Ruhr University Bochum
Faculty of Mechanical Engineering, Chair of Thermodynamics
Prof. em. Dr. Dr. e. h. Wolfgang Wagner

Projects

1. Investigation on a possible improvement of the uncertainty of IAPWS-95 in isobaric heat capacity in the liquid region near the melting line at high pressures. The results will be presented at the 2016 IAPWS Meeting in Dresden.
2. Working on a proposed improvement of the IAPWS-95 Release concerning the uncertainty of IAPWS-95 in isobaric heat capacity and a more accurate statement on the extrapolation into the metastable region “subcooled liquid”.

Recent Publications

- Wagner, W., Thol, M.:
  The Behavior of IAPWS-95 from 250 to 300 K and Pressures up to 400 MPa: Evaluation Based on Recently Derived Property Data.
  J. Phys. Chem. Ref. Data 44 (2015), pp. 043102.
- Kretzschmar, H.-J.; Feistel, R.; Wagner, W.; Miyagawa, K.; Harvey, A. H.; Cooper, J. R.; Hiegemann, M.; Blangetti, F. L.; Orlov, K. A.; Weber, I.; Singh, A.; Herrmann, S.:
  The IAPWS Industrial Formulation for the Thermodynamic Properties of Seawater.
  Desalination and Water Treatment 55 (2015), pp. 1177-1199,
  doi: 10.1080/19443994.2014.925838.
- Kretzschmar, H.-J.; Herrmann, S.; Feistel, R.; Wagner, W.:
  The International IAPWS Formulation for the Thermodynamic Properties of Seawater for Desalination Processes.
  The International Desalination Association World Congress on Desalination and Water Reuse, San Diego, CA, USA (2015), doi: 10.13140/RG.2.1.4734.7444.

Siemens Energy Solutions, Erlangen
Michael Rziha

Projects

1. Development of new Technical Guidance Documents:
   - Application of Film Forming Amines in Fossil, Combined Cycle, and Biomass Power Plants
   - HRSG High Pressure Evaporator Sampling for Internal Deposit Identification and Determining the Need to Chemical Clean
   - Both documents are ready to be adopted by the EC in Stockholm.
2. Developing of drafts for a new technical guidance documents
   - “Ensuring the Integrity and Reliability of Demineralised Make-up Water Supply to the Unit Cycle”, to be discussed within PCC Working Group during the Dresden meeting.
   - “Corrosion Product Sampling for Cycling Plants”, to be discussed within PCC Working Group during the Dresden meeting.

Siemens Energy Solutions, Erlangen
Ingo Weber, Stefan Bennoit, Julien Bonifay

Projects

1. Implementation of the fast steam property spline-interpolation algorithms into the heat cycle simulation code KRAWAL
   - The draft "IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using the Spline-Based Table Look-Up Method (SBTL)" has been implemented into the heat cycle code KRAWAL which is used worldwide by Siemens.
   - The computing time consumption of KRAWAL has been significantly reduced.
2. Implementation of the fast steam property spline-interpolation algorithms into the non-stationary power-plant simulation code DYNAPLANT
   - The draft "IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using the Spline-Based Table Look-Up Method (SBTL)" has been implemented into the non-stationary power-plant simulation code DYNAPLANT.
   - The computing time consumption of DYNAPLANT has been significantly reduced.

Recent Publications

- Kretzschmar, H.-J.; Feistel, R.; Wagner, W.; Miyagawa, K.; Harvey, A. H.; Cooper, J. R.; Hiegemann, M.; Blangetti, F. L.; Orlov, K. A.; Weber, I.; Singh, A.; Herrmann, S.:
  The IAPWS Industrial Formulation for the Thermodynamic Properties of Seawater.
  Desalination and Water Treatment 55 (2015), pp. 1177-1199.
- Kunick, M.; Kretzschmar, H.-J.; Gampe, U.; di Mare, F.; Hrubý, J.; Duška, M.; Vinš, V.; Singh, A.; Miyagawa, K.; Weber, I.; Pawellek, R.; Novi, A.; Blangetti, F.; Friend, D. G.; Harvey, A.H.:
  Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL),
  J. Eng. Gas Turbines Power (2016), in preparation.

STEAG Energy Services, Zwingenberg
Dr. Reiner Pawellek, Dr. Tobias Löw

Project

1. Implementation of the fast steam property spline-interpolation algorithms into the heat cycle simulation code EBSILON
   - The draft "IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using the Spline-Based Table Look-Up Method (SBTL)" has been implemented into the heat cycle code EBSILON which is used worldwide by the power industry.
   - The computing time consumption of EBSILON has been significantly reduced.

Recent Publications

- Kunick, M.; Kretzschmar, H.-J.; Gampe, U.; di Mare, F.; Hrubý, J.; Duška, M.; Vinš, V.; Singh, A.; Miyagawa, K.; Weber, I.; Pawellek, R.; Novi, A.; Blangetti, F.; Friend, D. G.; Harvey, A.H.:
  Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL),
  J. Eng. Gas Turbines Power (2016), in preparation.

Zittau/Goerlitz University of Applied Sciences
Department of Technical Thermodynamics
Prof. Dr. Hans-Joachim Kretzschmar

Projects

1. Development of fast property algorithms based on spline interpolation
   - The draft “IAPWS Guideline on the Fast Calculation of Steam and Water Properties in Computational Fluid Dynamics Using the Spline-Based Table Look-Up Method (SBTL)” has been completed and adopted by IAPWS
   - Spline property algorithms were developed for functions of the variables specific volume and specific internal energy (v,u) and related inverse functions for water and steam based on the scientific formulation IAPWS-IF95.
   - The range of validity of the spline-property functions based on IAPWS-IF97 has been expanded to metastable subcooled steam and metastable superheated liquid water.
   - Spline property algorithms have been developed for functions of the variables specific volume an specific enthalpy (v,h) as well as for the related inverse functions for water and steam based on the industrial formulation IAPWS-IF97.
2. Application of the developed spline algorithms for calculating thermodynamic properties

   The developed spline property algorithms have been implemented into the following process simulation codes:
   - Non-stationary thermo-hydraulic cycle program RELAP-7 of the Idaho National Institute INL
   - Heat cycle simulation program EBSILON of STEAG Energy Services
   - Heat cycle simulation program KRAWAL of Siemens Energy Solutions
   - Non-stationary heat cycle program DYNAPLANT of Siemens Energy Solutions.
3. Updating the algorithms for calculating transport properties of moist air and working on the ASHRAE Research Project 1767

Recent Publications

- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.: Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air.
  Int. J. Thermophys. (2016), in preparation.
- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.: Digital Supplement to "Virial Approximation of the TEOS-10 Equation for the Enhancement Factor of Water in Humid Air".
  Int. J. Thermophys. (2016), in preparation.
- Kunick, M.; Kretzschmar, H.-J.; Gampe, U.; di Mare, F.; Hrubý, J.; Duška, M.; Vinš, V.; Singh, A.; Miyagawa, K.; Weber, I.; Pawellek, R.; Novi, A.; Blangetti, F.; Friend, D. G.; Harvey, A.H.:
  Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method (SBTL),
  J. Eng. Gas Turbines Power (2016), in preparation.
- Feistel, R.; Wielgosz, R.; Bell, S. A.; Camões, M. F.; Cooper, J. R.; Dexter, P.; Dickson, A. G.; Fisicaro, P.; Harvey, A. H.; Heinonen, M.; Hellmuth, O.; Kretzschmar, H.-J.; Lovell-Smith, J. W.; McDougall, T. J.; Pawlowicz, R.; Ridout, P.; Seitz, S.; Spitzer, P.; Stoica, D.; Wolf, H.: Metrological challenges for measurements of key climatological observables: Oceanic salinity and pH, and atmospheric humidity. Part 1: Overview.
  Metrologia 53 (2016), pp. R1–R11.

- Vogel, E., Span, R., Herrmann, S.:
  Reference Correlation for the Viscosity of Ethane.
  J. Phys. Chem. Ref. Data 44 (2015), 0431011.
- Herrmann, S.; Vogel, E.:
  Viscosity and Density of Normal Butane Simultaneously Measured at Temperatures from (298 to 448) K and at Pressures up to 30 MPa Incorporating the Near-Critical Region.
  J. Chem. Eng. Data 60 (2015), 3703–3720.
- Herrmann, S.; Hassel, E.; Vogel, E.:
  Viscosity and Density of Isobutane Measured in Wide Ranges of Temperature and Pressure Including the Near-Critical Region.
  AIChE J. 61 (2015), 3116-3137.
- Kunick, M.; Kretzschmar, H.-J.; di Mare, F.; Gampe, U.:
  CFD Analysis of Steam Turbines with the IAPWS Standard on the Spline-Based Table Look-Up Method (SBTL) for the Fast Calculation of Real Fluid Properties.
  In: Proceedings of ASME Turbo Expo 2015: Turbine Technical Conference and Exposition. GT2015, Montreal, Canada (2015). ISBN: 978-0-7918-5679-6
- Herrmann, S.; Hassel, E.; Vogel, E.:
  Simultaneous Viscosity-Density Measurements of Gases over a Wide Range of Temperature and Pressure Using a Vibrating-Wire Viscometer and a Single-Sinker Densimeter.
  In: Young Scientist 2015 9th International Conference of Young Scientists of the Academic Coordination Centre in the Euroregion Neisse, Adamczuk, F.; Adamczuk, J. (Hrsg.), Publishing House Wydawnictwo 'AD REM': Jelenia Gora (2015), 31-40, ISBN: 978-83-65295-16-3.
- Kretzschmar, H.-J.; Feistel, R.; Wagner, W.; Miyagawa, K.; Harvey, A. H.; Cooper, J. R.; Hiegemann, M.; Blangetti, F. L.; Orlov, K. A.; Weber, I.; Singh, A.; Herrmann, S.:
  The IAPWS Industrial Formulation for the Thermodynamic Properties of Seawater.
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- Kretzschmar, H.-J.; Herrmann, S.; Feistel, R.; Wagner, W.:
  The International IAPWS Formulation for the Thermodynamic Properties of Seawater for Desalination Processes.
  The International Desalination Association World Congress on Desalination and Water Reuse, San Diego, CA, USA (2015), doi: 10.13140/RG.2.1.4734.7444.