German National Committee to IAPWS Executive Committee

Research Activities on the Thermodynamic Properties of Water and Steam of the German National Committee in the Period 2018/2019

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Chair: Prof. Dr. Hans-Joachim Kretzschmar
Zittau/Goerlitz University of Applied Sciences, Zittau

Vice Chair: Ingo Weber
Siemens Power and Gas, Erlangen

Annual Meeting of the German National Committee

The 2019 Annual Meeting of the German National Committee took place at Siemens AG Power and Gas Division in Erlangen on 15th March 2019. 24 colleagues attended this meeting. Six papers were presented in the scientific session.

In the following, activities of certain members of the German National committee are summarized.

Baltic Sea Research Institute, Warnemuende
Dr. Rainer Feistel

Recent Publications

- Feistel, R.:
  Distinguishing between Clausius, Boltzmann and Pauling Entropies of Frozen Non-equilibrium States.
  Entropy (2019), submitted.
- Ebeling, W.; Feistel, R.; Krienke, H.:
  On statistical calculations of individual ionic activity coefficients of electrolytes and seawater. I.
  Online preprint 14 Apr 2019.
  DOI: 10.13140/RG.2.2.18591.20640
- Feistel, R.:
  Defining relative humidity in terms of water activity. Part 2: relations to osmotic pressures.
  Metrologia 56, 015015 (2019).
  https://doi.org/10.1088/1681-7575/aaf446
- Hellmuth, O.; Shchekin, A. K.; Feistel, R.; Schmelzer, J. W. P.; Abyzov, A. S.:
  Physical interpretation of ice contact angles, fitted to experimental data on immersion freezing of kaolinite particles.
  Interfac. Phenom. Heat Transfer 6, 37-74 (2018).
  DOI: 10.1615/InterfacPhenomHeatTransfer.2018026166
- Hellmuth, O., Feistel, R.; Foken, T.:
  Technical Note: A Look-up-Table of the TEOS-10 Based Mass Density of Humid Air for Quick-Look Applications.
  Atmos. Chem. Phys. (2019), to be submitted.
- Feistel, R.:
  Thermodynamic Properties of Seawater, Ice and Humid Air: TEOS-10, Before and Beyond.
  Ocean Sci. 14, 471-502 (2018).
  https://doi.org/10.5194/os-14-471-2018

- Burchard, H.; Bolding, K.; Feistel, R.; Gräwe, U.; Klingbeil, K.; MacCready, P.; Mohrholz, V.; Umlauf, L.; van der Lee, E.:
  The Knudsen theorem and the Total Exchange Flow analysis framework applied to the Baltic Sea.
  Progress in Oceanography 165, 268-286 (2018).
  https://doi.org/10.1016/j.pocean.2018.04.004
- Feistel, R.; Lovell-Smith, J. W.:
  Implementing systematic error in the weight matrix of generalized least-squares regression.
  published online (2018).
  https://doi.org/10.13140/RG.2.2.25098.16320

GFZ German Research Centre for Geosciences
Section 4.8 - Geoenergy
Dr. Harald Milsch, Ulrike Hoffert

Projects

1. Commissioning and optimization of a capillary-type high pressure-high temperature viscometer for aqueous electrolyte solutions at up to 50 MPa and 473 K.
2. Measurements of viscosity of pure and mixed NaCl, $CaCl_2$, and $MgCl_2$ aqueous solutions at up to 40 MPa and 353 K.

Publications

- Hoffert, U., Milsch, H.:
  A modified flow-through apparatus for high pressure viscosity measurements of salt solutions.
  17th International Conference on the Properties of Water and Steam – ICPWS17, Prague, Czech Republic (2018).
- Hoffert, U. and Milsch, H.:
  Methods for measuring the density and viscosity of saline geothermal fluids under reservoir conditions.
  Proceedings World Geothermal Congress 2020, Reykjavik, Iceland, Paper 13131 (2019).

Helmut Schmidt University / University of the Federal Armed Forces Hamburg
Institute of Thermodynamics
Prof. Dr. Karsten Meier, Dr. Robert Hellmann

Projects

1. Thermophysical properties of mixtures of water vapor and simple gases from first-principles calculations.
2. Measurements of the speed of sound in water and derived thermodynamic properties of water.

Recent Publications

- Hellmann, R.:
  Cross second virial coefficient and dilute gas transport properties of the ($H_2O + CO_2$) system from first-principles calculations.
  Fluid Phase Equilib. 485, 251-263 (2019).
- Hellmann, R.:
  First-Principles Calculation of the Cross Second Virial Coefficient and the Dilute Gas Shear Viscosity, Thermal Conductivity, and Binary Diffusion Coefficient of the ($H_2O + N_2$) System.
  J. Chem. Eng. Data (2019), submitted.

- El Hawary, A.; Meier, K.:
  Highly Accurate Densities and Isobaric and Isochoric Heat Capacities of Compressed Liquid Water Derived from New Speed-of-Sound Measurements.
  N.N. (2019), in preparation.

Leibniz Institute for Tropospheric Research, Leipzig
Dr. Olaf Hellmuth

Recent Publications (published, submitted, in preparation)

- Hellmuth, O.; Shchekin, A. K.; Feistel, R.; Schmelzer, J. W. P.; Abyzov, A. S.:
  Physical interpretation of ice contact angles, fitted to experimental data on immersion freezing of kaolinite particles.
  Interfac. Phenom. Heat Transfer 6, 37-74 (2018).
  DOI: 10.1615/InterfacPhenomHeatTransfer.2018026166.
- Foken, T.; Hellmuth, O.; Huwe, B.; Sonntag, D.:
  Chapter 6: Physical Quantities.
  In: T. Foken (ed.): Springer Handbook of Atmospheric Measurements. Springer (in preparation). Chapter accepted.
- Sonntag, D.; Foken, T.; Vömel, H.; Hellmuth, O.:
  Chapter 9: Humidity Sensors.
  In: T. Foken (ed.): Springer Handbook of Atmospheric Measurements. Springer (in preparation). Chapter accepted.
- Görner, Ch.; Franke, J.; Kronenberg, R.; Hellmuth, O.; Bernhofer, Ch.:
  Multivariate non-parametric Euclidean distance model for hourly disaggregation of daily climate data.
  Theoretical and Applied Climatology (2019), submitted.
- Hellmuth, O.; Schmelzer, J. W. P.; Feistel, R.:
  Ice-crystal nucleation in water: Thermodynamic driving force and surface tension.
  Entropy, Special Issue “Crystallization Thermodynamics” (2019), submitted.
- Hellmuth, O.; Feistel, R.; Foken, T.:
  Technical Note: TEOS-10 based mass density for quick-look applications.
  Atmos. Chem. Phys. (2019), submitted.
- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Real-Gas Effects in Humid Air: Possible Implications of the Advanced Seawater Standard TEOS-10 for Hygrometry at Atmospheric Pressure. **Part I:** Thermostatic Foundation.
  In preparation for “Wiss. Mitteil. Inst. f. Meteorol. Univ. Leipzig“.
- Hellmuth, O.; Feistel, R.; Lovell-Smith, J. W.; Kalová, J.; Kretzschmar, H.-J.; Herrmann, S.:
  Real-Gas Effects in Humid Air: Possible Implications of the Advanced Seawater Standard TEOS-10 for Hygrometry at Atmospheric Pressure. **Part II:** Performance of Enhancement Factor and Relative Fugacity.
  In preparation for “Wiss. Mitteil. Inst. F. Meteorol. Univ. Leipzig“.
- Hellmuth, O.; Feistel, R.:
  Real-Gas Effects in Humid Air: Possible Implications of the Advanced Seawater Standard TEOS-10 for Hygrometry at Atmospheric Pressure. **Part III:** Effects on Radiative Warming and Cooling in the Water-Vapour Absorption Bands and on the Surface Energy Balance.
  In preparation for “Wiss. Mitteil. Inst. F. Meteorol. Univ. Leipzig“.

Ruhr University Bochum
Faculty of Mechanical Engineering, Chair of Thermal Turbomachines and Aeroengines
Prof. Dr. Francesca di Mare

Project:

1. Implementation of the Fast Steam Property Algorithms Based on Spline Interpolation into the in-house code Shar-C for high-fidelity calculation of unsteady, turbulent flow of condensing steam in low-pressure turbines.
   - The in-house, density-based CFD solver Shar-C accounts for complex thermodynamics, including non-equilibrium condensation and two-phase flow based on tabulation techniques. The two-phase flow is treated by means of the mono-dispersed Source-Term Euler-Euler model and the non-equilibrium condensation effects are modeled based on the classical theory of droplet nucleation and droplet growth. The solver is equipped with a high-resolution, low-dissipation spatial discretization, whilst a 4^{th} – order explicit scheme is employed for time integration. Both a finite-volume and a finite-difference version of the code are available. Classic RANS turbulence models (e.g. k-ω SST, Spalart-Allmaras) as well as scale-resolving models (Wall-Adaptive Large Eddy Simulation) have been implemented and validated. The accuracy of the discretization schemes has been demonstrated in a Direct Numerical Simulation of decaying, isotropic turbulence also in combination with non-ideal gas properties.

Recent Publications

- Post, P.; di Mare, F.:
  Highly efficient Euler-Euler approach for condensing steam flows in turbomachines, GPPS-NA-2018-106.
  Proceedings of GPPS Forum 18, Global Power and Propulsion Society, Montreal, 7th-9th May 2018.
- Post, P.; Sembritzky, M.; di Mare, F.:
  Towards scale resolving computations of condensing wet steam flows.
  ASME Paper GT2019-91269, Proceedings of ASME Turbo Expo 2019: Turbine Technical Conference and Exposition GT2019, June 17 – 21, 2019, Phoenix, Arizona, USA.
- Post, P.; di Mare, F.:
  Highly efficient Euler-Euler approach with source-term tabulation for condensing wet steam flows.
  Proceedings of the 2^{nd} International Workshop on non-ideal compressible fluid dynamics (NICFD2018), Bochum, Germany, 4th-5th October, 2018.
- Iseni, S.; Post, P.; Sembritzky, M.; di Mare, F.:
  Numerical analysis of the influence of air humidity on a transonic compressor stage.
  Proceedings of the IGTC 2019 Conference, 17th-22nd November, 2019, Tokyo, Japan.
- Post, P.; Winhart, B.; di Mare, F.:
  Large eddy simulation of a condensing flow in a steam turbine cascade.
  Proceedings of the IGTC 2019 Conference, 17th-22nd November, 2019, Tokyo, Japan.
- 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.; Wagner, W.; 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, in preparation.

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

Projects:

1. The work on the new reference equation of state for heavy water (D_2O) has been completed. The release published in 2017 has been revised to account for the last changes. The revised release was adopted by IAPWS on the 2018 annual meeting and was subsequently published on the IAPWS website (http://www.iapws.org/relguide/Heavy.html). Details on the new equation of state were published in the Journal of Physical and Chemical Reference Data.
2. The work on a new mixed gas hydrate model consistent to reference equations of state comes into its final phase. This work started as a collaboration of Ruhr University Bochum (Prof. Dr. Roland Span, Dr. Andreas Jäger) and the Institute of Thermomechanics of the CAS (Dr. Jan Hrubý, Dr. Václav Vinš). The work is now carried on as a collaboration of Ruhr University Bochum (Prof. Dr. Roland Span, Dr. Sebastian Hielscher), the Institute of Thermomechanics of the CAS (Dr. Jan Hrubý, Dr. Václav Vinš), and TU Dresden (Prof. Dr. Cornelia Breitkopf, Dr. Andreas Jäger). Recently, Dr. Sebastian Hielscher was promoted Dr.-Ing. based on his work on hydrates. Further work will likely address hydrogen hydrates and hydrate types that are stable only in mixed hydrates.

Recent Publications

- Herrig, S.; Thol, M.; Harvey, A. H.; Lemmon, E. W.:
  A Reference Equation of State for Heavy Water,
  J. Phys. Chem. Ref. Data 47, 043102 (2018).
- Hielscher, S.; Semrau, B.; Jäger, A.; Vinš, V.; Breitkopf, C.; Hrubý, J.; Span, R.:
  Modification of a model for mixed hydrates to represent double cage occupancy,
  Fluid Phase Equilibria 490, 48-60 (2019).

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

Project

1. Completion of the 3rd edition of the book "International Steam Tables".
2. Preparation of the Chapter "Thermophysikalische Stoffwerte von Wasser (Thermophysical properties of Water)" for the VDI-Wärmeatlas (VDI-Heat Atlas) 2018.

Recent Publications

- Kretzschmar, H.-J.; Wagner, W.:
  International Steam Tables – Properties of Water and Steam based on the Industrial Formulation IAPWS-IF97.
  Springer-Verlag, Berlin (2019).
- Kretzschmar, H.-J.; Wagner, W.:
  Thermophysikalische Stoffwerte von Wasser.
  In: P. Stephan et al. (Hrsg.), Springer Reference Technik, VDI-Wärmeatlas, 12. Auflage. VDI Springer Reference (2019).
- 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.; Wagner, W.; 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, in preparation.

Siemens Power and Gas, Erlangen / PPCHEM AG
Michael Rziha

Activities

- New TGD on Air In Leakage (AIL)
- New TGD on film forming substances (FFS) for industrial plants.
- New TGD Chemistry Management in Generator Water Cooling during Operation and Shutdown
- Revision of TGD8-16 on Application of FFS in Fossil, Combined Cycle and Biomass Plants

Beside that also white papers are in preparation with the perspective becoming in near future also a TGD. Those are in particular a white paper about FFS application in nuclear plants and a white paper about corrosion product sampling and monitoring for cycling plant. This white on corrosion product monitoring was also part of the international collaboration, which was and is excellently progressing with important results.

Also for the elaboration of the white paper on chemistry for geothermal plants is in progress further.

With respect to promoting IAPWS, there had been numerous activities and events recently making IAPWS more and more known to the entire world. Just a few highlights:

- The 3rd IAPWS conference on FFS in Heidelberg this year was a great success with increasing number of participants (attracted more than 70 participants from 22 countries)
- The 6th IAPWS conference EHF (European HRSG Forum) in Athens was also extremely well visited, also with more than 70 participants from around the globe. Straight after this EHF a 1 day symposium of the "re-animated" Greek IAPWS (HIAPWS) was held and also this was a real highlight, since the HIAPWS seems now coming really back to the scene and showed a strong willingness and motivation to do that.
- Australia and New Zealand had also organized very successful meetings this year. In both events around 50 participants from each country had been present and both events demonstrated a great motivation and interest for a stronger and intensive collaboration with IAPWS. Also in both events it was demonstrated that the IAPWS TGD have taken over a leading role as the number 1 reference and guiding documents for all power plant chemistry applications and questions.
- Another superb example for the leading role of IAPWS and the TGD of PCC are that the IEC have withdrawn their standard on steam purity (which was in place since many decades) in favor of the IAPWS TGD 5-13 and so this TGD is now THE worldwide standard on steam purity for all kind of turbines.

Projects

Development of new Technical Guidance Documents:

1. FFS in Industrial Plants – Release in Banff 2019
2. Chemistry Management in Generator Water Cooling – Release in Banff 2019
3. Film Forming Substances (FFS) for Nuclear Plants – "White Paper is in preparation"
4. Demin Water Integrity – Final Draft will be discussed in Banff, 2019.
5. Corrosion product (CP) sampling and analysing – "White Paper" is in preparation. Excellent results by Int. Collaboration gained so far and those will be integrated into this white paper.
6. Chemistry in Geothermal Plant – "White Paper" will be introduced in Banff

Siemens Power and Gas, Erlangen
Ingo Weber

Projects

1. Implementation of the fast steam property spline-interpolation algorithms into the heat cycle simulation code KRAWAL
   - The "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.

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.; Wagner, W.; 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, 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 "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.; Wagner, W.; 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, in preparation.

Technical University of Dresden
Institute of Power Engineering, Chair of Technical Thermodynamics
Prof. Dr. Cornelia Breitkopf, Dr. Andreas Jäger, Erik Mickoleit

Projects:

1. The work on a new model for mixed gas hydrates continues. This work started as a collaboration of Ruhr-Universität Bochum (Prof. Dr. Roland Span, Dr. Andreas Jäger) and the Institute of Thermomechanics of the CAS (Dr. Jan Hrubý, Dr. Václav Vinš). The work is now carried on as a collaboration of Ruhr-Universität Bochum (Prof. Dr. Roland Span, Sebastian Hielscher), the Institute of Thermomechanics of the CAS (Dr. Jan Hrubý, Dr. Václav Vinš), and TU Dresden (Prof. Dr. Cornelia Breitkopf, Dr. Andreas Jäger). The model for CCS-relevant mixed hydrates has been modified in a way that double occupancy is now also taken into account. This resulted in a publication by Hielscher et al. (2019).

2. The multi-fluid mixture model was combined with different versions of the predictive excess Gibbs energy model COSMO-SAC [Jäger et al. (2019)]. Results of the new model for water have been presented on the 17th ICPWS in Prague (2018).
3. Molecular simulations of volumetric properties and cage occupancies of gas hydrates in different crystal structures have been conducted and are ongoing work (Dr. Tommy Lorenz, Dr. Andreas Jäger). Properties of gas hydrate formers in structures that these hydrate formers do not form, if they are in a binary mixture with water, are important for the development of a model for mixed hydrates. As these quantities cannot be obtained experimentally, simulations are a viable option. First results will be presented on the 17th ICPWS in Prague (2018). A paper is in preparation.

Recent Publications

- Hielscher, S.; Semrau, B.; Jäger, A.; Vinš, V.; Breitkopf, C.; Hrubý, J.; Span, R.: Modification of a model for mixed hydrates to represent double cage occupancy. Fluid Phase Equilib. 490, 48-60 (2019).
- Jäger, A.; Mickoleit, E.; Breitkopf, C.: A combination of multi-fluid mixture models with COSMO-SAC. Fluid Phase Equilib. 476, 147-156 (2018).

University of Rostock, Rostock
Institute of Chemistry, Chair of Technical Thermodynamics
Dr. Javid Safarov

Project

1. Thermophysical Properties of Sea- and geothermal waters, aqueous salt solutions
   Thermophysical Properties of Sea- and geothermal waters, aqueous salt solutions, seawater over a wide range of temperatures, pressures and concentration were reported.
   An equation of state (EOS) for fitting of the (p,ρ,T) data has been developed as a function of pressure, temperature and molality. Various thermophysical properties were calculated.

Recent Publications

- Mirzaliyev, A.; Safarov, J.; Hassel, E.: Thermophysical properties of Thessaloniki Aegean seawater. Journal of Scientific Works of Azerbaijan Technical University 4, 30-36 (2018).
- Mirzaliyev, A.; Safarov, J.; Hassel, E.: Viscosity of the Caspian Seawater. Journal of Scientific Works of Azerbaijan Technical University 2, 39-45 (2018).
- Ziraman, D. U.; Safarov, J. T.; Doğan, Ö. M.; Hassel, E. P.; Uysal, B. Z.: Apparent molar volumes V_ϕ of calcium acetate ($Ca(CH_3COO)_2$ (aq)) at T=(273.15 to 353.15) K and pressures up to 100 MPa. Journal of the Serbian Chemical Society 83, 1005-1016 (2018).
- Mirzaliyev, A.; Safarov, J.; Hassel, E.: Chemical and thermophysical properties of Bosporus Seawater. "Transactions" of Pedagogical University of Azerbaijan. Mathematical and Natural Sciences Series 2, 67-75 (2018).
- Talibov, M. A.; Safarov, J. T., Hassel, E.; Abdulagatov, I. M.: High-Pressure and High-Temperature Density and Vapor-Pressure Measurements and Derived Thermodynamic Properties of Natural Waters of Yardimli District of Azerbaijan. High Temperature – High Pressure 47, 223-255 (2018).

- Ahmadov, A.; Safarov, J.; Bashirov, M.; Hassel, E.:
  Density of geothermal energy resources of Gabala region of Azerbaijan at high pressures and wide range of temperatures.
  Monitoring, Science and technology (*Nauka i texnologiya*), Maxachkala, Russian Federation 4, 56-61 (2017).
- Gilbert, W. J. R.; Safarov, J.; Minnick, D. L.; Rocha, M. A.; Hassel, E.; Shiflett, M.:
  Density, Viscosity, and Vapor Pressure Measurements of Water + Lithium bis(trifluromethylsulfonyl) imide Solutions.
  J. Chem. Eng. Data 62, 2056-2066 (2017).
- Safarov, J.; Mammadova, E.; Shahverdiyev, A.; Hassel, E.:
  Thermodynamic properties of the Arkivan-Seyfeddin (Masalli, Azerbaijan) geothermal water.
  Monitoring, Science and technology (*Nauka i texnologiya*), Maxachkala, Russian Federation 2, 82-91 (2017).

Zittau/Goerlitz University of Applied Sciences
Faculty of Mechanical Engineering / KCE-ThermoFluidProperties, Dresden
Prof. Dr. Hans-Joachim Kretzschmar, Dr. Sebastian Herrmann, Dr. Matthias Kunick

Projects

1. Development of fast property calculation algorithms based on spline interpolation
   - The Spline-Based Table Look-Up Method (SBTL) is being applied to the mixture humid air.
2. Application of the developed SBTL method for calculating thermodynamic properties

   The developed spline-based property libraries have been implemented into the following process simulation codes:
   - Non-stationary thermo-hydraulic code ATHLET of the German Society of Global Research for Safety (GRS), Garching
   - Non-stationary thermo-hydraulic code RELAP-7 of the Idaho National Laboratory (INL)
   - Heat-cycle simulation software KRAWAL of Siemens Power and Gas, Erlangen
   - Heat-cycle simulation software EBSILON of STEAG Energy Services, Zwingenberg
   - Process simulation software of Fraunhofer UMSICHT, Oberhausen
3. Development of algorithms for the transport properties of moist air, ASHRAE Research Project RP-1767.
4. Development of a new ASHRAE standard for calculating thermodynamic properties of moist air, ASHRAE Project SPC-213P.
5. Completion of the 3rd edition of the book "International Steam Tables".
6. Preparation of the Chapter "Thermophysikalische Stoffwerte von Wasser (Thermophysical properties of Water)" for the VDI-Wärmeatlas (VDI-Heat Atlas) 2018
7. Preparation of Chapter 1 for the ASHRAE Handbook of Fundamentals

Recent Publications

- Kretzschmar, H.-J.; Wagner, W.:
  International Steam Tables – Properties of Water and Steam based on the Industrial Formulation IAPWS-IF97.
  Springer-Verlag, Berlin (2019).
- Kretzschmar, H.-J.; Wagner, W.:
  Thermophysikalische Stoffwerte von Wasser.
  In: P. Stephan et al. (Hrsg.), Springer Reference Technik, VDI-Wärmeatlas, 12. Auflage.
  VDI Springer Reference (2019).

- Kunick, M.:
  Fast Calculation of Thermophysical Properties in Extensive Process Simulations with the Spline-Based Table Look-Up Method (SBTL).
  Fortschritt-Bericht VDI, Reihe 6, Energietechnik, Nr. 618 (2018).
- Herrmann, S.; Kretzschmar, H.-J.; Aute, V. C.; Gatley, D. P.; Vogel, E.:
  Transport Properties of Real Moist Air, Dry Air, Steam, and Water.
  Report ASHRAE RP-1767, ASHRAE, Atlanta, GA (2019).
- Kretzschmar, H.-J.; Herrmann, S.; Schneider, M.; Jaehne, I.:
  Learning System Thermopr@ctice for the Calculation of Exercises with Mathcad.
  In: Proceedings of the Congress INFORINO, Trudi Mechdunarodny Nauchno-Metodichesky Konferenzy, Isdatjelstvo, Moscow Power Engineering Institute, Moskva (2018).
- Herrmann, S.; Vogel, E.:
  New Formulation for the Viscosity of n-Butane.
  J. Phys. Chem. Ref. Data 47, 013104 (2018).
- Herrmann, S.; Hellmann, R.; Vogel, E.:
  Update: Reference Correlation for the Viscosity of Ethane [J. Phys. Chem. Ref. Data 44, 043101 (2015)].
  J. Phys. Chem. Ref. Data 47, 023103 (2018).
- 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.; Wagner, W.; 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, in preparation.
- Herrmann, S.; Kretzschmar, H.-J.; Aute, V. C.; Gatley, D. P.; Vogel, E.:
  Transport Properties of Real Moist Air, Dry Air, Steam, and Water.
  Science and Technology for the Built Environment, in preparation.