

German National Committee to IAPWS

Research Activities on the Thermodynamic Properties of Water and Steam Report "Research in Progress 2015"

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Projects

1. Development of fast property algorithms based on spline interpolation
 - 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 and specific enthalpy (v, h) as well as for the related inverse functions for water and steam based on the industrial formulation IAPWS-IF97.
 - 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 expanded to IAPWS-95 and the metastable subcooled steam region of IAPWS-IF97
 - The evaluation by the IAPWS Evaluation Task Group has been supported.
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.

Recent Publications

- 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: Turbine Technical Conference and Exposition: Proceedings of ASME Turbo Expo (2015).
- Kunick, M.; Kretzschmar, H.-J.; Gampe, U.; di Mare, F.:
Simulation instationärer Prozesse und CFD in Dampfturbinen mithilfe eines neuen Spline-basierten Stoffwert-Berechnungsverfahrens (Simulation of non-stationary processes and CFD in steam turbines using the new spline-based property calculation method).
In: Kraftwerkstechnik 2014, Eds. Beckmann, M. und Hurtado, A., Verlag Saxonica, Freiberg, S. 515-526 (2014)
- 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, 2014, 1-23.
- Kretzschmar, H.-J.; Herrmann, S.; Feistel, R.; Wagner, W.:
The International IAPWS Formulation for the Thermodynamic Properties of Seawater for Desalination Processes.
In Proceedings of the International Desalination Association World Congress on Desalination and Water Reuse, San Diego CA, Accepted (2015).
 - Kraft, I.; Kretzschmar, H.-J.:
Reale Fluide und Grundlagen der Wärmeübertragung, Lernheft THD101: Grundlagen der Technischen Thermodynamik (Real fluids and the basics of heat transfer, Learning booklet THD101: Basics of Technical Thermodynamics).
AKAD, Bildungsgesellschaft mbH, Art.-Nr. 10880 (2014).
 - Kraft, I.; Kretzschmar, H.-J.:
Gasgemische und feuchte Luft, Lernheft THD102: Grundlagen der Technischen Thermodynamik (Gas mixtures and humid air, Learning booklet THD102: Basics of Technical Thermodynamics).
AKAD, Bildungsgesellschaft mbH (2014). Art.-Nr. 11112 (2014).
 - Kraft, I.; Kretzschmar, H.-J.:
Verbrennungsrechnung, Lernheft THD103: Grundlagen der Technischen Thermodynamik (Combustion calculation, Learning booklet THD103: Basics of Technical Thermodynamics).
AKAD, Bildungsgesellschaft mbH, Art.-Nr. 11113, (2014).
 - Kretzschmar, H.-J.; Stoecker, I.; Kunick, M.; Herrmann, S.; Nicke, M.:
Calculation of Thermodynamic Properties on Pocket Calculators, Smart Phones, Tablets, Notebooks, and Online.
In: Proceedings of the Congress INFORINO, Trudi Mehdunarodny Nauchno-Metodichesky Konferenzy, Isdatjelstvo, Moskva 2014, PP. 179-182 (2014), ISBN.: 978-5-7046-1535-4.
 - Feistel, R.; Wielgosz, R.; Bell, S. A.; Camões, M. F.; Cooper, J. R.; Dexter, P.; Dickson, A. G.; Fiscaro, 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.
Revised version, submitted for publication in Metrologia.