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STUDIEREN_OHNE_GRENZEN



Research Topics in the Field of Thermophysical Properties of Fluids

Development of
Property Calculation Algorithms

Preparation of Property Libraries for
Industrial and Scientific Applications



- Participation in the development of the “Industrial Formulation IAPWS-IF97“ of the International Association for the Properties of Water and Steam (IAPWS) (1990-1997, 2009)
- Development of 5 Supplementary Standards to IAPWS-IF97 (1998-2006, 2014)
 - Backward equations of the variables (p,h) , (p,s) , (h,s)
- EU-Project “Advanced Adiabatic Compressed Air Energy Storage“ AA-CAES (2003-2008)
 - Development of thermodynamic property algorithms for humid air
- ASHRAE Research Project RP 1485 of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) (2007-2009, 2013, 2018)
 - Development of thermodynamic property algorithms for humid air
 - Property tables for humid air, water, and steam in ASHRAE Handbooks 2009, 2013, and 2017
- Development of the “IAPWS Industrial-Formulation 2013 on the Thermodynamic Properties of Seawater“ for desalination and cooling processes (2011-2013)

**Development of
Property Calculation Algorithms**



- ASHRAE Project SPC 213: “Methods for calculating moist Air Thermodynamic Properties” (2012-2019)
- ASHRAE Research Project URP 1767: “Formulation of Transport Properties of Moist Air” (2016-2019)
- Development of a spline-based table look-up method for accurate and extremely fast property calculations (2008-2018)



“IAPWS Guideline 2015 on the Fast Calculation of Steam and Water Properties with the Spline-Based Table Look-Up Method SBTL“

Property Libraries for Working Fluids for Power Engineering

Pure and Pseudo-Pure Fluids:

- Steam, water and ice
- Air, nitrogen
- Carbon dioxide incl. dry ice
- Ammonia
- Hydrogen, helium
- Ethanol, methanol, hydrocarbons
- Siloxanes for ORC processes
- Refrigerants

Ideal Gas Mixtures:

- Fuel gases
- Combustion gas mixtures
- Humid air

Real Fluid Mixtures:

- Humid combustion gases incl. carbon dioxide / water mixtures
- Humid air
- Ammonia / water mixtures
- Water / lithium bromide mixtures
- Seawater

Calculable Properties:

- Thermodynamic properties
- Transport properties
- Thermodynamic derivatives
- Inverse (backward) functions

Available Interfaces for the Property Libraries

- FluidEXL for **Excel**
- FluidLAB for **MATLAB**
- FluidMAT for **Mathcad**
- FluidEES for **Engineering Equation Solver EES**
- FluidVIEW for **LabView**
- FluidDYM for **Dymola** und **SimulationX (Modelica)**

Cooperation with Industry and Scientific Institutions

Licenses for Property Libraries:

for more than 300 companies worldwide,

e.g. Siemens (KRAWAL), ALSTOM (ALPRO), STEAG (EBSILON), INL Idaho Falls (RELAP-7), Fichtner (KPRO), Vattenfall, E.ON, RWE, EnBW, KEMA, BASF, MAN, DLR, Voith, Visteon, ... and

for more than 80 universities worldwide,

e.g. MIT Cambridge (USA), Univ. Auckland (NZ), Univ. Lisbon, Univ. Princeton, Univ. Maryland, Univ. Glasgow, Univ. Toulouse, RWTH Aachen, TU Munich, TU Hamburg, TU Berlin, Univ. Stuttgart, ...

Offer: Collaboration in projects, where properties of fluids are required.

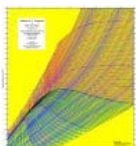
Selected Publications



Kretzschmar, H.-J. and W. Wagner:
International Steam Tables,
Properties of Water and Steam
Based on the Industrial Formulation
IAPWS-IF97, Third Edition.
Springer-Verlag, Berlin (2019)



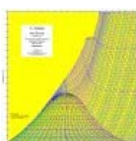
Wagner, W., Kretzschmar, H.-J.:
Chapter 2.1 Properties of Water and Steam.
In: **VDI Heat Atlas, 2nd. ed.**,
Springer-Verlag, Berlin (2010)



Kretzschmar, H.-J. and Stöcker, I.:
Mollier h-s Diagram for Water and Steam
Springer-Verlag, Berlin (1998, 2008,
2009, 2012)



Herrmann, S.; Kretzschmar, H.-J.; Gatley, D.P.:
In: **2009, 2013, and 2017**
ASHRAE HANDBOOK FUNDAMENTALS,
SI and I-P Editions,
Chapter 1 PSYCHROMETRICS,
Table 2: Thermodynamic Properties of Moist Air
at Standard Atmospheric Pressure.
Table 3: Thermodynamic Properties of Water
and Steam at Saturation.
ASHRAE, Inc., Atlanta GA (2009, 2013, 2017)



Kretzschmar, H.-J. and Stöcker, I.:
T-s Diagram for Water and Steam
Springer-Verlag, Berlin (2003)

These slides are available at www.thermodynamics-zittau.de and www.thermofluidprop.com