

KCE-ThermoFluidProperties www.thermofluidprop.com



Property Libraries for Calculating Heat Cycles, Boilers, Turbines and Refrigerators

Water and Steam

Library LibIF97

- Industrial Formulation IAPWS-IF97 (Revision 2007)
- Supplementary Standards IAPWS-IF97-S01, -S03rev, -S04, and -S05
- IAPWS Revised Advisory Note No. 3 on Thermodynamic Derivatives (2008)

Library LibIF97 META

 Industrial Formulation IAPWS-IF97 (Revision 2007) for metastable steam

Humid Combustion Gas Mixtures

Library LibHuGas

Model: Ideal mixture of the real fluids: CO₂ - Span, Wagner H₂O - IAPWS-95 O_2 - Schmidt, Wagner N_2 - Span et al.

- Ar Tegeler et al.
 - and of the ideal gases: SO₂, CO, Ne
- (Scientific Formulation of Bücker et al.) Consideration of
 - Dissociation from VDI 4670
 - Poynting effect

Humid Air

Library LibHuAir

Model: Ideal mixture of the real fluids:

 Drv air from Lemmon et al. Steam, water and ice from IAPWS-IF97 and IAPWS-06

Consideration of:

- Condensation and freezing of steam
- Dissociation from VDI 4670 Poynting effect from
- ASHRAE RP-1485

Extremely Fast **Property Calculations**

Spline-Based Table Look-up Method (SBTL)

Library LibSBTL_IF97 Library LibSBTL_95 Library LibSBTL_HuAir

For steam, water, humid air, carbon dioxide and other fluids and mixtures according **IAPWS Guideline 2015** for Computational Fluid Dynamics (CFD), real-time and non-stationary simulations

Carbon Dioxide Including Dry Ice

Library LibCO2

Formulation of Span and Wagner (1996)

Seawater

Library LibSeaWa

IAPWS Industrial Formulation 2013

Ice

Library LibICE

Ice from IAPWS-06, Melting and sublimation pressures from IAPWS-08. Water from IAPWS-IF97, Steam from IAPWS-95 and -IF97

Ideal Gas Mixtures

Library LibIdGasMix

Model: Ideal mixture of the ideal gases:

Ar	NO	He	Propylene
Ne	H₂O	F ₂	Propane
N ₂	SO ₂	NH ₃	Iso-Butane
O ₂	H ₂	Methane	n-Butane
CO	H₂S	Ethane	Benzene
CO ₂	ОН	Ethylene	Methanol
Air			

Dissociation from the VDI Guideline 4670

from VDI Guideline 4670

Consideration of: Dissociation from the VDI Guideline 4670

Humid Air

Library ASHRAE LibHuAirProp

Model: Virial equation from ASHRAE Report RP-1485 for real mixture of the real fluids.

- Dry air
- Steam
- Consideration of
- Enhancement of the partial saturation pressure of water vapor
- at elevated total pressures
 - www.ashrae.org/bookstore

Dry Air Including Liquid Air

Library LibRealAir

Formulation of Lemmon et al. (2000)

Refrigerants

Ammonia

Library LibNH3

Formulation of Tillner-Roth et al. (1993)

R134a

Library LibR134a

Formulation of Tillner-Roth and Baehr (1994)

Iso-Butane

Library LibButane Iso

Formulation of Bücker and Wagner (2006)

n-Butane

Library LibButane n

Formulation of Bücker and Wagner (2006)

Mixtures for Absorption Processes

Ammonia/Water Mixtures

Library LibAmWa

IAPWS Guideline 2001 of Tillner-Roth and Friend (1998) Helmholtz energy equation for the mixing term (also useable for calculating the Kalina Cycle)

Water/Lithium Bromide Mixtures Library LibWaLi

Formulation of Kim and Infante Ferreira (2004) Gibbs energy equation for the mixing term

Liquid Coolants

Liquid Secondary Refrigerants

Library LibSecRef

Liquid solutions of water with			
$C_2H_6O_2$	Ethylene glycol		
$C_3H_8O_2$	Propylene glycol		
C₂H₅OH	Ethanol		
CH₃OH	Methanol		
C ₃ H ₈ O ₃	Glycerol		
K ₂ CO ₃	Potassium carbonate		
CaCl ₂	Calcium chloride		
MgCl ₂	Magnesium chloride		
NaCl	Sodium chloride		
C ₂ H ₃ KO ₂	Potassium acetate		
CHKO ₂	Potassium formate		
LiCI	Lithium chloride		
NH ₃	Ammonia		

Formulation of the International Institute of Refrigeration (IIR 2010)

Consideration of:

Library LibIDGAS

Model: Ideal gas mixture

Ethanol

Library LibC2H5OH

Formulation of Schroeder et al. (2014)

Methanol

Library LibCH3OH

Formulation of de Reuck and Craven (1993)

Propane

Library LibPropane

Formulation of Lemmon et al. (2009)

Siloxanes as ORC Working Fluids

Octamethylcyclotetrasiloxane $C_8H_{24}O_4Si_4$ Library LibD4 Decamethylcyclopentasiloxane $C_{10}H_{30}O_5Si_5$ Library LibD5 Tetradecamethylhexasiloxane $C_{14}H_{42}O_5Si_6$ Library LibMD4M Hexamethyldisiloxane $C_6H_{18}OSi_2$ Library LibMM Formulation of Colonna et al. (2006)

Dodecamethylcyclohexasiloxane $C_{12}H_{36}O_6Si_6$ Library LibD6 Decamethyltetrasiloxane $C_{10}H_{30}O_3Si_4$ Library LibMD2M Dodecamethylpentasiloxane $C_{12}H_{36}O_4Si_5$ Library LibMD3M Octamethyltrisiloxane $C_8H_{24}O_2Si_3$ Library LibMDM Formulation of Colonna et al. (2008)

Nitrogen and Oxygen

Libraries LibN2 and LibO2

Formulations of Span et al. (2000) and Schmidt and Wagner (1985)

Hydrogen

Library LibH2

Formulation of Leachman et al. (2009)

Helium

Library LibHe Formulation of Arp et al. (1998)

Hydrocarbons

Decane $C_{10}H_{22}$ Library LibC10H22 Isopentane C_5H_{12} Library LibC5H12_Iso Neopentane C_5H_{12} Library LibC5H12_Neo Isohexane C_6H_{14} Library LibC6H14 Toluene C_7H_8 Library LibC7H8 Formulation of Lemmon and Span (2006)

Further Fluids

Carbon monoxide CO Library LibCO Carbonyl sulfide COS Library LibCOS Hydrogen sulfide H_2S Library LibH2S Nitrous oxide N_2O Library LibN2O Sulfur dioxide SO₂ Library LibSO2 Acetone C_3H_6O Library LibC3H6O

Formulation of Lemmon and Span (2006)



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The following thermodynamic and transport properties can be calculated^a:

Thermodynamic Properties

- Vapor pressure p_s
- Saturation temperature T_s
- Density ρ
- Specific volume v
- Enthalpy h
- Internal energy u
- Entropy s
 Exergy e
- Isobaric heat capacity c_p
 Isochoric heat capacity c_v
- Isentropic exponent κ
- Speed of sound w
- Surface tension σ

Transport Properties

- Dynamic viscosity η
- Kinematic viscosity ν
- Thermal conductivity $\boldsymbol{\lambda}$
- Prandtl number *Pr*
- Thermal diffusivity a

Backward Functions

- *T*, *v*, *s* (*p*,*h*)
- *T*, *v*, *h* (*p*,*s*)
- p, T, v (h,s)
- p, T (v,h)
- p, T (v,u)

Thermodynamic Derivatives

 Partial derivatives used in process modeling can be calculated.

a Not all of these property functions are available in all property libraries.