

# Property Libraries

## for Water, Steam, Humid Air, and other Working Fluids for Calculating Heat Cycles, Turbines, Heat Pumps, and Refrigeration Processes

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### Steam, Water, and Ice

#### Library LibIF97

- Industrial Formulation IAPWS-IF97 (Revision 2007)
- Supplementary Standards IAPWS-IF97-S01 IAPWS-IF97-S03ref IAPWS-IF97-S04 IAPWS-IF97-S05
- IAPWS Revised Advisory Note No. 3 on Thermodynamic Derivatives (2008)

#### Library LibICE

- Ice from IAPWS-06
- Melting line and sublimation line from IAPWS-08
- Water from IAPWS-IF97
- Steam from IAPWS-95 and IAPWS-IF97

#### Library LibSBTL\_IF97 Library LibSBTL\_95

Extremely fast property calculations according to the IAPWS Guideline 2015 Spline-based Table Look-up Method (SBTL) applied to the Industrial Formulation IAPWS-IF97 and to the Scientific Formulation IAPWS-95 for Computational Fluid Dynamics (CFD) and the simulation of non-stationary processes

#### 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:

- CO<sub>2</sub> - Span and Wagner (1994)
- O<sub>2</sub> - Schmidt and Wagner (1995)
- H<sub>2</sub>O - IAPWS-95
- Ar - Tegeler et al. (1999)
- N<sub>2</sub> - Span et. al. (2000)

and of the ideal gases:

- SO<sub>2</sub>, CO, Ne (Bücker et al., 2003)

Consideration of:

- Condensation of steam
- Dissociation and Poynting effect

#### Library LibIdGasMix

Model: Ideal gas mixture of 25 ideal gases from VDI-Guideline 4670 (2003)

### Humid Air

#### Library LibHuAir

Model: Ideal mixture of the real fluids:

- Dry air from Lemmon et al. (2000)
- Steam, water, and ice from IAPWS-IF97 and IAPWS-06

Consideration of:

- Condensation and freezing of steam
- Dissociation from the VDI-Guideline 4670 (2003)
- Poynting effect from ASHRAE RP-1485

#### Library ASHRAE LibHuAirProp

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

### Carbon Dioxide Including Dry Ice

#### Library LibCO2

Formulation of Span and Wagner (1994)

### Ammonia/Water - Mixtures

#### Library LibAmWa

IAPWS Guideline 2001 of Tillner-Roth and Friend (1998)

### Water/Lithium Bromide - Mixtures

#### Library LibWaLi

Formulation of Kim and Infante Ferreira (2004)

### Dry Air Including Liquid State

#### Library LibRealAir

Formulation of Lemmon et al. (2000)

### Seawater

#### Library LibSeaWa

IAPWS Industrial Formulation (2013)

### Ammonia

#### Library LibNH3

Formulation of Tillner-Roth et al. (1993)

### Hydrogen

#### Library LibH2

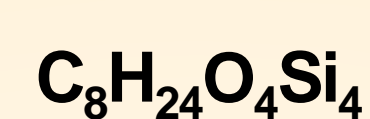
Formulation of Leachman et al. (2009)

### Nitrogen and Oxygen

#### Libraries LibN2 and LibO2

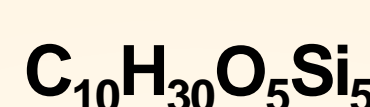
Formulations of Span et al. (2000) and Schmidt and Wagner (1985)

### Siloxanes as ORC Working Fluids



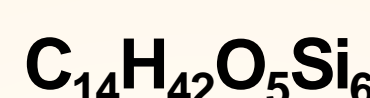
Octamethylcyclotetrasiloxane

#### Library LibD4



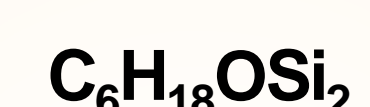
Decamethylcyclopentasiloxane

#### Library LibD5



Tetradecamethylhexasiloxane

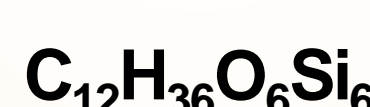
#### Library LibMD4M



Hexamethyldisiloxane

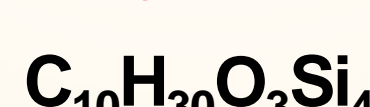
#### Library LibMM

Formulation of Colonna et al. (2006)



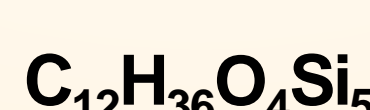
Dodecamethylcyclohexasiloxane

#### Library LibD6



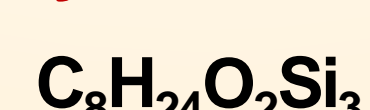
Decamethyltetrasiloxane

#### Library LibMD2M



Dodecamethylpentasiloxane

#### Library LibMD3M



Octamethyltrisiloxane

#### Library LibMDM

Formulation of Colonna et al. (2008)

### R134a

#### Library LibR134a

Formulation of Tillner-Roth and Baehr (1994)

### Iso-Butane

#### Library LibButane\_Iso

Formulation of Bücker and Wagner (2006)

### Liquid Coolants

#### Library LibSecRef

Liquid solutions of water with

- |   |                     |
|---|---------------------|
| C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>  | Ethylene glycol     |
| C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>  | Propylene glycol    |
| C <sub>2</sub> H <sub>5</sub> OH              | Ethanol             |
| CH <sub>3</sub> OH                            | Methanol            |
| C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>  | Glycerol            |
| K <sub>2</sub> CO <sub>3</sub>                | Potassium carbonate |
| CaCl <sub>2</sub>                             | Calcium chloride    |
| MgCl <sub>2</sub>                             | Magnesium chloride  |
| NaCl  | Sodium chloride     |
| C <sub>2</sub> H <sub>3</sub> KO <sub>2</sub> | Potassium acetate   |
| CHKO <sub>2</sub>                             | Potassium formate   |
| LiCl  | Lithium chloride    |
| NH <sub>3</sub>                               | Ammonia             |

Formulation of the International Institute of Refrigeration (IIR 2010)

### Propane

#### Library LibPropane

Formulation of Lemmon et al. (2009)

### n-Butane

#### Library LibButane\_n

Formulation of Bücker and Wagner (2006)

### Ethanol

#### Library LibC2H5OH

Formulation of Schroeder et al. (2012)

### Methanol

#### Library LibCH3OH

Formulation of de Reuck and Craven (1993)

### Helium

#### Library LibHe

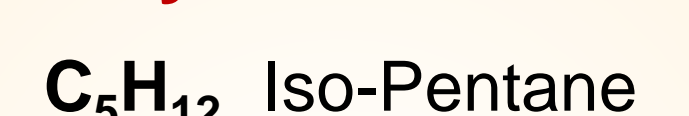
Formulation of Arp et al. (1998)

### Hydrocarbons



Decane

#### Library LibC10H22



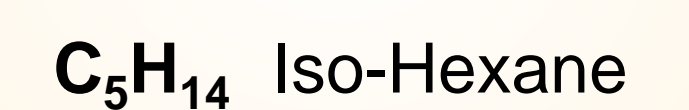
Iso-Pentane

#### Library LibC5H12\_ISO



Neo-Pentane

#### Library LibC5H12\_NEO



Iso-Hexane

#### Library LibC5H14



Toluene

#### Library LibC7H8

Formulation of Lemmon and Span (2006)

### Other Fluids

CO Carbon monoxide

#### Library LibCO

COS Carbonyl sulfide

#### Library LibCOS

H<sub>2</sub>S Hydrogen sulfide

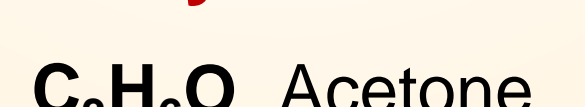
#### Library LibH2S

N<sub>2</sub>O Dinitrogen monoxide

#### Library LibN2O

SO<sub>2</sub> Sulfur dioxide

#### Library LibSO2



Acetone

#### Library LibC3H6O

Formulation of Lemmon and Span (2006)