



BRIEF DOCUMENTATION ON THE MATHCAD™ CALCULATION SHEET

LiCl&H2O WebProps.mcd

The four attached pages show what the user of the calculation sheet gets to see when using it. They are succinctly described in the following:

- Page 1 This is the opening page which, besides the contact address of the author, also includes a disclaimer regarding the use of the calculation sheet.
- Page 3 This page shows what the calculation sheet does in general. The page includes a nomenclature of the properties calculated as well as their units for both input and output. Two sets of functions are available, one for pure water substance and the other for aqueous solutions of lithium chloride. It shows the user where background information can be found. It also alerts the user for limitations that must be taken into account when using this calculation sheet.
- Page 4 Shows a public function that calculates and displays properties of pure water at saturation as function of temperature (The program that actually carries out the calculations is not available to the user). An editable field is where the user enters the input value. The user shall be careful not to change the name of this variable, but only its value within the valid range. The table with the output values answers automatically to any change in the input, if the calculation is set to automatic (the user may change this setting).
- Page 5 Shows a public function that calculates and displays properties of aqueous solutions of lithium chloride (The program that actually carries out the calculations is not available to the user). An editable field is where the user enters the input values. The user shall be careful not to change the names of these variables, but only their value within the valid ranges. The table with the output values answers automatically to any change in the input, if the calculation is set to automatic (the user may change this setting).

The calculation sheet itself has no help features, and will produce short but informative messages on errors generated during the execution or due to unacceptable input values.

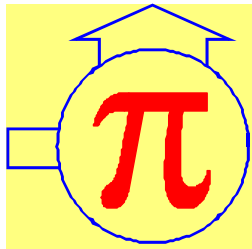
Users willing to get access to the calculating program shall contact the author for arrangements.

Zurich, 20041021

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THERMOPHYSICAL PROPERTIES OF LiCl - H₂O Solutions



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DISCLAIMER

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Nomenclature used in this Mathcad program:

Temperature:	T	(K),
Pressure:	P	(kPa),
Mass Fraction of LiCl in the liquid phase	ξ	(-),
Density	ρ	(kg.m ³),
Viscosity	η	(mPa.s),
Thermal Conductivity	λ	(W/m.K),
Surface Tension	σ	(mN/m),
Mass Diffusivity	D	(m ² /s),
Reduced Temperature	θ	(-),
Enthalpy	h	(kJ/kg),
Specific Thermal Capacity	C_p	(kJ/kg.K),

Public functions:

Functions for Pure Water Substance

PvH2O(T)	Vapour Pressure of water
$\rho_{LH2O}(T)$	Density of the Condensed Water Phase
$\rho_{GH2O}(T)$	Density of the Gaseous Water Phase
$\sigma_{H2O}(T)$	Surface Tension of Water
IfgH2O(T)	Phase Change Enthalpy of Water
$\eta_{LH2O}(T)$	Dynamic Viscosity of Liquid Phase Water
$\eta_{GH2O}(T)$	Dynamic Viscosity of Gaseous Phase Water
$\lambda_{LH2O}(T)$	Thermal Conductivity of Liquid Phase Water
$\lambda_{GH2O}(T)$	Thermal Conductivity of Gaseous Phase Water
$C_{pLH2O}(T)$	Specific Thermal Capacity of Liquid Phase Water
$D_{OH2O}(T)$	Self Diffusion Coefficient of Liquid Phase Water

Functions for the Solution

$T_{cryst}(\xi)$	Crystallization Temperature as Function of Mass Fraction
$\xi_{fromTP}(T,P)$	Equilibrium Mass Fraction for Temperature T and Vapour Pressure P
$P_{vs}(T,\xi)$	Vapour Pressure
$\rho_s(T,\xi)$	Solution Density
$\sigma_s(T,\xi)$	Solution Surface Tension
$\eta_s(T,\xi)$	Solution Dynamic Viscosity
$\lambda_s(T,\xi)$	Solution Thermal Conductivity
$C_{ps}(T,\xi)$	Solution Specific Thermal Capacity
$D_{hd}(T,\xi)$	Differential enthalpy of Solution (kJ/kg H ₂ O) ¹
$D_{H2OSol}(T,\xi)$	Diffusion Coefficient of Water Vapour into the Solution
$PrandtlS(T,\xi)$	Prandtl Number of the Solution
$SchmidtS(T,\xi)$	Schmidt Number for the Diffusion of Water into the Solution

NOTES:

¹ This is kJ per kg of diluted water, i.e., water that is added to a solution of a given concentration;

Detailed background at: www.mrc-eng.com/Downloads/Aqueous_LiCl&CaCl2_Solution_Props.PDF

Only limited range checking is done on the input values. An output value of 0 (zero) indicates mostly an input value (pair) that is not in the range of validity of the equations. The equations themselves are only applicable for liquid phase solutions, down to the crystallization boundary. Error messages are issued for most invalid input pairs. The user shall carefully check the input values to obtain correct results.



Public Functions

Water Substance

INPUT VALUES

Tit := 283.15

ShowH2OProps(Tit) =

"Vapour Pressure	[kPa] "	1.2279
"Liquid Density	[m3/kg] "	999.7029
"Vapour Density	[m3/kg] "	$9.3955 \cdot 10^{-3}$
"Vaporization Enthalpy	[kJ/kg] "	$2.4791 \cdot 10^3$
"Surface Tension	[mN/m] "	74.2238
"Liquid Viscosity	[mPa.s] "	1.3059
"Vapour Viscosity	[mPa.s] "	$9.4612 \cdot 10^{-3}$
"Liquid Thermal Conductivity	[W/(m.K)] "	0.582
"Vapour Thermal Conductivity	[W/(m.K)] "	0.0172
"Liquid Specific Thermal Capacity	[kJ/(kg.K)] "	4.1559
"Self Diffusion Coefficient	[m2/s] "	$1.6614 \cdot 10^{-12}$



Public Functions

Aqueous LiCl Solutions

INPUT VALUES



Pit := 0.67

Tit := 283.15

ξ_{it} := 0.1



ShowSolutionProps(Pit, Tit, ξ_{it}) =

"Crystallization Temperature	[K] "	261.29
"LiCl Mass Fraction	[-] "	0.2521
"Vapour Pressure	[kPa] "	1.0821
"Density	[kg/m ³] "	1.0562·10 ³
"Surface Tension	[mN/m] "	78.222
"Viscosity	[mPa.s] "	1.8376
"Thermal Conductivity	[W/(m.K)]"	0.5592
"Specific Thermal Capacity	[kJ/(kg.K)] "	3.6241
"Differential Dilution Enthalpy	[kJ/(kg H ₂ O)] "	0.5319
"H ₂ O Mass Diffusivity into Solution	[m ² /s] "	1.2586·10 ⁻¹²
"Prandtl Number	[-]"	11.91
"Schmidt Number	[-]"	1.3824·10 ⁶

