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BRIEF DOCUMENTATION ON THE MATHCAD™ CALCULATION SHEET

NH3&H2O WEBPROPS.MCD

The five 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 24 — This page opens the calculations section (pages2 ÷23 are not accessible to the user). It shows the user the nomenclature (symbols of the various properties and their units) and gives information on 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 25 — Includes access to the functions that carry out calculations on vapour-liquid equilibrium (VLE). The first table shows information on the functions available from this section, the variables required as input, and the units of the output. Further down are the input variables which values the user may change. The functions themselves are not accessible to the user, but will return the results calculated with the values input.

Page 26 — Does the same as above for the thermodynamic properties. Here again, the user may only change the input values. The results are returned by functions listed below the input values.

Page 27 — This page has the same structure as the previous two, now for the calculation of the transport properties of the solution, and behaves in the very same manner.

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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PROPERTIES OF AQUA - AMMONIA

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Calculations

Nomenclature used in this Mathcad program:

Temperature	T	[K],
Pressure	P	[bar],
Liquid Solution Enthalpy	HL	[kJ/kg],
Vapor Solution Enthalpy	HG	[kJ/kg],
Mass Fraction of NH_3 in the liquid phase	ξ	[-],
Mass Fraction of NH_3 in the vapor phase	ζ	[-],
Mole Fraction of NH_3 in the vapor phase	y	[-],
Mole Fraction of NH_3 in the vapor phase	x	[-],
Density	ρ	[kg/m^3],
Viscosity	η	[µPa.s],
Thermal Conductivity	λ	[mW/m.K],
Surface Tension	σ	[mN/m],
Mass Diffusivity	*D*	[m^2/s],
Reduced Temperature	θ	[-],

Detailed background information regarding the methods and equations used in this calculation sheet are available on the web at:
www.mrc-eng.com/Downloads/NH3&H2O Props English.PDF,
or directly from the author at the address given above.

A limited range checking on the input values is made by the program. It concerns, however, only the values input for the mass fraction of ammonia. All input values shall be carefully considered by the user in order to arrive at correct results.

Public Functions

Vapour Liquid Equilibrium

TfromPξ (P,ξ)	Temperature, given Pressure and NH_3 liquid Mass Fraction,	[K]
TfromPζ (P,ζ)	Temperature, given Pressure and NH_3 vapour Mass Fraction,	[K]
ζfromPξ (P,ξ)	NH_3 vapour Mass Fraction given Pressure and NH_3 liquid Mass Fraction,	[-]
ξfromPζ (P,ζ)	NH_3 liquid Mass Fraction given Pressure and NH_3 vapour Mass Fraction,	[-]
Xmol (ξ)	NH_3 liquid Molar Fraction given NH_3 liquid Mass Fraction,	[-]
Xmass(x)	NH_3 liquid Mass Fraction given NH_3 Liquid Molar Fraction,	[-]

INPUT VALUES

$Pit := 5.0$

$\xi it := 0.58$

$\zeta it := 0.78$

$xit := 0.75$

$TfromP\xi(Pit, \xi it) = ▪$

$TfromP\zeta(Pit, \zeta it) = ▪$

$\zeta fromP\xi(Pit, \xi it) = ▪$

$\xi fromP\zeta(Pit, \zeta it) = ▪$

$Xmol(\xi it) = ▪$

$Xmass(xit) = ▪$

Thermodynamic Properties

Tcs (ξ)	Solution critical temperature given NH_3 liquid Mass Fraction,	[K]
Pcs (ξ)	Solution critical pressure given NH_3 liquid Mass Fraction,	[bar]
CpSLPξ (P,ξ)	Liquid Solution Cp given pressure and NH_3 liquid Mass Fraction,	[kJ/kg.K]
ρSLPξ (P,ξ)	Liquid Solution ρ given pressure and NH_3 liquid Mass Fraction,	[kg/m^3]
HLfromTξ (T,ξ)	Liquid Enthalpy given Temperature and NH_3 liquid Mass Fraction,	[kJ/kg]
ρSGPζ (P,ζ)	Vapour Solution ρ given pressure and NH_3 vapour Mass Fraction,	[kg/m^3]
CpSGPζ (P,ζ)	Vapour Solution Cp given pressure and NH_3 vapour Mass Fraction,	[kJ/kg.K]
HGfromTζ (T,ζ)	Vapour Enthalpy given Temperature and NH_3 vapour Mass Fraction,	[kJ/kg]

INPUT VALUES

$Pit := 5.2$

$\xi it := 0.50$

$\zeta it := 0.78$

$Tit := 298.75$

$Tcs(\xi it) = ■$

$Pcs(\xi it) = ■$

$CpSLP\xi(Pit, \xi it) = ■$

$\rho SLP\xi(Pit, \xi it) = ■$

$HLfromT\xi(TfromP\xi(Pit, \xi it), \xi it) = ■$

$HLfromT\xi(Tit, \xi it) = ■$

$\rho SGP\zeta(Pit, \zeta it) = ■$

$CpSGP\zeta(Pit, \zeta it) = ■$

$HGfromT\zeta(TfromP\xi(Pit, \xi it), \zeta fromP\xi(Pit, \xi it)) = ■$

$HGfromT\zeta(Tit, \zeta it) = ■$

Transport Properties

ηSLPξ (P,ξ)	Liquid Solution η given pressure and NH_3 liquid Mass Fraction,	[μPa.s]
ηSLTξ (T,ξ)	Liquid Solution η given temperature and NH_3 liquid Mass Fraction,	[μPa.s]
λSLPξ (P,ξ)	Liquid Solution λ given temperature and NH_3 liquid Mass Fraction,	[mW/m.K]
σSLPξ (P,ξ)	Solution σ given temperature and NH_3 liquid Mass Fraction,	[mN/m]
DVSLPξ (P,ξ)	Vapour diffusivity in the liquid given pressure and NH_3 liquid Mass Fraction,	[m^2/s]
ηSGPζ (P,ζ)	Vapour Solution η given temperature and NH_3 vapour Mass Fraction,	[μPa.s]
λSGPζ (P,ζ)	Vapour Solution λ given temperature and NH_3 vapour Mass Fraction,	[mW/m.K]

INPUT VALUES

$Pit := 5.2$

$\xi it := 0.58$

$\zeta it := 0.78$

$Tit := 298.75$

$\eta SLP\xi(Pit, \xi it) = ▮$

$\eta SLT\xi(Tit, \xi it) = ▮$

$\lambda SLP\xi(Pit, \xi it) = ▮$

$\sigma SLP\xi(Pit, \xi it) = ▮$

$DVSLP\xi(Pit, \xi it) = ▮$

$\eta SGP\zeta(Pit, \zeta it) = ▮$

$\lambda SGP\zeta(Pit, \zeta it) = ▮$