Klea® 404A Data Sheet – SI Units

Physical Property Data for Klea® 404A

Property		Units	Value
Bubble Point	1 atm)	°C	-46.2
Dew Point	(1atm)	°C	-45.5
Bubble Point Pressure	(25°C)	Bar	12.55
Critical Temperature		°C	72.0
Critical Pressure		Bar	37.29
Critical Density		kg/m^3	486.54
Latent Heat of Vaporisation	Tm=25°C	kJ/kg	140.25
Trouton's Constant		J/mol.K	86.3
Volumetric Coefficient of thermal expansion	(LIQ,-40°C)	1/K	0.0025
Saturated vapour density	@(1atm)	kg/m^3	5.48

Equation of State (Martin-Hou)

The Equation of State (EOS) in this document is based on Mexichem's data which is similar to Refprop data but not identical.

$$Pr = \frac{XT_r}{V_r - B} + \sum_{i=1,4} \frac{(A_i + B_i T_r + C_i \exp(-KT_r))}{(V_r - B)^{(i+1)}}$$

Where :

$T_r = T/T_c$, $P_r = P/P_c$, $V_r = V/V_c$
X = 3.8644416
B = 0.0
K = 5.475
T_c, P_c, RHO_c = 344.7(K), 37.46(bara), 493(kg/m^3)

A_1, B_1, C_1 = -12.365196613, 7.267663747, -11.815938601
A_2, B_2, C_2 = 9.919709493, -6.3378844502, -127.25315779
A_3, B_3, C_3 = -3.0486302819, 0.0, 0.0
A_4, B_4, C_4 = 0.0, 9.3213426646, -1108.550675

Applicable Range: 0-30 bara, 0-100K superheat

Saturation Envelope — Bubble Point Temperatures

Bubble Point Temperature (T_b) = $A + BX + CX^2 + DX^3$

T_b = Bubble Point Temperature in K
X = Ln(P)
P = Pressure in bara

A = 226.6627706
B = 20.79978648
C = 2.150291272
D = 0.311005915

Saturation Envelope — Dew Point Temperatures

Bubble Point Temperature (T_d) = $A + BX + CX^2 + DX^3$

T_d = Dew Point Temperature in K
X = Ln(P)
P = Pressure in bara

A = 227.4150931
B = 20.65996527
C = 2.163579095
D = 0.305837941

Saturation Envelope — Mid Point Temperatures

Mid Point Temperature (T_m) = $A + BX + CX^2 + DX^3$

Tm = Average of Dew and Bubble Point Temperatures in K
X = Ln(P)
P = Pressure in bara

A = 227.0374945
B = 20.73086231
C = 2.156716801
D = 0.308448391

Latent Heat Vaporisation

$DH_{vap} = A + Bx + Cx^2 + Dx^3 + Ex^4$

Where $x = (1 - (T/Tc))^{(1/3)}$

A = 14.97617873
B= 52.81362377
C = 661.1404448
D = -713.1600563
E = 288.6597654

T_m = Temperature K
T_c = Critical Temperature K
T_c = 345.2K
DH_{vap} = kJ/kg

Ideal Gas Heat Capacity

C_p (ideal) = A + BT + CT^2 + D/T^3 + ET

A = 0.197431154
B = 0.002575682
C = 1.01573E-06
D = -4.69114E-10
E = 0

T = Temperature K
C_p(ideal) = kJ/kg.K

Saturated Liquid Enthalpy

Hliq = A + Bx + Cx^2 + Dx^3+ Ex^4

where x = $(1- (T/T_c))^{(1/3)}$

A = 335.452948
B = -17.18689277
C = -244.5534059
D = -188.0332744
E = 0

T = Bubble Point Temperature K
T_c = Critical Temperature K
T_c = 345.2 K
H_{liq} = kJ/kg

Liquid Density

d_{liq} = A + Bx + Cx^2 + Dx^3 + Ex^4
Where x = $(1 - (T/Tc))^{(1/3)}$

A = 469.7403981
B = 993.4400025
C = 94.25217658
D = 277.8995859
E = 0

T = Bubble Point Temperature K
T_c = Critical Temperature K
T_c = 345.2 K
d_{liq} = kg/m^3

Liquid Viscosity

μ_{liq} = A + B/T + CT^2 +D/T^3 + E/T

A = -6.859343701
B = 0.020803979
C = -2.03945E-05
D = -4.84788E-09
E = 812.9813437

T = Bubble Point Temperature K
μ_{liq} = cP

Liquid Thermal Conductivity

$K_{liq} = A + BT + CT^2 + DT^3 + E/T$

A = 174.1964231
B = -0.20702572
C = -0.001104491
D = 1.8546E-06
E = 0

T = Bubble Point Temperature K
K_{liq} = W/m.K

Saturated Vapour Density

$d_{vap} = A + Bx + Cx^2 + Dx^3 + Ex^4$
Where $x = (1-(T/Tc))^{(1/3)}$

A = 453.7187921
B = -554.4345112
C = -1499.151203
D = 2684.331531
E = -1026.731886

T = Dew Point Temperature K
T_c = Critical Temperature K
T_c = 345.2 K
d_{vap} = kg/m^3

Vapour Viscosity (Ideal Vapour)

$\mu_{vap} = A + BX + CX^2 + DX^3 + EX$

A = -0.03914989
B = 0
C = 2.98247E-07
D = 0
E = 7.521293344

T = Temperature K
μ_{vap} = cP

Vapour Thermal Conductivity (Ideal Vapour)

$K_{vap} = A + BT + CT^2 + DT^3$

A = 0
B = 0
C = -1.76382E-06
D = 4.902E-09

T = Temperature K
K_{vap} = W/m.K

Saturation Envelope			
Pressure	Temperatures		
Bara	BUB T (°C)	MID T (°C)	DEW T (°C)
2	-30.9	-30.6	-30.3
3	-20.6	-20.3	-20.0
4	-12.7	-12.4	-12.1
6	-0.5	-0.3	0.0
8	8.9	9.1	9.3
10	16.6	16.9	17.1
12	23.3	23.5	23.7
15	31.9	32.1	32.3
20	43.8	43.9	44.1
25	53.5	53.6	53.8
30	61.8	61.9	62.0
36	70.4	70.4	70.5

Liquid Properties					
Temp °C	**Liquid Density Kg/M^3**	**Liquid Enthalpy kJ/kg**	**Latent Heat kJ/kg**	**Liquid Viscosity cP**	**Liq Thermal Conductivity W/m-K**
-50	**1317.8**	**134.59**	**202.92**	**0.36**	**0.094**
-40	**1286.9**	**147.15**	**196.38**	**0.31**	**0.089**
-30	**1255**	**159.93**	**189.51**	**0.27**	**0.085**
-20	**1221.8**	**172.97**	**182.19**	**0.23**	**0.081**
-10	**1186.9**	**186.31**	**174.34**	**0.20**	**0.077**
0	**1150**	**200**	**165.82**	**0.18**	**0.073**
10	**1110.4**	**214.12**	**156.45**	**0.16**	**0.069**
20	**1067.3**	**228.75**	**145.99**	**0.14**	**0.065**
30	**1019.4**	**244.03**	**134.11**	**0.12**	**0.062**
40	**964.65**	**260.17**	**120.26**	**0.10**	**0.058**
50	**899.07**	**277.57**	**103.44**	**0.09**	**0.054**
60	**813.01**	**297.18**	**81.22**	**0.07**	**0.051**
70	**655.33**	**323.96**	**41.08**	**0.05**	**0.052**

The Temperatures Used:- For Latent Heat they are mid-point temperatures
for the rest they are bubble point temperatures.

Vapour Properties				
Temp °C	ID.Gas cP J/g.K	ID.Gas Viscosity cP	ID Gas Thermal Conductivity W/M-K	Sat Vap Density Kg/m^3
-50	0.716	0.0090	0.0087	4.44
-40	0.737	0.0094	0.0094	6.98
-30	0.757	0.0098	0.0102	10.55
-20	0.777	0.0102	0.0110	15.41
-10	0.796	0.0106	0.0119	21.91
0	0.816	0.0110	0.0128	30.47
10	0.835	0.0114	0.0139	41.66
20	0.853	0.0119	0.0152	56.31
30	0.872	0.0125	0.0167	75.61
40	0.890	0.0133	0.0188	101.57
50	0.908	0.0144	0.0219	138.04
60	0.925	0.0163	0.0275	194.57
70	0.943	0.0217	0.0469	321.83

The Temperatures used:- For Vapour Density they are dew point temperatures.

The correlations in this document should not be used outside the applicable ranges quoted.

Please contact Mexichem for further advice.

Mexichem Refrigerants

Mexichem UK Limited, The Heath Business & Technical Park, Runcorn, Cheshire, WA7 4QX
Tel: +44 (0)1928 518880 E-mail: info@mexichem.com www.mexichemfluor.com