

## Klea® 410A Data Sheet – SI Units

## Physical Property Data for Klea® 410A

| Property                            | Units             | Value   |
|-------------------------------------|-------------------|---------|
| Molecular Weight                    |                   | 72.585  |
| Boiling Point                       | (1atm) °C         | -51.95  |
| Melting Point                       | °C                | -116    |
| Critical Temperature                | °C                | 71.00   |
| Critical Pressure                   | Bara              | 49.1    |
| Critical Density                    | kg/m <sup>3</sup> | 493     |
| Vapour Pressure                     | (25°C) Bara       | 16.66   |
| Latent Heat of Vaporisation at nBpt | kJ/kg             | 268.0   |
| Saturated vapour Density at nBpt    | kg/m <sup>3</sup> | 4.19    |
| Coeff.Vol.Therm.Exp (LIQ,0-20°C)    | °C <sup>-1</sup>  | 0.00358 |

## Equation of State (Martin-Hou)

$$P_r = \frac{X T_r}{V_r - B} + \sum_{i=1, 4} \frac{(A_i + B_i T_r + C_i \exp(-K T_r))}{(V_r - B)^{(i+1)}}$$

Where :

$$T_r = T/T_c, P_r = P/P_c, V_r = V/V_c = V \cdot \text{RHO}_c$$

$$X = 3.9581669$$

$$B = 1.6730567592E-05$$

$$K = 4.98693632976211$$

$$T_c, P_c, \text{RHO}_c = 344.15(\text{K}), 49.1(\text{bara}), 493.00(\text{kg/m}^3)$$

$$A_1, B_1, C_1 = -7.63508148346917, 3.13785456660298, -200.10104493804$$

$$A_2, B_2, C_2 = -0.526007890121690, 2.29979778680507, 302.787529325433$$

$$A_3, B_3, C_3 = -0.924483754592590, 0.0, 0.0$$

$$A_4, B_4, C_4 = 0.886464961112581, -0.494678283732852, -59.035545208739$$

This correlation is applicable over the ranges of T and P consistent with the Thermodynamic Tables for 410A.

## Extended Antoine Equation

$$\ln(P) = A + \frac{B}{C + T} + DT + E \ln(T)$$

$$A = 78.003928$$

$$B = -4076.4422$$

$$C = 0$$

$$D = 0.02065787$$

$$E = -11.878228$$

P = Vapour pressure bara

T = Temperature K

### Latent Heat Of Vaporisation

$$DH_{\text{vap}} = A + BX + CX^2 + DX^3 + EX^4$$

$$\text{Where } x = (1 - (T/T_c))^{(1/3)}$$

|                |   |
|----------------|---|
| A = 0          | T = Temperature K                       |
| B = 314.92863  | T <sub>c</sub> = Critical Temperature K |
| C = -86.385264 |   |
| D = 612.07716  | DH <sub>vap</sub> = kJ/kg               |
| E = -515.30242 |   |

### Ideal Gas Heat Capacity

$$C_p (\text{ideal}) = A + BT + CT^2 + DT^3 + E/T^2$$

|                   |                                |
|-------------------|--------------------------------|
| A = 0.59429312    | T = Temperature K              |
| B = 9.900117E-05  | C <sub>p</sub> (ideal) kJ/kg.K |
| C = 2.652063E-06  |                                |
| D = -1.239926E-09 |                                |
| E = -2014.8791    |                                |

### Saturated Liquid Enthalpy

$$H_{\text{liq}} = A + BX + CX^2 + DX^3 + EX^4$$

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

|                |   |
|----------------|---|
| A = 275.71426  | T = Temperature K                       |
| B = -280.52509 | T <sub>c</sub> = Critical Temperature K |
| C = 577.11261  | H <sub>liq</sub> kJ/kg                  |
| D = -1430.1314 |   |
| E = 685.7202   |   |

### Liquid Density

$$d_{\text{liq}} = A + BX + CX^2 + DX^3 + EX^4$$

|              |   |
|--------------|---|
| A = 493      | T = Temperature K                       |
| B = 930.2971 | T <sub>c</sub> = Critical Temperature K |
| C = 416.4226 | d <sub>liq</sub> kg/m <sup>3</sup>      |
| D = -86.8832 |   |
| E = 0        |   |

### Liquid Viscosity

$$\ln(\mu_{liq}) = A + B/T + CT$$

|              |                   |
|--------------|-------------------|
| A = 4.550395 | T = Temperature K |
| B = -386.497 | $\mu_{liq}$ cP    |
| C = -0.01806 |                   |

### Liquid Thermal Conductivity

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

|                  |                   |
|------------------|-------------------|
| A = 0.8148462    | T = Temperature K |
| B = -5.97897E-02 | $K_{liq}$ W/m.K   |
| C = 1.7297E-05   |                   |
| D = -1.82606E-08 |                   |

### Surface Tension

$$\sigma = A (1 - (T/T_c))^{1.26}$$

|               |                                |
|---------------|--------------------------------|
| A = 63.295116 | T = Temperature K              |
|               | $T_c$ = Critical Temperature K |
|               | $\sigma$ mN/m                  |

### Saturated Vapour Density

$$d_{vap} = (1 - y^3) * RHO_c$$

$$y = A + BX + CX^2 + DX^3 + EX^4 + FX^5$$

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

|                |  |
|----------------|--|
| A = 0.36359063 | T = Temperature K                            |
| B = 2.6775079  | $T_c$ = Critical Temperature K               |
| C = -5.9330937 | $RHO_c$ = Critical Density kg/m <sup>3</sup> |
| D = 9.5070291  | $d_{vap}$ kg/m <sup>3</sup>                  |
| E = -9.1236153 |  |
| F = 3.5429932  |  |

### Ideal Gas Viscosity

$$\mu_{ig} = A + BT + CT^2$$

|                  |                   |
|------------------|-------------------|
| A = -3.46082E-03 | T = Temperature K |
| B = 6.39738E-05  | $\mu_{ig}$ cP     |
| C = -3.05649E-08 |                   |

**Vapour Viscosity (Saturated Vapour)**

$$\mu_{\text{vap}} = A + BT + CT^2$$

A = 0.03689842                      T = Temperature K  
 B = -2.62186E-04                     $\mu_{\text{vap}}$  cP  
 C = 6.19587E-07

**Ideal Gas Thermal Conductivity**

$$K_{\text{ig}} = A + BT$$

A = -0.01037773                      T = Temperature K  
 B = 8.18218E-05                       $K_{\text{ig}}$  W/m.K

**Saturated Vapour Thermal Conductivity**

$$K_{\text{vap}} = A + BT + CT^2$$

A = 0.04719455                      T = Temperature K  
 B = -3.860968E-04                     $K_{\text{vap}}$  W/m.K  
 C = 9.3945155E-07

**Vapour Speed of Sound (Saturated Vapour)**

$$\mu = A + BT + CT^2 + DT^3 + E/T$$

A = 2370.3798                      T = Temperature K  
 B = -14.587020                       $\mu$  = m/s  
 C = 0.04487231  
 D = -5.300999E-05  
 E = -132002.76

| Temp °C | Liquid Enth<br>kJ/kg. | Latent Heat<br>kJ/kg. | Sat Vap Enth<br>kJ/kg. | Liquid cP<br>kJ/kg.K | Id Gas cP<br>kJ/kg.K |
|---------|-----------------------|-----------------------|------------------------|----------------------|----------------------|
| -60.00  | 20.3                  | 273.7                 | 294.0                  | 1.205                | 0.680                |
| -50.00  | 32.5                  | 266.6                 | 299.1                  | 1.242                | 0.694                |
| -40.00  | 45.2                  | 258.8                 | 303.9                  | 1.281                | 0.709                |
| -30.00  | 58.2                  | 250.3                 | 308.4                  | 1.323                | 0.723                |
| -20.00  | 71.6                  | 240.9                 | 312.6                  | 1.368                | 0.738                |
| -10.00  | 85.6                  | 230.7                 | 316.2                  | 1.417                | 0.752                |
| 0.00    | 100.0                 | 219.4                 | 319.4                  | 1.472                | 0.767                |
| 10.00   | 115.0                 | 206.8                 | 321.9                  | 1.534                | 0.782                |
| 20.00   | 130.7                 | 192.8                 | 323.5                  | 1.607                | 0.797                |
| 25.00   | 138.9                 | 185.0                 | 323.9                  | 1.650                | 0.804                |
| 30.00   | 147.2                 | 176.8                 | 324.0                  | 1.699                | 0.812                |
| 40.00   | 164.8                 | 158.1                 | 322.9                  | 1.823                | 0.827                |
| 50.00   | 183.9                 | 135.6                 | 319.5                  | 2.023                | 0.842                |
| 60.00   | 206.1                 | 105.6                 | 311.6                  | 2.488                | 0.858                |

| Temp °C | Vapour Press<br>bara | Liquid Density<br>Kg/m <sup>3</sup> | Liquid Viscosity<br>cP | Liq. Therm Cond<br>W/m.K | Surf Tension<br>mN/m |
|---------|----------------------|-------------------------------------|------------------------|--------------------------|----------------------|
| -60.00  | 0.66                 | 1353                                | 0.329                  | 0.149                    | 18.7                 |
| -50.00  | 1.12                 | 1326                                | 0.298                  | 0.139                    | 17.0                 |
| -40.00  | 1.79                 | 1299                                | 0.268                  | 0.130                    | 15.2                 |
| -30.00  | 2.74                 | 1270                                | 0.239                  | 0.121                    | 13.5                 |
| -20.00  | 4.04                 | 1239                                | 0.213                  | 0.114                    | 11.8                 |
| -10.00  | 5.78                 | 1206                                | 0.188                  | 0.107                    | 10.2                 |
| 0.00    | 8.05                 | 1170                                | 0.166                  | 0.100                    | 8.7                  |
| 10.00   | 10.94                | 1132                                | 0.145                  | 0.094                    | 7.2                  |
| 20.00   | 14.55                | 1089                                | 0.127                  | 0.089                    | 5.7                  |
| 25.00   | 16.66                | 1066                                | 0.119                  | 0.086                    | 5.0                  |
| 30.00   | 19.00                | 1041                                | 0.111                  | 0.083                    | 4.3                  |
| 40.00   | 24.41                | 986                                 | 0.096                  | 0.078                    | 3.0                  |
| 50.00   | 30.91                | 918                                 | 0.084                  | 0.073                    | 1.9                  |
| 60.00   | 38.64                | 827                                 | 0.072                  | 0.068                    | 0.8                  |

| Temp °C | Sat Vap Density<br>Kg/m <sup>3</sup> | Ideal Gas Viscosity<br>cP | Sat Vap Viscosity<br>cP | Ideal Gas Therm Cond<br>W/m.K | Saturated Therm Cond<br>W/m.K | Speed of Sound<br>m/s |
|---------|--------------------------------------|---------------------------|-------------------------|-------------------------------|-------------------------------|-----------------------|
| -60.00  | 2.81                                 | 0.0088                    | -                       | -                             | -                             | 167.2                 |
| -50.00  | 4.59                                 | 0.0093                    | 0.0092                  | 0.0079                        | 0.0078                        | 169.2                 |
| -40.00  | 7.17                                 | 0.0098                    | 0.0094                  | 0.0087                        | 0.0082                        | 170.6                 |
| -30.00  | 10.78                                | 0.0103                    | 0.0098                  | 0.0095                        | 0.0089                        | 171.6                 |
| -20.00  | 15.71                                | 0.0108                    | 0.0102                  | 0.0103                        | 0.0097                        | 171.9                 |
| -10.00  | 22.32                                | 0.0113                    | 0.0108                  | 0.0112                        | 0.0106                        | 171.5                 |
| 0.00    | 31.07                                | 0.0117                    | 0.0115                  | 0.0120                        | 0.0118                        | 170.3                 |
| 10.00   | 42.55                                | 0.0122                    | 0.0123                  | 0.0128                        | 0.0132                        | 168.1                 |
| 20.00   | 57.62                                | 0.0127                    | 0.0133                  | 0.0136                        | 0.0147                        | 164.6                 |
| 25.00   | 66.88                                | 0.0129                    | 0.0138                  | 0.0140                        | 0.0156                        | 162.4                 |
| 30.00   | 77.55                                | 0.0131                    | 0.0144                  | 0.0144                        | 0.0165                        | 159.8                 |
| 40.00   | 104.4                                | 0.0136                    | 0.0156                  | 0.0152                        | 0.0184                        | 153.4                 |
| 50.00   | 142.4                                | 0.0140                    | 0.0169                  | 0.0161                        | 0.0205                        | 145.1                 |
| 60.00   | 202.4                                | 0.0145                    | -                       | 0.0169                        | 0.0228                        | 134.7                 |

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

Please contact Mexichem for further advice.

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Refrigerants

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