Important Psychrometry Formulas PDF

Formulas
Examples
with Units

List of 86
Important Psychrometry Formulas

1) By-Pass Factor Formulas

1.1) By-Pass Factor of Cooling Coil Formula

Evaluate Formula

Formula

$$BPF = \exp\left(-\frac{U \cdot A_c}{m_{air} \cdot c}\right)$$

Example with Units

$$0.8803 = \exp\left(-\frac{50\,\text{W/m}^2\text{*K} \cdot 64\,\text{m}^2}{6\,\text{kg} \cdot 4.184\,\text{kJ/kg*K}}\right)$$

1.2) By-Pass Factor of Heating Coil Formula

Evaluate Formula

Formula

$$BPF = \exp\left(-\frac{U \cdot A_c}{m_{air} \cdot c}\right)$$

Example with Units

$$0.8803 = \exp\left(-\frac{50\,\text{W/m}^2\text{*K} \cdot 64\,\text{m}^2}{6\,\text{kg} \cdot 4.184\,\text{kJ/kg*K}}\right)$$

1.3) Efficiency of Cooling Coil Formula

Evaluate Formula

Formula

$$\eta = \frac{T_i - T_f}{T_i - T_c}$$

Example with Units

$$16 = \frac{105\,\text{K} - 345\,\text{K}}{105\,\text{K} - 120\,\text{K}}$$

1.4) Efficiency of Cooling Coil given By-pass Factor Formula

Evaluate Formula

Formula

$$\eta = 1 - BPF$$

Example

$$0.15 = 1 - 0.85$$

1.5) Efficiency of Heating Coil Formula

Evaluate Formula

Formula

$$\eta = \frac{T_f - T_i}{T_c - T_i}$$

Example with Units

$$16 = \frac{345\,\text{K} - 105\,\text{K}}{120\,\text{K} - 105\,\text{K}}$$

1.6) Efficiency of Heating Coil given By-pass Factor Formula

Evaluate Formula

Formula

$$\eta = 1 - BPF$$

Example

$$0.15 = 1 - 0.85$$

1.7) LMTD of Coil given By-Pass Factor Formula

Evaluate Formula

Formula

$$\Delta T_m = \frac{T_f - T_i}{\ln\left(\frac{1}{BPF}\right)}$$

Example with Units

$$1476.7511 = \frac{345\,\mathrm{K} - 105\,\mathrm{K}}{\ln\left(\frac{1}{0.85}\right)}$$

1.8) Mass of Air Passing over Coil given By-Pass Factor Formula

Evaluate Formula

Formula

$$m_{air} = -\left(\frac{U \cdot A_c}{c \cdot \ln(BPF)}\right)$$

Example with Units

$$4.706\,\mathrm{kg} = -\left(\frac{50\,\mathrm{W/m^2{*}K} \cdot 64\,\mathrm{m^2}}{4.184\,\mathrm{kJ/kg{*}K} \cdot \ln(0.85)}\right)$$

1.9) Overall Heat Transfer Coefficient given By-Pass Factor Formula

Evaluate Formula

Formula

$$U = -\frac{\ln(BPF) \cdot m_{air} \cdot c}{A_c}$$

Example with Units

$$63.7481\,\mathrm{W/m^2{*}K} = -\frac{\ln(0.85) \cdot 6\,\mathrm{kg} \cdot 4.184\,\mathrm{kJ/kg{*}K}}{64\,\mathrm{m^2}}$$

1.10) Sensible Heat given Out by Coil using By-Pass Factor Formula

Evaluate Formula

Formula

$$SH = \frac{U \cdot A_c \cdot (T_f - T_i)}{\ln\left(\frac{1}{BPF}\right)}$$

Example with Units

$$4.7E{+}6\,\mathrm{J} = \frac{50\,\mathrm{W/m^2{*}K} \cdot 64\,\mathrm{m^2} \cdot (345\,\mathrm{K} - 105\,\mathrm{K})}{\ln\left(\frac{1}{0.85}\right)}$$

1.11) Surface Area of Coil given By-Pass Factor Formula

Evaluate Formula

Formula

$$A_c = -\frac{\ln(BPF) \cdot m_{air} \cdot c}{U}$$

Example with Units

$$81.5975\,\mathrm{m^2} = -\frac{\ln(0.85) \cdot 6\,\mathrm{kg} \cdot 4.184\,\mathrm{kJ/kg{*}K}}{50\,\mathrm{W/m^2{*}K}}$$

1.12) Wet Bulb Depression Formula

Evaluate Formula

Formula

$$WBD = t_{db} - T_w$$

Example

$$96 = 110 - 14$$

2) Degree of Saturation Formulas

2.1) Degree of Saturation given Partial Pressure of Water Vapour Formula

Evaluate Formula

Formula

$$S = \frac{p_v}{p_s} \cdot \frac{1 - \frac{p_s}{p_t}}{1 - \frac{p_v}{p_t}}$$

Example with Units

$$0.1484 = \frac{60\,\mathrm{Bar}}{91\,\mathrm{Bar}} \cdot \frac{1 - \frac{91\,\mathrm{Bar}}{100\,\mathrm{Bar}}}{1 - \frac{60\,\mathrm{Bar}}{100\,\mathrm{Bar}}}$$

2.2) Degree of Saturation given Relative Humidity Formula

Evaluate Formula

Formula

$$S = \Phi \cdot \frac{1 - \frac{p_s}{p_t}}{1 - \frac{\Phi \cdot p_s}{p_t}}$$

Example with Units

$$0.1264 = 0.616523 \cdot \frac{1 - \frac{91\,\text{Bar}}{100\,\text{Bar}}}{1 - \frac{0.616523 \cdot 91\,\text{Bar}}{100\,\text{Bar}}}$$

2.3) Degree of Saturation given Specific Humidity Formula

Evaluate Formula

Formula

$$S = \frac{\omega}{\omega_s}$$

Example

$$0.2632 = \frac{0.25}{0.95}$$

2.4) Partial Pressure of Water Vapor in Saturated Air given Degree of Saturation Formula

Evaluate Formula

Formula

$$p_s = \left(\frac{1}{p_t} + \frac{S}{p_v} \cdot \left(1 - \frac{p_v}{p_t} \right) \right)^{-1}$$

Example with Units

$$88.2353\,\text{Bar} = \left(\frac{1}{100\,\text{Bar}} + \frac{0.2}{60\,\text{Bar}} \cdot \left(1 - \frac{60\,\text{Bar}}{100\,\text{Bar}} \right) \right)^{-1}$$

2.5) Total Pressure of Moist Air given Degree of Saturation Formula

Evaluate Formula

Formula

$$p_t = \frac{(S - 1) \cdot p_s \cdot p_v}{S \cdot p_s - p_v}$$

Example with Units

$$104.4976\,\text{Bar} = \frac{(0.2 - 1) \cdot 91\,\text{Bar} \cdot 60\,\text{Bar}}{0.2 \cdot 91\,\text{Bar} - 60\,\text{Bar}}$$

3) Enthalpy Formulas

3.1) Dry Bulb Temperature given Enthalpy of Moist Air Formula

Evaluate Formula

Formula

$$t_{db} = \frac{h - 2500 \cdot \omega}{1.005 + 1.9 \cdot \omega}$$

Example with Units

$$1469.5946 = \frac{2800\,\text{kJ/kg} - 2500 \cdot 0.25}{1.005 + 1.9 \cdot 0.25}$$

3.2) Enthalpy of Dry Air Formula

Evaluate Formula

Formula

$$h_{dry} = 1.005 \cdot t_{db}$$

Example with Units

$$110.55\,\text{kJ/kg} = 1.005 \cdot 110$$

3.3) Enthalpy of Moist Air Formula

Evaluate Formula

Formula

$$h = 1.005 \cdot t_{db} + \omega \cdot (2500 + 1.9 \cdot t_{db})$$

Example with Units

$$787.8\,\text{kJ/kg} = 1.005 \cdot 110 + 0.25 \cdot (2500 + 1.9 \cdot 110)$$

3.4) Specific Enthalpy of Water Vapor Formula

Evaluate Formula

Formula

$$h_{dry} = 2500 + 1.9 \cdot t_{db}$$

Example with Units

$$2709\,\text{kJ/kg} = 2500 + 1.9 \cdot 110$$

3.5) Specific Humidity given Enthalpy of Moist Air Formula

Evaluate Formula

Formula

$$\omega = \frac{h - 1.005 \cdot t_{db}}{2500 + 1.9 \cdot t_{db}}$$

Example with Units

$$0.9928 = \frac{2800\,\text{kJ/kg} - 1.005 \cdot 110}{2500 + 1.9 \cdot 110}$$

3.6) Enthalpy of Saturated Air Formulas

3.6.1) Coefficient of Performance given enthalpy of liquid refrigerant leaving condenser (hf3) Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{h_1 - hf_3}{h_2 - h_1}$$

Example with Units

$$11.2 = \frac{260\,\text{kJ/kg} - 36\,\text{kJ/kg}}{280\,\text{kJ/kg} - 260\,\text{kJ/kg}}$$

3.6.2) Enthalpy at point 1 given Liquid enthalpy at point 1 Formula

Evaluate Formula

Formula

$$h_1 = h_{f1} + x_1 \cdot h_{fg}$$

Example with Units

$$200\,\text{kJ/kg} = 100\,\text{kJ/kg} + 0.1 \cdot 1000\,\text{kJ/kg}$$

3.6.3) Enthalpy at point 2 Formula

Evaluate Formula

Formula

$$h_2 = h_{f2} + \left(x_2 \cdot h_{fg} \right)$$

Example with Units

$$350\,\text{kJ/kg} = 150\,\text{kJ/kg} + \left(0.2 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.4) Enthalpy at Point 4 given Liquid Enthalpy at Point 4 Formula

Evaluate Formula

Formula

$$h_4 = h_{f4} + \left(x_4 \cdot h_{fg} \right)$$

Example with Units

$$880\,\text{kJ/kg} = 80\,\text{kJ/kg} + \left(0.8 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.5) Entropy at point 1 Formula

Evaluate Formula

Formula

$$s_1 = s_{f1} + \left(\frac{x_1 \cdot h_{fg}}{T_1} \right)$$

Example with Units

$$3.4\,\text{kJ/kg*K} = 3\,\text{kJ/kg*K} + \left(\frac{0.1 \cdot 1000\,\text{kJ/kg}}{250\,\text{K}} \right)$$

3.6.6) Entropy at point 2 Formula

Evaluate Formula

Formula

$$s_2 = s_{f2} + \left(\frac{x_2 \cdot h_{fg}}{T_2} \right)$$

Example with Units

$$7.4444 \, \text{kJ/kg*K} = 7 \, \text{kJ/kg*K} + \left(\frac{0.2 \cdot 1000 \, \text{kJ/kg}}{450 \, \text{K}} \right)$$

3.6.7) Refrigerating Effect given Enthalpy at Inlet of Compressor and Exit of Condenser Formula

Evaluate Formula

Formula

$$R_E = h_1 - hf_3$$

Example with Units

$$224 \, \text{kJ/kg} = 260 \, \text{kJ/kg} - 36 \, \text{kJ/kg}$$

3.6.8) Refrigerating Effect(for given h1 and h4) Formula

Evaluate Formula

Formula

$$R_E = h_1 - h_4$$

Example with Units

$$80 \, \text{kJ/kg} = 260 \, \text{kJ/kg} - 180 \, \text{kJ/kg}$$

3.6.9) Work done during isentropic compression(per Kg of refrigerant) Formula

Evaluate Formula

Formula

$$w = h_2 - h_1$$

Example with Units

$$20 \, \text{KJ} = 280 \, \text{kJ/kg} - 260 \, \text{kJ/kg}$$

3.6.10) Theoretical Vapour compression cycle with Wet vapour after compression Formulas

3.6.10.1) Coefficient of Performance given enthalpy of liquid refrigerant leaving condenser (hf3) Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{h_1 - hf_3}{h_2 - h_1}$$

Example with Units

$$11.2 = \frac{260 \, \text{kJ/kg} - 36 \, \text{kJ/kg}}{280 \, \text{kJ/kg} - 260 \, \text{kJ/kg}}$$

3.6.10.2) Enthalpy at point 1 given Liquid enthalpy at point 1 Formula

Evaluate Formula

Formula

$$h_1 = h_{f1} + x_1 \cdot h_{fg}$$

Example with Units

$$200 \, \text{kJ/kg} = 100 \, \text{kJ/kg} + 0.1 \cdot 1000 \, \text{kJ/kg}$$

3.6.10.3) Enthalpy at point 2 Formula

Evaluate Formula

Formula

$$h_2 = h_{f2} + \left(x_2 \cdot h_{fg} \right)$$

Example with Units

$$350 \, \text{kJ/kg} = 150 \, \text{kJ/kg} + \left(0.2 \cdot 1000 \, \text{kJ/kg} \right)$$

3.6.10.4) Enthalpy at Point 4 given Liquid Enthalpy at Point 4 Formula

Evaluate Formula

Formula

$$h_4 = h_{f4} + \left(x_4 \cdot h_{fg} \right)$$

Example with Units

$$880 \, \text{kJ/kg} = 80 \, \text{kJ/kg} + \left(0.8 \cdot 1000 \, \text{kJ/kg} \right)$$

3.6.10.5) Entropy at point 1 Formula

Evaluate Formula

Formula

$$s_1 = s_{f1} + \left(\frac{x_1 \cdot h_{fg}}{T_1} \right)$$

Example with Units

$$3.4\,\text{kJ/kg*K} = 3\,\text{kJ/kg*K} + \left(\frac{0.1 \cdot 1000\,\text{kJ/kg}}{250\,\text{K}} \right)$$

3.6.10.6) Entropy at point 2 Formula

Evaluate Formula

Formula

$$s_2 = s_{f2} + \left(\frac{x_2 \cdot h_{fg}}{T_2} \right)$$

Example with Units

$$7.4444\,\text{kJ/kg*K} = 7\,\text{kJ/kg*K} + \left(\frac{0.2 \cdot 1000\,\text{kJ/kg}}{450\,\text{K}} \right)$$

3.6.10.7) Refrigerating Effect given Enthalpy at Inlet of Compressor and Exit of Condenser Formula

Evaluate Formula

Formula

$$R_E = h_1 - hf_3$$

Example with Units

$$224\,\text{kJ/kg} = 260\,\text{kJ/kg} - 36\,\text{kJ/kg}$$

3.6.10.8) Refrigerating Effect(for given h1 and h4) Formula

Evaluate Formula

Formula

$$R_E = h_1 - h_4$$

Example with Units

$$80\,\text{kJ/kg} = 260\,\text{kJ/kg} - 180\,\text{kJ/kg}$$

3.6.11) Theoretical Vapour compression cycle with Superheated vapour after compression Formulas

3.6.11.1) Coefficient of Performance given enthalpy of liquid refrigerant leaving condenser (hf3) Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{h_1 - hf_3}{h_2 - h_1}$$

Example with Units

$$11.2 = \frac{260\,\text{kJ/kg} - 36\,\text{kJ/kg}}{280\,\text{kJ/kg} - 260\,\text{kJ/kg}}$$

3.6.11.2) Enthalpy at point 1 given Liquid enthalpy at point 1 Formula

Evaluate Formula

Formula

$$h_1 = h_{f1} + x_1 \cdot h_{fg}$$

Example with Units

$$200\,\text{kJ/kg} = 100\,\text{kJ/kg} + 0.1 \cdot 1000\,\text{kJ/kg}$$

3.6.11.3) Enthalpy at point 2 Formula

Evaluate Formula

Formula

$$h_2 = h_{f2} + \left(x_2 \cdot h_{fg} \right)$$

Example with Units

$$350\,\text{kJ/kg} = 150\,\text{kJ/kg} + \left(0.2 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.11.4) Enthalpy at Point 4 given Liquid Enthalpy at Point 4 Formula

Evaluate Formula

Formula

$$h_4 = h_{f4} + \left(x_4 \cdot h_{fg} \right)$$

Example with Units

$$880\,\mathrm{kJ/kg} = 80\,\mathrm{kJ/kg} + \left(0.8 \cdot 1000\,\mathrm{kJ/kg} \right)$$

3.6.11.5) Entropy at point 1 Formula

Evaluate Formula

Formula

$$s_1 = s_{f1} + \left(\frac{x_1 \cdot h_{fg}}{T_1} \right)$$

Example with Units

$$3.4\,\mathrm{kJ/kg{*}K} = 3\,\mathrm{kJ/kg{*}K} + \left(\frac{0.1 \cdot 1000\,\mathrm{kJ/kg}}{250\,\mathrm{K}} \right)$$

3.6.11.6) Entropy at point 2 Formula

Evaluate Formula

Formula

$$s_2 = s_{f2} + \left(\frac{x_2 \cdot h_{fg}}{T_2} \right)$$

Example with Units

$$7.4444\,\mathrm{kJ/kg{*}K} = 7\,\mathrm{kJ/kg{*}K} + \left(\frac{0.2 \cdot 1000\,\mathrm{kJ/kg}}{450\,\mathrm{K}} \right)$$

3.6.11.7) Refrigerating Effect given Enthalpy at Inlet of Compressor and Exit of Condenser Formula

Evaluate Formula

Formula

$$R_E = h_1 - hf_3$$

Example with Units

$$224\,\mathrm{kJ/kg} = 260\,\mathrm{kJ/kg} - 36\,\mathrm{kJ/kg}$$

3.6.11.8) Refrigerating Effect(for given h1 and h4) Formula

Evaluate Formula

Formula

$$R_E = h_1 - h_4$$

Example with Units

$$80\,\mathrm{kJ/kg} = 260\,\mathrm{kJ/kg} - 180\,\mathrm{kJ/kg}$$

3.6.12) Theoretical Vapour compression cycle with Superheated vapour before compression Formulas

3.6.12.1) Coefficient of Performance given enthalpy of liquid refrigerant leaving condenser (hf3) Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{h_1 - hf_3}{h_2 - h_1}$$

Example with Units

$$11.2 = \frac{260\,\mathrm{kJ/kg} - 36\,\mathrm{kJ/kg}}{280\,\mathrm{kJ/kg} - 260\,\mathrm{kJ/kg}}$$

3.6.12.2) Enthalpy at point 1 given Liquid enthalpy at point 1 Formula

Evaluate Formula

Formula

$$h_1 = h_{f1} + x_1 \cdot h_{fg}$$

Example with Units

$$200\,\mathrm{kJ/kg} = 100\,\mathrm{kJ/kg} + 0.1 \cdot 1000\,\mathrm{kJ/kg}$$

3.6.12.3) Enthalpy at point 2 Formula

Evaluate Formula

Formula

$$h_2 = h_{f2} + \left(x_2 \cdot h_{fg} \right)$$

Example with Units

$$350\,\text{kJ/kg} = 150\,\text{kJ/kg} + \left(0.2 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.12.4) Enthalpy at Point 4 given Liquid Enthalpy at Point 4 Formula

Evaluate Formula

Formula

$$h_4 = h_{f4} + \left(x_4 \cdot h_{fg} \right)$$

Example with Units

$$880\,\text{kJ/kg} = 80\,\text{kJ/kg} + \left(0.8 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.12.5) Entropy at point 1 Formula

Evaluate Formula

Formula

$$s_1 = s_{f1} + \left(\frac{x_1 \cdot h_{fg}}{T_1} \right)$$

Example with Units

$$3.4\,\text{kJ/kg*K} = 3\,\text{kJ/kg*K} + \left(\frac{0.1 \cdot 1000\,\text{kJ/kg}}{250\,\text{K}} \right)$$

3.6.12.6) Entropy at point 2 Formula

Evaluate Formula

Formula

$$s_2 = s_{f2} + \left(\frac{x_2 \cdot h_{fg}}{T_2} \right)$$

Example with Units

$$7.4444\,\text{kJ/kg*K} = 7\,\text{kJ/kg*K} + \left(\frac{0.2 \cdot 1000\,\text{kJ/kg}}{450\,\text{K}} \right)$$

3.6.12.7) Refrigerating Effect given Enthalpy at Inlet of Compressor and Exit of Condenser Formula

Evaluate Formula

Formula

$$R_E = h_1 - hf_3$$

Example with Units

$$224\,\text{kJ/kg} = 260\,\text{kJ/kg} - 36\,\text{kJ/kg}$$

3.6.12.8) Refrigerating Effect(for given h1 and h4) Formula

Evaluate Formula

Formula

$$R_E = h_1 - h_4$$

Example with Units

$$80\,\text{kJ/kg} = 260\,\text{kJ/kg} - 180\,\text{kJ/kg}$$

3.6.13) Theoretical Vapour compression cycle with Under-cooling or sub-cooling if refrigerant Formulas

3.6.13.1) Coefficient of Performance given enthalpy of liquid refrigerant leaving condenser (hf3) Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{h_1 - hf_3}{h_2 - h_1}$$

Example with Units

$$11.2 = \frac{260\,\text{kJ/kg} - 36\,\text{kJ/kg}}{280\,\text{kJ/kg} - 260\,\text{kJ/kg}}$$

3.6.13.2) Enthalpy at point 1 given Liquid enthalpy at point 1 Formula

Evaluate Formula

Formula

$$h_1 = h_{f1} + x_1 \cdot h_{fg}$$

Example with Units

$$200\,\text{kJ/kg} = 100\,\text{kJ/kg} + 0.1 \cdot 1000\,\text{kJ/kg}$$

3.6.13.3) Enthalpy at point 2 Formula

Evaluate Formula

Formula

$$h_2 = h_{f2} + \left(x_2 \cdot h_{fg} \right)$$

Example with Units

$$350\,\text{kJ/kg} = 150\,\text{kJ/kg} + \left(0.2 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.13.4) Enthalpy at Point 4 given Liquid Enthalpy at Point 4 Formula

Evaluate Formula

Formula

$$h_4 = h_{f4} + \left(x_4 \cdot h_{fg} \right)$$

Example with Units

$$880\,\text{kJ/kg} = 80\,\text{kJ/kg} + \left(0.8 \cdot 1000\,\text{kJ/kg} \right)$$

3.6.13.5) Entropy at point 1 Formula

Evaluate Formula

Formula

$$s_1 = s_{f1} + \left(\frac{x_1 \cdot h_{fg}}{T_1} \right)$$

Example with Units

$$3.4\,\text{kJ/kg*K} = 3\,\text{kJ/kg*K} + \left(\frac{0.1 \cdot 1000\,\text{kJ/kg}}{250\,\text{K}} \right)$$

3.6.13.6) Entropy at point 2 Formula

Evaluate Formula

Formula

$$s_2 = s_{f2} + \left(\frac{x_2 \cdot h_{fg}}{T_2} \right)$$

Example with Units

$$7.4444\,\text{kJ/kg*K} = 7\,\text{kJ/kg*K} + \left(\frac{0.2 \cdot 1000\,\text{kJ/kg}}{450\,\text{K}} \right)$$

3.6.13.7) Refrigerating Effect given Enthalpy at Inlet of Compressor and Exit of Condenser Formula

Evaluate Formula

Formula

$$R_E = h_1 - hf_3$$

Example with Units

$$224\,\text{kJ/kg} = 260\,\text{kJ/kg} - 36\,\text{kJ/kg}$$

3.6.13.8) Refrigerating Effect(for given h1 and h4) Formula

Evaluate Formula

Formula

$$R_E = h_1 - h_4$$

Example with Units

$$80\,\text{kJ/kg} = 260\,\text{kJ/kg} - 180\,\text{kJ/kg}$$

4) Enthalpy of Moist air Formulas

5) Humidity Formulas

5.1) Relative Humidity Formulas

5.1.1) Partial Pressure of Vapor given Relative Humidity Formula

Evaluate Formula

Formula

$$p_v = \Phi \cdot p_s$$

Example with Units

$$56.1036\,\text{Bar} = 0.616523 \cdot 91\,\text{Bar}$$

5.1.2) Relative Humidity given Degree of Saturation Formula

Evaluate Formula

Formula

$$\Phi = \frac{S}{1 - \frac{p_s}{p_t} \cdot (1 - S)}$$

Example with Units

$$0.7353 = \frac{0.2}{1 - \frac{91\,\text{Bar}}{100\,\text{Bar}} \cdot (1 - 0.2)}$$

5.1.3) Relative Humidity given Mass of Water Vapor Formula

Evaluate Formula

Formula

$$\Phi = \frac{m_v}{m_s}$$

Example with Units

$$0.6 = \frac{3\,\text{kg}}{5\,\text{kg}}$$

5.1.4) Relative Humidity given Partial Pressure of Water Vapor Formula

Evaluate Formula

Formula

$$\Phi = \frac{p_v}{p_s}$$

Example with Units

$$0.6593 = \frac{60\,\text{Bar}}{91\,\text{Bar}}$$

5.1.5) Saturation Pressure of Water Vapor given Relative Humidity Formula

Evaluate Formula

Formula

$$p_s = \frac{p_v}{\Phi}$$

Example with Units

$$97.32\,\text{Bar} = \frac{60\,\text{Bar}}{0.616523}$$

5.2) Specific Humidity Formulas

5.2.1) Maximum Specific Humidity Formula

Evaluate Formula

Formula

$$\omega_{max} = \frac{0.622 \cdot p_s}{p_t - p_s}$$

Example with Units

$$6.2891 = \frac{0.622 \cdot 91\,\text{Bar}}{100\,\text{Bar} - 91\,\text{Bar}}$$

5.2.2) Partial Pressure of Dry Air given Specific Humidity Formula

Evaluate Formula

Formula

$$p_a = \frac{0.622 \cdot p_v}{\omega}$$

Example with Units

$$149.28\,\text{Bar} = \frac{0.622 \cdot 60\,\text{Bar}}{0.25}$$

5.2.3) Partial Pressure of Water Vapor given Specific Humidity Formula

Evaluate Formula

Formula

$$p_v = \frac{p_t}{1 + \frac{0.622}{\omega}}$$

Example with Units

$$28.6697\,\text{Bar} = \frac{100\,\text{Bar}}{1 + \frac{0.622}{0.25}}$$

5.2.4) Specific Humidity given Mass of Water Vapor and Dry Air Formula

Evaluate Formula

Formula

$$\omega = \frac{m_v}{m_a}$$

Example with Units

$$0.3 = \frac{3\,\text{kg}}{10\,\text{kg}}$$

5.2.5) Specific Humidity given Partial Pressure of Water Vapor Formula

Evaluate Formula

Formula

$$\omega = \frac{0.622 \cdot p_v}{p_t - p_v}$$

Example with Units

$$0.933 = \frac{0.622 \cdot 60\,\text{Bar}}{100\,\text{Bar} - 60\,\text{Bar}}$$

5.2.6) Specific Humidity given Specific Volumes Formula

Evaluate Formula

Formula

$$\omega = \frac{v_a}{v_v}$$

Example with Units

$$0.4 = \frac{0.02\,\text{m}^3/\text{kg}}{0.05\,\text{m}^3/\text{kg}}$$

5.2.7) Total Pressure of Moist Air given Specific Humidity Formula

Evaluate Formula

Formula

$$p_t = p_v + \frac{0.622 \cdot p_v}{\omega}$$

Example with Units

$$209.28\,\text{Bar} = 60\,\text{Bar} + \frac{0.622 \cdot 60\,\text{Bar}}{0.25}$$

6) Pressure of Water Vapor Formulas

6.1) Dry Bulb Temperature using Carrier's Equation Formula

Evaluate Formula

Formula

$$t_{db} = \left(\left(p_w - p_v \right) \cdot \frac{1544 - 1.44 \cdot T_w}{p_t - p_w} \right) + T_w$$

Example with Units

$$231.6914 = \left(\left(65\,\text{Bar} - 60\,\text{Bar} \right) \cdot \frac{1544 - 1.44 \cdot 14}{100\,\text{Bar} - 65\,\text{Bar}} \right) + 14$$

6.2) Partial Pressure of Water Vapor Formula

Evaluate Formula

Formula

$$p_v = p_w - \frac{(p_t - p_w) \cdot (t_{db} - T_w)}{1544 - 1.44 \cdot T_w}$$

Example with Units

$$62.795\,\text{Bar} = 65\,\text{Bar} - \frac{(100\,\text{Bar} - 65\,\text{Bar}) \cdot (110 - 14)}{1544 - 1.44 \cdot 14}$$

6.3) Saturation Pressure Corresponding to Wet Bulb Temperature Formula

Evaluate Formula

Formula

$$p_w = \frac{p_v + p_t \cdot \left(\frac{t_{db} - T_w}{1544 - 1.44 \cdot T_w}\right)}{1 + \left(\frac{t_{db} - T_w}{1544 - 1.44 \cdot T_w}\right)}$$

Example with Units

$$62.3706\,\text{Bar} = \frac{60\,\text{Bar} + 100\,\text{Bar} \cdot \left(\frac{110 - 14}{1544 - 1.44 \cdot 14}\right)}{1 + \left(\frac{110 - 14}{1544 - 1.44 \cdot 14}\right)}$$

6.4) Total Pressure of Moist Air using Carrier's Equation Formula

Evaluate Formula

Formula

$$p_t = \frac{(p_w - p_v) \cdot (1544 - 1.44 \cdot T_w)}{t_{db} - T_w} + p_w$$

Example with Units

$$144.3667\,\text{Bar} = \frac{(65\,\text{Bar} - 60\,\text{Bar}) \cdot (1544 - 1.44 \cdot 14)}{110 - 14} + 65\,\text{Bar}$$

6.5) Wet Bulb Temperature using Carrier's Equation Formula

Evaluate Formula

Formula

$$T_w = \frac{1544 \cdot (p_w - p_v) - t_{db} \cdot (p_t - p_w)}{1.44 \cdot (p_w - p_v) - (p_t - p_w)}$$

Example with Units

$$-139.2086 = \frac{1544 \cdot (65\,\text{Bar} - 60\,\text{Bar}) - 110 \cdot (100\,\text{Bar} - 65\,\text{Bar})}{1.44 \cdot (65\,\text{Bar} - 60\,\text{Bar}) - (100\,\text{Bar} - 65\,\text{Bar})}$$

7) Relative Humidity Formulas

8) Specific Humidity Formulas

9) Vapour Density Formulas

9.1) Dry Bulb Temperature given Vapor Density Formula

Evaluate Formula

Formula

$$t_d = \frac{\omega \cdot (p_t - p_v)}{287 \cdot \rho_v}$$

Example with Units

$$108.885\,\text{K} = \frac{0.25 \cdot (100\,\text{Bar} - 60\,\text{Bar})}{287 \cdot 32\,\text{kg/m}^3}$$

9.2) Partial Pressure of Dry Air given Vapor Density Formula

Evaluate Formula

Formula

$$p_a = \frac{\rho_v \cdot 287 \cdot t_d}{\omega}$$

Example with Units

$$128.576\,\text{Bar} = \frac{32\,\text{kg/m}^3 \cdot 287 \cdot 350\,\text{K}}{0.25}$$

9.3) Partial Pressure of Vapor given Vapor Density Formula

Evaluate Formula

Formula

$$p_v = p_t - \left(\frac{\rho_v \cdot 287 \cdot t_d}{\omega}\right)$$

Example with Units

$$-28.576\,\text{Bar} = 100\,\text{Bar} - \left(\frac{32\,\text{kg/m}^3 \cdot 287 \cdot 350\,\text{K}}{0.25}\right)$$

9.4) Specific Humidity given Vapor Density Formula

Evaluate Formula

Formula

$$\omega = \frac{\rho_v \cdot t_d \cdot 287}{p_t - p_v}$$

Example with Units

$$0.8036 = \frac{32\,\text{kg/m}^3 \cdot 350\,\text{K} \cdot 287}{100\,\text{Bar} - 60\,\text{Bar}}$$

9.5) Total Pressure of Moist Air given Vapour Density Formula

Evaluate Formula

Formula

$$p_t = \frac{287 \cdot \rho_v \cdot t_d}{\omega} + p_v$$

Example with Units

$$188.576\,\text{Bar} = \frac{287 \cdot 32\,\text{kg/m}^3 \cdot 350\,\text{K}}{0.25} + 60\,\text{Bar}$$

9.6) Vapour Density Formula

Evaluate Formula

Formula

$$\rho_v = \frac{\omega \cdot (p_t - p_v)}{287 \cdot t_d}$$

Example with Units

$$9.9552\,\text{kg/m}^3 = \frac{0.25 \cdot (100\,\text{Bar} - 60\,\text{Bar})}{287 \cdot 350\,\text{K}}$$

Variables used in list of Psychrometry Formulas above

- A_c Surface Area of Coil *(Square Meter)*
- **BPF** By Pass Factor
- **c** Specific Heat Capacity *(Kilojoule per Kilogram per K)*
- $COP_{theoretical}$ Theoretical Coefficient of Performance
- **h** Enthalpy of Moist Air *(Kilojoule per Kilogram)*
- h_1 Enthalpy of the Vapour Refrigerant at T1 *(Kilojoule per Kilogram)*
- h_2 Enthalpy of the vapour refrigerant at T2 *(Kilojoule per Kilogram)*
- h_4 Enthalpy of the vapour refrigerant at T4 *(Kilojoule per Kilogram)*
- h_{dry} Enthalpy of Dry Air *(Kilojoule per Kilogram)*
- h_{f1} Liquid Enthalpy at Point 1 *(Kilojoule per Kilogram)*
- h_{f2} Liquid Enthalpy at Point 2 *(Kilojoule per Kilogram)*
- h_{f4} Liquid Enthalpy at Point 4 *(Kilojoule per Kilogram)*
- h_{fg} Latent Heat of Fusion *(Kilojoule per Kilogram)*
- hf_3 Sensible Heat at Temperature T3 *(Kilojoule per Kilogram)*
- m_a Mass of Dry Air *(Kilogram)*
- m_{air} Mass of Air *(Kilogram)*
- m_s Mass of Water Vapor in Saturated Air *(Kilogram)*
- m_v Mass of Water Vapor in Moist Air *(Kilogram)*
- p_a Partial Pressure of Dry Air *(Bar)*
- p_s Partial Pressure of Water Vapour in Saturated Air *(Bar)*
- p_t Total Pressure of Moist Air *(Bar)*
- p_v Pressure of Water Vapor *(Bar)*
- p_w Saturation Pressure Corresponding to WBT *(Bar)*

Constants, Functions, Measurements used in list of Psychrometry Formulas above

- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Bar (Bar)
  Pressure Unit Conversion
- Measurement: **Energy** in Joule (J), Kilojoule (KJ)
  Energy Unit Conversion
- Measurement: **Heat of Combustion (per Mass)** in Kilojoule per Kilogram (kJ/kg)
  Heat of Combustion (per Mass) Unit Conversion
- Measurement: **Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg*K)
  Specific Heat Capacity Unit Conversion
- Measurement: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Specific Volume** in Cubic Meter per Kilogram (m³/kg)
  Specific Volume Unit Conversion
- Measurement: **Specific Entropy** in Kilojoule per Kilogram K (kJ/kg*K)
  Specific Entropy Unit Conversion

- **R_E** Refrigerating Effect *(Kilojoule per Kilogram)*
- **S** Degree of Saturation
- **s_1** Entropy at Point 1 *(Kilojoule per Kilogram K)*
- **s_2** Entropy at point 2 *(Kilojoule per Kilogram K)*
- **s_{f1}** Liquid Entropy at Point 1 *(Kilojoule per Kilogram K)*
- **s_{f2}** Liquid entropy at point 2 *(Kilojoule per Kilogram K)*
- **SH** Sensible Heat *(Joule)*
- **T_1** Temperature at the suction of compressor *(Kelvin)*
- **T_2** Temperature at Discharge of Compressor *(Kelvin)*
- **T_c** Temperature of Coil *(Kelvin)*
- **t_d** Dry Bulb Temperature *(Kelvin)*
- **t_{db}** Dry Bulb Temperature in °C
- **T_f** Final Temperature *(Kelvin)*
- **T_i** Initial Temperature *(Kelvin)*
- **T_w** Wet Bulb Temperature
- **U** Overall Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **w** Work Done *(Kilojoule)*
- **WBD** Wet Bulb Depression
- **x_1** Dryness Fraction at point 1
- **x_2** Dryness Fraction at point 2
- **x_4** Dryness Fraction at point 4
- **ΔT_m** Logarithmic Mean Temperature Difference
- **η** Efficiency
- **v_a** Specific Volume of Dry Air *(Cubic Meter per Kilogram)*
- **v_v** Specific Volume of Water Vapor *(Cubic Meter per Kilogram)*
- **ρ_v** Vapor Density *(Kilogram per Cubic Meter)*
- **Φ** Relative Humidity
- **ω** Specific Humidity
- **ω_{max}** Maximum Specific Humidity

- ω_s Specific Humidity of Saturated Air

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