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Psychrometry Formulas

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List of 45 Psychrometry Formulas

Psychrometry

1) Wet Bulb Depression

Open Calculator

fx $$\mathrm{WBD} = \mathrm{t_{db}} - \mathrm{T_w}$$

ex $$96 = 110 - 14$$

By-Pass Factor of Heating and Cooling coil

2) By-Pass Factor of Cooling Coil

Open Calculator

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

ex $$0.88032 = \exp\left(-\frac{50\mathrm{W/m^2{*}K} \cdot 64\mathrm{m^2}}{6\mathrm{kg} \cdot 4.184\mathrm{kJ/kg{*}K}}\right)$$

3) By-Pass Factor of Heating Coil

Open Calculator

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

ex $$0.88032 = \exp\left(-\frac{50\mathrm{W/m^2{*}K} \cdot 64\mathrm{m^2}}{6\mathrm{kg} \cdot 4.184\mathrm{kJ/kg{*}K}}\right)$$

4) LMTD of Coil given By-Pass Factor

Open Calculator

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

ex $$1476.751 = \frac{345K - 105K}{\ln\left(\frac{1}{0.85}\right)}$$

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

Open Calculator

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

ex $$4.706026kg = -\left(\frac{50W/m^2*K \cdot 64m^2}{4.184kJ/kg*K \cdot \ln(0.85)}\right)$$

6) Overall Heat Transfer Coefficient given By-Pass Factor

Open Calculator

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

ex $$63.74805W/m^2*K = -\frac{\ln(0.85) \cdot 6kg \cdot 4.184kJ/kg*K}{64m^2}$$

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

Open Calculator

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

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

8) Surface Area of Coil given By-Pass Factor

Open Calculator

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

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

Degree of Saturation

9) Degree of Saturation given Partial Pressure of Water Vapour

Open Calculator

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

$$0.148352 = \frac{60Bar}{91Bar} \cdot \frac{1 - \frac{91Bar}{100Bar}}{1 - \frac{60Bar}{100Bar}}$$

10) Degree of Saturation given Relative Humidity

Open Calculator

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

ex $$0.126405 = 0.616523 \cdot \frac{1 - \frac{91\text{Bar}}{100\text{Bar}}}{1 - \frac{0.616523 \cdot 91\text{Bar}}{100\text{Bar}}}$$

11) Degree of Saturation given Specific Humidity

Open Calculator

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

ex $$0.263158 = \frac{0.25}{0.95}$$

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

Open Calculator

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

ex $$88.23529\text{Bar} = \left(\frac{1}{100\text{Bar}} + \frac{0.2}{60\text{Bar}} \cdot \left(1 - \frac{60\text{Bar}}{100\text{Bar}} \right) \right)^{-1}$$

13) Total Pressure of Moist Air given Degree of Saturation

Open Calculator

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

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

Efficiency of Heating and Cooling coil

14) Efficiency of Cooling Coil

Open Calculator

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

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

15) Efficiency of Cooling Coil given By-pass Factor

Open Calculator

$$\eta = 1 - \text{BPF}$$

$$0.15 = 1 - 0.85$$

16) Efficiency of Heating Coil

Open Calculator

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

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

17) Efficiency of Heating Coil given By-pass Factor

Open Calculator

fx $\eta = 1 - \mathrm{BPF}$

ex $0.15 = 1 - 0.85$

Enthalpy of Moist air

18) Dry Bulb Temperature given Enthalpy of Moist Air

Open Calculator

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

ex $1469.595 = \frac{2800\mathrm{kJ/kg} - 2500 \cdot 0.25}{1.005 + 1.9 \cdot 0.25}$

19) Enthalpy of Dry Air

Open Calculator

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

ex $110.55\mathrm{kJ/kg} = 1.005 \cdot 110$

20) Enthalpy of Moist Air

Open Calculator

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

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

21) Specific Enthalpy of Water Vapor

Open Calculator

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

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

22) Specific Humidity given Enthalpy of Moist Air

Open Calculator

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

ex $$0.992783 = \frac{2800\text{kJ/kg} - 1.005 \cdot 110}{2500 + 1.9 \cdot 110}$$

Pressure of Water Vapor

23) Dry Bulb Temperature using Carrier's Equation

Open Calculator

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

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

24) Partial Pressure of Water Vapor

Open Calculator

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

ex $$62.79504\text{Bar} = 65\text{Bar} - \frac{(100\text{Bar} - 65\text{Bar}) \cdot (110 - 14)}{1544 - 1.44 \cdot 14}$$

25) Saturation Pressure Corresponding to Wet Bulb Temperature

Open Calculator

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

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

26) Total Pressure of Moist Air using Carrier's Equation

Open Calculator

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

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

27) Wet Bulb Temperature using Carrier's Equation

Open Calculator

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

ex $$-139.208633 = \frac{1544 \cdot (65\text{Bar} - 60\text{Bar}) - 110 \cdot (100\text{Bar} - 65\text{Bar})}{1.44 \cdot (65\text{Bar} - 60\text{Bar}) - (100\text{Bar} - 65\text{Bar})}$$

Relative Humidity

28) Partial Pressure of Vapor given Relative Humidity

Open Calculator

fx $p_v = \Phi \cdot p_s$

ex $56.10359\text{Bar} = 0.616523 \cdot 91\text{Bar}$

29) Relative Humidity given Degree of Saturation

Open Calculator

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

ex $0.735294 = \frac{0.2}{1 - \frac{91\text{Bar}}{100\text{Bar}} \cdot (1 - 0.2)}$

30) Relative Humidity given Mass of Water Vapor

Open Calculator

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

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

31) Relative Humidity given Partial Pressure of Water Vapor

Open Calculator

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

ex $0.659341 = \frac{60\text{Bar}}{91\text{Bar}}$

32) Saturation Pressure of Water Vapor given Relative Humidity

Open Calculator

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

$$97.31997\text{Bar} = \frac{60\text{Bar}}{0.616523}$$

Specific Humidity

33) Maximum Specific Humidity

Open Calculator

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

$$6.289111 = \frac{0.622 \cdot 91\text{Bar}}{100\text{Bar} - 91\text{Bar}}$$

34) Partial Pressure of Dry Air given Specific Humidity

Open Calculator

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

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

35) Partial Pressure of Water Vapor given Specific Humidity

Open Calculator

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

ex $$28.66972\text{Bar} = \frac{100\text{Bar}}{1 + \frac{0.622}{0.25}}$$

36) Specific Humidity given Mass of Water Vapor and Dry Air

Open Calculator

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

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

37) Specific Humidity given Partial Pressure of Water Vapor

Open Calculator

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

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

38) Specific Humidity given Specific Volumes

Open Calculator

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

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

39) Total Pressure of Moist Air given Specific Humidity

Open Calculator

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

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

Vapour Density

40) Dry Bulb Temperature given Vapor Density

Open Calculator

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

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

41) Partial Pressure of Dry Air given Vapor Density

Open Calculator

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

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

42) Partial Pressure of Vapor given Vapor Density

Open Calculator

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

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

43) Specific Humidity given Vapor Density

Open Calculator

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

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

44) Total Pressure of Moist Air given Vapour Density

Open Calculator

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

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

45) Vapour Density

Open Calculator

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

ex $$9.955202\text{kg/m}^3 = \frac{0.25 \cdot (100\text{Bar} - 60\text{Bar})}{287 \cdot 350\text{K}}$$

Variables Used

- A_c Surface Area of Coil *(Square Meter)*
- **BPF** By Pass Factor
- **c** Specific Heat Capacity *(Kilojoule per Kilogram per K)*
- **h** Enthalpy of Moist Air *(Kilojoule per Kilogram)*
- h_{dry} Enthalpy of Dry Air *(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)*
- **S** Degree of Saturation
- **SH** Sensible Heat *(Joule)*
- 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)*
- **WBD** Wet Bulb Depression
- 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

Constants, Functions, Measurements used

- Function: **exp**, exp(Number)
  Exponential function
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- 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)
  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

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