Important Basics of Modes of Heat Transfer Formulas PDF

Formulas
Examples
with Units

List of 13
Important Basics of Modes of Heat Transfer Formulas

1) Heat Transfer through Plane Wall or Surface Formula

Evaluate Formula

Formula

$$q = -k \cdot A_c \cdot \frac{t_o - t_i}{w}$$

Example with Units

$$799.8571\,\text{W} = -10.18\,\text{W/(m*K)} \cdot 11\,\text{m}^2 \cdot \frac{321\,\text{K} - 371\,\text{K}}{7\,\text{m}}$$

2) Ohm's Law Formula

Evaluate Formula

Formula

$$V = I \cdot R$$

Example with Units

$$31.5\,\text{V} = 2.1\,\text{A} \cdot 15\,\Omega$$

3) Overall Heat Transfer based on Thermal Resistance Formula

Evaluate Formula

Formula

$$q_{overall} = \frac{\Delta T_{Overall}}{\Sigma R_{Thermal}}$$

Example with Units

$$2.7947\,\text{W} = \frac{55\,\text{K}}{19.68\,\text{K/W}}$$

4) Radial Heat Flowing through Cylinder Formula

Evaluate Formula

Formula

$$Q = k \cdot 2 \cdot \pi \cdot \Delta T \cdot \frac{l}{\ln\left(\frac{r_{outer}}{r_{inner}}\right)}$$

Example with Units

$$2731.399\,\text{J} = 10.18\,\text{W/(m*K)} \cdot 2 \cdot 3.1416 \cdot 5.25\,\text{K} \cdot \frac{6.21\,\text{m}}{\ln\left(\frac{7.51\,\text{m}}{3.5\,\text{m}}\right)}$$

5) Radiation Thermal Resistance Formula

Evaluate Formula

Formula

$$R_{th} = \frac{1}{\varepsilon \cdot [\text{Stefan-BoltZ}] \cdot A_{base} \cdot \left(T_1 + T_2 \right) \cdot \left(\left(\left(T_1 \right)^2 \right) + \left(\left(T_2 \right)^2 \right) \right)}$$

Example with Units

$$0.0076\,\mathrm{K/W} = \frac{1}{0.95 \cdot 5.7\text{E-}8 \cdot 9\,\mathrm{m^2} \cdot \left(503\,\mathrm{K} + 293\,\mathrm{K} \right) \cdot \left(\left(\left(503\,\mathrm{K} \right)^2 \right) + \left(\left(293\,\mathrm{K} \right)^2 \right) \right)}$$

6) Radiative Heat Transfer Formula

Evaluate Formula

Formula

$$Q = [\text{Stefan-BoltZ}] \cdot SA_{Body} \cdot F \cdot \left(T_1^{\ 4} - T_2^{\ 4} \right)$$

Example with Units

$$2730.1103\,\mathrm{J} = 5.7\text{E-}8 \cdot 8.5\,\mathrm{m^2} \cdot 0.1 \cdot \left(503\,\mathrm{K}^{\ 4} - 293\,\mathrm{K}^{\ 4} \right)$$

7) Radiosity Formula

Evaluate Formula

Formula

$$J = \frac{E_{Leaving}}{SA_{Body} \cdot t_{sec}}$$

Example with Units

$$0.0588\,\mathrm{W/m^2} = \frac{19\,\mathrm{J}}{8.5\,\mathrm{m^2} \cdot 38\,\mathrm{s}}$$

8) Rate of Convective Heat Transfer Formula

Evaluate Formula

Formula

$$q = h_{transfer} \cdot A_{Exposed} \cdot \left(T_w - T_a \right)$$

Example with Units

$$732.6\,\mathrm{W} = 13.2\,\mathrm{W/m^2{*}K} \cdot 11.1\,\mathrm{m^2} \cdot \left(305\,\mathrm{K} - 300\,\mathrm{K} \right)$$

9) Temperature Difference using Thermal Analogy to Ohm's Law Formula

Evaluate Formula

Formula

$$\Delta T = q \cdot R_{th}$$

Example with Units

$$7.5\,\mathrm{K} = 750\,\mathrm{W} \cdot 0.01\,\mathrm{K/W}$$

10) Thermal Diffusivity Formula

Evaluate Formula

Formula

$$\alpha = \frac{k}{\rho \cdot C_o}$$

Example with Units

$$0.4619\,\mathrm{m^2/s} = \frac{10.18\,\mathrm{W/(m{*}K)}}{5.51\,\mathrm{kg/m^3} \cdot 4\,\mathrm{J/(kg{*}K)}}$$

11) Thermal Resistance in Convection Heat Transfer Formula

Evaluate Formula

Formula

$$R_{th} = \frac{1}{A_{expo} \cdot h_{conv}}$$

Example with Units

$$0.0045\,\mathrm{K/W} = \frac{1}{11.1\,\mathrm{m^2} \cdot 20\,\mathrm{W/m^2{*}K}}$$

12) Thermal Resistance of Spherical Wall Formula

Evaluate Formula

Formula

$$r_{th} = \frac{r_2 - r_1}{4 \cdot \pi \cdot k \cdot r_1 \cdot r_2}$$

Example with Units

$$0.0013\,\mathrm{K/W} = \frac{6\,\mathrm{m} - 5\,\mathrm{m}}{4 \cdot 3.1416 \cdot 2\,\mathrm{W/(m{*}K)} \cdot 5\,\mathrm{m} \cdot 6\,\mathrm{m}}$$

13) Total Emissive Power of Radiating Body Formula

Evaluate Formula

Formula

$$E_b = \left(\varepsilon \cdot \left(T_e\right)^4\right) \cdot [\text{Stefan-BoltZ}]$$

Example with Units

$$2.812\,\mathrm{W} = \left(0.95 \cdot \left(85\,\mathrm{K}\right)^4\right) \cdot 5.7\mathrm{E}{-8}$$

Variables used in list of Basics of Modes of Heat Transfer Formulas above

- A_{base} Base Area *(Square Meter)*
- A_c Cross Sectional Area *(Square Meter)*
- A_{expo} Exposed Surface Area *(Square Meter)*
- $A_{Exposed}$ Exposed Surface Area *(Square Meter)*
- C_o Specific Heat Capacity *(Joule per Kilogram per K)*
- E_b Emissive Power per Unit Area *(Watt)*
- $E_{Leaving}$ Energy Leaving Surface *(Joule)*
- **F** Geometric View Factor
- h_{conv} Co-efficient of Convective Heat Transfer *(Watt per Square Meter per Kelvin)*
- $h_{transfer}$ Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **I** Electric Current *(Ampere)*
- **J** Radiosity *(Watt per Square Meter)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **l** Length of Cylinder *(Meter)*
- **q** Heat Flow Rate *(Watt)*
- **Q** Heat *(Joule)*
- $q_{overall}$ Overall Heat Transfer *(Watt)*
- **R** Resistance *(Ohm)*
- r_1 Radius of 1st Concentric Sphere *(Meter)*
- r_2 Radius of 2nd Concentric Sphere *(Meter)*
- r_{inner} Inner Radius of Cylinder *(Meter)*
- r_{outer} Outer Radius of Cylinder *(Meter)*
- r_{th} Thermal Resistance of Sphere Without Convection *(Kelvin per Watt)*
- R_{th} Thermal Resistance *(Kelvin per Watt)*
- SA_{Body} Body Surface Area *(Square Meter)*
- T_1 Temperature of Surface 1 *(Kelvin)*

Constants, Functions, Measurements used in list of Basics of Modes of Heat Transfer Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[Stefan-BoltZ]**, 5.670367E-8 *Stefan-Boltzmann Constant*
- 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: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Electric Current** in Ampere (A) *Electric Current Unit Conversion*
- Measurement: **Temperature** in Kelvin (K) *Temperature Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Energy** in Joule (J) *Energy Unit Conversion*
- Measurement: **Power** in Watt (W) *Power Unit Conversion*
- Measurement: **Electric Resistance** in Ohm (Ω) *Electric Resistance Unit Conversion*
- Measurement: **Temperature Difference** in Kelvin (K) *Temperature Difference Unit Conversion*
- Measurement: **Thermal Resistance** in Kelvin per Watt (K/W) *Thermal Resistance Unit Conversion*
- Measurement: **Thermal Conductivity** in Watt per Meter per K (W/(m*K)) *Thermal Conductivity Unit Conversion*
- Measurement: **Electric Potential** in Volt (V) *Electric Potential Unit Conversion*
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))

- T_2 Temperature of Surface 2 *(Kelvin)*
- T_a Ambient Air Temperature *(Kelvin)*
- T_e Effective Radiating Temperature *(Kelvin)*
- t_i Inside Temperature *(Kelvin)*
- t_o Outside Temperature *(Kelvin)*
- t_{sec} Time in seconds *(Second)*
- T_w Surface Temperature *(Kelvin)*
- **V** Voltage *(Volt)*
- **w** Width of Plane Surface *(Meter)*
- **α** Thermal Diffusivity *(Square Meter Per Second)*
- **ΔT** Temperature Difference *(Kelvin)*
- $\Delta T_{Overall}$ Overall Temperature Difference *(Kelvin)*
- **ε** Emissivity
- **ρ** Density *(Kilogram per Cubic Meter)*
- $\Sigma R_{Thermal}$ Total Thermal Resistance *(Kelvin per Watt)*

Specific Heat Capacity Unit Conversion

- Measurement: **Heat Flux Density** in Watt per Square Meter (W/m²)
  Heat Flux Density 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: **Diffusivity** in Square Meter Per Second (m²/s)
  Diffusivity Unit Conversion

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