Important Conduction, Convection and Radiation Formulas PDF

Formulas
Examples
with Units

List of 13
Important Conduction, Convection and Radiation Formulas

1) Black Bodies Heat Exchange by Radiation Formula

Evaluate Formula

Formula

$$q = \varepsilon \cdot [Stefan\text{-}BoltZ] \cdot A_{cs} \cdot \left(T_1^{\,4} - T_2^{\,4} \right)$$

Example with Units

$$77.7041\,\text{W/m}^2 = 0.95 \cdot 5.7\text{E-}8 \cdot 41\,\text{m}^2 \cdot \left(101.01\,\text{K}^{\,4} - 91.114\,\text{K}^{\,4} \right)$$

2) Convective Processes Heat Transfer Coefficient Formula

Evaluate Formula

Formula

$$q = h_t \cdot \left(T_w - T_{aw} \right)$$

Example with Units

$$77.7005\,\text{W/m}^2 = 13.2\,\text{W/m}^2\text{*K} \cdot \left(305\,\text{K} - 299.1136\,\text{K} \right)$$

3) Critical Thickness of Insulation for Cylinder Formula

Evaluate Formula

Formula

$$r_c = \frac{k_o}{h_t}$$

Example with Units

$$0.7712\,\text{m} = \frac{10.18\,\text{W/(m*K)}}{13.2\,\text{W/m}^2\text{*K}}$$

4) Heat Exchange by Radiation due to Geometric Arrangement Formula

Evaluate Formula

Formula

$$q = \varepsilon \cdot A_{cs} \cdot [Stefan\text{-}BoltZ] \cdot SF \cdot \left(T_1^{\,4} - T_2^{\,4} \right)$$

Example with Units

$$77.7042\,\text{W/m}^2 = 0.95 \cdot 41\,\text{m}^2 \cdot 5.7\text{E-}8 \cdot 1.000001 \cdot \left(101.01\,\text{K}^{\,4} - 91.114\,\text{K}^{\,4} \right)$$

5) Heat Transfer Formula

Evaluate Formula

Formula

$$Q_c = \frac{T_{vd}}{R_{th}}$$

Example with Units

$$48.1005\,\text{W} = \frac{0.3367035\,\text{K}}{0.007\,\text{K/W}}$$

6) Heat Transfer According to Fourier's Law Formula

Evaluate Formula

Formula

$$Q_c = -\left(k_o \cdot A_s \cdot \frac{\Delta T}{L}\right)$$

Example with Units

$$48.1005\,\text{W} = -\left(10.18\,\text{W/(m*K)} \cdot 0.1314747\,\text{m}^2 \cdot \frac{-105\,\text{K}}{2.92166\,\text{m}}\right)$$

7) Heat Transfer by Conduction at Base Formula

Evaluate Formula

Formula

$$Q_{fin} = \left(k_o \cdot A_{cs} \cdot P_f \cdot h\right)^{0.5} \cdot \left(t_o - t_a\right)$$

Example with Units

$$6498.2461\,\text{W} = \left(10.18\,\text{W/(m*K)} \cdot 41\,\text{m}^2 \cdot 0.046\,\text{m} \cdot 30.17\,\text{W/m}^2\text{*K}\right)^{0.5} \cdot \left(573\,\text{K} - 303\,\text{K}\right)$$

8) Newton's Law of Cooling Formula

Evaluate Formula

Formula

$$q = h_t \cdot \left(T_w - T_f\right)$$

Example with Units

$$77.7\,\text{W/m}^2 = 13.2\,\text{W/m}^2\text{*K} \cdot \left(305\,\text{K} - 299.113636\,\text{K}\right)$$

9) Non Ideal Body Surface Emittance Formula

Evaluate Formula

Formula

$$e = \varepsilon \cdot [\text{Stefan-BoltZ}] \cdot T_w^4$$

Example with Units

$$466.1591\,\text{W/m}^2 = 0.95 \cdot 5.7\text{E-}8 \cdot 305\,\text{K}^4$$

10) One Dimensional Heat Flux Formula

Evaluate Formula

Formula

$$q = -\frac{k_o}{t} \cdot \left(T_{w2} - T_{w1}\right)$$

Example with Units

$$77.7099\,\text{W/m}^2 = -\frac{10.18\,\text{W/(m*K)}}{0.131\,\text{m}} \cdot \left(299\,\text{K} - 300\,\text{K}\right)$$

11) Thermal Conductivity given Critical Thickness of Insulation for Cylinder Formula

Evaluate Formula

Formula

$$k_o = r_c \cdot h_o$$

Example with Units

$$10.18\,\text{W/(m*K)} = 0.771212\,\text{m} \cdot 13.2000021\,\text{W/m}^2\text{*K}$$

12) Thermal Resistance in Conduction Formula

Evaluate Formula

Formula

$$R_{th} = \frac{L}{k_o \cdot A_{cs}}$$

Example with Units

$$0.007\,\text{K/W} = \frac{2.92166\,\text{m}}{10.18\,\text{W/(m*K)} \cdot 41\,\text{m}^2}$$

13) Thermal Resistance in Convection Heat Transfer Formula

Evaluate Formula

Formula

$$R_{th} = \frac{1}{A_e \cdot h_{co}}$$

Example with Units

$$0.007\,\text{K/W} = \frac{1}{11.1\,\text{m}^2 \cdot 12.870012\,\text{W/m}^2\text{*K}}$$

Variables used in list of Conduction, Convection and Radiation Formulas above

- A_{cs} Cross Sectional Area *(Square Meter)*
- A_{cs} Cross Sectional Area *(Square Meter)*
- A_e Exposed Surface Area *(Square Meter)*
- A_s Surface Area of Heat Flow *(Square Meter)*
- **e** Real Surface Radiant Surface Emittance *(Watt per Square Meter)*
- **h** Convective Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- h_{co} Coefficient of Convective Heat Transfer *(Watt per Square Meter per Kelvin)*
- h_o Heat Transfer Coefficient at Outer Surface *(Watt per Square Meter per Kelvin)*
- h_t Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- k_o Thermal Conductivity of Fin *(Watt per Meter per K)*
- **L** Thickness of The Body *(Meter)*
- P_f Perimeter of the Fin *(Meter)*
- **q** Heat Flux *(Watt per Square Meter)*
- **q** Heat Flux *(Watt per Square Meter)*
- Q_c Heat Flow Through a Body *(Watt)*
- Q_{fin} Rate of Conductive Heat Transfer *(Watt)*
- r_c Critical Thickness of Insulation *(Meter)*
- R_{th} Thermal Resistance *(Kelvin per Watt)*
- **SF** Shape Factor
- **t** Wall Thickness *(Meter)*
- T_1 Temperature of Surface 1 *(Kelvin)*
- T_2 Temperature of Surface 2 *(Kelvin)*
- t_a Ambient Temperature *(Kelvin)*
- T_{aw} Recovery Temperature *(Kelvin)*
- T_f Temperature of Characteristic Fluid *(Kelvin)*
- t_o Base Temperature *(Kelvin)*
- T_{vd} Thermal Potential Difference *(Kelvin)*

Constants, Functions, Measurements used in list of Conduction, Convection and Radiation Formulas above

- constant(s): **[Stefan-BoltZ]**, 5.670367E-8 *Stefan-Boltzmann Constant*
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Power** in Watt (W)
  Power 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: **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

- T_w Surface Temperature *(Kelvin)*
- T_w Surface Temperature *(Kelvin)*
- T_{w1} Temperature of Wall 1 *(Kelvin)*
- T_{w2} Temperature of Wall 2 *(Kelvin)*
- ΔT Temperature Difference *(Kelvin)*
- ε Emissivity

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