Important Conduction in Sphere Formulas PDF

Formulas
Examples
with Units

List of 11
Important Conduction in Sphere Formulas

1) Convection Resistance for Spherical Layer Formula

Evaluate Formula

Formula

$$r_{th} = \frac{1}{4 \cdot \pi \cdot r^2 \cdot h}$$

Example with Units

$$0.0013\,\mathrm{K/W} = \frac{1}{4 \cdot 3.1416 \cdot 1.4142\,\mathrm{m}^2 \cdot 30\,\mathrm{W/m^{2}*K}}$$

2) Heat Flow Rate through Spherical Composite Wall of 2 Layers in Series Formula

Evaluate Formula

Formula

$$Q' = \frac{T_i - T_o}{\frac{1}{4 \cdot \pi \cdot k_1} \cdot \left(\frac{1}{r_1} - \frac{1}{r_2}\right) + \frac{1}{4 \cdot \pi \cdot k_2} \cdot \left(\frac{1}{r_2} - \frac{1}{r_3}\right)}$$

Example with Units

$$1.3889\,\mathrm{W} = \frac{305\,\mathrm{K} - 300\,\mathrm{K}}{\frac{1}{4 \cdot 3.1416 \cdot 0.001\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{5\,\mathrm{m}} - \frac{1}{6\,\mathrm{m}}\right) + \frac{1}{4 \cdot 3.1416 \cdot 0.002\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{6\,\mathrm{m}} - \frac{1}{7\,\mathrm{m}}\right)}$$

3) Heat Flow Rate through Spherical Wall Formula

Evaluate Formula

Formula

$$Q = \frac{T_i - T_o}{\frac{r_2 - r_1}{4 \cdot \pi \cdot k \cdot r_1 \cdot r_2}}$$

Example with Units

$$3769.9112\,\mathrm{W} = \frac{305\,\mathrm{K} - 300\,\mathrm{K}}{\frac{6\,\mathrm{m} - 5\,\mathrm{m}}{4 \cdot 3.1416 \cdot 2\,\mathrm{W/(m*K)} \cdot 5\,\mathrm{m} \cdot 6\,\mathrm{m}}}$$

4) Inner Surface Temperature of Spherical Wall Formula

Evaluate Formula

Formula

$$T_i = T_o + \frac{Q}{4 \cdot \pi \cdot k} \cdot \left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

Example with Units

$$305\,\mathrm{K} = 300\,\mathrm{K} + \frac{3769.9111843\,\mathrm{W}}{4 \cdot 3.1416 \cdot 2\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{5\,\mathrm{m}} - \frac{1}{6\,\mathrm{m}}\right)$$

5) Outer Surface Temperature of Spherical Wall Formula

Evaluate Formula

Formula

$$T_o = T_i - \frac{Q}{4 \cdot \pi \cdot k} \cdot \left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

Example with Units

$$300\,\mathrm{K} = 305\,\mathrm{K} - \frac{3769.9111843\,\mathrm{W}}{4 \cdot 3.1416 \cdot 2\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{5\,\mathrm{m}} - \frac{1}{6\,\mathrm{m}}\right)$$

6) Thermal Resistance of Spherical Composite Wall of 2 Layers in Series with Convection Formula

Evaluate Formula

Formula

$$R_{th} = \frac{1}{4 \cdot \pi} \cdot \left(\frac{1}{h_i \cdot r_1^2} + \frac{1}{k_1} \cdot \left(\frac{1}{r_1} - \frac{1}{r_2}\right) + \frac{1}{k_2} \cdot \left(\frac{1}{r_2} - \frac{1}{r_3}\right) + \frac{1}{h_o \cdot r_3^2}\right)$$

Example with Units

$$7.3198\,\mathrm{K/W} = \frac{1}{4 \cdot 3.1416} \cdot \left(\frac{1}{0.001038\,\mathrm{W/m^{2}*K} \cdot 5\,\mathrm{m}^2} + \frac{1}{0.001\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{5\,\mathrm{m}} - \frac{1}{6\,\mathrm{m}}\right) + \frac{1}{0.002\,\mathrm{W/(m*K)}} \cdot \left(\frac{1}{6\,\mathrm{m}} - \frac{1}{7\,\mathrm{m}}\right) + \frac{1}{0.002486\,\mathrm{W/m^{2}*K} \cdot 7\,\mathrm{m}^2}\right)$$

7) 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

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

8) Thickness of Spherical Wall to Maintain given Temperature Difference Formula

Evaluate Formula

Formula

$$t = \frac{1}{\frac{1}{r} - \frac{4 \cdot \pi \cdot k \cdot (T_i - T_o)}{Q}} - r$$

Example with Units

$$0.07\,\text{m} = \frac{1}{\frac{1}{1.4142\,\text{m}} - \frac{4 \cdot 3.1416 \cdot 2\,\text{W/(m*K)} \cdot (305\,\text{K} - 300\,\text{K})}{3769.9111843\,\text{W}}} - 1.4142\,\text{m}$$

9) Total Thermal Resistance of Spherical Wall of 2 Layers without Convection Formula

Evaluate Formula

Formula

$$r_{tr} = \frac{r_2 - r_1}{4 \cdot \pi \cdot k_1 \cdot r_1 \cdot r_2} + \frac{r_3 - r_2}{4 \cdot \pi \cdot k_2 \cdot r_2 \cdot r_3}$$

Example with Units

$$3.5999\,\text{K/W} = \frac{6\,\text{m} - 5\,\text{m}}{4 \cdot 3.1416 \cdot 0.001\,\text{W/(m*K)} \cdot 5\,\text{m} \cdot 6\,\text{m}} + \frac{7\,\text{m} - 6\,\text{m}}{4 \cdot 3.1416 \cdot 0.002\,\text{W/(m*K)} \cdot 6\,\text{m} \cdot 7\,\text{m}}$$

10) Total Thermal Resistance of Spherical wall of 3 Layers without Convection Formula

Evaluate Formula

Formula

$$R_{tr} = \frac{r_2 - r_1}{4 \cdot \pi \cdot k_1 \cdot r_1 \cdot r_2} + \frac{r_3 - r_2}{4 \cdot \pi \cdot k_2 \cdot r_2 \cdot r_3} + \frac{r_4 - r_3}{4 \cdot \pi \cdot k_3 \cdot r_3 \cdot r_4}$$

Example with Units

$$3.9552\,\text{K/W} = \frac{6\,\text{m} - 5\,\text{m}}{4 \cdot 3.1416 \cdot 0.001\,\text{W/(m*K)} \cdot 5\,\text{m} \cdot 6\,\text{m}} + \frac{7\,\text{m} - 6\,\text{m}}{4 \cdot 3.1416 \cdot 0.002\,\text{W/(m*K)} \cdot 6\,\text{m} \cdot 7\,\text{m}} + \frac{8\,\text{m} - 7\,\text{m}}{4 \cdot 3.1416 \cdot 0.004\,\text{W/(m*K)} \cdot 7\,\text{m} \cdot 8\,\text{m}}$$

11) Total Thermal Resistance of Spherical Wall with Convection on Both Side Formula

Evaluate Formula

Formula

$$R_{tr} = \frac{1}{4 \cdot \pi \cdot r_1^2 \cdot h_i} + \frac{r_2 - r_1}{4 \cdot \pi \cdot k \cdot r_1 \cdot r_2} + \frac{1}{4 \cdot \pi \cdot r_2^2 \cdot h_o}$$

Example with Units

$$3.9571\,\text{K/W} = \frac{1}{4 \cdot 3.1416 \cdot {5\,\text{m}}^2 \cdot 0.001038\,\text{W/m²*K}} + \frac{6\,\text{m} - 5\,\text{m}}{4 \cdot 3.1416 \cdot 2\,\text{W/(m*K)} \cdot 5\,\text{m} \cdot 6\,\text{m}} + \frac{1}{4 \cdot 3.1416 \cdot {6\,\text{m}}^2 \cdot 0.002486\,\text{W/m²*K}}$$

Variables used in list of Conduction in Sphere Formulas above

- **h** Convection Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **h_i** Inner Convection Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **h_o** External Convection Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **k_1** Thermal Conductivity of 1st Body *(Watt per Meter per K)*
- **k_2** Thermal Conductivity of 2nd Body *(Watt per Meter per K)*
- **k_3** Thermal Conductivity of 3rd Body *(Watt per Meter per K)*
- **Q** Heat Flow Rate *(Watt)*
- **Q'** Heat Flow Rate of Wall of 2 Layers *(Watt)*
- **r** Radius of Sphere *(Meter)*
- **r_1** Radius of 1st Concentric Sphere *(Meter)*
- **r_2** Radius of 2nd Concentric Sphere *(Meter)*
- **r_3** Radius of 3rd Concentric Sphere *(Meter)*
- **r_4** Radius of 4th Concentric Sphere *(Meter)*
- **r_{th}** Thermal Resistance of Sphere Without Convection *(Kelvin per Watt)*
- **R_{th}** Thermal Resistance of Sphere *(Kelvin per Watt)*
- **r_{tr}** Sphere Thermal Resistance Without Convection *(Kelvin per Watt)*
- **R_{tr}** Sphere Thermal Resistance *(Kelvin per Watt)*
- **t** Thickness Of Conduction Sphere *(Meter)*
- **T_i** Inner Surface Temperature *(Kelvin)*
- **T_o** Outer Surface Temperature *(Kelvin)*

Constants, Functions, Measurements used in list of Conduction in Sphere Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Power** in Watt (W)
  Power 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 Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion

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