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Conduction in Plane Wall Formulas

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List of 22 Conduction in Plane Wall Formulas

Conduction in Plane Wall

2 Layers

1) Area of Composite Wall of 2 Layers

Open Calculator

fx $$A_{w2} = \frac{Q_{l2}}{T_{i2} - T_{o2}} \cdot \left(\frac{L_1}{k_1} + \frac{L_2}{k_2} \right)$$

ex $$866.6667\text{m}^2 = \frac{120\text{W}}{420.75\text{K} - 420\text{K}} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)}} + \frac{5\text{m}}{1.2\text{W/(m*K)}} \right)$$

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

Open Calculator

fx $$Q_{l2} = \frac{T_{i2} - T_{o2}}{\frac{L_1}{k_1 \cdot A_{w2}} + \frac{L_2}{k_2 \cdot A_{w2}}}$$

ex $$120\text{W} = \frac{420.75\text{K} - 420\text{K}}{\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2}}$$

3) Inner Surface Temperature of Composite Wall for 2 Layers in Series

Open Calculator

fx $$T_{i2} = T_{o2} + Q_{l2} \cdot \left(\frac{L_1}{k_1 \cdot A_{w2}} + \frac{L_2}{k_2 \cdot A_{w2}} \right)$$

ex $$420.75\text{K} = 420\text{K} + 120\text{W} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2} \right)$$

4) Interface Temperature of Composite Wall of 2 Layers given Inner Surface Temperature

Open Calculator

fx $$T_2 = T_1 - \frac{Q_{l2} \cdot L_1}{k_1 \cdot A_{w2}}$$

ex $$420.5769\text{K} = 420.74997\text{K} - \frac{120\text{W} \cdot 2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2}$$

5) Interface Temperature of Composite Wall of 2 Layers given Outer Surface Temperature

Open Calculator

$$T_2 = T_{o2} + \frac{Q_{l2} \cdot L_2}{k_2 \cdot A_{w2}}$$

$$420.5769\text{K} = 420\text{K} + \frac{120\text{W} \cdot 5\text{m}}{1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2}$$

6) Length of 2nd Layer of Composite Wall in Conduction through Walls

Open Calculator

$$L_2 = k_2 \cdot A_{w2} \cdot \left(\frac{T_{i2} - T_{o2}}{Q_{l2}} - \frac{L_1}{k_1 \cdot A_{w2}} \right)$$

$$5\text{m} = 1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2 \cdot \left(\frac{420.75\text{K} - 420\text{K}}{120\text{W}} - \frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2} \right)$$

7) Outer Surface Temperature of Composite Wall of 2 Layers for Conduction

Open Calculator

$$T_{o2} = T_{i2} - Q_{l2} \cdot \left(\frac{L_1}{k_1 \cdot A_{w2}} + \frac{L_2}{k_2 \cdot A_{w2}} \right)$$

$$420\text{K} = 420.75\text{K} - 120\text{W} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2} \right)$$

8) Thermal Resistance of Composite Wall with 2 Layers in Series

Open Calculator

$$R_{th2} = \frac{L_1}{k_1 \cdot A_{w2}} + \frac{L_2}{k_2 \cdot A_{w2}}$$

$$0.00625\text{K/W} = \frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 866.6667\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 866.6667\text{m}^2}$$

3 Layers

9) Area of Composite Wall of 3 Layers

Open Calculator

$$A_{w3} = \frac{Q_{l3}}{T_{i3} - T_{o3}} \cdot \left(\frac{L_1}{k_1} + \frac{L_2}{k_2} + \frac{L_3}{k_3} \right)$$

$$1383.333\text{m}^2 = \frac{150\text{W}}{300.75\text{K} - 300\text{K}} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)}} + \frac{5\text{m}}{1.2\text{W/(m*K)}} + \frac{6\text{m}}{4\text{W/(m*K)}} \right)$$

10) Heat Flow Rate through Composite Wall of 3 Layers in Series

Open Calculator

fx $$Q_{l3} = \frac{T_{i3} - T_{o3}}{\frac{L_1}{k_1 \cdot A_{w3}} + \frac{L_2}{k_2 \cdot A_{w3}} + \frac{L_3}{k_3 \cdot A_{w3}}}$$

ex $$150\text{W} = \frac{300.75\text{K} - 300\text{K}}{\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{6\text{m}}{4\text{W/(m*K)} \cdot 1383.33333\text{m}^2}}$$

11) Inner Surface Temperature of Composite Wall of 3 Layers in Series

Open Calculator

fx $$T_{i3} = T_{o3} + Q_{l3} \cdot \left(\frac{L_1}{k_1 \cdot A_{w3}} + \frac{L_2}{k_2 \cdot A_{w3}} + \frac{L_3}{k_3 \cdot A_{w3}} \right)$$

ex $$300.75\text{K} = 300\text{K} + 150\text{W} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{6}{4\text{W/(m*K)} \cdot}$$

12) Length of 3rd Layer of Composite Wall in Conduction through Walls

Open Calculator

fx $$L_3 = k_3 \cdot A_{w3} \cdot \left(\frac{T_{i3} - T_{o3}}{Q_{l3}} - \frac{L_1}{k_1 \cdot A_{w3}} - \frac{L_2}{k_2 \cdot A_{w3}} \right)$$

ex $$6\text{m} = 4\text{W/(m*K)} \cdot 1383.33333\text{m}^2 \cdot \left(\frac{300.75\text{K} - 300\text{K}}{150\text{W}} - \frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 1383.33333\text{m}^2} - \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 13}$$

13) Outer Surface Temperature of Composite Wall of 3 Layers for Conduction

Open Calculator

fx $$T_{o3} = T_{i3} - Q_{l3} \cdot \left(\frac{L_1}{k_1 \cdot A_{w3}} + \frac{L_2}{k_2 \cdot A_{w3}} + \frac{L_3}{k_3 \cdot A_{w3}} \right)$$

ex $$300\text{K} = 300.75\text{K} - 150\text{W} \cdot \left(\frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{6}{4\text{W/(m*K)} \cdot}$$

14) Thermal Resistance of Composite Wall with 3 Layers in Series

Open Calculator

fx $$R_{th3} = \frac{L_1}{k_1 \cdot A_{w3}} + \frac{L_2}{k_2 \cdot A_{w3}} + \frac{L_3}{k_3 \cdot A_{w3}}$$

ex $$0.005\text{K/W} = \frac{2\text{m}}{1.6\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{5\text{m}}{1.2\text{W/(m*K)} \cdot 1383.33333\text{m}^2} + \frac{6\text{m}}{4\text{W/(m*K)} \cdot 1383.33333\text{m}^2}$$

Single Plane Wall

15) Area of Plane Wall Required for Given Temperature Difference

Open Calculator

fx $$A_{w1} = \frac{Q \cdot L}{k \cdot (T_i - T_o)}$$

ex $$50\text{m}^2 = \frac{125\text{W} \cdot 3\text{m}}{10\text{W/(m*K)} \cdot (400.75\text{K} - 400\text{K})}$$

16) Inner Surface Temperature of Plane Wall

Open Calculator

fx $$T_i = T_o + \frac{Q \cdot L}{k \cdot A_{w1}}$$

ex $$400.75\text{K} = 400\text{K} + \frac{125\text{W} \cdot 3\text{m}}{10\text{W/(m*K)} \cdot 50\text{m}^2}$$

17) Outer Surface Temperature of Wall in Conduction through Wall

Open Calculator

fx $$T_o = T_i - \frac{Q \cdot L}{k \cdot A_{w1}}$$

ex $$400\text{K} = 400.75\text{K} - \frac{125\text{W} \cdot 3\text{m}}{10\text{W/(m*K)} \cdot 50\text{m}^2}$$

18) Temperature at Distance x from Inner Surface in Wall

Open Calculator

fx $$T = T_i - \frac{x}{L} \cdot (T_i - T_o)$$

ex $$400.375\text{K} = 400.75\text{K} - \frac{1.5\text{m}}{3\text{m}} \cdot (400.75\text{K} - 400\text{K})$$

19) Thermal Conductivity of Material Required to Maintain Given Temperature Difference

Open Calculator

fx $$k = \frac{Q \cdot L}{(T_i - T_o) \cdot A_{w1}}$$

ex $$10\text{W/(m*K)} = \frac{125\text{W} \cdot 3\text{m}}{(400.75\text{K} - 400\text{K}) \cdot 50\text{m}^2}$$

20) Thermal Resistance of Wall

Open Calculator

fx $$R_{th} = \frac{L}{k \cdot A}$$

ex $$0.023077\text{K/W} = \frac{3\text{m}}{10\text{W/(m*K)} \cdot 13\text{m}^2}$$

21) Thickness of Plane Wall for Conduction through Wall

Open Calculator

fx $$L = \frac{(T_i - T_o) \cdot k \cdot A_{w1}}{Q}$$

ex $$3\text{m} = \frac{(400.75\text{K} - 400\text{K}) \cdot 10\text{W/(m*K)} \cdot 50\text{m}^2}{125\text{W}}$$

22) Total Thermal Resistance of Plane Wall with Convection on Both Sides

Open Calculator

fx $$r_{th} = \frac{1}{h_i \cdot A_{w1}} + \frac{L}{k \cdot A_{w1}} + \frac{1}{h_o \cdot A_{w1}}$$

ex $$0.022856\text{K/W} = \frac{1}{1.35\text{W/m}^2\text{*K} \cdot 50\text{m}^2} + \frac{3\text{m}}{10\text{W/(m*K)} \cdot 50\text{m}^2} + \frac{1}{9.8\text{W/m}^2\text{*K} \cdot 50\text{m}^2}$$

Variables Used

- **A** Cross-Sectional Area *(Square Meter)*
- A_{w1} Area of Wall *(Square Meter)*
- A_{w2} Area of 2 Layer Wall *(Square Meter)*
- A_{w3} Area of 3 Layer Wall *(Square Meter)*
- h_i Inside Convection *(Watt per Square Meter per Kelvin)*
- h_o External Convection *(Watt per Square Meter per Kelvin)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- k_1 Thermal Conductivity 1 *(Watt per Meter per K)*
- k_2 Thermal Conductivity 2 *(Watt per Meter per K)*
- k_3 Thermal Conductivity 3 *(Watt per Meter per K)*
- **L** Length *(Meter)*
- L_1 Length 1 *(Meter)*
- L_2 Length 2 *(Meter)*
- L_3 Length 3 *(Meter)*
- **Q** Heat Flow Rate *(Watt)*
- Q_{l2} Heat Flow Rate 2 Layer *(Watt)*
- Q_{l3} Heat Flow Rate 3 Layer *(Watt)*
- r_{th} Thermal Resistance with Convection *(Kelvin per Watt)*
- R_{th} Thermal Resistance *(Kelvin per Watt)*
- R_{th2} Thermal Resistance of 2 Layer *(Kelvin per Watt)*
- R_{th3} Thermal Resistance of 3 Layer *(Kelvin per Watt)*
- **T** Temperature *(Kelvin)*
- T_1 Temperature of Surface 1 *(Kelvin)*
- T_2 Temperature of Surface 2 *(Kelvin)*
- T_i Inner Surface Temperature *(Kelvin)*
- T_{i2} Inner Surface Temperature 2 layer wall *(Kelvin)*
- T_{i3} Inner Surface Temperature 3 Layer Wall *(Kelvin)*
- T_o Outer Surface Temperature *(Kelvin)*
- T_{o2} Outer Surface Temperature of 2 Layer *(Kelvin)*
- T_{o3} Outer Surface Temperature 3 Layer *(Kelvin)*
- **x** Distance from Inner Surface *(Meter)*

Constants, Functions, Measurements used

- 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: **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

Check other formula lists

- Conduction in Cylinder Formulas
- Conduction in Plane Wall Formulas
- Conduction in Sphere Formulas
- Conduction Shape Factors for Different Configurations Formulas
- Other shapes Formulas
- Steady State Heat Conduction with Heat Generation Formulas
- Transient Heat Conduction Formulas

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