## Important Conduction in Cylinder Formulas PDF

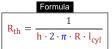


**Formulas Examples** with Units

## List of 16

Important Conduction in Cylinder Formulas

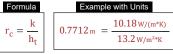
#### 1) Convection Resistance for Cylindrical Layer Formula 🕝





## 2) Critical Thickness of Insulation for Cylinder Formula C





## Evaluate Formula

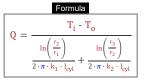
Evaluate Formula

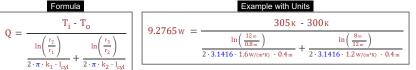
Evaluate Formula (

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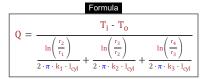
Evaluate Formula

## 3) Heat Flow Rate through Cylindrical Composite Wall of 2 Layers Formula 🗂





## 4) Heat Flow Rate through Cylindrical Composite Wall of 3 Layers Formula 🕝



#### Example with Units

$$8.4081w \ = \frac{305\,\text{K} - 300\,\text{K}}{\frac{\ln\left(\frac{12\,\text{m}}{0.8\,\text{m}}\right)}{2 \cdot 3.1416 \cdot 1.6\,\text{W/(m^*K)} \cdot 0.4\,\text{m}}} + \frac{\ln\left(\frac{8\,\text{m}}{12\,\text{m}}\right)}{2 \cdot 3.1416 \cdot 1.2\,\text{W/(m^*K)} \cdot 0.4\,\text{m}}} + \frac{\ln\left(\frac{14\,\text{m}}{8\,\text{m}}\right)}{2 \cdot 3.1416 \cdot 4\,\text{W/(m^*K)} \cdot 0.4\,\text{m}}}$$

## 5) Heat Flow Rate through Cylindrical Wall Formula 🕝





## 6) Inner Surface Temperature of Cylindrical Wall in Conduction Formula C

Example with Units

$$T_{i} = T_{o} + \frac{Q \cdot ln\left(\frac{r_{2}}{r_{1}}\right)}{2 \cdot \pi \cdot k \cdot l_{cyl}} = 300.9812 \,\kappa = 300 \,\kappa + \frac{9.27 \,w \cdot ln\left(\frac{12 \,m}{0.8 \,m}\right)}{2 \cdot 3.1416 \cdot 10.18 \,w/(m^{*}\!K) \cdot 0.4 \,m}$$

7) Length of Cylindrical Wall for given Heat Flow Rate Formula C

## Formula

Example with Units 
$$= \frac{9.27 \text{w} \cdot \ln \left(\frac{12 \text{m}}{0.8 \text{m}}\right)}{2 \cdot 3.1416 \cdot 10.18 \text{W/(m*K)} \cdot \left(305 \text{ K} - 300 \text{ K}\right)}$$

## 8) Outer Surface Temperature of Cylindrical Composite Wall of 2 Layers Formula 🕝

Formula

$$T_{o} = T_{i} - Q \cdot \left( \frac{\ln\left(\frac{r_{2}}{r_{1}}\right)}{2 \cdot \pi \cdot k_{1} \cdot l_{cyl}} + \frac{\ln\left(\frac{r_{3}}{r_{2}}\right)}{2 \cdot \pi \cdot k_{2} \cdot l_{cyl}} \right)$$

#### Example with Units

$$300.0035 \,\kappa \, = \, 305 \,\kappa \, - \, 9.27 \,w \, \cdot \left( \frac{\ln \left( \frac{12 \,\text{m}}{0.8 \,\text{m}} \right)}{2 \cdot 3.1416 \cdot 1.6 \,\text{W/(m*K)} \, \cdot \, 0.4 \,\text{m}} + \frac{\ln \left( \frac{8 \,\text{m}}{12 \,\text{m}} \right)}{2 \cdot 3.1416 \cdot 1.2 \,\text{W/(m*K)} \, \cdot \, 0.4 \,\text{m}} \right)$$

## 9) Outer Surface Temperature of Cylindrical Wall given Heat Flow Rate Formula 🗂

Formula

$$304.0188\kappa = 305\kappa - \frac{9.27w \cdot \ln\left(\frac{12m}{0.8m}\right)}{2 \cdot 3.1416 \cdot 10.18W/(m^*K) \cdot 0.4m}$$

## 10) Thermal Conductivity given Critical Thickness of Insulation for Cylinder Formula 🕝

Formula

Example with Units  $k = r_c \cdot h_o$  | 6.545 W/(m\*K) = 0.77 m  $\cdot$  8.5 W/m<sup>2\*</sup>K

## Evaluate Formula 🕝

Evaluate Formula 🕝

Evaluate Formula

Evaluate Formula [

Evaluate Formula

Evaluate Formula

## 11) Thermal Conductivity of Cylindrical Wall given Temperature Difference Formula 🦵

Formula

$$k = \frac{Q \cdot ln\left(\frac{r_2}{r_1}\right)}{2 \cdot \pi \cdot l_{cyl} \cdot \left(T_i - T_o\right)}$$

Example with Units  $k = \frac{Q \cdot ln \left(\frac{r_2}{r_1}\right)}{2 \cdot \pi \cdot l_{cyl} \cdot \left(T_i - T_o\right)} \; \middle| \; \left| \; 1.9977 \, \text{W/(m*K)} \; = \frac{9.27 \, \text{w} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right| \; | \; \left| \; 1.9977 \, \text{W/(m*K)} \; \right| = \frac{9.27 \, \text{w} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right| \; | \; \left| \; 1.9977 \, \text{W/(m*K)} \; \right| = \frac{9.27 \, \text{w} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right| \; | \; \left| \; 1.9977 \, \text{W/(m*K)} \; \right| = \frac{9.27 \, \text{W} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right| \; | \; \left| \; 1.9977 \, \text{W/(m*K)} \; \right| = \frac{9.27 \, \text{W} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right| \; | \; \left| \; 1.9977 \, \text{W/(m*K)} \; \right| = \frac{9.27 \, \text{W} \cdot ln \left(\frac{12 \, \text{m}}{0.8 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 0.4 \, \text{m} \cdot \left(\; 305 \, \text{K} \; - \; 300 \, \text{K} \right)} \right|$ 

## 12) Thermal Resistance for Radial Heat Conduction in Cylinders Formula 🗂

Evaluate Formula

$$R_{th} = \frac{\ln\left(\frac{r_o}{r_i}\right)}{2 \cdot \pi \cdot k \cdot l_{cyl}}$$

 $R_{th} = \frac{\ln\left(\frac{r_{o}}{r_{i}}\right)}{2 \cdot \pi \cdot k \cdot l_{cyl}} \quad \left| \quad 0.023 \, \text{k/w} \right| = \frac{\ln\left(\frac{9 \, \text{m}}{5 \, \text{m}}\right)}{2 \cdot 3.1416 \cdot 10.18 \, \text{W/(m*K)} \cdot 0.4 \, \text{m}}$ 

## 13) Thickness of Cylindrical Wall to Maintain given Temperature Difference Formula 🕝

Formula

Evaluate Formula

 $t = r_1 \cdot \left( e^{\left( \frac{\left( T_1 + T_0 \right) \cdot 2 \cdot \pi \cdot k \cdot l_{cyl}}{Q} - 1 \right)} - 1 \right) \left| \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K) \cdot 0.4 \, m}{9.27 \, W}} - 1 \right) \right| \left| 787656.992 \, m \right| = 0.8 \, m \cdot \left( e^{\frac{\left( 305 \, \kappa - 300 \, \kappa \right) \cdot 2 \cdot 3.1416 \cdot 10.18 \, W/(m^2 K)} - 1 \right)$ 

## 14) Total Thermal Resistance of 2 Cylindrical Resistances Connected in Series Formula 🕝

Evaluate Formula

$$R_{th} = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2 \cdot \pi \cdot k_1 \cdot l_{cyl}} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{2 \cdot \pi \cdot k_2 \cdot l_{cyl}}$$

$$0.539\,\text{K/W} \,= \frac{\ln\!\left(\frac{12\,\text{m}}{0.8\,\text{m}}\right)}{2\cdot 3.1416\cdot 1.6\,\text{W/(m*K)}\,\cdot 0.4\,\text{m}} + \frac{\ln\!\left(\frac{8\,\text{m}}{12\,\text{m}}\right)}{2\cdot 3.1416\cdot 1.2\,\text{W/(m*K)}\,\cdot 0.4\,\text{m}}$$

## 15) Total Thermal Resistance of 3 Cylindrical Resistances Connected in Series Formula 🕝

Evaluate Formula

 $R_{th} = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2 \cdot \pi \cdot k \cdot 1} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{2 \cdot \pi \cdot k \cdot 1} + \frac{\ln\left(\frac{r_4}{r_3}\right)}{2 \cdot \pi \cdot k \cdot 1}$ 

$$0.5947 \, \text{K/W} \, = \frac{ln \bigg(\frac{12\,\text{m}}{0.8\,\text{m}}\bigg)}{2 \cdot 3.1416 \cdot 1.6 \, \text{W/(m^*K)} \, \cdot 0.4 \, \text{m}} + \frac{ln \bigg(\frac{8\,\text{m}}{12\,\text{m}}\bigg)}{2 \cdot 3.1416 \cdot 1.2 \, \text{W/(m^*K)} \, \cdot 0.4 \, \text{m}} + \frac{ln \bigg(\frac{14\,\text{m}}{8\,\text{m}}\bigg)}{2 \cdot 3.1416 \cdot 4 \, \text{W/(m^*K)} \, \cdot 0.4 \, \text{m}}$$

## 16) Total Thermal Resistance of Cylindrical Wall with Convection on Both Sides Formula 🗂

Evaluate Formula (

$$R_{th} = \frac{1}{2 \cdot \pi \cdot r_1 \cdot l_{cyl} \cdot h_i} + \frac{\ln\left(\frac{r_2}{r_1}\right)}{2 \cdot \pi \cdot k \cdot l_{cyl}} + \frac{1}{2 \cdot \pi \cdot r_2 \cdot l_{cyl} \cdot h_{ext}}$$

$$0.4776 \text{ k/w } = \frac{1}{2 \cdot 3.1416 \cdot 0.8 \text{ m} \cdot 0.4 \text{ m} \cdot 1.35 \text{ W/m}^{2*} \text{K}} + \frac{\ln \left(\frac{12 \text{ m}}{0.8 \text{ m}}\right)}{2 \cdot 3.1416 \cdot 10.18 \text{ W/(m*K)} \cdot 0.4 \text{ m}} + \frac{1}{2 \cdot 3.1416 \cdot 12 \text{ m} \cdot 0.4 \text{ m} \cdot 9.8 \text{ W/m}^{2*} \text{K}}$$

## Variables used in list of Conduction in Cylinder Formulas above

- h Convection heat transfer (Watt per Square Meter per Kelvin)
- h<sub>ext</sub> External Convection Heat Transfer Coefficient (Watt per Square Meter per Kelvin)
- h<sub>i</sub> Inside Convection Heat Transfer Coefficient (Watt per Square Meter per Kelvin)
- h<sub>o</sub> Heat Transfer Coefficient at Outer Surface (Watt per Square Meter per Kelvin)
- h<sub>t</sub> Heat Transfer Coefficient (Watt per Square Meter per Kelvin)
- **k** Thermal Conductivity (Watt per Meter per K)
- **k<sub>1</sub>** Thermal Conductivity 1 (Watt per Meter per K)
- **k<sub>2</sub>** Thermal Conductivity 2 (Watt per Meter per K)
- k<sub>3</sub> Thermal Conductivity 3 (Watt per Meter per K)
- Icyl Length of Cylinder (Meter)
- **Q** Heat Flow Rate (Watt)
- R Cylinder Radius (Meter)
- r<sub>1</sub> Radius of 1st Cylinder (Meter)
- r<sub>2</sub> Radius of 2nd Cylinder (Meter)
- r<sub>3</sub> Radius of 3rd Cylinder (Meter)
- r₄ Radius of 4th Cylinder (Meter)
- rc Critical Thickness of Insulation (Meter)
- ri Inner Radius (Meter)
- ro Outer Radius (Meter)
- Rth Thermal Resistance (Kelvin per Watt)
- t Thickness (Meter)
- T<sub>i</sub> Inner Surface Temperature (Kelvin)
- To Outer Surface Temperature (Kelvin)

# Constants, Functions, Measurements used in list of Conduction in Cylinder Formulas above

- constant(s): pi,
  - 3.14159265358979323846264338327950288 Archimedes' constant
- constant(s): e,
  - 2.71828182845904523536028747135266249 Napier's constant
- Functions: In, In(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: 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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