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Electric Heating Formulas

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List of 14 Electric Heating Formulas

Electric Heating

Dielectric Heating

1) Capacitance Dielectric

Open Calculator

fx $$C_d = \frac{\varepsilon_r \cdot 8.85 \cdot 10^{-12} \cdot A}{4 \cdot \pi \cdot t_d}$$

ex $$0.700144\mu F = \frac{3.14 \cdot 8.85 \cdot 10^{-12} \cdot 13m^2}{4 \cdot \pi \cdot 41.06\mu m}$$

2) Dielectric Loss

Open Calculator

fx $$P_l = \frac{V^2}{2 \cdot X_c} \cdot \sin(2 \cdot \Phi)$$

ex $$45.58028VA = \frac{(200V)^2}{2 \cdot 380\Omega} \cdot \sin(2 \cdot 60^\circ)$$

3) Loss Tangent

Open Calculator

fx $$\tan \delta = \frac{X_c}{R}$$

ex $$36.89049^\circ = \frac{380\Omega}{590.19\Omega}$$

4) Net Resistance

Open Calculator

fx $$R = \frac{X_c}{\tan \delta}$$

ex $$590.1978\Omega = \frac{380\Omega}{36.89^\circ}$$

5) Power Loss Density

Open Calculator

fx $$P_d = f \cdot (\varepsilon_r'') \cdot 8.85418782 \cdot 10^{-12} \cdot F^2$$

ex $$0.013813\text{W/m}^3 = 5\text{MHz} \cdot 0.78 \cdot 8.85418782 \cdot 10^{-12} \cdot (20\text{V/m})^2$$

6) Thickness of Dielectric

Open Calculator

fx $$t_d = \frac{\varepsilon_r \cdot 8.85 \cdot 10^{-12} \cdot A}{4 \cdot \pi \cdot C_d}$$

ex $$41.06846\mu\text{m} = \frac{3.14 \cdot 8.85 \cdot 10^{-12} \cdot 13\text{m}^2}{4 \cdot \pi \cdot 0.70\mu\text{F}}$$

Furnace Heating

7) Energy Efficiency

Open Calculator

fx $$\eta = \frac{E_t}{E_a}$$

ex $$0.521739 = \frac{1.2\text{KJ}}{2.3\text{KJ}}$$

8) Energy Required by Furnace to Melt Steel

Open Calculator

fx $$E = (m \cdot S_{heat} \cdot (T_2 - T_1)) + (m \cdot L_{heat})$$

ex $$13.02476KJ = (35.98kg \cdot 138J/(kg*K) \cdot (299K - 300K)) + (35.98kg \cdot 0.5KJ)$$

9) Equivalent Inductance of Furnace

Open Calculator

fx $$L = \frac{\pi \cdot 4 \cdot \pi \cdot 10^{-7} \cdot N_{coil}^2 \cdot D_{melt}^2}{4 \cdot H_{melt}}$$

ex $$38.19537\mu H = \frac{\pi \cdot 4 \cdot \pi \cdot 10^{-7} \cdot (24)^2 \cdot (10.75cm)^2}{4 \cdot 17.20cm}$$

10) Heat Conduction

Open Calculator

fx $$Q = \frac{k \cdot A_{furnace} \cdot T_{total} \cdot (T_1 - T_2)}{t_w}$$

ex $$1.097528W = \frac{11.09W/(m*K) \cdot 20.5cm^2 \cdot 28s \cdot (300K - 299K)}{58cm}$$

11) Heat Radiation

Open Calculator

fx $$H = 5.72 \cdot e \cdot K \cdot \left(\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right)$$

ex $$3.356142W/m^2*K = 5.72 \cdot 0.91 \cdot 0.6 \cdot \left(\left(\frac{300K}{100}\right)^4 - \left(\frac{299K}{100}\right)^4\right)$$

12) Operating Frequency

Open Calculator

$$f_{furnace} = \frac{\rho \cdot 10^9}{4 \cdot \pi^2 \cdot t_c^2 \cdot \mu_r}$$

$$2.845287\text{kHz} = \frac{113.59\mu\Omega\text{*cm} \cdot 10^9}{4 \cdot \pi^2 \cdot (10.60\text{cm})^2 \cdot 0.9}$$

13) Specific Resistance using Operating Frequency

Open Calculator

$$\rho = \frac{f_{furnace} \cdot 4 \cdot \pi^2 \cdot t_c^2 \cdot \mu_r}{10^9}$$

$$113.3789\mu\Omega\text{*cm} = \frac{2.84\text{kHz} \cdot 4 \cdot \pi^2 \cdot (10.60\text{cm})^2 \cdot 0.9}{10^9}$$

14) Thickness of Cylinder

Open Calculator

$$t_c = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{\rho \cdot 10^9}{\mu_r \cdot f_{furnace}}}$$

$$10.60986\text{cm} = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{113.59\mu\Omega\text{*cm} \cdot 10^9}{0.9 \cdot 2.84\text{kHz}}}$$

Variables Used

- **A** Surface Area *(Square Meter)*
- **$A_{furnace}$** Area of Furnace *(Square Centimeter)*
- **C_d** Capacitance of Dielectric *(Microfarad)*
- **D_{melt}** Diameter of Melt *(Centimeter)*
- **e** Emissivity
- **E** Energy *(Kilojoule)*
- **E_a** Actual Energy *(Kilojoule)*
- **E_t** Theoretical Energy *(Kilojoule)*
- **f** Frequency *(Megahertz)*
- **F** Electric Field Strength *(Volt per Meter)*
- **$f_{furnace}$** Frequency of Induction Furnace *(Kilohertz)*
- **H** Heat Radiation *(Watt per Square Meter per Kelvin)*
- **H_{melt}** Height of Melt *(Centimeter)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **K** Radiating Efficiency
- **L** Inductance *(Microhenry)*
- **L_{heat}** Latent Heat *(Kilojoule)*
- **m** Mass *(Kilogram)*
- **N_{coil}** Number of Coil Turns
- **P_d** Power Density *(Watt Per Cubic Meter)*
- **P_l** Power Loss *(Volt Ampere)*
- **Q** Heat Conduction *(Watt)*
- **R** Resistance *(Ohm)*
- **S_{heat}** Specific Heat *(Joule per Kilogram per K)*

- T_1 Temperature of Wall 1 *(Kelvin)*
- T_2 Temperature of Wall 2 *(Kelvin)*
- t_c Thickness of Cylinder *(Centimeter)*
- t_d Thickness of Dielectric *(Micrometer)*
- T_{total} Total Time *(Second)*
- t_w Thickness of Wall *(Centimeter)*
- $\tan \delta$ Loss Tangent *(Degree)*
- V Voltage *(Volt)*
- X_c Capacitive Reactance *(Ohm)*
- ε_r Relative Permittivity
- ε_r'' Complex Relative Permittivity
- η Energy Efficiency
- μ_r Relative Permeability
- ρ Specific Resistance *(Microhm Centimeter)*
- Φ Phase Difference *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Micrometer (µm), Centimeter (cm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²), Square Centimeter (cm²)
  Area Unit Conversion
- Measurement: **Energy** in Kilojoule (KJ)
  Energy Unit Conversion
- Measurement: **Power** in Volt Ampere (VA), Watt (W)
  Power Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Megahertz (MHz), Kilohertz (kHz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Microfarad (µF)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion

- Measurement: **Inductance** in Microhenry (µH)
  Inductance Unit Conversion
- Measurement: **Electric Field Strength** in Volt per Meter (V/m)
  Electric Field Strength 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: **Electric Resistivity** in Microhm Centimeter (µΩ*cm)
  Electric Resistivity Unit Conversion
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity Unit Conversion
- Measurement: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Power Density** in Watt Per Cubic Meter (W/m³)
  Power Density Unit Conversion

Check other formula lists

- **Electric Heating Formulas**

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