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Boiling Formulas

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List of 14 Boiling Formulas

Boiling

1) Correlation for Heat Flux proposed by Mostinski

Open Calculator

fx $$h_b = 0.00341 \cdot \left(P_c^{2.3}\right) \cdot \left(T_e^{2.33}\right) \cdot \left(P_r^{0.566}\right)$$

ex $$110240.4\text{W/m}^2{*}^\circ\text{C} = 0.00341 \cdot \left((5.9\text{Pa})^{2.3}\right) \cdot \left((10^\circ\text{C})^{2.33}\right) \cdot \left((1.1)^{0.566}\right)$$

2) Critical Heat Flux by Zuber

Open Calculator

fx $$q_{Max} = \left((0.149 \cdot L_v \cdot \rho_v) \cdot \left(\frac{(\sigma \cdot [g]) \cdot (\rho_L - \rho_v)}{\rho_v^2}\right)^{\frac{1}{4}}\right)$$

ex $$58.17133\text{W/m}^2 = \left((0.149 \cdot 19\text{J/mol} \cdot 0.5\text{kg/m}^3) \cdot \left(\frac{(72.75\text{N/m} \cdot [g]) \cdot (1000\text{kg/m}^3 - 0.5\text{kg/m}^3)}{(0.5\text{kg/m}^3)^2}\right)^{\frac{1}{4}}\right)$$

3) Excess Temperature in Boiling

Open Calculator

fx $$T_{excess} = T_{surface} - T_{Sat}$$

ex $$297\text{K} = 670\text{K} - 373\text{K}$$

4) Heat Flux in Fully Developed Boiling State for Higher Pressures

Open Calculator

fx $$q_{rate} = 283.2 \cdot A \cdot \left((\Delta T_x)^3\right) \cdot \left((p_{HT})^{\frac{4}{3}}\right)$$

ex $$150.3508\text{W} = 283.2 \cdot 5\text{m}^2 \cdot \left((2.25^\circ\text{C})^3\right) \cdot \left((3\text{E\^{}-8MPa})^{\frac{4}{3}}\right)$$

5) Heat Flux in Fully Developed Boiling State for Pressure upto 0.7 Megapascal

Open Calculator

fx $$q_{rate} = 2.253 \cdot A \cdot \left((\Delta T_x)^{3.96}\right)$$

ex $$279.495\text{W} = 2.253 \cdot 5\text{m}^2 \cdot \left((2.25^\circ\text{C})^{3.96}\right)$$

6) Heat Transfer Coefficient for Forced Convection Local Boiling Inside Vertical Tubes

Open Calculator

fx $$h = \left(2.54 \cdot \left(\left(\Delta T_x\right)^3\right) \cdot \exp\left(\frac{p}{1.551}\right)\right)$$

ex $$29.04564 \text{W/m²*°C} = \left(2.54 \cdot \left(\left(2.25\,°\text{C}\right)^3\right) \cdot \exp\left(\frac{0.00607\text{MPa}}{1.551}\right)\right)$$

7) Heat Transfer Coefficient given Biot Number

Open Calculator

fx $$h_{transfer} = \frac{Bi \cdot k}{\ell}$$

ex $$4.467776 \text{W/m²*K} = \frac{2.19 \cdot 10.18 \text{W/(m*K)}}{4.99\text{m}}$$

8) Modified Heat of Vaporization

Open Calculator

fx $$\lambda = \left(h_{fg} + \left(c_{pv}\right) \cdot \left(\frac{T_w - T_{Sat}}{2}\right)\right)$$

ex $$2636 \text{J/kg} = \left(2260 \text{J/kg} + \left(23.5 \text{J/(kg*K)}\right) \cdot \left(\frac{405\text{K} - 373\text{K}}{2}\right)\right)$$

9) Modified Heat Transfer Coefficient under Influence of Pressure

Open Calculator

fx $$h_p = \left(h_1\right) \cdot \left(\left(\frac{p_s}{p_1}\right)^{0.4}\right)$$

ex $$44.95387 \text{W/m²*K} = \left(10.9 \text{W/m²*K}\right) \cdot \left(\left(\frac{3.5\text{Pa}}{0.101325\text{Pa}}\right)^{0.4}\right)$$

10) Radiation Heat Transfer Coefficient

Open Calculator

fx $$h_r = \left(\frac{[\text{Stefan-BoltZ}] \cdot \varepsilon \cdot \left(\left(\left(T_w\right)^4\right) - \left(\left(T_{Sat}\right)^4\right)\right)}{T_w - T_{Sat}}\right)$$

ex $$12.70509 \text{W/m²*K} = \left(\frac{[\text{Stefan-BoltZ}] \cdot 0.95 \cdot \left(\left(\left(405\text{K}\right)^4\right) - \left(\left(373\text{K}\right)^4\right)\right)}{405\text{K} - 373\text{K}}\right)$$

11) Radius of Vapour Bubble in Mechanical Equilibrium in Superheated Liquid

Open Calculator

fx $$r = \frac{2 \cdot \sigma \cdot [R] \cdot \left(T_{Sat}^2\right)}{P_l \cdot L_v \cdot \left(T_l - T_{Sat}\right)}$$

ex $$0.14151\text{m} = \frac{2 \cdot 72.75\text{N/m} \cdot [R] \cdot \left((373\text{K})^2\right)}{200000\text{Pa} \cdot 19\text{J/mol} \cdot (686\text{K} - 373\text{K})}$$

12) Saturated Temperature given Excess Temperature

Open Calculator

fx $$T_{Sat} = T_{surface} - T_{excess}$$

ex $$373\text{K} = 670\text{K} - 297\text{K}$$

13) Surface Temperature given Excess Temperature

Open Calculator

fx $$T_{surface} = T_{Sat} + T_{excess}$$

ex $$670\text{K} = 373\text{K} + 297\text{K}$$

14) Total Heat Transfer Coefficient

Open Calculator

fx $$h_T = h_{FB} \cdot \left(\left(\frac{h_{FB}}{h_{transfer}}\right)^{\frac{1}{3}}\right) + h_r$$

ex $$5449.994\text{W/m}^2\text{*K} = 921\text{W/m}^2\text{*K} \cdot \left(\left(\frac{921\text{W/m}^2\text{*K}}{4.476\text{W/m}^2\text{*K}}\right)^{\frac{1}{3}}\right) + 12.70\text{W/m}^2\text{*K}$$

Variables Used

- **A** Area *(Square Meter)*
- **Bi** Biot Number
- **c_{pv}** Specific Heat of Water Vapor *(Joule per Kilogram per K)*
- **h** Heat Transfer Coefficient for Forced Convection *(Watt per Square Meter per Celcius)*
- **h_1** Heat Transfer Coefficient at Atmospheric Pressure *(Watt per Square Meter per Kelvin)*
- **h_b** Heat Transfer Coefficient For Nucleate Boiling *(Watt per Square Meter per Celcius)*
- **h_{FB}** Heat Transfer Coefficient in Film Boiling Region *(Watt per Square Meter per Kelvin)*
- **h_{fg}** Latent Heat of Vaporization *(Joule per Kilogram)*
- **h_p** Heat Transfer Coefficient at Some Pressure P *(Watt per Square Meter per Kelvin)*
- **h_r** Radiation Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **h_T** Total Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **$h_{transfer}$** Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **L_v** Enthalpy of Vaporization of Liquid *(Joule Per Mole)*
- **p** System Pressure in Vertical Tubes *(Megapascal)*
- **p_1** Standard Atmospheric Pressure *(Pascal)*
- **P_c** Critical Pressure *(Pascal)*
- **p_{HT}** Pressure *(Megapascal)*
- **P_l** Pressure of Superheated Liquid *(Pascal)*
- **P_r** Reduced Pressure
- **p_s** System Pressure *(Pascal)*
- **q_{Max}** Critical Heat Flux *(Watt per Square Meter)*
- **q_{rate}** Rate of Heat Transfer *(Watt)*
- **r** Radius of Vapor Bubble *(Meter)*
- **T_e** Excess Temperature in Nucleate Boiling *(Celsius)*
- **T_{excess}** Excess Temperature in Heat Transfer *(Kelvin)*
- **T_l** Temperature of Superheated Liquid *(Kelvin)*
- **T_{Sat}** Saturation Temperature *(Kelvin)*
- **$T_{surface}$** Surface Temperature *(Kelvin)*
- **T_w** Plate Surface Temperature *(Kelvin)*
- **ΔT_x** Excess Temperature *(Degree Celsius)*

- **ε** Emissivity
- **λ** Modified Heat of Vaporization *(Joule per Kilogram)*
- **ρ_L** Density of Liquid *(Kilogram per Cubic Meter)*
- **ρ_V** Density of Vapor *(Kilogram per Cubic Meter)*
- **σ** Surface Tension *(Newton per Meter)*
- ℓ Thickness of Wall *(Meter)*

Constants, Functions, Measurements used

- Constant: **[g]**, 9.80665 Meter/Second²
  Gravitational acceleration on Earth
- Constant: **[Stefan-BoltZ]**, 5.670367E-8 Kilogram Second^-3 Kelvin^-4
  Stefan-Boltzmann Constant
- Constant: **[R]**, 8.31446261815324 Joule / Kelvin * Mole
  Universal gas constant
- Function: **exp**, exp(Number)
  Exponential function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Celsius (°C), Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa), Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Temperature Difference** in Degree Celsius (°C)
  Temperature Difference Unit Conversion
- Measurement: **Thermal Conductivity** in Watt per Meter per K (W/(m*K))
  Thermal Conductivity Unit Conversion
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity 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 Celcius (W/m²*°C), Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Surface Tension** in Newton per Meter (N/m)
  Surface Tension Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Latent Heat** in Joule per Kilogram (J/kg)
  Latent Heat Unit Conversion
- Measurement: **Energy Per Mole** in Joule Per Mole (J/mol)
  Energy Per Mole Unit Conversion
- Measurement: **Rate of Heat Transfer** in Watt (W)
  Rate of Heat Transfer Unit Conversion

Check other formula lists

- **Boiling Formulas**
- **Condensation Formulas**
- **Important Formulas of Condensation Number, Average Heat Transfer Coefficient and Heat Flux**

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