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Boiling Formulas

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List of 13 Boiling Formulas

Boiling

1) Convective Processes Heat Transfer Coefficient

Open Calculator

fx $Q = h_t \cdot (T_w - T_{aw})$

ex $69.432 \text{W/m}^2 = 13.2 \text{W/m}^2\text{*K} \cdot (305\text{K} - 299.74\text{K})$

2) Critical heat flux to nucleate pool boiling

Open Calculator

fx $Q_c = 0.18 \cdot \Delta H \cdot \rho_v \cdot \left(\frac{Y \cdot [g] \cdot (\rho_l - \rho_v)}{\rho_v^2} \right)^{0.25}$

ex $332.8425 \text{W/m}^2 = 0.18 \cdot 500 \text{J/mol} \cdot 0.5 \text{kg/m}^3 \cdot \left(\frac{21.8 \text{N/m} \cdot [g] \cdot (4 \text{kg/m}^3 - 0.5 \text{kg/m}^3)}{(0.5 \text{kg/m}^3)^2} \right)^{0.25}$

3) Emissivity given heat transfer coefficient by radiation

Open Calculator

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

ex $0.406974 = \frac{1.5 \text{W/m}^2\text{*K}}{[\text{Stefan-BoltZ}] \cdot \left(\frac{(300\text{K})^4 - (200\text{K})^4}{300\text{K} - 200\text{K}} \right)}$

4) Enthalpy of evaporation given critical heat flux

Open Calculator

fx $\Delta H = \frac{Q_c}{0.18 \cdot \rho_v \cdot \left(\frac{Y \cdot [g] \cdot (\rho_l - \rho_v)}{\rho_v^2} \right)^{0.25}}$

ex $500 \text{J/mol} = \frac{332.842530370989 \text{W/m}^2}{0.18 \cdot 0.5 \text{kg/m}^3 \cdot \left(\frac{21.8 \text{N/m} \cdot [g] \cdot (4 \text{kg/m}^3 - 0.5 \text{kg/m}^3)}{(0.5 \text{kg/m}^3)^2} \right)^{0.25}}$

5) Enthalpy of evaporation to nucleate pool boiling

Open Calculator

fx $$\Delta H = \left(\left(\frac{1}{Q} \right) \cdot \mu_f \cdot \left(\frac{[g] \cdot (\rho_l - \rho_v)}{Y} \right)^{0.5} \cdot \left(\frac{C_l \cdot \Delta T}{C_s \cdot (Pr)^{1.7}} \right)^3 \right)^{0.5}$$

ex $$500J/mol = \left(\left(\frac{1}{69.4281385117412W/m^2} \right) \cdot 8Pa{*}s \cdot \left(\frac{[g] \cdot (4kg/m^3 - 0.5kg/m^3)}{21.8N/m} \right)^{0.5} \cdot \left(\frac{3J/(kg{*}K) \cdot 12K}{0.55 \cdot (0.7)^{1.7}} \right.$$

6) Heat flux to nucleate pool boiling

Open Calculator

fx $$Q = \mu_f \cdot \Delta H \cdot \left(\frac{[g] \cdot (\rho_l - \rho_v)}{Y} \right)^{0.5} \cdot \left(\frac{C_l \cdot \Delta T}{C_s \cdot \Delta H \cdot (Pr)^{1.7}} \right)^{3.0}$$

ex $$69.42814W/m^2 = 8Pa{*}s \cdot 500J/mol \cdot \left(\frac{[g] \cdot (4kg/m^3 - 0.5kg/m^3)}{21.8N/m} \right)^{0.5} \cdot \left(\frac{3J/(kg{*}K) \cdot 12K}{0.55 \cdot 500J/mol \cdot (0.7)^{1.7}} \right)^{3.0}$$

7) Heat transfer coefficient by convection for stable film boiling

Open Calculator

fx $$h_c = 0.62 \cdot \left(\frac{k_v^3 \cdot \rho_v \cdot [g] \cdot (\rho_l - \rho_v) \cdot (\Delta H + (0.68 \cdot C_v) \cdot \Delta T)}{\mu_v \cdot D \cdot \Delta T} \right)^{0.25}$$

ex $$1.15W/m^2{*}K = 0.62 \cdot \left(\frac{(11.524W/(m{*}K))^3 \cdot 0.5kg/m^3 \cdot [g] \cdot (4kg/m^3 - 0.5kg/m^3) \cdot (500J/mol + (0.68 \cdot 5J/}{1000Pa{*}s \cdot 100m \cdot 12K} \right.$$

8) Heat transfer coefficient by radiation

Open Calculator

fx $$h_r = \frac{h - h_c}{0.75}$$

ex $$1.5W/m^2{*}K = \frac{2.275W/m^2{*}K - 1.15W/m^2{*}K}{0.75}$$

9) Heat transfer coefficient due to radiation for horizontal tubes

Open Calculator

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

ex $$1.5W/m^2{*}K = [Stefan\text{-}BoltZ] \cdot 0.406974 \cdot \left(\frac{(300K)^4 - (200K)^4}{300K - 200K} \right)$$

10) Heat transfer coefficient for convection

Open Calculator

fx $h_c = h - 0.75 \cdot h_r$

ex $1.15\text{W/m²*K} = 2.275\text{W/m²*K} - 0.75 \cdot 1.5\text{W/m²*K}$

11) Heat transfer coefficient in film boiling

Open Calculator

fx $h = h_c + 0.75 \cdot h_r$

ex $2.275\text{W/m²*K} = 1.15\text{W/m²*K} + 0.75 \cdot 1.5\text{W/m²*K}$

12) Maximum heat flux to nucleate pool boiling

Open Calculator

fx $$Q_m = \left(1.464 \cdot 10^{-9}\right) \cdot \left(\frac{C_l \cdot k_l^2 \cdot \rho_l^{0.5} \cdot (\rho_l - \rho_v)}{\rho_v \cdot \Delta H \cdot \mu_f^{0.5}}\right)^{0.5} \cdot \left(\frac{\Delta H \cdot \rho_v \cdot \Delta T}{Y \cdot T_f}\right)^{2.3}$$

ex

$$0.002903\text{W/m²} = \left(1.464 \cdot 10^{-9}\right) \cdot \left(\frac{3\text{J/(kg*K)} \cdot (380\text{W/(m*K)})^2 \cdot (4\text{kg/m³})^{0.5} \cdot (4\text{kg/m³} - 0.5\text{kg/m³})}{0.5\text{kg/m³} \cdot 500\text{J/mol} \cdot (8\text{Pa*s})^{0.5}}\right)^{0.5} \cdot$$

13) Thermal Resistance in Convection Heat Transfer

Open Calculator

fx $$R_{th} = \frac{1}{A_e \cdot h_{co}}$$

ex $$0.004505\text{K/W} = \frac{1}{11.1\text{m²} \cdot 20\text{W/m²*K}}$$

Variables Used

- **ΔH** Change in Enthalpy of Vaporization *(Joule Per Mole)*
- **A_e** Exposed Surface Area *(Square Meter)*
- **C_l** Specific Heat of Liquid *(Joule per Kilogram per K)*
- **C_s** Constant in Nucleate Boiling
- **C_v** Specific Heat of Vapour *(Joule per Kilogram per K)*
- **D** Diameter *(Meter)*
- **h** Heat Transfer Coefficient by Boiling *(Watt per Square Meter per Kelvin)*
- **h_c** Heat Transfer Coefficient by Convection *(Watt per Square Meter per Kelvin)*
- **h_{co}** Coefficient of Convective Heat Transfer *(Watt per Square Meter per Kelvin)*
- **h_r** Heat Transfer Coefficient by Radiation *(Watt per Square Meter per Kelvin)*
- **h_t** Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **k_l** Thermal Conductivity of Liquid *(Watt per Meter per K)*
- **k_v** Thermal Conductivity of Vapor *(Watt per Meter per K)*
- **Pr** Prandtl Number
- **Q** Heat Flux *(Watt per Square Meter)*
- **Q_c** Critical Heat Flux *(Watt per Square Meter)*
- **Q_m** Maximum Heat Flux *(Watt per Square Meter)*
- **R_{th}** Thermal Resistance *(Kelvin per Watt)*
- **T_{aw}** Recovery Temperature *(Kelvin)*
- **T_f** Temperature of Fluid *(Kelvin)*
- **T_s** Saturation Temperature *(Kelvin)*
- **T_w** Surface Temperature *(Kelvin)*
- **T_{wa}** Wall Temperature *(Kelvin)*
- **Y** Surface Tension *(Newton per Meter)*
- **ΔT** Excess Temperature *(Kelvin)*
- **ε** Emissivity
- **μ_f** Dynamic Viscosity of Fluid *(Pascal Second)*
- **μ_v** Dynamic Viscosity of Vapour *(Pascal Second)*
- **ρ_l** Density of Liquid *(Kilogram per Cubic Meter)*
- **ρ_v** Density of Vapour *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Constant: **[Stefan-BoltZ]**, 5.670367E-8
  Stefan-Boltzmann Constant
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Temperature Difference** in Kelvin (K)
  Temperature Difference 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: **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/m^2)
  Heat Flux Density Unit Conversion
- Measurement: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m^2*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Surface Tension** in Newton per Meter (N/m)
  Surface Tension Unit Conversion
- Measurement: **Dynamic Viscosity** in Pascal Second (Pa*s)
  Dynamic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion
- Measurement: **Energy Per Mole** in Joule Per Mole (J/mol)
  Energy Per Mole Unit Conversion

Check other formula lists

- **Boiling Formulas**

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