Important Basics of Heat Transfer Formulas PDF

Formulas
Examples
with Units

List of 17
Important Basics of Heat Transfer Formulas

1) Colburn Factor using Chilton Colburn Analogy Formula

Evaluate Formula

Formula

$$j_H = \frac{Nu}{(Re)\cdot(Pr)^{\frac{1}{3}}}$$

Example

$$0.0045 = \frac{12.6}{(3125)\cdot(0.7)^{\frac{1}{3}}}$$

2) Colburn J-Factor given Fanning Friction Factor Formula

Evaluate Formula

Formula

$$j_H = \frac{f}{2}$$

Example

$$0.0045 = \frac{0.009}{2}$$

3) Equivalent Diameter of Non-Circular Duct Formula

Evaluate Formula

Formula

$$D_e = \frac{4\cdot A_{cs}}{P}$$

Example with Units

$$1.25\,\text{m} = \frac{4\cdot 25\,\text{m}^2}{80\,\text{m}}$$

4) Equivalent Diameter when Flow in Rectangular Duct Formula

Evaluate Formula

Formula

$$D_e = \frac{4\cdot L\cdot B}{2\cdot(L+B)}$$

Example with Units

$$1.2214\,\text{m} = \frac{4\cdot 1.9\,\text{m}\cdot 0.9\,\text{m}}{2\cdot(1.9\,\text{m}+0.9\,\text{m})}$$

5) Fanning Friction Factor given Colburn J-Factor Formula

Evaluate Formula

Formula

$$f = 2\cdot j_H$$

Example

$$0.0092 = 2\cdot 0.0046$$

6) Heat Transfer Coefficient based on Temperature Difference Formula

Evaluate Formula

Formula

$$h_{ht} = \frac{q}{\Delta T_{Overall}}$$

Example with Units

$$0.3127\,\text{W/m}^2\text{*K} = \frac{17.2\,\text{W/m}^2}{55\,\text{K}}$$

7) Heat Transfer Coefficient given Local Heat Transfer Resistance of Air Film Formula

Evaluate Formula

Formula

$$h_{ht} = \frac{1}{(A) \cdot HT_{Resistance}}$$

Example with Units

$$1.5004\,W/m^{2}*K = \frac{1}{(0.05\,m^{2}) \cdot 13.33\,K/W}$$

8) Heat Transfer from Stream of Gas flowing in Turbulent Motion Formula

Evaluate Formula

Formula

$$h_{ht} = \frac{16.6 \cdot c_p \cdot (G)^{0.8}}{D^{0.2}}$$

Example with Units

$$2.9307\,W/m^{2}*K = \frac{16.6 \cdot 0.0002\,kcal(IT)/kg*°C \cdot (0.1\,kg/s/m^{2})^{0.8}}{0.24\,m^{0.2}}$$

9) Hydraulic Radius Formula

Evaluate Formula

Formula

$$r_H = \frac{A_{cs}}{P}$$

Example with Units

$$0.3125\,m = \frac{25\,m^{2}}{80\,m}$$

10) Internal Diameter of Pipe given Heat Transfer Coefficient for Gas in Turbulent Motion Formula

Evaluate Formula

Formula

$$D = \left(\frac{16.6 \cdot c_p \cdot (G)^{0.8}}{h}\right)^{\frac{1}{0.2}}$$

Example with Units

$$0.2497\,m = \left(\frac{16.6 \cdot 0.0002\,kcal(IT)/kg*°C \cdot (0.1\,kg/s/m^{2})^{0.8}}{2.5\,kcal(IT)/h*m^{2}*°C}\right)^{\frac{1}{0.2}}$$

11) J-Factor for Pipe Flow Formula

Evaluate Formula

Formula

$$j_H = 0.023 \cdot (Re)^{-0.2}$$

Example

$$0.0046 = 0.023 \cdot (3125)^{-0.2}$$

12) Local Heat Transfer Resistance of Air-Film Formula

Evaluate Formula

Formula

$$HT_{Resistance} = \frac{1}{h_{ht} \cdot A}$$

Example with Units

$$13.3333\,K/W = \frac{1}{1.5\,W/m^{2}*K \cdot 0.05\,m^{2}}$$

13) Log Mean Temperature Difference for CoCurrent Flow Formula

Evaluate Formula

Formula

$$LMTD = \frac{\left(T_{ho} - T_{co}\right) - \left(T_{hi} - T_{ci}\right)}{\ln\left(\frac{T_{ho} - T_{co}}{T_{hi} - T_{ci}}\right)}$$

Example with Units

$$18.2048\,\text{K} = \frac{\left(20\,\text{K} - 10\,\text{K}\right) - \left(35\,\text{K} - 5\,\text{K}\right)}{\ln\left(\frac{20\,\text{K} - 10\,\text{K}}{35\,\text{K} - 5\,\text{K}}\right)}$$

14) Log Mean Temperature Difference for Counter Current Flow Formula

Evaluate Formula

Formula

$$LMTD = \frac{\left(T_{ho} - T_{ci}\right) - \left(T_{hi} - T_{co}\right)}{\ln\left(\frac{T_{ho} - T_{ci}}{T_{hi} - T_{co}}\right)}$$

Example with Units

$$19.5762\,\text{K} = \frac{\left(20\,\text{K} - 5\,\text{K}\right) - \left(35\,\text{K} - 10\,\text{K}\right)}{\ln\left(\frac{20\,\text{K} - 5\,\text{K}}{35\,\text{K} - 10\,\text{K}}\right)}$$

15) Logarithmic Mean Area of Cylinder Formula

Evaluate Formula

Formula

$$A_{mean} = \frac{A_o - A_i}{\ln\left(\frac{A_o}{A_i}\right)}$$

Example with Units

$$9.8652\,\text{m}^2 = \frac{12\,\text{m}^2 - 8\,\text{m}^2}{\ln\left(\frac{12\,\text{m}^2}{8\,\text{m}^2}\right)}$$

16) Reynolds Number given Colburn Factor Formula

Evaluate Formula

Formula

$$Re = \left(\frac{j_H}{0.023}\right)^{\frac{-1}{0.2}}$$

Example

$$3125 = \left(\frac{0.0046}{0.023}\right)^{\frac{-1}{0.2}}$$

17) Wetted Perimeter given Hydraulic Radius Formula

Evaluate Formula

Formula

$$P = \frac{A_{cs}}{r_H}$$

Example with Units

$$80.6452\,\text{m} = \frac{25\,\text{m}^2}{0.31\,\text{m}}$$

Variables used in list of Basics of Heat Transfer Formulas above

- **A** Area *(Square Meter)*
- **A_{cs}** Cross Sectional Area of Flow *(Square Meter)*
- **A_i** Inner Area of Cylinder *(Square Meter)*
- **A_{mean}** Logarithmic Mean Area *(Square Meter)*
- **A_o** Outer Area of Cylinder *(Square Meter)*
- **B** Breadth of Rectangle *(Meter)*
- **c_p** Specific Heat Capacity *(Kilocalorie (IT) per Kilogram per Celcius)*
- **D** Internal Diameter of Pipe *(Meter)*
- **D_e** Equivalent Diameter *(Meter)*
- **f** Fanning Friction Factor
- **G** Mass Velocity *(Kilogram per Second per Square Meter)*
- **h** Heat Transfer Coefficient for Gas *(Kilocalorie (IT) per Hour per Square Meter per Celcius)*
- **h_{ht}** Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **$HT_{Resistance}$** Local Heat Transfer Resistance *(Kelvin per Watt)*
- **j_H** Colburn's j-factor
- **L** Length of Rectangular Section *(Meter)*
- **LMTD** Log Mean Temperature Difference *(Kelvin)*
- **Nu** Nusselt Number
- **P** Wetted Perimeter *(Meter)*
- **Pr** Prandtl Number
- **q** Heat Transfer *(Watt per Square Meter)*
- **r_H** Hydraulic Radius *(Meter)*
- **Re** Reynolds Number
- **T_{ci}** Inlet Temperature of Cold Fluid *(Kelvin)*
- **T_{co}** Outlet Temperature of Cold Fluid *(Kelvin)*
- **T_{hi}** Inlet Temperature of Hot Fluid *(Kelvin)*
- **T_{ho}** Outlet Temperature of Hot Fluid *(Kelvin)*
- **$\Delta T_{Overall}$** Overall Temperature Difference *(Kelvin)*

Constants, Functions, Measurements used in list of Basics of Heat Transfer Formulas above

- Functions: **ln**, ln(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: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Thermal Resistance** in Kelvin per Watt (K/W)
  Thermal Resistance Unit Conversion
- Measurement: **Specific Heat Capacity** in Kilocalorie (IT) per Kilogram per Celcius (kcal(IT)/kg*°C)
  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 Kelvin (W/m²*K), Kilocalorie (IT) per Hour per Square Meter per Celcius (kcal(IT)/h*m²*°C)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Mass Velocity** in Kilogram per Second per Square Meter (kg/s/m²)
  Mass Velocity Unit Conversion

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