Important Heat Transfer Formulas PDF

Formulas
Examples
with Units

List of 21
Important Heat Transfer Formulas

1) Average Coefficient of heat transfer for vapour condensing outside of horizontal tubes of diameter D Formula

Evaluate Formula

Formula

$$\bar{h} = 0.725 \cdot \left(\frac{\left(k^3\right) \cdot \left(\rho_f^2\right) \cdot g \cdot h_{fg}}{N \cdot d_t \cdot \mu_f \cdot \Delta T} \right)^{\frac{1}{4}}$$

Example with Units

$$390.5305\,\text{W/m²*K} = 0.725 \cdot \left(\frac{\left(10.18\,\text{W/(m*K)}^3\right) \cdot \left(10\,\text{kg/m}^3{}^2\right) \cdot 9.8\,\text{m/s²} \cdot 2260\,\text{kJ/kg}}{11 \cdot 3000\,\text{mm} \cdot 0.029\,\text{N*s/m²} \cdot 29\,\text{K}} \right)^{\frac{1}{4}}$$

2) Heat Rejection Factor Formula

Evaluate Formula

Formula

$$HRF = \frac{R_E + W}{R_E}$$

Example with Units

$$1.6 = \frac{1000\,\text{J/min} + 600\,\text{J/min}}{1000\,\text{J/min}}$$

3) Heat Rejection Factor given COP Formula

Evaluate Formula

Formula

$$HRF = 1 + \left(\frac{1}{COP_r} \right)$$

Example

$$1.5 = 1 + \left(\frac{1}{2} \right)$$

4) Heat Transfer in Condenser given Overall Heat Transfer Coefficient Formula

Evaluate Formula

Formula

$$q = U \cdot SA \cdot \Delta T$$

Example with Units

$$19336.4808\,\text{W} = 641.13\,\text{W/m²*K} \cdot 1.04\,\text{m²} \cdot 29\,\text{K}$$

5) Heat Transfer in Condenser given Overall Thermal Resistance Formula

Evaluate Formula

Formula

$$q = \frac{\Delta T}{R_{th}}$$

Example with Units

$$1450\,\text{W} = \frac{29\,\text{K}}{0.02\,\text{K/W}}$$

6) Heat transfer takes place from outside surface to inside surface of tube Formula

Evaluate Formula

Formula

$$q = \frac{k \cdot SA \cdot \left(T_2 - T_3 \right)}{x}$$

Example with Units

$$7.5401\,\text{W} = \frac{10.18\,\text{W/(m*K)} \cdot 1.04\,\text{m}^2 \cdot \left(310\,\text{K} - 302\,\text{K} \right)}{11233\,\text{mm}}$$

7) Heat Transfer takes place from vapour refrigerant to outside of tube Formula

Evaluate Formula

Formula

$$q = h \cdot A \cdot \left(T_1 - T_2 \right)$$

Example with Units

$$-6600\,\text{W} = 13.2\,\text{W/m²*K} \cdot 50\,\text{m}^2 \cdot \left(300\,\text{K} - 310\,\text{K} \right)$$

8) Load on Condenser Formula

Evaluate Formula

Formula

$$Q_C = R_E + W$$

Example with Units

$$1600\,\text{J/min} = 1000\,\text{J/min} + 600\,\text{J/min}$$

9) Mean Surface area of Tube when Heat transfer takes place from outside to inside surface of tube Formula

Evaluate Formula

Formula

$$SA = \frac{q \cdot x}{k \cdot \left(T_2 - T_3 \right)}$$

Example with Units

$$1.04\,\text{m}^2 = \frac{7.54\,\text{W} \cdot 11233\,\text{mm}}{10.18\,\text{W/(m*K)} \cdot \left(310\,\text{K} - 302\,\text{K} \right)}$$

10) Overall Coefficient of Heat Transfer for Condensation on Vertical Surface Formula

Evaluate Formula

Formula

$$U = 0.943 \cdot \left(\frac{\left(k^3 \right) \cdot \left(\rho_f - \rho v \right) \cdot g \cdot h_{fg}}{\mu_f \cdot H \cdot \Delta T} \right)^{\frac{1}{4}}$$

Example with Units

$$641.1352\,\text{W/m²*K} = 0.943 \cdot \left(\frac{\left(10.18\,\text{W/(m*K)}^3 \right) \cdot \left(10\,\text{kg/m}^3 - 0.002\,\text{kg/m}^3 \right) \cdot 9.8\,\text{m/s}^2 \cdot 2260\,\text{kJ/kg}}{0.029\,\text{N*s/m}^2 \cdot 1300\,\text{mm} \cdot 29\,\text{K}} \right)^{\frac{1}{4}}$$

11) Overall Temperature difference given Heat Transfer Formula

Evaluate Formula

Formula

$$\Delta T_o = q \cdot R_{th}$$

Example with Units

$$0.1508\,\text{K} = 7.54\,\text{W} \cdot 0.02\,\text{K/W}$$

12) Overall Temperature difference when Heat Transfer from vapour refrigerant to outside of tube Formula

Evaluate Formula

Formula

$$\Delta T_o = \frac{q}{h \cdot A}$$

Example with Units

$$0.0114\,\text{K} = \frac{7.54\,\text{W}}{13.2\,\text{W/m²*K} \cdot 50\,\text{m²}}$$

13) Overall Temperature difference when Heat transfer takes place from outside to inside surface of tube Formula

Evaluate Formula

Formula

$$\Delta T_o = \frac{q \cdot x}{k \cdot SA}$$

Example with Units

$$7.9999\,\text{K} = \frac{7.54\,\text{W} \cdot 11233\,\text{mm}}{10.18\,\text{W/(m*K)} \cdot 1.04\,\text{m²}}$$

14) Overall thermal resistance in condenser Formula

Evaluate Formula

Formula

$$R_{th} = \frac{\Delta T_o}{q}$$

Example with Units

$$0.0265\,\text{K/W} = \frac{0.2\,\text{K}}{7.54\,\text{W}}$$

15) Refrigeration Capacity given Load on Condenser Formula

Evaluate Formula

Formula

$$R_E = Q_C - W$$

Example with Units

$$1000\,\text{J/min} = 1600\,\text{J/min} - 600\,\text{J/min}$$

16) Temperature at Inside Surface of Tube given Heat Transfer Formula

Evaluate Formula

Formula

$$T_3 = T_2 + \left(\frac{q \cdot x}{k \cdot SA}\right)$$

Example with Units

$$317.9999\,\text{K} = 310\,\text{K} + \left(\frac{7.54\,\text{W} \cdot 11233\,\text{mm}}{10.18\,\text{W/(m*K)} \cdot 1.04\,\text{m²}}\right)$$

17) Temperature at Outside Surface of Tube given Heat Transfer Formula

Evaluate Formula

Formula

$$T_2 = \left(\frac{q \cdot x}{k \cdot SA}\right) + T_3$$

Example with Units

$$309.9999\,\text{K} = \left(\frac{7.54\,\text{W} \cdot 11233\,\text{mm}}{10.18\,\text{W/(m*K)} \cdot 1.04\,\text{m²}}\right) + 302\,\text{K}$$

18) Temperature at Outside Surface of Tube provided Heat Transfer Formula

Evaluate Formula

Formula

$$T_2 = T_1 - \left(\frac{q}{h \cdot A}\right)$$

Example with Units

$$299.9886\,\text{K} = 300\,\text{K} - \left(\frac{7.54\,\text{W}}{13.2\,\text{W/m²*K} \cdot 50\,\text{m²}}\right)$$

19) Temperature of Refrigerant Vapour condensing Film given Heat Transfer Formula

Evaluate Formula

Formula

$$T_1 = \left(\frac{q}{h \cdot A}\right) + T_2$$

Example with Units

$$310.0114\,\text{K} = \left(\frac{7.54\,\text{W}}{13.2\,\text{W/m²*K} \cdot 50\,\text{m²}}\right) + 310\,\text{K}$$

20) Thickness of Tube when Heat transfer takes places from outside to inside surface of tube Formula

Evaluate Formula

Formula

$$x = \frac{k \cdot SA \cdot \left(T_2 - T_3\right)}{q}$$

Example with Units

$$11233.1034\,\text{mm} = \frac{10.18\,\text{W/(m*K)} \cdot 1.04\,\text{m²} \cdot \left(310\,\text{K} - 302\,\text{K}\right)}{7.54\,\text{W}}$$

21) Work done by Compressor given Load on Condenser Formula

Evaluate Formula

Formula

$$W = Q_C - R_E$$

Example with Units

$$600\,\text{J/min} = 1600\,\text{J/min} - 1000\,\text{J/min}$$

Variables used in list of Heat Transfer Formulas above

- **A** Area *(Square Meter)*
- **COP_r** Coefficient of Performance of Refrigerator
- **d_t** Diameter of Tube *(Millimeter)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **h** Coefficient of Heat Transfer *(Watt per Square Meter per Kelvin)*
- **H** Height of Surface *(Millimeter)*
- **$\bar{h}$** Average Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **h_{fg}** Latent Heat of Vaporization *(Kilojoule per Kilogram)*
- **HRF** Heat Rejection Factor
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **N** Number of Tubes
- **q** Heat Transfer *(Watt)*
- **Q_C** Load on Condenser *(Joule per Minute)*
- **R_E** Refrigeration Capacity *(Joule per Minute)*
- **R_{th}** Thermal Resistance *(Kelvin per Watt)*
- **SA** Surface Area *(Square Meter)*
- **T_1** Vapour condensing film temperature *(Kelvin)*
- **T_2** Outside Surface Temperature *(Kelvin)*
- **T_3** Inside Surface temperature *(Kelvin)*
- **U** Overall Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **W** Compressor Work Done *(Joule per Minute)*
- **x** Tube Thickness *(Millimeter)*
- **ΔT** Temperature Difference *(Kelvin)*
- **ΔT_o** Overall Temperature Difference *(Kelvin)*
- **μ_f** Viscosity of Film *(Newton Second per Square Meter)*
- **ρ_f** Density of Liquid Condensate *(Kilogram per Cubic Meter)*
- **ρv** Density *(Kilogram per Cubic Meter)*

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

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Power** in Watt (W)
  Power 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: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Dynamic Viscosity** in Newton Second per Square Meter (N*s/m²)
  Dynamic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Latent Heat** in Kilojoule per Kilogram (kJ/kg)
  Latent Heat Unit Conversion
- Measurement: **Rate of Heat Transfer** in Joule per Minute (J/min)
  Rate of Heat Transfer Unit Conversion

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