Heat Exchanger and its Effectiveness Formulas

List of 15 Heat Exchanger and its Effectiveness Formulas

Heat Exchanger and its Effectiveness

1) Capacity Rate

Open Calculator

fx $C = \dot{m} \cdot c$

ex $152.25\text{W/K} = 101.5\text{kg/s} \cdot 1.5\text{J/(kg*K)}$

2) Effectiveness of Counter-Current Heat Exchanger if Cold Fluid is Minimum Fluid

Open Calculator

fx $$\varepsilon_c = \left(\text{modulus} \frac{(T_{ci} - T_{co})}{T_{hi} - T_{co}} \right)$$

ex $$0.5 = \left(\text{modulus} \frac{(283\text{K} - 303\text{K})}{343\text{K} - 303\text{K}} \right)$$

3) Effectiveness of Counter-Current Heat Exchanger if Hot Fluid is Minimum Fluid

Open Calculator

fx $$\varepsilon_h = \frac{T_{hi} - T_{ho}}{T_{hi} - T_{co}}$$

ex $$0.5 = \frac{343\text{K} - 323\text{K}}{343\text{K} - 303\text{K}}$$

4) Effectiveness of Parallel-Flow Heat Exchanger if Cold Fluid is Minimum Fluid

Open Calculator

fx $$\varepsilon_c = \frac{T_{co} - T_{ci}}{T_{hi} - T_{ci}}$$

ex $$0.333333 = \frac{303\text{K} - 283\text{K}}{343\text{K} - 283\text{K}}$$

5) Effectiveness of Parallel-Flow Heat Exchanger if Hot Fluid is Minimum Fluid

Open Calculator

fx $$\varepsilon_h = \left(\frac{T_{hi} - T_{ho}}{T_{hi} - T_{ci}} \right)$$

ex $$0.333333 = \left(\frac{343\text{K} - 323\text{K}}{343\text{K} - 283\text{K}} \right)$$

6) Fouling Factor

Open Calculator

$$R_f = \left(\frac{1}{U_d}\right) - \left(\frac{1}{U}\right)$$

$$1.000641 \text{m}^2\text{K/W} = \left(\frac{1}{0.975 \text{W/m}^2\text{*K}}\right) - \left(\frac{1}{40 \text{W/m}^2\text{*K}}\right)$$

7) Heat Exchanger Effectiveness

Open Calculator

$$\epsilon = \frac{Q_{Actual}}{Q_{Max}}$$

$$0.01665 = \frac{999 \text{J/s}}{60000 \text{J/s}}$$

8) Heat Exchanger Effectiveness for Minimum Fluid

Open Calculator

$$\epsilon = \frac{\Delta T_{\text{Min Fluid}}}{\Delta T_{\text{Max HE}}}$$

$$0.90625 = \frac{290 \text{K}}{320 \text{K}}$$

9) Heat Transfer in Heat Exchanger given Cold Fluid Properties

Open Calculator

$$Q = \text{modulus}(m_c \cdot c_c \cdot (T_{ci} - T_{co}))$$

$$63000 \text{J} = \text{modulus}(9 \text{kg} \cdot 350 \text{J/(kg*K)} \cdot (283 \text{K} - 303 \text{K}))$$

10) Heat Transfer in Heat Exchanger given Hot Fluid Properties

Open Calculator

$$Q = m_h \cdot c_h \cdot (T_{hi} - T_{ho})$$

$$48000 \text{J} = 8 \text{kg} \cdot 300 \text{J/(kg*K)} \cdot (343 \text{K} - 323 \text{K})$$

11) Heat Transfer in Heat Exchanger given Overall Heat Transfer Coefficient

Open Calculator

$$Q = U \cdot A \cdot \Delta T_m$$

$$4275.2 \text{J} = 40 \text{W/m}^2\text{*K} \cdot 6.68 \text{m}^2 \cdot 16 \text{K}$$

12) Maximum Possible Rate of Heat Transfer

Open Calculator

$$Q_{Max} = C_{min} \cdot (T_{hi} - T_{ci})$$

$$60000 \text{J/s} = 1000 \text{W/K} \cdot (343 \text{K} - 283 \text{K})$$

13) Number of Heat Transfer Units

Open Calculator

fx $$NTU = \frac{U \cdot A}{C_{min}}$$

ex $$0.2672 = \frac{40W/m^2*K \cdot 6.68m^2}{1000W/K}$$

14) Overall Heat Transfer Coefficient for Unfinned Tube

Open Calculator

fx $$U_d = \frac{1}{\left(\frac{1}{h_{outside}}\right) + R_o + \left(\frac{\left(d_o \cdot \left(\ln\left(\frac{d_o}{d_i}\right)\right)\right)}{2 \cdot k}\right) + \left(\frac{R_i \cdot A_o}{A_i}\right) + \left(\frac{A_o}{h_{inside} \cdot A_i}\right)}$$

ex $$0.975937W/m^2*K = \frac{1}{\left(\frac{1}{17W/m^2*K}\right) + 0.001m^2K/W + \left(\frac{\left(2.68m \cdot \left(\ln\left(\frac{2.68m}{1.27m}\right)\right)\right)}{2 \cdot 10.18W/(m*K)}\right) + \left(\frac{0.002m^2K/W \cdot 14m^2}{12m^2}\right) + \left(\frac{14m^2}{1.35W/m^2*K \cdot 12m^2}\right)}$$

15) Rate of Heat Transfer using Correction Factor and LMTD

Open Calculator

fx $$q = U \cdot A \cdot F \cdot \Delta T_m$$

ex $$2009.344W = 40W/m^2*K \cdot 6.68m^2 \cdot 0.47 \cdot 16K$$

Variables Used

- **A** Area of Heat Exchanger *(Square Meter)*
- **A_i** Inside Tube Surface Area *(Square Meter)*
- **A_o** Outside Tube Surface Area *(Square Meter)*
- **c** Specific Heat Capacity *(Joule per Kilogram per K)*
- **C** Capacity Rate *(Watt per Kelvin)*
- **c_c** Specific Heat Capacity of Cold Fluid *(Joule per Kilogram per K)*
- **c_h** Specific Heat Capacity of Hot Fluid *(Joule per Kilogram per K)*
- **C_{min}** Minimum Capacity Rate *(Watt per Kelvin)*
- **d_i** Inside Tube Diameter *(Meter)*
- **d_o** Outside Tube Diameter *(Meter)*
- **F** Correction Factor
- **h_{inside}** Inside Convection Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **$h_{outside}$** External Convection Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **$\dot{m}$** Mass Flow Rate *(Kilogram per Second)*
- **m_c** Mass of Cold Fluid *(Kilogram)*
- **m_h** Mass of Hot Fluid *(Kilogram)*
- **NTU** Number of Heat Transfer Units
- **q** Heat Transfer *(Watt)*
- **Q** Heat *(Joule)*
- **Q_{Actual}** Actual Rate of Heat Transfer *(Joule per Second)*
- **Q_{Max}** Maximum Possible Rate of Heat Transfer *(Joule per Second)*
- **R_f** Fouling Factor *(Square Meter Kelvin per Watt)*
- **R_i** Fouling Factor on Inside of Tube *(Square Meter Kelvin per Watt)*
- **R_o** Fouling Factor on Outside of Tube *(Square Meter Kelvin per Watt)*
- **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)*
- **U** Overall Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **U_d** Overall Heat Transfer Coefficient after Fouling *(Watt per Square Meter per Kelvin)*
- **ΔT_m** Log Mean Temperature Difference *(Kelvin)*
- **$\Delta T_{Max\ HE}$** Maximum Temperature Difference in Heat Exchanger *(Kelvin)*

- $\Delta T_{Min\ Fluid}$ Temperature Difference of Minimum Fluid *(Kelvin)*
- ϵ Effectiveness of Heat Exchanger
- ε_c Effectiveness of HE when Cold Fluid is Min Fluid
- ε_h Effectiveness of HE when Hot Fluid is Min Fluid

Constants, Functions, Measurements used

- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Function: **modulus**, modulus
  Modulus of number
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Watt (W)
  Power 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: **Mass Flow Rate** in Kilogram per Second (kg/s)
  Mass Flow Rate Unit Conversion
- Measurement: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient Unit Conversion
- Measurement: **Rate of Heat Transfer** in Joule per Second (J/s)
  Rate of Heat Transfer Unit Conversion
- Measurement: **Fouling Factor** in Square Meter Kelvin per Watt (m²K/W)
  Fouling Factor Unit Conversion
- Measurement: **Heat Capacity Rate** in Watt per Kelvin (W/K)
  Heat Capacity Rate Unit Conversion

Check other formula lists

- Basics of Heat Transfer Formulas
- Co-Relation of Dimensionless Numbers Formulas
- Heat Exchanger Formulas
- Heat Exchanger and its Effectiveness Formulas
- Heat Transfer from Extended Surfaces (Fins) Formulas
- Heat Transfer from Extended Surfaces (Fins), Critical Thickness of Insulation and Thermal Resistance Formulas
- Thermal Resistance Formulas
- Unsteady State Heat Conduction Formulas

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