Convection Heat Transfer Formulas

List of 31 Convection Heat Transfer Formulas

Convection Heat Transfer

1) Correlation for Local Nusselt Number for Laminar Flow on Isothermal Flat Plate

Open Calculator

fx $$Nu_x = \frac{0.3387 \cdot \left(Re_l^{\frac{1}{2}}\right) \cdot \left(Pr^{\frac{1}{3}}\right)}{\left(1 + \left(\left(\frac{0.0468}{Pr}\right)^{\frac{2}{3}}\right)\right)^{\frac{1}{4}}}$$

ex $$0.482931 = \frac{0.3387 \cdot \left((0.55)^{\frac{1}{2}}\right) \cdot \left((7.29)^{\frac{1}{3}}\right)}{\left(1 + \left(\left(\frac{0.0468}{7.29}\right)^{\frac{2}{3}}\right)\right)^{\frac{1}{4}}}$$

2) Correlation for Nusselt Number for Constant Heat Flux

Open Calculator

fx $$Nu_x = \frac{0.4637 \cdot \left(Re_l^{\frac{1}{2}}\right) \cdot \left(Pr^{\frac{1}{3}}\right)}{\left(1 + \left(\left(\frac{0.0207}{Pr}\right)^{\frac{2}{3}}\right)\right)^{\frac{1}{4}}}$$

ex $$0.663497 = \frac{0.4637 \cdot \left((0.55)^{\frac{1}{2}}\right) \cdot \left((7.29)^{\frac{1}{3}}\right)}{\left(1 + \left(\left(\frac{0.0207}{7.29}\right)^{\frac{2}{3}}\right)\right)^{\frac{1}{4}}}$$

3) Drag Coefficient for Bluff Bodies

Open Calculator

fx $$C_D = \frac{2 \cdot F_D}{A \cdot \rho_{Fluid} \cdot (u_\infty^2)}$$

ex $$0.404285 = \frac{2 \cdot 80\text{N}}{2.67\text{m}^2 \cdot 1.225\text{kg/m}^3 \cdot \left((11\text{m/s})^2\right)}$$

4) Drag Force for Bluff Bodies

Open Calculator

fx $$F_D = \frac{C_D \cdot A \cdot \rho_{Fluid} \cdot (u_\infty^2)}{2}$$

ex $$79.94367\text{N} = \frac{0.404 \cdot 2.67\text{m}^2 \cdot 1.225\text{kg/m}^3 \cdot \left((11\text{m/s})^2\right)}{2}$$

5) Friction Coefficient given Shear Stress at Wall

Open Calculator

fx $$C_f = \frac{\tau_w \cdot 2}{\rho_{Fluid} \cdot (u_\infty^2)}$$

ex $$0.074212 = \frac{5.5\text{Pa} \cdot 2}{1.225\text{kg/m}^3 \cdot \left((11\text{m/s})^2\right)}$$

6) Friction Factor given Reynolds Number for Flow in Smooth Tubes

Open Calculator

fx $$f = \frac{0.316}{(Re_d)^{\frac{1}{4}}}$$

ex $$0.04614 = \frac{0.316}{(2200)^{\frac{1}{4}}}$$

7) Friction Factor given Stanton Number for Turbulent Flow in Tube

Open Calculator

fx $$f = 8 \cdot St$$

ex $$0.045 = 8 \cdot 0.005625$$

8) Local Friction Coefficient given Local Reynolds Number

Open Calculator

fx $$C_{fx} = 2 \cdot 0.332 \cdot \left(Re_l^{-0.5}\right)$$

ex $$0.895337 = 2 \cdot 0.332 \cdot \left((0.55)^{-0.5}\right)$$

9) Local Nusselt Number for Constant Heat Flux given Prandtl Number

Open Calculator

fx $$Nu_x = 0.453 \cdot \left(Re_l^{\frac{1}{2}}\right) \cdot \left(Pr^{\frac{1}{3}}\right)$$

ex $$0.651411 = 0.453 \cdot \left((0.55)^{\frac{1}{2}}\right) \cdot \left((7.29)^{\frac{1}{3}}\right)$$

10) Local Nusselt Number for Plate Heated over its Entire Length

Open Calculator

fx $$\mathrm{Nu_x} = 0.332 \cdot \left(\mathrm{Pr}^{\frac{1}{3}}\right) \cdot \left(\mathrm{Re_l}^{\frac{1}{2}}\right)$$

ex $$0.477414 = 0.332 \cdot \left((7.29)^{\frac{1}{3}}\right) \cdot \left((0.55)^{\frac{1}{2}}\right)$$

11) Local Skin Friction Coefficient for Turbulent Flow on Flat Plates

Open Calculator

fx $$\mathrm{C_{fx}} = 0.0592 \cdot \left(\mathrm{Re_l}^{-\frac{1}{5}}\right)$$

ex $$0.066719 = 0.0592 \cdot \left((0.55)^{-\frac{1}{5}}\right)$$

12) Local Stanton Number

Open Calculator

fx $$\mathrm{St_x} = \frac{\mathrm{h_x}}{\rho_{\mathrm{Fluid}} \cdot \mathrm{C_p} \cdot \mathrm{u_\infty}}$$

ex $$2.378574 = \frac{40\mathrm{W/m^2{*}K}}{1.225\mathrm{kg/m^3} \cdot 1.248\mathrm{J/(kg{*}K)} \cdot 11\mathrm{m/s}}$$

13) Local Stanton Number given Local Friction Coefficient

Open Calculator

fx $$\mathrm{St_x} = \frac{\mathrm{C_{fx}}}{2 \cdot \left(\mathrm{Pr}^{\frac{2}{3}}\right)}$$

ex $$0.103732 = \frac{0.78}{2 \cdot \left((7.29)^{\frac{2}{3}}\right)}$$

14) Local Stanton Number given Prandtl Number

Open Calculator

$$St_x = \frac{0.332 \cdot \left(Re_l^{\frac{1}{2}}\right)}{Pr^{\frac{2}{3}}}$$

$$0.065489 = \frac{0.332 \cdot \left((0.55)^{\frac{1}{2}}\right)}{(7.29)^{\frac{2}{3}}}$$

15) Local Velocity of Sound

Open Calculator

$$a = \sqrt{(\gamma \cdot [R] \cdot T_m)}$$

$$201.0181\text{m/s} = \sqrt{(16.2 \cdot [R] \cdot 300\text{K})}$$

16) Local Velocity of Sound when Air Behaves as Ideal Gas

Open Calculator

$$a = 20.045 \cdot \sqrt{(T_m)}$$

$$347.1896\text{m/s} = 20.045 \cdot \sqrt{(300\text{K})}$$

17) Mass Flow Rate from Continuity Relation for One Dimensional Flow in Tube

Open Calculator

$$\dot{m} = \rho_{Fluid} \cdot A_T \cdot u_m$$

$$133.7455\text{kg/s} = 1.225\text{kg/m}^3 \cdot 10.3\text{m}^2 \cdot 10.6\text{m/s}$$

18) Mass Flow Rate given Mass Velocity

Open Calculator

fx $\dot{m} = G \cdot A_T$

ex $133.9\text{kg/s} = 13\text{kg/s/m}^2 \cdot 10.3\text{m}^2$

19) Mass Velocity

Open Calculator

fx $G = \frac{\dot{m}}{A_T}$

ex $13\text{kg/s/m}^2 = \frac{133.9\text{kg/s}}{10.3\text{m}^2}$

20) Mass Velocity given Mean Velocity

Open Calculator

fx $G = \rho_{Fluid} \cdot u_m$

ex $12.985\text{kg/s/m}^2 = 1.225\text{kg/m}^3 \cdot 10.6\text{m/s}$

21) Mass Velocity given Reynolds Number

Open Calculator

fx $G = \frac{Re_d \cdot \mu}{d}$

ex $13.58025\text{kg/s/m}^2 = \frac{2200 \cdot 0.6\text{P}}{9.72\text{m}}$

22) Nusselt Number for Plate heated over its Entire Length

Open Calculator

fx $$Nu_L = 0.664 \cdot \left((Re_L)^{\frac{1}{2}} \right) \cdot \left(Pr^{\frac{1}{3}} \right)$$

ex $$5.757831 = 0.664 \cdot \left((20)^{\frac{1}{2}} \right) \cdot \left((7.29)^{\frac{1}{3}} \right)$$

23) Nusselt Number for Turbulent Flow in Smooth Tube

Open Calculator

fx $$Nu_d = 0.023 \cdot \left(Re_d^{0.8} \right) \cdot \left(Pr^{0.4} \right)$$

ex $$24.03018 = 0.023 \cdot \left((2200)^{0.8} \right) \cdot \left((7.29)^{0.4} \right)$$

24) Prandtl Number given Recovery Factor for Gases for Laminar Flow

Open Calculator

fx $$Pr = \left(r^2 \right)$$

ex $$6.25 = \left((2.5)^2 \right)$$

25) Recovery Factor

Open Calculator

fx $$r = \left(\frac{T_{aw} - T_{\infty}}{T_o - T_{\infty}} \right)$$

ex $$1.888889 = \left(\frac{410\text{K} - 325\text{K}}{370\text{K} - 325\text{K}} \right)$$

26) Recovery Factor for Gases with Prandtl Number near Unity under Laminar Flow

Open Calculator

$$r = Pr^{\frac{1}{2}}$$

$$2.7 = (7.29)^{\frac{1}{2}}$$

27) Recovery Factor for Gases with Prandtl Number near Unity under Turbulent Flow

Open Calculator

$$r = Pr^{\frac{1}{3}}$$

$$1.938991 = (7.29)^{\frac{1}{3}}$$

28) Reynolds Number given Friction Factor for Flow in Smooth Tubes

Open Calculator

$$Re_d = \left(\frac{0.316}{f}\right)^4$$

$$2431.634 = \left(\frac{0.316}{0.045}\right)^4$$

29) Reynolds Number given Mass Velocity

Open Calculator

$$Re_d = \frac{G \cdot d}{\mu}$$

$$2106 = \frac{13\text{kg/s/m}^2 \cdot 9.72\text{m}}{0.6\text{P}}$$

30) Shear Stress at Wall given Friction Coefficient

Open Calculator

fx $$\tau_w = \frac{C_f \cdot \rho_{Fluid} \cdot \left(u_\infty^2\right)}{2}$$

ex $$5.484325\text{Pa} = \frac{0.074 \cdot 1.225\text{kg/m}^3 \cdot \left((11\text{m/s})^2\right)}{2}$$

31) Stanton Number given Friction Factor for Turbulent Flow in Tube

Open Calculator

fx $$St = \frac{f}{8}$$

ex $$0.005625 = \frac{0.045}{8}$$

Variables Used

- **a** Local Velocity of Sound *(Meter per Second)*
- **A** Frontal Area *(Square Meter)*
- A_T Cross Sectional Area *(Square Meter)*
- C_D Drag Coefficient
- C_f Friction Coefficient
- C_{fx} Local Friction Coefficient
- C_p Specific Heat at Constant Pressure *(Joule per Kilogram per K)*
- **d** Diameter of Tube *(Meter)*
- **f** Fanning Friction Factor
- F_D Drag Force *(Newton)*
- **G** Mass Velocity *(Kilogram per Second per Square Meter)*
- h_x Local Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- $\dot{m}$ Mass Flow Rate *(Kilogram per Second)*
- Nu_d Nusselt Number
- Nu_L Nusselt Number at Location L
- Nu_x Local Nusselt number
- **Pr** Prandtl Number
- **r** Recovery Factor
- Re_d Reynolds Number in Tube
- Re_l Local Reynolds Number
- Re_L Reynolds Number
- **St** Stanton Number

- **St_x** Local Stanton Number
- **T_∞** Static Temperature of Free Stream *(Kelvin)*
- **T_{aw}** Adiabatic Wall Temperature *(Kelvin)*
- **T_m** Temperature of Medium *(Kelvin)*
- **T_o** Stagnation Temperature *(Kelvin)*
- **u_∞** Free Stream Velocity *(Meter per Second)*
- **u_m** Mean velocity *(Meter per Second)*
- **γ** Ratio of Specific Heat Capacities
- **μ** Dynamic Viscosity *(Poise)*
- **ρ_{Fluid}** Density of Fluid *(Kilogram per Cubic Meter)*
- **τ_w** Shear Stress *(Pascal)*

Constants, Functions, Measurements used

- Constant: **[R]**, 8.31446261815324 Joule / Kelvin * Mole
  Universal gas constant
- Function: **sqrt**, sqrt(Number)
  Square root 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: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Newton (N)
  Force 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: **Dynamic Viscosity** in Poise (P)
  Dynamic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

- Measurement: **Mass Velocity** in Kilogram per Second per Square Meter ($kg/s/m^2$)
  Mass Velocity Unit Conversion
- Measurement: **Stress** in Pascal (Pa)
  Stress Unit Conversion

Check other formula lists

- **Basics of Modes of Heat Transfer Formulas**
- **Convection Heat Transfer Formulas**

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