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Boundary Layer Flow Formulas

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List of 21 Boundary Layer Flow Formulas

Boundary Layer Flow

1) Area of Surface for Average Drag Coefficient

$$fx \quad A = \frac{F_D}{\frac{1}{2} \cdot C_D \cdot \rho_f \cdot V_\infty^2}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 0.794763m^2 = \frac{0.03N}{\frac{1}{2} \cdot 3.77E^{-3} \cdot 890kg/m^3 \cdot (0.15m/s)^2}$$

2) Average Coefficient of Drag for Drag Force

$$fx \quad C_D = \frac{F_D}{\frac{1}{2} \cdot \rho_f \cdot A \cdot V_\infty^2}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 0.003793 = \frac{0.03N}{\frac{1}{2} \cdot 890kg/m^3 \cdot 0.79m^2 \cdot (0.15m/s)^2}$$


3) Coefficient of Drag for Blasius's Solution

$$fx \quad C_D = \frac{1.328}{\sqrt{Re}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 0.003429 = \frac{1.328}{\sqrt{1.5E5}}$$




4) Coefficient of Drag for Reynold Number 

$$\text{fx } C_D = \frac{1.46}{\sqrt{R_e}}$$

Open Calculator 

$$\text{ex } 0.00377 = \frac{1.46}{\sqrt{1.5E5}}$$

5) Distance from Leading Edge 

$$\text{fx } x = \delta \cdot \frac{\sqrt{R_e}}{5.48}$$

Open Calculator 

$$\text{ex } 0.989448\text{m} = 0.014\text{m} \cdot \frac{\sqrt{1.5E5}}{5.48}$$

6) Distance from Leading Edge for Blasius's Solution 

$$\text{fx } x = \delta \cdot \frac{\sqrt{R_e}}{4.91}$$

Open Calculator 

$$\text{ex } 1.104313\text{m} = 0.014\text{m} \cdot \frac{\sqrt{1.5E5}}{4.91}$$

7) Drag Force for Average Drag Coefficient 

$$\text{fx } F_D = \frac{1}{2} \cdot C_D \cdot \rho_f \cdot A \cdot V_\infty^2$$

Open Calculator 

$$\text{ex } 0.02982\text{N} = \frac{1}{2} \cdot 3.77E^{-3} \cdot 890\text{kg/m}^3 \cdot 0.79\text{m}^2 \cdot (0.15\text{m/s})^2$$

8) Drag Force on Plate 

$$\text{fx } F_D = 0.73 \cdot b \cdot \mu \cdot V_\infty \cdot \sqrt{R_e}$$

Open Calculator 


$$\text{ex } 0.031383\text{N} = 0.73 \cdot 0.74\text{m} \cdot 0.001\text{N*s/m}^2 \cdot 0.15\text{m/s} \cdot \sqrt{1.5E5}$$



9) Freestream Velocity for Local Drag Coefficient [Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)


$$fx \quad V_{\infty} = \sqrt{\frac{\tau}{\frac{1}{2} \cdot \rho_f \cdot CD^*}}$$

$$ex \quad 0.151021\text{m/s} = \sqrt{\frac{0.068\text{N/m}^2}{\frac{1}{2} \cdot 890\text{kg/m}^3 \cdot 0.0067}}$$

10) Length of Plate for Reynold Number [Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

$$fx \quad L = \frac{Re \cdot \mu}{\rho_f \cdot V_{\infty}}$$

$$ex \quad 1.123596\text{m} = \frac{1.5\text{E}5 \cdot 0.001\text{N}^*\text{s/m}^2}{890\text{kg/m}^3 \cdot 0.15\text{m/s}}$$

11) Local Drag Coefficient for Shear Stress [Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$fx \quad CD^* = \frac{\tau}{\frac{1}{2} \cdot \rho_f \cdot V_{\infty}^2}$$

$$ex \quad 0.006792 = \frac{0.068\text{N/m}^2}{\frac{1}{2} \cdot 890\text{kg/m}^3 \cdot (0.15\text{m/s})^2}$$

12) Reynold Number at End of Plate [Open Calculator !\[\]\(248b91fcdac4810ffd15cf33fb6aec6f_img.jpg\)](#)

$$fx \quad Re = \frac{\rho_f \cdot V_{\infty} \cdot L}{\mu}$$

$$ex \quad 149520 = \frac{890\text{kg/m}^3 \cdot 0.15\text{m/s} \cdot 1.12\text{m}}{0.001\text{N}^*\text{s/m}^2}$$



13) Reynold Number for Drag Coefficient in Blasius's Solution 

$$fx \quad R_e = \left(\frac{1.328}{C_D} \right)^2$$

Open Calculator 


$$ex \quad 124083.3 = \left(\frac{1.328}{3.77E^{-3}} \right)^2$$

14) Reynold Number for Drag Force on Plate 

$$fx \quad R_e = \left(\frac{F_D}{0.73 \cdot b \cdot \mu \cdot V_\infty} \right)^2$$

Open Calculator 

$$ex \quad 137072.7 = \left(\frac{0.03N}{0.73 \cdot 0.74m \cdot 0.001N^*s/m^2 \cdot 0.15m/s} \right)^2$$

15) Shear Stress at Boundary for Turbulent Boundary Layer over Flat Plate 

$$fx \quad \tau = 0.0225 \cdot \rho_f \cdot V_\infty^2 \cdot \left(\frac{\mu}{\rho_f \cdot V_\infty \cdot \delta} \right)^{\frac{1}{4}}$$

Open Calculator 

$$ex \quad 0.068526N/m^2 = 0.0225 \cdot 890kg/m^3 \cdot (0.15m/s)^2 \cdot \left(\frac{0.001N^*s/m^2}{890kg/m^3 \cdot 0.15m/s \cdot 0.014m} \right)^{\frac{1}{4}}$$

16) Shear Stress for Local Drag Coefficient 

$$fx \quad \tau = \frac{1}{2} \cdot CD^* \cdot \rho_f \cdot V_\infty^2$$

Open Calculator 

$$ex \quad 0.067084N/m^2 = \frac{1}{2} \cdot 0.0067 \cdot 890kg/m^3 \cdot (0.15m/s)^2$$



17) Thickness of Boundary Layer 

$$\text{fx } \delta = \frac{5.48 \cdot x}{\sqrt{R_e}}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 0.015423\text{m} = \frac{5.48 \cdot 1.09\text{m}}{\sqrt{1.5\text{E}5}}$$

18) Thickness of Boundary Layer for Blasius's Solution 

$$\text{fx } \delta = \frac{4.91 \cdot x}{\sqrt{R_e}}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 0.013819\text{m} = \frac{4.91 \cdot 1.09\text{m}}{\sqrt{1.5\text{E}5}}$$

19) Velocity of Fluid for Reynold Number 

$$\text{fx } V_{\infty} = \frac{R_e \cdot \mu}{\rho_f \cdot L}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 0.150482\text{m/s} = \frac{1.5\text{E}5 \cdot 0.001\text{N}^*\text{s}/\text{m}^2}{890\text{kg}/\text{m}^3 \cdot 1.12\text{m}}$$


20) Viscosity of Liquid for Drag Force on Plate 

$$\text{fx } \mu = \frac{F_D}{0.73 \cdot b \cdot V_{\infty} \cdot \sqrt{R_e}}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 0.000956\text{N}^*\text{s}/\text{m}^2 = \frac{0.03\text{N}}{0.73 \cdot 0.74\text{m} \cdot 0.15\text{m/s} \cdot \sqrt{1.5\text{E}5}}$$



21) Width of Plate for Drag Force on Plate [Open Calculator](#) 

$$\text{fx } b = \frac{F_D}{0.73 \cdot \mu \cdot V_\infty \cdot \sqrt{R_e}}$$

$$\text{ex } 0.707394\text{m} = \frac{0.03\text{N}}{0.73 \cdot 0.001\text{N}\cdot\text{s}/\text{m}^2 \cdot 0.15\text{m}/\text{s} \cdot \sqrt{1.5\text{E}5}}$$










Variables Used

- **A** Area of Surface for Boundary Layer Flow (*Square Meter*)
- **b** Breadth of Plate for Boundary Layer Flow (*Meter*)
- **C_D** Coefficient of Drag for Boundary Layer Flow
- **CD^{*}** Local Drag Coefficient for Boundary Layer
- **F_D** Drag Force on Boundary Layer Flow Plate (*Newton*)
- **L** Length of Plate for Boundary Layer Flow (*Meter*)
- **R_e** Reynolds Number for Boundary Layer Flow
- **V_∞** Freestream Velocity for Boundary Layer Flow (*Meter per Second*)
- **x** Distance Leading Edge for Boundary Layer Flow (*Meter*)
- **μ** Viscosity of Fluid for Boundary Layer Flow (*Newton Second per Square Meter*)
- **ρ_f** Fluid Density for Boundary Layer Flow (*Kilogram per Cubic Meter*)
- **δ** Thickness of Boundary Layer (*Meter*)
- **τ** Shear Stress for Boundary Layer Flow (*Newton per Square Meter*)










Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Meter (m)
Length 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:** **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:** **Stress** in Newton per Square Meter (N/m²)
Stress Unit Conversion 



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