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Fluid Force Formulas

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List of 18 Fluid Force Formulas

Fluid Force

1) Beale Number

Open Calculator

$$B_n = \frac{HP}{P \cdot V_{piston} \cdot f_{engine}}$$

$$0.101892 = \frac{160\text{hp}}{56\text{N/m}^2 \cdot 205\text{m}^3 \cdot 102\text{Hz}}$$

2) Body Force Work Rate

Open Calculator

$$F_{body} = \frac{F}{VI}$$

$$2.083333 = \frac{2.5\text{N}}{1.2\text{m}^3}$$

3) Force in Direction of Jet Striking Stationary Vertical Plate

Open Calculator

$$F_{inertial} = \rho_{liquid} \cdot A \cdot V_o^2$$

$$2569.011\text{N/m}^2 = 49\text{kg/m}^3 \cdot 0.02\text{m}^2 \cdot (51.2\text{m/s})^2$$

4) Inertial Force per Unit Area

Open Calculator

$$F_{inertial} = u_f^2 \cdot \rho_{liquid}$$

$$7056\text{N/m}^2 = (12\text{m/s})^2 \cdot 49\text{kg/m}^3$$

5) Stokes Force

Open Calculator

$$SF = 6 \cdot \pi \cdot r \cdot \mu_d \cdot u$$

$$10.39082\text{N} = 6 \cdot \pi \cdot 5\text{m} \cdot 0.075\text{P} \cdot 14.7\text{m/s}$$

6) Upthrust Force

Open Calculator

$$UF = VI \cdot g \cdot \rho_{liquid}$$

$$576.24\text{N} = 1.2\text{m}^3 \cdot 9.8\text{m/s}^2 \cdot 49\text{kg/m}^3$$

Applications of Fluid Force

7) Area of Wetted Surface given Total Hydrostatic Force

Open Calculator

$$A_{wet} = \frac{F_{hs}}{\gamma_1 \cdot h_G}$$

$$0.281762\text{m}^2 = \frac{121\text{N}}{1342\text{N/m}^3 \cdot 0.32\text{m}}$$

8) Distance between Plates given Dynamic Viscosity of Fluid

Open Calculator

$$y = \mu_d \cdot \frac{u}{\tau}$$

$$0.012971\text{m} = 0.075\text{P} \cdot \frac{14.7\text{m/s}}{8.5\text{N/m}^2}$$

9) Dynamic Viscosity of Fluids

Open Calculator

$$\mu_d = \frac{\tau \cdot y}{u}$$

$$0.07517\text{P} = \frac{8.5\text{N/m}^2 \cdot 0.013\text{m}}{14.7\text{m/s}}$$

10) Dynamic Viscosity of Gases

Open Calculator

fx $$\mu_d = \frac{a \cdot T^{\frac{1}{2}}}{1 + \frac{B}{T}}$$

ex $$4.11264\text{P} = \frac{0.0455 \cdot (85\text{K})^{\frac{1}{2}}}{1 + \frac{1.70}{85\text{K}}}$$

11) Dynamic Viscosity of Liquids

Open Calculator

fx $$\mu_d = a \cdot e^{\frac{B}{T}}$$

ex $$0.464192\text{P} = 0.0455 \cdot e^{\frac{1.70}{85\text{K}}}$$

12) Friction Factor given Frictional Velocity

Open Calculator

fx $$f = 8 \cdot \left(\frac{V_f}{V_{mean}}\right)^2$$

ex $$2.823253 = 8 \cdot \left(\frac{6\text{m/s}}{10.1\text{m/s}}\right)^2$$

13) Normal Stress 1

Open Calculator

fx $$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

ex $$100.7188 = \frac{100\text{N/m}^2 + 0.2\text{N/m}^2}{2} + \sqrt{\left(\frac{100\text{N/m}^2 - 0.2\text{N/m}^2}{2}\right)^2 + (8.5\text{N/m}^2)^2}$$

14) Normal Stress 2

Open Calculator

fx $$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

ex $$-0.518771\text{N/m}^2 = \frac{100\text{N/m}^2 + 0.2\text{N/m}^2}{2} - \sqrt{\left(\frac{100\text{N/m}^2 - 0.2\text{N/m}^2}{2}\right)^2 + (8.5\text{N/m}^2)^2}$$

15) Shear Stress using Dynamic Viscosity of Fluid

Open Calculator

fx $$\tau = \mu_d \cdot \frac{u}{y}$$

ex $$8.480769\text{N/m}^2 = 0.075\text{P} \cdot \frac{14.7\text{m/s}}{0.013\text{m}}$$

16) Torque given Thickness of Oil

Open Calculator

fx $$\tau = \pi \cdot \mu_d \cdot \omega \cdot \frac{r_{outer}^4 - r_{inner}^4}{2} \cdot h \cdot \sin(\theta)$$

ex $$1389.86\text{N*m} = \pi \cdot 0.075\text{P} \cdot 2\text{rad/s} \cdot \frac{(7\text{m})^4 - (4\text{m})^4}{2} \cdot 55\text{m} \cdot \sin(30^\circ)$$

17) Torque on Shaft

Open Calculator

fx $$\tau_s = F \cdot \frac{D_{shaft}}{2}$$

ex $$0.625\text{N*m} = 2.5\text{N} \cdot \frac{0.5\text{m}}{2}$$

18) Total Hydrostatic Force

Open Calculator

fx $F_{hs} = \gamma_1 \cdot h_G \cdot A_{wet}$

ex $240.4864\text{N} = 1342\text{N/m}^3 \cdot 0.32\text{m} \cdot 0.56\text{m}^2$

Variables Used

- **a** Constant A
- **A** Cross Sectional Area of Jet *(Square Meter)*
- A_{wet} Wet Surface Area *(Square Meter)*
- **B** Constant B
- B_n Beale Number
- D_{shaft} Shaft Diameter *(Meter)*
- **f** Friction Factor
- **F** Force *(Newton)*
- F_{body} Body Force Work Rate
- f_{engine} Engine Frequency *(Hertz)*
- F_{hs} Hydrostatic Force *(Newton)*
- $F_{inertial}$ Inertial Force per Unit Area *(Newton per Square Meter)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **h** Thickness of Oil *(Meter)*
- h_G Depth of Centroid *(Meter)*
- **HP** Engine Power *(Horsepower)*
- **P** Average Gas Pressure *(Newton per Square Meter)*
- **r** Radius *(Meter)*
- r_{inner} Inner Radius *(Meter)*
- r_{outer} Outer Radius *(Meter)*
- **SF** Stokes Force *(Newton)*
- **T** Temperature *(Kelvin)*
- **u** Velocity of Moving Plate on Liquid *(Meter per Second)*
- u_f Fluid Velocity *(Meter per Second)*
- **UF** Upthrust Force *(Newton)*
- V_f Friction Velocity *(Meter per Second)*
- V_{mean} Mean Velocity *(Meter per Second)*

- V_o Initial Velocity of Liquid Jet *(Meter per Second)*
- V_{piston} Piston Swept Volume *(Cubic Meter)*
- **Vl** Volume Immersed *(Cubic Meter)*
- **y** Distance between Plates Carrying Fluid *(Meter)*
- γ_1 Specific Weight 1 *(Newton per Cubic Meter)*
- **θ** Theta *(Degree)*
- μ_d Dynamic Viscosity of Fluid *(Poise)*
- ρ_{liquid} Liquid Density *(Kilogram per Cubic Meter)*
- σ_1 Normal Stress 1
- σ_2 Normal Stress 2 *(Newton per Square Meter)*
- σ_x Principal Stress along x *(Newton per Square Meter)*
- σ_y Principal Stress along y *(Newton per Square Meter)*
- **τ** Torque Exerted on Wheel *(Newton Meter)*
- τ_s Torque Exerted on Shaft *(Newton Meter)*
- **ω** Angular Velocity *(Radian per Second)*
- τ Shear Stress in Fluid *(Newton per Square Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m^2)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s^2)
  Acceleration Unit Conversion
- Measurement: **Power** in Horsepower (hp)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion

- Measurement: **Dynamic Viscosity** in Poise (P)
  Dynamic Viscosity Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Specific Weight** in Newton per Cubic Meter (N/m³)
  Specific Weight Unit Conversion
- Measurement: **Stress** in Newton per Square Meter (N/m²)
  Stress Unit Conversion

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- **Fluid in Motion Formulas**
- **Hydrostatic Fluid Formulas**
- **Liquid Jet Formulas**
- **Pipes Formulas**
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