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Relation between Forces on the Prototype and Forces on the Model Formulas

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List of 18 Relation between Forces on the Prototype and Forces on the Model Formulas

Relation between Forces on the Prototype and Forces on the Model

1) Density of Fluid for Ratio of Inertial Forces and Viscous Forces

Open Calculator

fx $$\rho_{fluid} = \frac{F_i \cdot \mu_{viscosity}}{F_v \cdot V_f \cdot L}$$

ex $$1.226429\text{kg/m}^3 = \frac{3.636\text{kN} \cdot 10.2\text{P}}{0.0504\text{kN} \cdot 20\text{m/s} \cdot 3\text{m}}$$

2) Dynamic Viscosity for Ratio of Inertial Forces and Viscous Force

Open Calculator

fx $$\mu_{viscosity} = \frac{F_v \cdot \rho_{fluid} \cdot V_f \cdot L}{F_i}$$

ex $$10.18812\text{P} = \frac{0.0504\text{kN} \cdot 1.225\text{kg/m}^3 \cdot 20\text{m/s} \cdot 3\text{m}}{3.636\text{kN}}$$

3) Force on Model for Scale Factor Parameters

Open Calculator

fx $$F_m = \frac{F_p}{\alpha\rho \cdot \alpha V^2 \cdot \alpha L^2}$$

ex $$12.006\text{N} = \frac{69990.85\text{N}}{0.9999 \cdot (4.242)^2 \cdot (18)^2}$$

4) Force on Model given Force on Prototype

Open Calculator

fx $$F_m = \frac{F_p}{\alpha F}$$

ex $$12\text{N} = \frac{69990.85\text{N}}{5832.571}$$

5) Force on Prototype

Open Calculator

fx $$F_p = \alpha F \cdot F_m$$

ex $$69990.85\text{N} = 5832.571 \cdot 12\text{N}$$

6) Inertial Forces given Kinematic Viscosity

Open Calculator

fx $$F_i = \frac{F_v \cdot V_f \cdot L}{\nu}$$

ex $$3.636364\text{kN} = \frac{0.0504\text{kN} \cdot 20\text{m/s} \cdot 3\text{m}}{0.8316\text{m}^2\text{/s}}$$

7) Inertial Forces using Newton's Friction Model

Open Calculator

fx $$F_i = \frac{F_v \cdot \rho_{fluid} \cdot V_f \cdot L}{\mu_{viscosity}}$$

ex $$3.631765\text{kN} = \frac{0.0504\text{kN} \cdot 1.225\text{kg/m}^3 \cdot 20\text{m/s} \cdot 3\text{m}}{10.2\text{P}}$$

8) Kinematic Viscosity for Ratio of Inertial Forces and Viscous Force

Open Calculator

fx $$\nu = \frac{F_v \cdot V_f \cdot L}{F_i}$$

ex $$0.831683\text{m}^2/\text{s} = \frac{0.0504\text{kN} \cdot 20\text{m/s} \cdot 3\text{m}}{3.636\text{kN}}$$

9) Length for Ratio of Inertial Forces and Viscous Forces

Open Calculator

fx $$L = \frac{F_i \cdot \mu_{viscosity}}{F_v \cdot \rho_{fluid} \cdot V_f}$$

ex $$3.003499\text{m} = \frac{3.636\text{kN} \cdot 10.2\text{P}}{0.0504\text{kN} \cdot 1.225\text{kg/m}^3 \cdot 20\text{m/s}}$$

10) Length given Kinematic Viscosity, Ratio of Inertial forces and Viscous forces

Open Calculator

fx $$L = \frac{F_i \cdot \nu}{F_v \cdot V_f}$$

ex $$2.9997\text{m} = \frac{3.636\text{kN} \cdot 0.8316\text{m}^2/\text{s}}{0.0504\text{kN} \cdot 20\text{m/s}}$$

11) Relation between Forces on Prototype and Forces on Model

Open Calculator

fx $$F_p = \alpha\rho \cdot \left(\alpha V^2\right) \cdot \left(\alpha L^2\right) \cdot F_m$$

ex $$69955.87\text{N} = 0.9999 \cdot \left((4.242)^2\right) \cdot \left((18)^2\right) \cdot 12\text{N}$$

12) Scale Factor for Density of Fluid given Forces on Prototype and Model

Open Calculator

fx
$$\alpha\rho = \frac{F_p}{\alpha V^2 \cdot \alpha L^2 \cdot F_m}$$

ex
$$1.0004 = \frac{69990.85\text{N}}{(4.242)^2 \cdot (18)^2 \cdot 12\text{N}}$$

13) Scale Factor for Inertia Forces given Force on Prototype

Open Calculator

fx
$$\alpha F = \frac{F_p}{F_m}$$

ex
$$5832.571 = \frac{69990.85\text{N}}{12\text{N}}$$

14) Scale Factor for Length given Forces on Prototype and Force on Model

Open Calculator

fx
$$\alpha L = \sqrt{\frac{F_p}{\alpha\rho \cdot \alpha V^2 \cdot F_m}}$$

ex
$$18.0045 = \sqrt{\frac{69990.85\text{N}}{0.9999 \cdot (4.242)^2 \cdot 12\text{N}}}$$

15) Scale Factor for Velocity given Forces on Prototype and Force on Model

Open Calculator

$$\alpha V = \sqrt{\frac{F_p}{\alpha\rho \cdot \alpha L^2 \cdot F_m}}$$

$$4.24306 = \sqrt{\frac{69990.85\text{N}}{0.9999 \cdot (18)^2 \cdot 12\text{N}}}$$

16) Velocity given Kinematic Viscosity, Ratio of Inertial Forces and Viscous Forces

Open Calculator

$$V_f = \frac{F_i \cdot \nu}{F_v \cdot L}$$

$$19.998\text{m/s} = \frac{3.636\text{kN} \cdot 0.8316\text{m}^2\text{/s}}{0.0504\text{kN} \cdot 3\text{m}}$$

17) Velocity given Ratio of Inertial Forces and Viscous Forces using Newton's Friction model

Open Calculator

$$V_f = \frac{F_i \cdot \mu_{viscosity}}{F_v \cdot \rho_{fluid} \cdot L}$$

$$20.02332\text{m/s} = \frac{3.636\text{kN} \cdot 10.2\text{P}}{0.0504\text{kN} \cdot 1.225\text{kg/m}^3 \cdot 3\text{m}}$$

18) Viscous Forces using Newton's Friction model

Open Calculator

fx $$F_v = \frac{F_i \cdot \mu_{viscosity}}{\rho_{fluid} \cdot V_f \cdot L}$$

ex $$0.050459\text{kN} = \frac{3.636\text{kN} \cdot 10.2\text{P}}{1.225\text{kg/m}^3 \cdot 20\text{m/s} \cdot 3\text{m}}$$

Variables Used

- F_i Inertia Forces *(Kilonewton)*
- F_m Force on Model *(Newton)*
- F_p Force on Prototype *(Newton)*
- F_v Viscous Force *(Kilonewton)*
- L Characteristic length *(Meter)*
- V_f Velocity of Fluid *(Meter per Second)*
- αF Scale Factor for Inertia Forces
- αL Scale Factor for Length
- αV Scale Factor for Velocity
- $\alpha \rho$ Scale Factor for Density of Fluid
- $\mu_{viscosity}$ Dynamic Viscosity *(Poise)*
- v Kinematic Viscosity for Model Analysis *(Square Meter per Second)*
- ρ_{fluid} Density of Fluid *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Newton (N)
  Force Unit Conversion
- Measurement: **Dynamic Viscosity** in Poise (P)
  Dynamic Viscosity Unit Conversion
- Measurement: **Kinematic Viscosity** in Square Meter per Second (m^2/s)
  Kinematic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion

Check other formula lists

- **Froude Scaling and Scale Factor Formulas**
- **Relation between Forces on the Prototype and Forces on the Model Formulas**

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