Important Flushing or Circulation Processes and Vessel Interactions Formulas PDF

Formulas
Examples
with Units

List of 17
Important Flushing or Circulation Processes and Vessel Interactions Formulas

1) Average per Cycle Exchange Coefficient Formula

Evaluate Formula

Formula

$$E = 1 - \frac{\left(\frac{C_i}{C_o}\right)^1}{i}$$

Example

$$0.995 = 1 - \frac{\left(\frac{0.5}{50.0}\right)^1}{2}$$

2) Channel Depth given Vessel Blockage Ratio Formula

Evaluate Formula

Formula

$$D_{f'} = \frac{A_m}{S \cdot W}$$

Example with Units

$$11.9231\,\text{m} = \frac{31\,\text{m}^2}{0.05 \cdot 52\,\text{m}}$$

3) Channel Width given Vessel Blockage Ratio Formula

Evaluate Formula

Formula

$$W = \frac{A_m}{S \cdot D}$$

Example with Units

$$51.6667\,\text{m} = \frac{31\,\text{m}^2}{0.05 \cdot 12\,\text{m}}$$

4) Concentration of Substance after i Tidal Cycles Formula

Evaluate Formula

Formula

$$C_i = C_o \cdot \left(1 - E\right)^i$$

Example

$$0.5 = 50.0 \cdot \left(1 - 0.9\right)^2$$

5) Continuity and Energy Equations given Froude Number, Drawdown and Vessel Blockage Ratio Formula

Evaluate Formula

Formula

$$Fr = \sqrt{\frac{2 \cdot D_d \cdot \left(1 - D_d - S\right)^2}{1 - \left(1 - D_d - S\right)^2}}$$

Example

$$0.589 = \sqrt{\frac{2 \cdot 0.4 \cdot \left(1 - 0.4 - 0.05\right)^2}{1 - \left(1 - 0.4 - 0.05\right)^2}}$$

6) Direction of Wave Propagation for Froude Numbers up to Unity Formula

Evaluate Formula

Formula

$$\theta_{wp} = 35.27 \cdot \left(1 - e^{12 \cdot \left(F_n - 1\right)}\right)$$

Example

$$34.9797 = 35.27 \cdot \left(1 - e^{12 \cdot \left(0.6 - 1\right)}\right)$$

7) Drawdown with respect to Water Depth Formula

Evaluate Formula

Formula

$$D_d = \frac{\Delta d}{D}$$

Example with Units

$$0.4583 = \frac{5.5\,\text{m}}{12\,\text{m}}$$

8) Froude Number where Particle Motion in Vessel generated Waves does not Reach Bottom Formula

Evaluate Formula

Formula

$$Fr = \frac{V_s}{\sqrt{[g] \cdot D}}$$

Example with Units

$$9.2183 = \frac{100\,\text{m/s}}{\sqrt{9.8066\,\text{m/s}^2 \cdot 12\,\text{m}}}$$

9) Individual Wave Celerity created by Moving Vessel Formula

Evaluate Formula

Formula

$$C = V_s \cdot \cos\left(\theta\right)$$

Example with Units

$$28.3662\,\text{m/s} = 100\,\text{m/s} \cdot \cos\left(5.0\right)$$

10) Initial Concentration of Substance in Harbor Water Formula

Evaluate Formula

Formula

$$C_o = \frac{C_i}{\left(1 - E\right)^i}$$

Example

$$50 = \frac{0.5}{\left(1 - 0.9\right)^2}$$

11) Return Flow Velocity Formula

Evaluate Formula

Formula

$$V_r = V_s \cdot \left(\left(\frac{W \cdot D}{W \cdot \left(D - \Delta d\right) - A_m}\right) - 1\right)$$

Example with Units

$$103.2573\,\text{m/s} = 100\,\text{m/s} \cdot \left(\left(\frac{52\,\text{m} \cdot 12\,\text{m}}{52\,\text{m} \cdot \left(12\,\text{m} - 5.5\,\text{m}\right) - 31\,\text{m}^2}\right) - 1\right)$$

12) Vessel Blockage Ratio Formula

Evaluate Formula

Formula

$$S = \frac{A_m}{d_b \cdot W}$$

Example with Units

$$0.0108 = \frac{31\,\text{m}^2}{55\,\text{m} \cdot 52\,\text{m}}$$

13) Vessel Speed given Froude Number Formula

Evaluate Formula

Formula

$$V_s = Fr \cdot \sqrt{[g] \cdot D}$$

Example with Units

$$108.4803\,\text{m/s} = 10 \cdot \sqrt{9.8066\,\text{m/s}^2 \cdot 12\,\text{m}}$$

14) Vessel Speed given Individual Wave Celerity created by Moving Vessel Formula

Evaluate Formula

Formula

$$V_s = \frac{C}{\cos(\theta)}$$

Example with Units

$$102.2343\,\text{m/s} = \frac{29\,\text{m/s}}{\cos(5.0)}$$

15) Vessel Speed given Return Flow Velocity Formula

Evaluate Formula

Formula

$$V_s = \frac{V_r}{\left(\frac{W \cdot D}{W \cdot (D - \Delta d) - A_m}\right) - 1}$$

Example with Units

$$100.7192\,\text{m/s} = \frac{104\,\text{m/s}}{\left(\frac{52\,\text{m} \cdot 12\,\text{m}}{52\,\text{m} \cdot (12\,\text{m} - 5.5\,\text{m}) - 31\,\text{m}^2}\right) - 1}$$

16) Vessel's Midsection Wetted Cross-Sectional Area given Vessel Blockage Ratio Formula

Evaluate Formula

Formula

$$A_m = S \cdot W \cdot D$$

Example with Units

$$31.2\,\text{m}^2 = 0.05 \cdot 52\,\text{m} \cdot 12\,\text{m}$$

17) Water Depth given Froude Number Formula

Evaluate Formula

Formula

$$D = \frac{\left(\frac{V_s}{Fr}\right)^2}{[g]}$$

Example with Units

$$10.1972\,\text{m} = \frac{\left(\frac{100\,\text{m/s}}{10}\right)^2}{9.8066\,\text{m/s}^2}$$

Variables used in list of Flushing or Circulation Processes and Vessel Interactions Formulas above

- A_m Vessel's Midsection Wetted Cross-Sectional Area *(Square Meter)*
- **C** Individual Wave Celerity *(Meter per Second)*
- C_i Concentration of Substance after i Tidal Cycles
- C_o Initial Concentration
- **D** Water Depth *(Meter)*
- d_b Water Depth at Breaking *(Meter)*
- D_d Dimensionless Drawdown
- D_f Channel Depth for Flush Process *(Meter)*
- **E** Average per Cycle Exchange Coefficient
- F_n Froude Scaling
- **Fr** Froude Number
- **i** Tidal Cycles
- **S** Vessel Blockage Ratio
- V_r Return Flow Velocity *(Meter per Second)*
- V_s Vessel Speed *(Meter per Second)*
- **W** Channel Width corresponding to Mean Water Depth *(Meter)*
- **Δd** Water Surface Drawdown *(Meter)*
- **θ** Angle between Sailing Line
- θ_{wp} Direction of Wave Propagation

Constants, Functions, Measurements used in list of Flushing or Circulation Processes and Vessel Interactions Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- constant(s): **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **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: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion

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