



Density Currents in Harbors Formulas

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Examples!

Conversions!

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List of 27 Density Currents in Harbors Formulas

Density Currents in Harbors 🗗

1) Average Depth of Harbor for Water Volume Exchanged during Entire Tide Period

$$\mathbf{f}\mathbf{x} egin{aligned} \mathbf{h}' = rac{\left(rac{V_w}{G} \cdot \mathbf{A}_E
ight)^{rac{1}{2}}}{H^2} \end{aligned}$$

Open Calculator

ex
$$15.87659 \mathrm{m} = rac{\left(rac{50 \mathrm{m}^3/\mathrm{s}}{0.1} \cdot 61 \mathrm{m}^2
ight)^{rac{1}{2}}}{11}$$

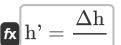
2) Average Harbor Depth

$$\mathbf{f}\mathbf{x}egin{bmatrix} \mathbf{h'} = rac{\Delta \mathbf{h} \cdot \mathbf{V}}{\mathrm{P}} \end{bmatrix}$$

$$4.2 ext{m} = rac{21 ext{m} \cdot 6.4 ext{m}^3}{32 ext{m}^3}$$



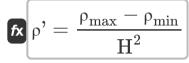
3) Average Harbor Depth given Portion caused by Filling



Open Calculator 🖸

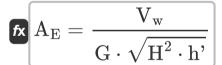
$$\boxed{\mathbf{ex} \ 6\mathbf{m} = \frac{21\mathbf{m}}{3.5}}$$

4) Average River Density over one Tide Period given Relative Density



Open Calculator

5) Cross-Sectional Area of Entrance given Water Volume exchanged during entire Tide Period



Open Calculator 🗗

ex
$$61.54575 \mathrm{m}^2 = rac{50 \mathrm{m}^3/\mathrm{s}}{0.1 \cdot \sqrt{11 \cdot 6 \mathrm{m}}}$$

6) Density Influence given Ratio of Water Volume entering Harbor per Tide

fx
$$lpha_{
m D}=lpha-lpha_{
m f}$$

$$oxed{ex} 6.5 = 10 - 3.5$$







7) Difference between High and Low Tide Levels given Portion caused by

Filling 🛂

fx
$$\Delta h = h' \cdot lpha_f$$

Open Calculator 🚰

$$21m = 6m \cdot 3.5$$

8) Difference between High and Low Tide Levels given Tidal Prism of Harbor Basin

$$\Delta h = \left(rac{P}{V}
ight) \cdot h'$$

Open Calculator 🗗

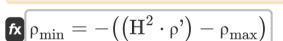
$$\mathbf{ex} \ 30\mathrm{m} = \left(\frac{32\mathrm{m}^3}{6.4\mathrm{m}^3}\right) \cdot 6\mathrm{m}$$

9) Maximum River Density given Relative Density $oldsymbol{oldsymbol{eta}}$ $ho_{
m max}=\left({
m H}^2\cdot
ho'
ight)+
ho_{
m min}$

Open Calculator

$$100 = (11 \cdot 8 \text{kg/m}^3) + 12$$

10) Minimum River Density given Relative Density



ex
$$12 = -((11 \cdot 8 \text{kg/m}^3) - 100)$$



11) Portion caused by Filling Evaluated by Comparing Tidal Prism of Harbor to Total Harbor Volume

 $lpha_{
m f} = rac{
m P}{
m V}$

Open Calculator

 $= \frac{32 ext{m}^3}{6.4 ext{m}^3}$

12) Portion caused by Filling given Average Harbor Depth

fx $lpha_{
m f}=rac{\Delta
m h}{
m h'}$

Open Calculator

 $\boxed{3.5 = \frac{21 \text{m}}{6 \text{m}}}$

13) Portion caused by Filling given Ratio of Water Volume Entering Harbor per Tide

fx $lpha_{
m f}=lpha-lpha_{
m D}$

Open Calculator 🚰

 $oxed{ex} 3.5 = 10 - 6.5$

14) Ratio of Water Volume entering Harbor per Tide to Harbor Volume

fx $lpha=lpha_{
m f}+lpha_{
m D}$

Open Calculator

 $ullet{ex}[10 = 3.5 + 6.5]$



15) Relative Density given River Density

 $\mathrm{H}^2 = rac{
ho_{\mathrm{max}} -
ho_{\mathrm{min}}}{
ho'}$

Open Calculator

ex $11 = \frac{100 - 12}{8 \text{kg/m}^3}$

16) Relative Density given Velocity in Dry Bed Curve

 $\mathbf{H}^2 = rac{\mathrm{V_{Dbc}^2}}{0.45 \cdot [\mathrm{g}] \cdot \mathrm{d}}$

ve 🗅

 $ext{ex} 5.098581 = rac{\left(4.5 ext{m/s}
ight)^2}{0.45 \cdot [ext{g}] \cdot 0.9 ext{m}}$

17) Tidal Prism of Harbor Basin 🛂

fx $P=lpha_{
m f}\cdot V$ ex $22.4{
m m}^{_3}=3.5\cdot 6.4{
m m}^{_3}$

Open Calculator 🗗

Open Calculator

18) Tidal Prism of Harbor Basin given Difference between High and Low Tide Levels

 $P = V \cdot \left(rac{\Delta h}{h'}
ight)$





19) Total Harbor Volume based upon Depth 🚰

 $V = rac{P}{lpha_{
m f}}$

Open Calculator 🗗

 $\boxed{9.142857 \text{m}^{_3} = \frac{32 \text{m}^{_3}}{3.5}}$

20) Total Harbor Volume based upon Depth given difference between High and Low Tide Levels

 $\text{fx} V = \frac{P}{\frac{\Delta h}{h'}}$

Open Calculator

 $= \frac{9.142857 \text{m}^3}{\frac{21 \text{m}}{6 \text{m}}}$

21) Total Water Volume Exchanged during entire Tide Period 🗹

fx $V_{
m w} = G \cdot A_{
m E} \cdot \sqrt{H^2 \cdot h'}$

Open Calculator 🗗

 $= 2 \times 10^{-3} = 1.0 \times 10^{-3$

22) Velocity in Dry Bed Curve

$$ag{V}_{
m Dbc} = 0.45 \cdot \sqrt{ ext{H}^2 \cdot [ext{g}] \cdot ext{d}}$$

Open Calculator

ex $4.433947 ext{m/s} = 0.45 \cdot \sqrt{11 \cdot [ext{g}] \cdot 0.9 ext{m}}$





Open Calculator

Open Calculator 2

Open Calculator

23) Water Depth given Velocity in Dry Bed Curve 🗹

 $\mathbf{f} \mathbf{x} = rac{\left(rac{\mathrm{V}_{\mathrm{Dbc}}}{0.45}
ight)^2}{\mathrm{H}^2 \cdot [\mathbf{g}]}$

 $\boxed{\textbf{ex}} \ 0.927015 \text{m} = \frac{\left(\frac{4.5 \text{m/s}}{0.45}\right)^2}{11 \cdot [\text{g}]}$

Density Influence

24) Density Influence

 $lpha_{
m D} = ({
m V_D} - {
m V_f}) \cdot rac{{
m T_D}}{2 \cdot {
m L}}$

 $\mathbf{ex} = (25 \mathrm{m/s} - 7 \mathrm{m/s}) \cdot rac{130 \mathrm{s}}{2 \cdot 180 \mathrm{m}}$

25) Filling Current Velocity given Density Influence

 $\overline{\mathrm{V}_{\mathrm{f}}} = - \left(\left(2 \cdot \mathrm{L} \cdot rac{lpha_{\mathrm{D}}}{\mathrm{T}_{\mathrm{D}}}
ight) - \mathrm{V}_{\mathrm{D}}
ight)$

 $extbf{ex} \left[7 ext{m/s} = - \left(\left(2 \cdot 180 ext{m} \cdot rac{6.5}{130 ext{s}}
ight) - 25 ext{m/s}
ight)
ight]$



26) Length of Harbor given Density Influence

 $\mathbf{L} = (\mathrm{V_D} - \mathrm{V_f}) \cdot rac{\mathrm{T_D}}{2 \cdot \mathrm{lpha_D}} igg|$

Open Calculator

$$ext{ex} 180 ext{m} = (25 ext{m/s} - 7 ext{m/s}) \cdot rac{130 ext{s}}{2 \cdot 6.5}$$

27) Time Interval over which Density Difference exists given Density Influence

 $\left| \mathbf{T}_{\mathrm{D}} = rac{2 \cdot \mathrm{L} \cdot \mathbf{lpha}_{\mathrm{D}}}{\mathrm{V}_{\mathrm{D}} - \mathrm{V}_{\mathrm{f}}}
ight|$

$$\boxed{130\mathrm{s} = \frac{2\cdot180\mathrm{m}\cdot6.5}{25\mathrm{m/s}-7\mathrm{m/s}}}$$



Variables Used

- A_E Cross Sectional Area of Entrance (Square Meter)
- **d** Water Depth (Meter)
- G Coefficient for Harbors
- h' Average Harbor Depth (Meter)
- H² Broad Sense Heritability
- L Length of Harbor (Meter)
- P Tidal Prism Filling Bay (Cubic Meter)
- T_D Time Interval (Second)
- **V** Total Harbor Volume (Cubic Meter)
- **V**_D Density Current Velocity (Meter per Second)
- V_{Dbc} Velocity in Dry Bed Curve (Meter per Second)
- V_f Filling Current Velocity (Meter per Second)
- V_w Total Water Volume (Cubic Meter per Second)
- α Ratio of Water Volume
- α_D Density Influence
- α_f Portion caused by Filling
- Ah Difference between High and Low Tide level (Meter)
- ρ' Average River Density (Kilogram per Cubic Meter)
- ρ_{max} Maximum River Density
- ρ_{min} Minimum River Density





Constants, Functions, Measurements used

- Constant: [g], 9.80665 Meter/Second²

 Gravitational acceleration on Farth
- Function: sqrt, sqrt(Number) Square root function
- Measurement: Length in Meter (m)
 Length Unit Conversion
- Measurement: Time in Second (s)
 Time Unit Conversion
- Measurement: Volume in Cubic Meter (m³)
 Volume Unit Conversion
- Measurement: Area in Square Meter (m²)

 Area Unit Conversion
- Measurement: Speed in Meter per Second (m/s)
 Speed Unit Conversion
- Measurement: Volumetric Flow Rate in Cubic Meter per Second (m³/s)
 Volumetric Flow Rate Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
 Density Unit Conversion





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- Calculation of Forces on Ocean Structures Formulas
- **Density Currents in Harbors** Formulas [7]
- **Density Currents in Rivers** Formulas [7]

- Estimating Marine and Coastal Winds Formulas
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