



# Design of a Solid Bowl Centrifuge for Sludge Dewatering Formulas

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# List of 33 Design of a Solid Bowl Centrifuge for Sludge Dewatering Formulas

# Design of a Solid Bowl Centrifuge for Sludge Dewatering ☑

# Centrifugal Acceleration Force

1) Bowl Radius given Centrifugal Acceleration Force

$$m R_b = rac{32.2 \cdot G}{\left(2 \cdot \pi \cdot N
ight)^2}$$

Open Calculator 🗗

ex 
$$3 ext{ft} = rac{32.2 \cdot 2000.779 ext{lb*ft/s}^2}{(2 \cdot \pi \cdot 2.5 ext{rev/s})^2}$$

#### 2) Centrifugal Acceleration Force in Centrifuge

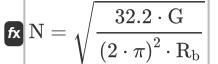
$$\mathbf{G} = rac{\mathrm{R_b} \cdot \left(2 \cdot \pi \cdot \mathrm{N}
ight)^2}{32.2}$$

Open Calculator 🗗

$$ext{ex} 2000.779 ext{lb*ft/s}^2 = rac{3 ext{ft} \cdot (2 \cdot \pi \cdot 2.5 ext{rev/s})^2}{32.2}$$



### 3) Rotational Speed of Centrifuge using Centrifugal Acceleration Force 🖒

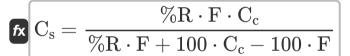


Open Calculator 🗗

$$\mathbf{ex}$$
  $2.5 \mathrm{rev/s} = \sqrt{rac{32.2 \cdot 2000.779 \mathrm{lb*ft/s^2}}{\left(2 \cdot \pi
ight)^2 \cdot 3 \mathrm{ft}}}$ 

#### **Percent Solids**

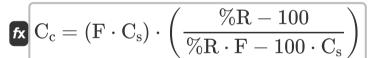
#### 4) Percent Cake Solids given Percent Solids Recovery



Open Calculator 🗗

$$extbf{ex} 25.03684 = rac{95.14 \cdot 5 \cdot 0.3}{95.14 \cdot 5 + 100 \cdot 0.3 - 100 \cdot 5}$$

#### 5) Percent Centrate Solids given Percent Solids Recovery



$$\begin{array}{c} \textbf{ex} \ 0.300104 = (5 \cdot 25) \cdot \left( \frac{95.14 - 100}{95.14 \cdot 5 - 100 \cdot 25} \right) \end{array}$$



#### 6) Percent Feed Solids given Percent Solids Recovery

-  $100 \cdot C_a \cdot C_a$ 

Open Calculator

 $F = \frac{100 \cdot C_s \cdot C_c}{\% R \cdot C_c + 100 \cdot C_s - \% R \cdot C_s}$ 

#### 7) Percent Solids Recovery to Determine Solids Capture

 $m \%R = 100 \cdot \left(rac{C_s}{F}
ight) \cdot \left(rac{F-C_c}{C_s-C_c}
ight)$ 

Open Calculator

 $95.1417 = 100 \cdot \left(\frac{25}{5}\right) \cdot \left(\frac{5-0.3}{25-0.3}\right)$ 

### Polymer Feed Rate

#### 8) Dry Sludge Feed given Polymer Feed Rate of Dry Polymer

fx  $S = \frac{2000 \cdot P}{D_p}$ 

Open Calculator 🗗

 $ext{ex} \left[ 76.5 ext{lb/h} = rac{2000 \cdot 0.765 ext{lb/h}}{20} 
ight]$ 





# 9) Percent Polymer Concentration given Polymer Feed Rate as Volumetric Flow Rate

 $m P = \left(rac{P}{8.34\cdot P_v\cdot G_p}
ight)$ 

Open Calculator

 $oxed{ex} 0.650195 = \left(rac{0.765 ext{lb/h}}{8.34 \cdot 7.82 ext{gal (UK)/hr} \cdot 1.8}
ight)$ 

# 10) Polymer Dosage when Polymer Feed Rate of Dry Polymer

 $\mathbf{E} \mathbf{D}_{\mathrm{p}} = rac{2000 \cdot \mathrm{P}}{\mathrm{S}}$ 

Open Calculator

 $\mathbf{ex} = \frac{2000 \cdot 0.765 \mathrm{lb/h}}{76.5 \mathrm{lb/h}}$ 

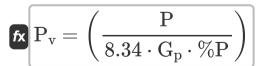
# 11) Polymer Feed Rate as Mass Flow Rate given Polymer Feed Rate as Volumetric Flow Rate

fx  $P = (P_v \cdot 8.34 \cdot G_p \cdot \%P)$ 

Open Calculator 🗗

 $\mathbf{ex} = 0.76477 \text{lb/h} = (7.82 \text{gal (UK)/hr} \cdot 8.34 \cdot 1.8 \cdot 0.65)$ 

# 12) Polymer Feed Rate as Volumetric Flow Rate



Open Calculator 🖸

 $ext{ex} \left[ 7.82235 ext{gal (UK)/hr} = \left( rac{0.765 ext{lb/h}}{8.34 \cdot 1.8 \cdot 0.65} 
ight) 
ight]$ 







### 13) Polymer Feed Rate of Dry Polymer

 $P = \frac{D_p \cdot S}{2000}$ 

Open Calculator 🗗

2000

 $ext{ex} \ 0.765 ext{lb/h} = rac{20 \cdot 76.5 ext{lb/h}}{2000}$ 

### 14) Specific Gravity of Polymer given Polymer Feed Rate as Volumetric

Flow Rate

 $\mathbf{G}_{\mathrm{p}} = \left(rac{\mathrm{P}}{8.34\cdot\mathrm{P_{v}}\cdot\%\mathrm{P}}
ight)$ 

Open Calculator 🖸

ex  $1.800541 = \left( \frac{0.765 \mathrm{lb/h}}{8.34 \cdot 7.82 \mathrm{gal} \ (\mathrm{UK}) / \mathrm{hr} \cdot 0.65} \right)$ 

# Sludge Volume and Feed Rate

15) Dewatered Sludge or Cake Discharge Rate

fx  $m [C_d = (S_f \cdot R)]$ 

Open Calculator 🚰

 $\texttt{ex} \ 27 \text{lb/h} = (45 \text{lb/h} \cdot 0.6)$ 

16) Digested Sludge using Sludge Feed Rate for Dewatering Facility

fx  $D_s = (S_v \cdot T)$ 

Open Calculator

 $24 {
m m}^3/{
m s} = (2.4 {
m m}^3/{
m s} \cdot 10 {
m s})^{-1}$ 





# 17) Operation Time given Sludge Feed Rate for Dewatering Facility

 $\left| \mathbf{T} = \left( rac{\mathrm{D_s}}{\mathrm{S_v}} 
ight) 
ight|$ 

Open Calculator

 $\boxed{10\mathrm{s} = \left(\frac{24\mathrm{m}^3/\mathrm{s}}{2.4\mathrm{m}^3/\mathrm{s}}\right)}$ 

#### 18) Percent Reduction in Sludge Volume

 $m / V = rac{V_i - V_o}{V_i}$ 

Open Calculator

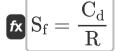
# 19) Sludge Feed Rate for Dewatering Facility

 $\mathbf{f}_{\mathbf{x}} \mathbf{S}_{\mathrm{v}} = \left( rac{\mathrm{D}_{\mathrm{s}}}{\mathrm{T}} 
ight)$ 

Open Calculator 🚰

 $\left[ 2.4\mathrm{m}^3/\mathrm{s} = \left( rac{24\mathrm{m}^3/\mathrm{s}}{10\mathrm{s}} 
ight) 
ight]$ 

# 20) Sludge Feed Rate using Dewatered Sludge Discharge Rate



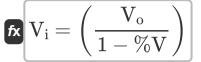
Open Calculator







#### 21) Sludge Volume-in given Percent Reduction in Sludge Volume 🗗



Open Calculator

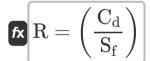
# 22) Sludge Volume-out given Percent Reduction in Sludge Volume 🗗

fx  $V_{\rm o} = V_{\rm i} \cdot (1 - \%V)$ 

Open Calculator

 $22.008 \mathrm{m}^{_3} = 28 \mathrm{m}^{_3} \cdot (1 - 0.214)$ 

# 23) Solids Recovery given Dewatered Sludge Discharge Rate 🛂



Open Calculator

# $\mathbf{ex} \ 0.6 = \left( \frac{27 \text{lb/h}}{45 \text{lb/h}} \right)$

# 24) Percent Solids given Weight Flow Rate of Sludge Feed 🛂

$$m fx = rac{7.48 \cdot W_s}{V \cdot 
ho_{water} \cdot G_s \cdot 60}$$

Open Calculator 2

$$= \frac{7.48 \cdot 3153.36 \text{lb/h}}{7 \text{gal (US)/min} \cdot 62.4 \text{lb/ft}^3 \cdot 2 \cdot 60}$$

Weight Flow Rate of Sludge Feed





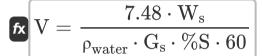


#### 25) Specific Gravity of Sludge using Weight Flow Rate

fx  $G_{
m s} = rac{7.48 \cdot W_{
m s}}{ V \cdot 
ho_{
m water} \cdot \% S \cdot 60}$ 

Open Calculator

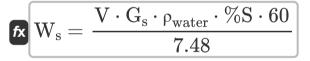
### 26) Volume Flow Rate of Sludge Feed using Weight Flow Rate



Open Calculator

ex 6.99998gal (US)/min =  $\frac{7.48 \cdot 3153.36$ lb/h 62.4lb/ft<sup>3</sup> · 2 · 0.45 · 60

#### 27) Weight Flow Rate of Sludge Feed



Open Calculator 🗗

 $ext{ex} | 3153.369 ext{lb/h} = rac{7 ext{gal (US)/min} \cdot 2 \cdot 62.4 ext{lb/ft}^3 \cdot 0.45 \cdot 60}{7.48} |$ 



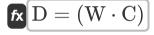
#### Wet Cake

# 28) Cake Density using Volume of Wet Cake 🗗

fx 
$$ho_{
m c} = \left(rac{
m W_r}{
m V_w}
ight)$$

Open Calculator

# 29) Dry Cake Rate using Wet Cake Discharge Rate



 $(29.9971b/h = (54.54lb/h \cdot 0.55)$ 

# $\left| \mathbf{C} \right| = \left( \frac{\mathrm{D}}{\mathrm{W}} \right)$

30) Percent Cake Solids using Wet Cake Discharge Rate

 $\left| 0.550055 = \left( rac{30 ext{lb/h}}{54.54 ext{lb/h}} 
ight) 
ight|$ 

# 31) Volume of Wet Cake

$$extbf{K} V_{
m w} = \left(rac{W_{
m r}}{
ho_c}
ight)$$

Open Calculator 2

Open Calculator 2

Open Calculator

ex  $15 ext{ft}^3/ ext{hr} = \left(rac{60 ext{lb}/ ext{h}}{4 ext{lb}/ ext{ft}^3}
ight)$ 



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#### 32) Wet Cake Discharge Rate

 $W = \left(\frac{D}{C}\right)$ 

Open Calculator 🗗

$$= 54.54545 lb/h = \left(\frac{30 lb/h}{0.55}\right)$$

#### 33) Wet Cake Rate using Volume of Wet Cake

fx  $W_{r} = (V_{w} \cdot \rho_{c})$ 

Open Calculator 🖸

$$extstyle extstyle ext$$



#### Variables Used

- %P Percent Polymer Concentration
- %R Percent Solids Recovery
- %S Percent Solids
- %V Volume Reduction
- C Cake Solids in Decimal
- C<sub>c</sub> Centrate Solids in Percent
- C<sub>d</sub> Cake Discharge Rate (Pound per Hour)
- Cs Cake Solids in Percent
- **D** Dry Cake Rate (Pound per Hour)
- D<sub>p</sub> Polymer Dosage
- D<sub>S</sub> Digested Sludge (Cubic Meter per Second)
- F Feed Solids in Percent
- G Centrifugal Acceleration Force (Pound Foot per Square Second)
- G<sub>p</sub> Specific Gravity of Polymer
- G<sub>s</sub> Specific Gravity of Sludge
- N Rotational Speed of Centrifuge (Revolution per Second)
- P Polymer Feed Rate (Pound per Hour)
- P<sub>v</sub> Volumetric Polymer Feed Rate (Gallon (UK) per Hour)
- R Solid Recovery in Decimal
- R<sub>b</sub> Bowl Radius (Foot)
- S Dry Sludge Feed (Pound per Hour)
- S<sub>f</sub> Sludge Feed Rate (Pound per Hour)





- S<sub>v</sub> Volumetric Sludge Feed Rate (Cubic Meter per Second)
- T Operation Time (Second)
- **V** Volume Flow Rate of Sludge Feed (Gallon (US) per Min)
- **V**<sub>i</sub> Sludge Volume in (Cubic Meter)
- Vo Sludge Volume Out (Cubic Meter)
- V<sub>w</sub> Volume of Wet Cake (Cubic Foot per Hour)
- W Wet Cake Discharge (Pound per Hour)
- W<sub>r</sub> Wet Cake Rate (Pound per Hour)
- W<sub>s</sub> Weight Flow Rate of Sludge Feed (Pound per Hour)
- ρ<sub>c</sub> Cake Density (Pound per Cubic Foot)
- Pwater Water Density (Pound per Cubic Foot)





### Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288
   Archimedes' constant
- 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 Foot (ft)
   Length Unit Conversion
- Measurement: Time in Second (s)

  Time Unit Conversion
- Measurement: Volume in Cubic Meter (m³)
   Volume Unit Conversion
- Measurement: Force in Pound Foot per Square Second (lb\*ft/s²)
   Force Unit Conversion
- Measurement: Volumetric Flow Rate in Gallon (UK) per Hour (gal (UK)/hr), Cubic Meter per Second (m³/s), Gallon (US) per Min (gal (US)/min), Cubic Foot per Hour (ft³/hr)
   Volumetric Flow Rate Unit Conversion
- Measurement: Mass Flow Rate in Pound per Hour (lb/h)
   Mass Flow Rate Unit Conversion
- Measurement: Angular Velocity in Revolution per Second (rev/s)
   Angular Velocity Unit Conversion
- Measurement: Density in Pound per Cubic Foot (lb/ft³)
   Density Unit Conversion





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- Design of a Circular Settling Tank Population Forecast Method Formulas
- for Sludge Dewatering

- Estimating the Design Sewage Discharge Formulas
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