Important Design of a Solid Bowl Centrifuge for Sludge Dewatering Formulas PDF

Formulas
Examples
with Units

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

1) Centrifugal Acceleration Force Formulas

1.1) Bowl Radius given Centrifugal Acceleration Force Formula

Evaluate Formula

Formula

$$R_b = \frac{32.2 \cdot G}{\left(2 \cdot \pi \cdot N\right)^2}$$

Example with Units

$$3\,\text{ft} = \frac{32.2 \cdot 2000.779\,\text{lb*ft/s}^2}{\left(2 \cdot 3.1416 \cdot 2.5\,\text{rev/s}\right)^2}$$

1.2) Centrifugal Acceleration Force in Centrifuge Formula

Evaluate Formula

Formula

$$G = \frac{R_b \cdot \left(2 \cdot \pi \cdot N\right)^2}{32.2}$$

Example with Units

$$2000.7791\,\text{lb*ft/s}^2 = \frac{3\,\text{ft} \cdot \left(2 \cdot 3.1416 \cdot 2.5\,\text{rev/s}\right)^2}{32.2}$$

1.3) Rotational Speed of Centrifuge using Centrifugal Acceleration Force Formula

Evaluate Formula

Formula

$$N = \sqrt{\frac{32.2 \cdot G}{\left(2 \cdot \pi\right)^2 \cdot R_b}}$$

Example with Units

$$2.5\,\text{rev/s} = \sqrt{\frac{32.2 \cdot 2000.779\,\text{lb*ft/s}^2}{\left(2 \cdot 3.1416\right)^2 \cdot 3\,\text{ft}}}$$

2) Percent Solids Formulas

2.1) Percent Cake Solids given Percent Solids Recovery Formula

Evaluate Formula

Formula

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

Example

$$25.0368 = \frac{95.14 \cdot 5 \cdot 0.3}{95.14 \cdot 5 + 100 \cdot 0.3 - 100 \cdot 5}$$

2.2) Percent Centrate Solids given Percent Solids Recovery Formula

Evaluate Formula

Formula

$$C_c = \left(F \cdot C_s\right) \cdot \left(\frac{\%R - 100}{\%R \cdot F - 100 \cdot C_s}\right)$$

Example

$$0.3001 = \left(5 \cdot 25\right) \cdot \left(\frac{95.14 - 100}{95.14 \cdot 5 - 100 \cdot 25}\right)$$

2.3) Percent Feed Solids given Percent Solids Recovery Formula

Evaluate Formula

Formula

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

Example

$$4.9986 = \frac{100 \cdot 25 \cdot 0.3}{95.14 \cdot 0.3 + 100 \cdot 25 - 95.14 \cdot 25}$$

2.4) Percent Solids Recovery to Determine Solids Capture Formula

Evaluate Formula

Formula

$$\%R = 100 \cdot \left(\frac{C_s}{F}\right) \cdot \left(\frac{F - C_c}{C_s - C_c}\right)$$

Example

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

3) Polymer Feed Rate Formulas

3.1) Dry Sludge Feed given Polymer Feed Rate of Dry Polymer Formula

Evaluate Formula

Formula

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

Example with Units

$$76.5\,\text{lb/h} = \frac{2000 \cdot 0.765\,\text{lb/h}}{20}$$

3.2) Percent Polymer Concentration given Polymer Feed Rate as Volumetric Flow Rate Formula

Evaluate Formula

Formula

$$\%P = \left(\frac{P}{8.34 \cdot P_v \cdot G_p}\right)$$

Example with Units

$$0.6502 = \left(\frac{0.765\,\text{lb/h}}{8.34 \cdot 7.82\,\text{gal (UK)/hr} \cdot 1.8}\right)$$

3.3) Polymer Dosage when Polymer Feed Rate of Dry Polymer Formula

Evaluate Formula

Formula

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

Example with Units

$$20 = \frac{2000 \cdot 0.765\,\text{lb/h}}{76.5\,\text{lb/h}}$$

3.4) Polymer Feed Rate as Mass Flow Rate given Polymer Feed Rate as Volumetric Flow Rate Formula

Evaluate Formula

Formula

$$P = \left(P_v \cdot 8.34 \cdot G_p \cdot \%P\right)$$

Example with Units

$$0.7648\,\text{lb/h} = \left(7.82\,\text{gal (UK)/hr} \cdot 8.34 \cdot 1.8 \cdot 0.65\right)$$

3.5) Polymer Feed Rate as Volumetric Flow Rate Formula

Evaluate Formula

Formula

$$P_v = \left(\frac{P}{8.34 \cdot G_p \cdot \%P}\right)$$

Example with Units

$$7.8223\,\text{gal (UK)/hr} = \left(\frac{0.765\,\text{lb/h}}{8.34 \cdot 1.8 \cdot 0.65}\right)$$

3.6) Polymer Feed Rate of Dry Polymer Formula

Evaluate Formula

Formula

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

Example with Units

$$0.765\,\text{lb/h} = \frac{20 \cdot 76.5\,\text{lb/h}}{2000}$$

3.7) Specific Gravity of Polymer given Polymer Feed Rate as Volumetric Flow Rate Formula

Evaluate Formula

Formula

$$G_p = \left(\frac{P}{8.34 \cdot P_v \cdot \%P} \right)$$

Example with Units

$$1.8005 = \left(\frac{0.765\,\text{lb/h}}{8.34 \cdot 7.82\,\text{gal (UK)/hr} \cdot 0.65} \right)$$

4) Sludge Volume and Feed Rate Formulas

4.1) Dewatered Sludge or Cake Discharge Rate Formula

Evaluate Formula

Formula

$$C_d = \left(S_f \cdot R \right)$$

Example with Units

$$27\,\text{lb/h} = \left(45\,\text{lb/h} \cdot 0.6 \right)$$

4.2) Digested Sludge using Sludge Feed Rate for Dewatering Facility Formula

Evaluate Formula

Formula

$$D_s = \left(S_v \cdot T \right)$$

Example with Units

$$24\,\text{m}^3\text{/s} = \left(2.4\,\text{m}^3\text{/s} \cdot 10\,\text{s} \right)$$

4.3) Operation Time given Sludge Feed Rate for Dewatering Facility Formula

Evaluate Formula

Formula

$$T = \left(\frac{D_s}{S_v} \right)$$

Example with Units

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

4.4) Percent Reduction in Sludge Volume Formula

Evaluate Formula

Formula

$$\%V = \frac{V_i - V_o}{V_i}$$

Example with Units

$$0.2143 = \frac{28\,\text{m}^3 - 22\,\text{m}^3}{28\,\text{m}^3}$$

4.5) Sludge Feed Rate for Dewatering Facility Formula

Evaluate Formula

Formula

$$S_v = \left(\frac{D_s}{T} \right)$$

Example with Units

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

4.6) Sludge Feed Rate using Dewatered Sludge Discharge Rate Formula

Evaluate Formula

Formula

$$S_f = \frac{C_d}{R}$$

Example with Units

$$45\,\text{lb/h} = \frac{27\,\text{lb/h}}{0.6}$$

4.7) Sludge Volume-in given Percent Reduction in Sludge Volume Formula

Evaluate Formula

Formula

$$V_i = \left(\frac{V_o}{1 - \%V}\right)$$

Example with Units

$$27.9898\,\text{m}^3 = \left(\frac{22\,\text{m}^3}{1 - 0.214}\right)$$

4.8) Sludge Volume-out given Percent Reduction in Sludge Volume Formula

Evaluate Formula

Formula

$$V_o = V_i \cdot (1 - \%V)$$

Example with Units

$$22.008\,\text{m}^3 = 28\,\text{m}^3 \cdot (1 - 0.214)$$

4.9) Solids Recovery given Dewatered Sludge Discharge Rate Formula

Evaluate Formula

Formula

$$R = \left(\frac{C_d}{S_f}\right)$$

Example with Units

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

5) Weight Flow Rate of Sludge Feed Formulas

5.1) Percent Solids given Weight Flow Rate of Sludge Feed Formula

Evaluate Formula

Formula

$$\%S = \frac{7.48 \cdot W_s}{V \cdot \rho_{water} \cdot G_s \cdot 60}$$

Example with Units

$$0.45 = \frac{7.48 \cdot 3153.36\,\text{lb/h}}{7\,\text{gal (US)/min} \cdot 62.4\,\text{lb/ft}^3 \cdot 2 \cdot 60}$$

5.2) Specific Gravity of Sludge using Weight Flow Rate Formula

Evaluate Formula

Formula

$$G_s = \frac{7.48 \cdot W_s}{V \cdot \rho_{water} \cdot \%S \cdot 60}$$

Example with Units

$$2 = \frac{7.48 \cdot 3153.36\,\text{lb/h}}{7\,\text{gal (US)/min} \cdot 62.4\,\text{lb/ft}^3 \cdot 0.45 \cdot 60}$$

5.3) Volume Flow Rate of Sludge Feed using Weight Flow Rate Formula

Evaluate Formula

Formula

$$V = \frac{7.48 \cdot W_s}{\rho_{water} \cdot G_s \cdot \%S \cdot 60}$$

Example with Units

$$7\,\text{gal (US)/min} = \frac{7.48 \cdot 3153.36\,\text{lb/h}}{62.4\,\text{lb/ft}^3 \cdot 2 \cdot 0.45 \cdot 60}$$

5.4) Weight Flow Rate of Sludge Feed Formula

Evaluate Formula

Formula

$$W_s = \frac{V \cdot G_s \cdot \rho_{water} \cdot \%S \cdot 60}{7.48}$$

Example with Units

$$3153.369\,\text{lb/h} = \frac{7\,\text{gal (US)/min} \cdot 2 \cdot 62.4\,\text{lb/ft}^3 \cdot 0.45 \cdot 60}{7.48}$$

6) Wet Cake Formulas

6.1) Cake Density using Volume of Wet Cake Formula

Evaluate Formula

Formula

$$\rho_c = \left(\frac{W_r}{V_w}\right)$$

Example with Units

$$4\,\text{lb/ft}^3 = \left(\frac{60\,\text{lb/h}}{15\,\text{ft}^3\text{/hr}}\right)$$

6.2) Dry Cake Rate using Wet Cake Discharge Rate Formula

Evaluate Formula

Formula

$$D = (W \cdot C)$$

Example with Units

$$29.997\,\text{lb/h} = (54.54\,\text{lb/h} \cdot 0.55)$$

6.3) Percent Cake Solids using Wet Cake Discharge Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5501 = \left(\frac{30\,\text{lb/h}}{54.54\,\text{lb/h}}\right)$$

6.4) Volume of Wet Cake Formula

Evaluate Formula

Formula

$$V_w = \left(\frac{W_r}{\rho_c}\right)$$

Example with Units

$$15\,\text{ft}^3\text{/hr} = \left(\frac{60\,\text{lb/h}}{4\,\text{lb/ft}^3}\right)$$

6.5) Wet Cake Discharge Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$54.5455\,\text{lb/h} = \left(\frac{30\,\text{lb/h}}{0.55}\right)$$

6.6) Wet Cake Rate using Volume of Wet Cake Formula

Evaluate Formula

Formula

$$W_r = (V_w \cdot \rho_c)$$

Example with Units

$$60\,\text{lb/h} = (15\,\text{ft}^3\text{/hr} \cdot 4\,\text{lb/ft}^3)$$

Variables used in list of Design of a Solid Bowl Centrifuge for Sludge Dewatering Formulas above

- **%P** Percent Polymer Concentration
- **%R** Percent Solids Recovery
- **%S** Percent Solids
- **%V** Volume Reduction
- **C** Cake Solids in Decimal
- C_c Centrate Solids in Percent
- C_d Cake Discharge Rate *(Pound per Hour)*
- C_s Cake Solids in Percent
- **D** Dry Cake Rate *(Pound per Hour)*
- D_p Polymer Dosage
- D_s Digested Sludge *(Cubic Meter per Second)*
- **F** Feed Solids in Percent
- **G** Centrifugal Acceleration Force *(Pound Foot per Square Second)*
- G_p Specific Gravity of Polymer
- G_s Specific Gravity of Sludge
- **N** Rotational Speed of Centrifuge *(Revolution per Second)*
- **P** Polymer Feed Rate *(Pound per Hour)*
- P_v Volumetric Polymer Feed Rate *(Gallon (UK) per Hour)*
- **R** Solid Recovery in Decimal
- R_b Bowl Radius *(Foot)*
- **S** Dry Sludge Feed *(Pound per Hour)*
- S_f Sludge Feed Rate *(Pound per Hour)*
- S_v Volumetric Sludge Feed Rate *(Cubic Meter per Second)*
- **T** Operation Time *(Second)*
- **V** Volume Flow Rate of Sludge Feed *(Gallon (US) per Min)*
- V_i Sludge Volume in *(Cubic Meter)*
- V_o Sludge Volume Out *(Cubic Meter)*
- V_w Volume of Wet Cake *(Cubic Foot per Hour)*

Constants, Functions, Measurements used in list of Design of a Solid Bowl Centrifuge for Sludge Dewatering Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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 Foot (ft) *Length Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Volume** in Cubic Meter (m^3) *Volume Unit Conversion*
- Measurement: **Force** in Pound Foot per Square Second ($lb*ft/s^2$) *Force Unit Conversion*
- Measurement: **Volumetric Flow Rate** in Gallon (UK) per Hour (gal (UK)/hr), Cubic Meter per Second (m^3/s), Gallon (US) per Min (gal (US)/min), Cubic Foot per Hour (ft^3/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/ft^3) *Density Unit Conversion*

- W Wet Cake Discharge *(Pound per Hour)*
- W_r Wet Cake Rate *(Pound per Hour)*
- W_s Weight Flow Rate of Sludge Feed *(Pound per Hour)*
- ρ_c Cake Density *(Pound per Cubic Foot)*
- ρ_{water} Water Density *(Pound per Cubic Foot)*

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