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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

Open Calculator

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

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

2) Centrifugal Acceleration Force in Centrifuge

Open Calculator

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

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

3) Rotational Speed of Centrifuge using Centrifugal Acceleration Force

Open Calculator

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

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

Percent Solids

4) Percent Cake Solids given Percent Solids Recovery

Open Calculator

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

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

5) Percent Centrate Solids given Percent Solids Recovery

Open Calculator

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

ex $$0.300104 = (5 \cdot 25) \cdot \left(\frac{95.14 - 100}{95.14 \cdot 5 - 100 \cdot 25}\right)$$

6) Percent Feed Solids given Percent Solids Recovery

Open Calculator

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

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

7) Percent Solids Recovery to Determine Solids Capture

Open Calculator

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

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

Polymer Feed Rate

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

Open Calculator

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

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

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

Open Calculator

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

$$0.650195 = \left(\frac{0.765\text{lb/h}}{8.34 \cdot 7.82\text{gal (UK)/hr} \cdot 1.8}\right)$$

10) Polymer Dosage when Polymer Feed Rate of Dry Polymer

Open Calculator

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

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

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

Open Calculator

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

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

12) Polymer Feed Rate as Volumetric Flow Rate

Open Calculator

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

$$7.82235\text{gal (UK)/hr} = \left(\frac{0.765\text{lb/h}}{8.34 \cdot 1.8 \cdot 0.65}\right)$$

13) Polymer Feed Rate of Dry Polymer

Open Calculator

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

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

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

Open Calculator

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

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

Sludge Volume and Feed Rate

15) Dewatered Sludge or Cake Discharge Rate

Open Calculator

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

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

16) Digested Sludge using Sludge Feed Rate for Dewatering Facility

Open Calculator

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

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

17) Operation Time given Sludge Feed Rate for Dewatering Facility

Open Calculator

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

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

18) Percent Reduction in Sludge Volume

Open Calculator

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

ex $$0.214286 = \frac{28m^3 - 22m^3}{28m^3}$$

19) Sludge Feed Rate for Dewatering Facility

Open Calculator

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

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

20) Sludge Feed Rate using Dewatered Sludge Discharge Rate

Open Calculator

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

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

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

Open Calculator

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

ex $$27.98982\text{m}^3 = \left(\frac{22\text{m}^3}{1 - 0.214} \right)$$

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

Open Calculator

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

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

23) Solids Recovery given Dewatered Sludge Discharge Rate

Open Calculator

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

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

Weight Flow Rate of Sludge Feed

24) Percent Solids given Weight Flow Rate of Sludge Feed

Open Calculator

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

ex $$0.449999 = \frac{7.48 \cdot 3153.36\text{lb/h}}{7\text{gal (US)/min} \cdot 62.4\text{lb/ft}^3 \cdot 2 \cdot 60}$$

25) Specific Gravity of Sludge using Weight Flow Rate

Open Calculator

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

$$1.999994 = \frac{7.48 \cdot 3153.36\text{lb/h}}{7\text{gal (US)/min} \cdot 62.4\text{lb/ft}^3 \cdot 0.45 \cdot 60}$$

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

Open Calculator

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

$$6.99998\text{gal (US)/min} = \frac{7.48 \cdot 3153.36\text{lb/h}}{62.4\text{lb/ft}^3 \cdot 2 \cdot 0.45 \cdot 60}$$

27) Weight Flow Rate of Sludge Feed

Open Calculator

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

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

Wet Cake

28) Cake Density using Volume of Wet Cake

Open Calculator

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

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

29) Dry Cake Rate using Wet Cake Discharge Rate

Open Calculator

fx $D = (W \cdot C)$

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

30) Percent Cake Solids using Wet Cake Discharge Rate

Open Calculator

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

ex $0.550055 = \left(\frac{30\text{lb/h}}{54.54\text{lb/h}}\right)$

31) Volume of Wet Cake

Open Calculator

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

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

32) Wet Cake Discharge Rate

Open Calculator

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

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

33) Wet Cake Rate using Volume of Wet Cake

Open Calculator

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

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

Variables Used

- **%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)*
- **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)*

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 (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

Check other formula lists

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- Design of a Circular Settling Tank Formulas
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