Important Formulas in Size Reduction Laws PDF

Formulas
Examples
with Units

List of 19
Important Formulas in Size Reduction Laws

1) Area of Feed given Crushing Efficiency Formula

Evaluate Formula

Formula

$$A_a = A_b - \left(\frac{\eta_c \cdot W_n}{e_s}\right)$$

Example with Units

$$99.5429\,\text{m}^2 = 100\,\text{m}^2 - \left(\frac{0.40 \cdot 20\,\text{J}}{17.5\,\text{J/m}^3}\right)$$

2) Area of Product given Crushing Efficiency Formula

Evaluate Formula

Formula

$$A_b = \left(\frac{\eta_c \cdot W_h}{e_s \cdot L}\right) + A_a$$

Example with Units

$$104.1114\,\text{m}^2 = \left(\frac{0.40 \cdot 22\,\text{J}}{17.5\,\text{J/m}^3 \cdot 11\,\text{cm}}\right) + 99.54\,\text{m}^2$$

3) Critical Speed of Conical Ball Mill Formula

Evaluate Formula

Formula

$$N_c = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{[g]}{R - r}}$$

Example with Units

$$4.3217\,\text{rev/s} = \frac{1}{2 \cdot 3.1416} \cdot \sqrt{\frac{9.8066\,\text{m/s}^2}{31.33\,\text{cm} - 30\,\text{cm}}}$$

4) Crushing Efficiency Formula

Evaluate Formula

Formula

$$\eta_c = \frac{e_s \cdot \left(A_b - A_a\right)}{W_h}$$

Example with Units

$$0.3659 = \frac{17.5\,\text{J/m}^3 \cdot \left(100\,\text{m}^2 - 99.54\,\text{m}^2\right)}{22\,\text{J}}$$

5) Energy Absorbed by Material while Crushing Formula

Evaluate Formula

Formula

$$W_h = \frac{e_s \cdot \left(A_b - A_a\right)}{\eta_c}$$

Example with Units

$$20.125\,\text{J} = \frac{17.5\,\text{J/m}^3 \cdot \left(100\,\text{m}^2 - 99.54\,\text{m}^2\right)}{0.40}$$

6) Feed Diameter based on Reduction Law Formula

Evaluate Formula

Formula

$$D_f = R_R \cdot D_p$$

Example with Units

$$18\,\text{cm} = 3.6 \cdot 5\,\text{cm}$$

7) Half of Gaps between Rolls Formula

Evaluate Formula

Formula

$$d = \left(\left(\cos\left(\alpha \right) \right) \cdot \left(R_f + R_c \right) \right) - R_c$$

Example with Units

$$3.5406\,\text{cm} = \left(\left(\cos\left(0.27\,\text{rad} \right) \right) \cdot \left(4.2\,\text{cm} + 14\,\text{cm} \right) \right) - 14\,\text{cm}$$

8) Maximum Diameter of Particle Nipped by Rolls Formula

Evaluate Formula

Formula

$$D_{[P,max]} = 0.04 \cdot R_c + d$$

Example with Units

$$4.06\,\text{cm} = 0.04 \cdot 14\,\text{cm} + 3.5\,\text{cm}$$

9) Mechanical Efficiency given Energy fed to System Formula

Evaluate Formula

Formula

$$\eta_w = \frac{W_n}{W_M}$$

Example with Units

$$0.4 = \frac{20\,\text{J}}{50\,\text{J}}$$

10) Power Consumption for Crushing only Formula

Evaluate Formula

Formula

$$P_c = P_l - P_o$$

Example with Units

$$41\,\text{W} = 45\,\text{W} - 4\,\text{W}$$

11) Power Consumption while Mill is Empty Formula

Evaluate Formula

Formula

$$P_o = P_l - P_c$$

Example with Units

$$4\,\text{W} = 45\,\text{W} - 41\,\text{W}$$

12) Product Diameter Based on Reduction Ratio Formula

Evaluate Formula

Formula

$$D_p = \frac{D_f}{R_R}$$

Example with Units

$$5\,\text{cm} = \frac{18\,\text{cm}}{3.6}$$

13) Projected Area of Solid Body Formula

Evaluate Formula

Formula

$$A_p = 2 \cdot \frac{F_D}{C_D \cdot \rho_l \cdot \left(v_{liquid} \right)^2}$$

Example with Units

$$0.0647\,\text{m}^2 = 2 \cdot \frac{80\,\text{N}}{1.98 \cdot 3.9\,\text{kg/m}^3 \cdot \left(17.9\,\text{m/s} \right)^2}$$

14) Radius of Ball Mill Formula

Evaluate Formula

Formula

$$R = \left(\frac{[g]}{\left(2 \cdot \pi \cdot N_c \right)^2} \right) + r$$

Example with Units

$$31.3348\,\text{cm} = \left(\frac{9.8066\,\text{m/s}^2}{\left(2 \cdot 3.1416 \cdot 4.314\,\text{rev/s} \right)^2} \right) + 30\,\text{cm}$$

15) Radius of Crushing Rolls Formula

Evaluate Formula

Formula

$$R_c = \frac{D_{[P,max]} - d}{0.04}$$

Example with Units

$$14\,\text{cm} = \frac{4.06\,\text{cm} - 3.5\,\text{cm}}{0.04}$$

16) Radius of Feed in Smooth Roll Crusher Formula

Evaluate Formula

Formula

$$R_f = \frac{R_c + d}{\cos\left(\alpha \right)} - R_c$$

Example with Units

$$4.1578\,\text{cm} = \frac{14\,\text{cm} + 3.5\,\text{cm}}{\cos\left(0.27\,\text{rad} \right)} - 14\,\text{cm}$$

17) Reduction Ratio Formula

Evaluate Formula

Formula

$$R_R = \frac{D_f}{D_p}$$

Example with Units

$$3.6 = \frac{18\,\text{cm}}{5\,\text{cm}}$$

18) Terminal Settling Velocity of Single Particle Formula

Evaluate Formula

Formula

$$V_t = \frac{V}{\left(\epsilon \right)^n}$$

Example with Units

$$0.1989\,\text{m/s} = \frac{0.1\,\text{m/s}}{\left(0.75 \right)^{2.39}}$$

19) Work required for Reduction of Particles Formula

Evaluate Formula

Formula

$$W_R = \frac{P_M}{\dot{m}}$$

Example with Units

$$0.9583\,\text{J/kg} = \frac{23\,\text{W}}{24\,\text{kg/s}}$$

Variables used in list of Important Formulas in Size Reduction Laws above

- $\in$ Void fraction
- A_a Area of Feed *(Square Meter)*
- A_b Area of Product *(Square Meter)*
- A_p Projected Area of Solid Particle Body *(Square Meter)*
- C_D Drag Coefficient
- **d** Half of Gap between Rolls *(Centimeter)*
- $D_{[P,max]}$ Maximum Diameter of Particle Nipped by Rolls *(Centimeter)*
- D_f Feed Diameter *(Centimeter)*
- D_p Product Diameter *(Centimeter)*
- e_s Surface Energy per Unit Area *(Joule per Cubic Meter)*
- F_D Drag Force *(Newton)*
- **L** Length *(Centimeter)*
- $\dot{m}$ Feed Rate to Machine *(Kilogram per Second)*
- **n** Richardsonb Zaki Index
- N_c Critical Speed of Conical Ball Mill *(Revolution per Second)*
- P_c Power Consumption for Crushing Only *(Watt)*
- P_l Power Consumption by Mill While Crushing *(Watt)*
- P_M Power Required by Machine *(Watt)*
- P_o Power Consumption While Mill is Empty *(Watt)*
- **r** Radius of Ball *(Centimeter)*
- **R** Radius of Ball Mill *(Centimeter)*
- R_c Radius of Crushing Rolls *(Centimeter)*
- R_f Radius of Feed *(Centimeter)*
- R_R Reduction Ratio
- **V** Settling Velocity of Group of Particles *(Meter per Second)*
- v_{liquid} Velocity of Liquid *(Meter per Second)*

Constants, Functions, Measurements used in list of Important Formulas in Size Reduction Laws above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[g]**, 9.80665 *Gravitational acceleration on Earth*
- 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 Centimeter (cm) *Length Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Energy** in Joule (J) *Energy Unit Conversion*
- Measurement: **Power** in Watt (W) *Power Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angle** in Radian (rad) *Angle Unit Conversion*
- Measurement: **Frequency** in Revolution per Second (rev/s) *Frequency Unit Conversion*
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s) *Mass Flow Rate Unit Conversion*
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³) *Density Unit Conversion*
- Measurement: **Energy Density** in Joule per Cubic Meter (J/m³) *Energy Density Unit Conversion*

- V_t Terminal Velocity of Single Particle *(Meter per Second)*
- W_h Energy Absorbed by Material *(Joule)*
- W_M Energy Fed to Machine *(Joule)*
- W_n Energy Absorbed By Unit Mass Of Feed *(Joule)*
- W_R Work Required for Reduction of Particles *(Joule per Kilogram)*
- α Half Angle of Nip *(Radian)*
- η_c Crushing Efficiency
- η_w Mechanical Efficiency in Terms of Energy Fed
- ρ_l Density of Liquid *(Kilogram per Cubic Meter)*

- Measurement: **Specific Energy** in Joule per Kilogram (J/kg)
  Specific Energy Unit Conversion

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