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Important Formulas in Size Reduction Laws

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List of 19 Important Formulas in Size Reduction Laws

Important Formulas in Size Reduction Laws

1) Area of Feed given Crushing Efficiency

Open Calculator

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

ex $$99.54286\text{m}^2 = 100\text{m}^2 - \left(\frac{0.40 \cdot 20\text{J}}{17.5\text{J/m}^3}\right)$$

2) Area of Product given Crushing Efficiency

Open Calculator

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

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

3) Critical Speed of Conical Ball Mill

Open Calculator

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

ex $$4.3217\text{rev/s} = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{[g]}{31.33\text{cm} - 30\text{cm}}}$$

4) Crushing Efficiency

Open Calculator

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

$$0.365909 = \frac{17.5\text{J/m}^3 \cdot (100\text{m}^2 - 99.54\text{m}^2)}{22\text{J}}$$

5) Energy Absorbed by Material while Crushing

Open Calculator

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

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

6) Feed Diameter based on Reduction Law

Open Calculator

$$D_f = R_R \cdot D_p$$

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

7) Half of Gaps between Rolls

Open Calculator

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

$$3.54063\text{cm} = ((\cos(0.27\text{rad})) \cdot (4.2\text{cm} + 14\text{cm})) - 14\text{cm}$$

8) Maximum Diameter of Particle Nipped by Rolls

Open Calculator

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

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

9) Mechanical Efficiency given Energy fed to System

Open Calculator

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

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

10) Power Consumption for Crushing only

Open Calculator

$$P_c = P_l - P_o$$

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

11) Power Consumption while Mill is Empty

Open Calculator

$$P_o = P_l - P_c$$

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

12) Product Diameter Based on Reduction Ratio

Open Calculator

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

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

13) Projected Area of Solid Body

Open Calculator

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

ex $$0.064667\text{m}^2 = 2 \cdot \frac{80\text{N}}{1.98 \cdot 3.9\text{kg/m}^3 \cdot (17.9\text{m/s})^2}$$

14) Radius of Ball Mill

Open Calculator

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

ex $$31.33475\text{cm} = \left(\frac{[g]}{(2 \cdot \pi \cdot 4.314\text{rev/s})^2} \right) + 30\text{cm}$$

15) Radius of Crushing Rolls

Open Calculator

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

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

16) Radius of Feed in Smooth Roll Crusher

Open Calculator

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

ex $$4.157842\text{cm} = \frac{14\text{cm} + 3.5\text{cm}}{\cos(0.27\text{rad})} - 14\text{cm}$$

17) Reduction Ratio

Open Calculator

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

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

18) Terminal Settling Velocity of Single Particle

Open Calculator

fx $$V_t = \frac{V}{(\in)^n}$$

ex $$0.198886\text{m/s} = \frac{0.1\text{m/s}}{(0.75)^{2.39}}$$

19) Work required for Reduction of Particles

Open Calculator

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

ex $$0.958333\text{J/kg} = \frac{23\text{W}}{24\text{kg/s}}$$

Variables Used

- $\in$ 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_I 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)*
- 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)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[g]**, 9.80665 Meter/Second²
  Gravitational acceleration on Earth
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- 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
- Measurement: **Specific Energy** in Joule per Kilogram (J/kg)
  Specific Energy Unit Conversion

Check other formula lists

- **Important Formulas in Size Reduction Laws**
- **Mechanical Separation Formulas**
- **Size Reduction Laws Formulas**

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