Important Basic Formulas of Mechanical Operations PDF

Formulas
Examples
with Units

List of 21
Important Basic Formulas of Mechanical Operations

1) Applied Pressure in Terms of Coefficient of Flowability for Solids Formula

Evaluate Formula

Formula

$$P_A = \frac{P_N}{K}$$

Example with Units

$$8.9982\,\text{Pa} = \frac{15\,\text{Pa}}{1.667}$$

2) Coefficient of Flowability of Solids Formula

Evaluate Formula

Formula

$$K = \frac{P_N}{P_A}$$

Example with Units

$$1.6667 = \frac{15\,\text{Pa}}{9\,\text{Pa}}$$

3) Energy Required to Crush Coarse Materials according to Bond's Law Formula

Evaluate Formula

Formula

$$E = W_i \cdot \left(\left(\frac{100}{d_2} \right)^{0.5} - \left(\frac{100}{d_1} \right)^{0.5} \right)$$

Example with Units

$$22.1506\,\text{J/kg} = 11.6\,\text{J/kg} \cdot \left(\left(\frac{100}{1.9\,\text{m}} \right)^{0.5} - \left(\frac{100}{3.5\,\text{m}} \right)^{0.5} \right)$$

4) Fraction of Cycle Time used for Cake Formation Formula

Evaluate Formula

Formula

$$f = \frac{t}{t_c}$$

Example with Units

$$0.2 = \frac{0.8\,\text{s}}{4\,\text{s}}$$

5) Mass Mean Diameter Formula

Evaluate Formula

Formula

$$D_W = \left(x_A \cdot D_{pi} \right)$$

Example with Units

$$3\,\text{m} = \left(0.6 \cdot 5\,\text{m} \right)$$

6) Material Characteristic using Angle of Friction Formula

Evaluate Formula

Formula

$$K_M = \frac{1 - \sin(\Phi)}{1 + \sin(\Phi)}$$

Example with Units

$$0.4217 = \frac{1 - \sin(24^\circ)}{1 + \sin(24^\circ)}$$

7) Number of Particles Formula

Evaluate Formula

Formula

$$N_p = \frac{m}{\rho_{particle} \cdot V_{particle}}$$

Example with Units

$$2.0492 = \frac{0.15\,kg}{12.2\,kg/m^3 \cdot 0.006\,m^3}$$

8) Porosity or Void Fraction Formula

Evaluate Formula

Formula

$$\varepsilon = \frac{v_0}{v_B}$$

Example with Units

$$0.0667 = \frac{0.02\,m^3}{0.3\,m^3}$$

9) Pressure Gradient using Kozeny Carman Equation Formula

Evaluate Formula

Formula

$$dPbydr = \frac{150 \cdot \mu \cdot (1 - \eta)^2 \cdot v}{(\Phi_p)^2 \cdot (De)^2 \cdot (\eta)^3}$$

Example with Units

$$10.3023\,N/m^3 = \frac{150 \cdot 0.59\,P \cdot (1 - 0.5)^2 \cdot 60\,m/s}{(18.46)^2 \cdot (0.55\,m)^2 \cdot (0.5)^3}$$

10) Projected Area of Solid Body Formula

Evaluate Formula

Formula

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

Example with Units

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

11) Sauter Mean Diameter Formula

Evaluate Formula

Formula

$$d_{sauter} = \frac{6 \cdot V_{particle\_1}}{S_{particle}}$$

Example with Units

$$8.9423\,m = \frac{6 \cdot 15.5\,m^3}{10.4\,m^2}$$

12) Specific Surface Area of Mixture Formula

Evaluate Formula

Formula

$$A_w = \frac{SA_{Total}}{M_T}$$

Example with Units

$$3.7063\,m\text{^}2/kg = \frac{53\,m^2}{14.3\,kg}$$

13) Sphericity of Cuboidal Particle Formula

Evaluate Formula

Formula

$$\Phi_{cuboidalparticle} = \frac{\left(\left(\left(L \cdot b \cdot h\right) \cdot \left(\frac{0.75}{\pi}\right)\right)^{\frac{1}{3}} \text{ ^ } 2\right) \cdot 4 \cdot \pi}{2 \cdot \left(L \cdot b + b \cdot h + h \cdot L\right)}$$

Example with Units

$$0.1306 = \frac{\left(\left(\left(3\,\text{m} \cdot 2\,\text{m} \cdot 12\,\text{m}\right) \cdot \left(\frac{0.75}{3.1416}\right)\right)^{\frac{1}{3}} \text{ ^ } 2\right) \cdot 4 \cdot 3.1416}{2 \cdot \left(3\,\text{m} \cdot 2\,\text{m} + 2\,\text{m} \cdot 12\,\text{m} + 12\,\text{m} \cdot 3\,\text{m}\right)}$$

14) Sphericity of Cylindrical Particle Formula

Evaluate Formula

Formula

$$\Phi_{cylindricalparticle} = \frac{\left(\left(\left(\left(R\right)^2 \cdot H \cdot \frac{3}{4}\right)^{\frac{1}{3}}\right)^2\right) \cdot 4 \cdot \pi}{2 \cdot \pi \cdot R \cdot \left(R + H\right)}$$

Example with Units

$$0.8209 = \frac{\left(\left(\left(\left(0.025\,\text{m}\right)^2 \cdot 0.11\,\text{m} \cdot \frac{3}{4}\right)^{\frac{1}{3}}\right)^2\right) \cdot 4 \cdot 3.1416}{2 \cdot 3.1416 \cdot 0.025\,\text{m} \cdot \left(0.025\,\text{m} + 0.11\,\text{m}\right)}$$

15) Sphericity of Particle Formula

Evaluate Formula

Formula

$$\Phi_p = \frac{6 \cdot V_s}{S_{particle} \cdot De}$$

Example with Units

$$18.4615 = \frac{6 \cdot 17.6\,\text{m}^3}{10.4\,\text{m}^2 \cdot 0.55\,\text{m}}$$

16) Surface Shape Factor Formula

Evaluate Formula

Formula

$$\Phi_s = \frac{1}{\Phi_p}$$

Example

$$0.0542 = \frac{1}{18.46}$$

17) Terminal Settling Velocity of Single Particle Formula

Evaluate Formula

Formula

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

Example with Units

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

18) Time Required for Cake Formation Formula

Evaluate Formula

Formula

$$t = f \cdot t_c$$

Example with Units

$$0.8\,\text{s} = 0.2 \cdot 4\,\text{s}$$

19) Total Number of Particles in Mixture Formula

Evaluate Formula

Formula

$$N_T = \frac{M_T}{\rho_p \cdot V_p}$$

Example with Units

$$143 = \frac{14.3\,\text{kg}}{100\,\text{kg/m}^3 \cdot .001\,\text{m}^3}$$

20) Total Surface Area of Particle using Spericity Formula

Evaluate Formula

Formula

$$A_{sa} = M \cdot \frac{6}{\Phi_p \cdot \rho_p \cdot d_p}$$

Example with Units

$$0.0163\,\text{m}^2 = 50.12\,\text{kg} \cdot \frac{6}{18.46 \cdot 100\,\text{kg/m}^3 \cdot 10\,\text{m}}$$

21) Total Surface Area of Particles Formula

Evaluate Formula

Formula

$$SA = S \cdot N_p$$

Example with Units

$$22.032\,\text{m}^2 = 10.8\,\text{m}^2 \cdot 2.04$$

Variables used in list of Basic Formulas of Mechanical Operations above

- $\in$ Void fraction
- A_p Projected Area of Solid Particle Body *(Square Meter)*
- A_{sa} Total Surface Area of Particles *(Square Meter)*
- A_w Specific Surface Area of Mixture *(Square Meter per Kilogram)*
- **b** Breadth *(Meter)*
- C_D Drag Coefficient
- d_1 Feed Diameter *(Meter)*
- d_2 Product Diameter *(Meter)*
- d_p Arithmetic Mean Diameter *(Meter)*
- D_{pi} Size Of Particles Present In Fraction *(Meter)*
- d_{sauter} Sauter Mean Diameter *(Meter)*
- D_W Mass Mean Diameter *(Meter)*
- **De** Equivalent Diameter *(Meter)*
- **dPbydr** Pressure Gradient *(Newton per Cubic Meter)*
- **E** Energy per Unit Mass of Feed *(Joule per Kilogram)*
- **f** Fraction of Cycle Time Used For Cake Formation
- F_D Drag Force *(Newton)*
- **h** Height *(Meter)*
- **H** Cylinder Height *(Meter)*
- **K** Coefficient of Flowability
- K_M Material Characteristic
- **L** Length *(Meter)*
- **m** Mixture Mass *(Kilogram)*
- **M** Mass *(Kilogram)*
- M_T Total Mass of Mixture *(Kilogram)*
- **n** Richardsonb Zaki Index
- N_p Number of Particles

Constants, Functions, Measurements used in list of Basic Formulas of Mechanical Operations above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sin**, sin(Angle) *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Volume** in Cubic Meter (m^3) *Volume Unit Conversion*
- Measurement: **Area** in Square Meter (m^2) *Area Unit Conversion*
- Measurement: **Pressure** in Pascal (Pa) *Pressure Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Dynamic Viscosity** in Poise (P) *Dynamic Viscosity Unit Conversion*
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3) *Density Unit Conversion*
- Measurement: **Specific Energy** in Joule per Kilogram (J/kg) *Specific Energy Unit Conversion*
- Measurement: **Pressure Gradient** in Newton per Cubic Meter (N/m^3) *Pressure Gradient Unit Conversion*
- Measurement: **Specific Area** in Square Meter per Kilogram (m^2/kg)

- N_T Total Number of Particles in Mixture
- P_A Applied Pressure *(Pascal)*
- P_N Normal Pressure *(Pascal)*
- **R** Cylinder Radius *(Meter)*
- **S** Surface Area of One Particle *(Square Meter)*
- $S_{particle}$ Surface Area of Particle *(Square Meter)*
- **SA** Surface Area *(Square Meter)*
- SA_{Total} Total Surface Area *(Square Meter)*
- **t** Time Required For Cake Formation *(Second)*
- t_c Total Cycle Time *(Second)*
- **v** Velocity *(Meter per Second)*
- **V** Settling Velocity of Group of Particles *(Meter per Second)*
- v_0 Volume of Voids in Bed *(Cubic Meter)*
- v_B Total Volume of Bed *(Cubic Meter)*
- v_{liquid} Velocity of Liquid *(Meter per Second)*
- V_p Volume Of One Particle *(Cubic Meter)*
- $V_{particle}$ Volume of Spherical Particle *(Cubic Meter)*
- $V_{particle\_1}$ Volume of Particle *(Cubic Meter)*
- V_s Volume of One Spherical Particle *(Cubic Meter)*
- V_t Terminal Velocity of Single Particle *(Meter per Second)*
- W_i Work Index *(Joule per Kilogram)*
- x_A Mass Fraction
- **ε** Porosity or Void Fraction
- **η** Porosity
- **μ** Dynamic Viscosity *(Poise)*
- ρ_l Density of Liquid *(Kilogram per Cubic Meter)*
- ρ_p Density Of Particle *(Kilogram per Cubic Meter)*
- $\rho_{particle}$ Density of One Particle *(Kilogram per Cubic Meter)*
- **Φ** Angle of Friction *(Degree)*
- $\Phi_{cuboidalparticle}$ Sphericity of Cuboidal Particle

Specific Area Unit Conversion

- $\Phi_{cylindricalparticle}$ Sphericity of Cylindrical Particle
- Φ_p Sphericity of Particle
- Φ_s Surface Shape Factor

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