OSF – Equipment Size reduction

Felipe B. Pinto 61387 – MIEQB

1 de outubro de 2024

Conteúdo

1 Crushing rolls 2
2 Jaw Crushers 3
3 Energy for size reduction 4

1 Crushing rolls

Compress particles between two rolls

$$\cos \beta/2 = \frac{r_1 + b/2}{r_1 + r_2}$$

r_1: Roll radius

r_2: Feed particle size

b: Distance between rolls

$\beta = 31°$: Parametrizado em 31º

2 Jaw Crushers

Crush the particles between two jaw like contraptions

- Two jaws one fixed one mobile
- Nip angle $\sim 30^\circ$
- Coarse reduction

3 Energy for size reduction

Very low efficiency $0.1 \to 2.0$ but effetive size reduction

- In producing elastic deformation of the particles before fracture occurs
- In causing elastic distortion of the equipment.
- In friction between particles, and between particles and the machine.
- In noise, heat and vibration in the plant, and In friction losses in the plant itself.

Empirical Law of Energy for size reduction

$$\frac{\mathrm{d}\boldsymbol{E}}{\mathrm{d}\boldsymbol{L}} = -\boldsymbol{C}\,\boldsymbol{L}^{\boldsymbol{p}}$$

E Energy spent for size reduction [kJ/kg]

L size of solids calculated as the mean diameter based on voume (d_V/m) Alternativelly Bond's diameter (d_{bond}/m) can be used, its estimated as the mesh size trough which 80% of the material passes in a sieving characterization experiment.

C empirical constant related to the solid properties and equipment properties

p empirical constant related to the size of solids

- $= -1.0$ Coarse reduction
- $= -1.5$ Intermediate reduction
- $= -2.0$ Fine reduction

Specifying p for each reduction and integrating we derive the following three laws

Rittinger's law (Fine reduction,$p = -2.0$)

$$\boldsymbol{E} = \boldsymbol{C}\ \Delta \boldsymbol{L}^{-1} = \boldsymbol{K_R}\,\boldsymbol{f_c}\ \Delta \boldsymbol{L}^{-1}$$

$$\boldsymbol{C} = \boldsymbol{K_R}\,\boldsymbol{f_c} \begin{cases} \boldsymbol{K_R}: & \text{Depende do triturador} \\ \boldsymbol{f_c}: & \text{Depende das particulas} \end{cases}$$

Note: Greater efficiency, $E \propto d^{-1}$

Bond's Law (Intermediate reduction, $p = -1.5$)

$$\boldsymbol{E} = 2\,\boldsymbol{C}\ \Delta \boldsymbol{L}^{-1/2} = \boldsymbol{E_i}\,\sqrt{100/\boldsymbol{L_1}}\left(1 - \boldsymbol{q}^{-1/2}\right)$$

$$\begin{cases} \boldsymbol{C} = \boldsymbol{E_i}\sqrt{100} \\ \boldsymbol{q} = \boldsymbol{L_0}/\boldsymbol{L_1} \end{cases}$$

Notes: Intermediate Efficiency, $E \propto L_0^{-1}$

Kick's Law (Coarse reduction, $p = -1.0$)

$$\boldsymbol{E} = \boldsymbol{C}\ \Delta \ln \boldsymbol{L} = \boldsymbol{K_K}\,\boldsymbol{f_c}\ \Delta \ln \boldsymbol{L}$$

$$\boldsymbol{C} = \boldsymbol{K_K}\,\boldsymbol{f_c} \begin{cases} \boldsymbol{K_K}: & \text{Depende do triturador} \\ \boldsymbol{f_c}: & \text{Depende das particulas} \end{cases}$$

Notes: Less energy efficiency, $E \propto L_0/L_1$