OSF – Equipment Size reduction

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15 de janeiro de 2024

Conteúdo

1 Crushing rolls

Compress particles between two rolls

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

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 $\sim 30°$
- Coarse reduction

3 Energy for size reduction

Very low efficiency $0.1 \rightarrow 2.0$ 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, $E \propto L_0/L_1$