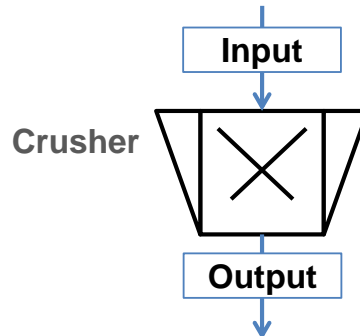# Crusher Bond's law

General description

This model is used to perform milling of the input stream. The crushing is performed according to the model proposed by Bond. The simplification is made, and the particle size distribution of the output stream is described by the normal function.

$$x_{80,out} = \frac{1}{\left(\dfrac{P}{10 \cdot w_i \cdot \dot{m}} + \dfrac{1}{\sqrt{x_{80,in}}}\right)^2},$$

$$\mu = x_{80,out} - 0.83\sigma,$$

$$q_3(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

- $x_{80,out}$ is the characteristic particle size of the output stream
- $x_{80,in}$ is the characteristic particle size of the input stream
- w_i is the Bond work index, dependent on the material
- P is the power input
- $\dot{m}$ is the mass flow of solids in the input stream
- $q_3(x)$ is the output mass related density distribution
- σ is the standard deviation of the output normal distribution
- μ is the mean value of the output normal distribution

List of average Bond work indices for various materials

Material	Bond work index [kWh/t]
Andesite	20.08
Barite	5.20
Basalt	18.18
Bauxite	9.66
Cement clinker	14.8
Clay	6.93
Coal	14.3
Coke	16.84
Copper ore	13.99
Diorite	22.99
Dolomite	12.4
Emery	62.45
Feldspar	11.88
Ferro-chrome	8.4
Ferro-manganese	9.13
Ferro-silicon	11
Flint	28.78
Fluorspar	9.8
Gabbro	20.3
Glass	13.54
Gneiss	22.14
Gold ore	16.42
Granite	16.64
Graphite	47.92
Gravel	17.67
Gypsum rock	7.40
Iron ore, hematite	14.12
Iron ore, hematite-specular	15.22
Iron ore, magnetite	10.97

Iron ore, oolitic	12.46
Iron ore, taconite	16.07
Lead ore	13.09
Lead-zinc ore	12.02
Limestone	14
Manganese ore	13.42
Magnesite	12.24
Molybdenum	14.08
Nickel ore	15.02
Oil shale	17.43
Phosphate rock	10.91
Potash ore	8.86
Pyrite ore	9.83
Pyrrhotite ore	10.53
Quartzite	10.54
Quartz	14.93
Rutile ore	13.95
Shale	17.46
Silica sand	15.51
Silicon carbide	27.46
Slag	11.26
Slate	15.73
Sodium silicate	14.74
Spodumene ore	11.41
Syenite	14.44
Tin ore	11.99
Titanium ore	13.56
Trap rock	21.25
Zinc ore	12.72

Unit parameters

Name	Symbol	Description	Units	Valid values
P	P	Power input	[kW]	P > 0
Deviation	σ	Standard deviation of the output distribution	[m]	Deviation > 0

Requirements

  – Solid phase
  – Particle size distribution

Application examples

  – *Example Flowsheets/Units/Crusher Bond.dlfw*
  – *Example Flowsheets/Processes/Comminution process.dlfw*
  – *Example Flowsheets/Processes/Granulation process.dlfw*

References

F. C. Bond, Crushing and grinding calculation – Part I, British Chemical Engineering 6 (6) (1961) 378-385.

F. C. Bond, Crushing and grinding calculation – Part II, British Chemical Engineering 6 (8), (1961) 543-548.

Denver Sala Basic: Selection Guide for Process Equipment, Colorado Springs, CO: Denver Equipment (1993).