Size Reduction Energy: Kick, Rittinger and Bond

Size reduction energy by Kick's, Rittinger's and Bond's laws, with Kick and Rittinger constants calibrated from one test (Perry's Eqs. 21-121 to 21-123).

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Test: specific energy	10.000	kWh/t
Test: feed size (80 % passing)	50.000	mm
Test: product size (80 % passing)	5.0000	mm
Duty: feed size (80 % passing)	25.000	mm
Duty: product size (80 % passing)	1.0000	mm
Bond work index	15.000	kWh/t
Throughput	50.000	t/h

Calculated results

Parameter	Value	Unit
Kick's law energy	13.979	kWh/t
Rittinger's law energy	53.333	kWh/t
Bond's law energy	3.7947	kWh/t
Power by Bond's law	189.74	kW

Formula and method

$$E_K = C_K \ln\frac{X_F}{X_P}, \quad E_R = C_R\left(\frac{1}{X_P}-\frac{1}{X_F}\right), \quad E_B = 10E_i\left(\frac{1}{\sqrt{X_P}}-\frac{1}{\sqrt{X_F}}\right) \ (\mu m)$$

Variables

E_0	Test: specific energy	J/kg
X_{F0}	Test: feed size (80 % passing)	m
X_{P0}	Test: product size (80 % passing)	m
X_F	Duty: feed size (80 % passing)	m
X_P	Duty: product size (80 % passing)	m
E_i	Bond work index	J/kg
$\dot{m}$	Throughput	kg/s
E_K	Kick's law energy	J/kg
E_R	Rittinger's law energy	J/kg
E_B	Bond's law energy	J/kg
P_B	Power by Bond's law	W

Method and standards

Walker's general law integrated for n = 1, 2 and 1.5.

Assumptions and limits

- Same material and machine type as the test.
- Sizes are 80 % passing sizes, as Bond's law requires; use the same basis for the test so the three laws compare.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 21
- Eqs. (21-120) to (21-123): Kick
- Rittinger and Bond

Report details

Report reference	FCC-58H3-CJ07 (the same inputs always give the same reference)
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Calculator	Size Reduction Energy: Kick, Rittinger and Bond
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/unit-operations/comminution-energy-kick-rittinger

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.