Cutting Power from Specific Cutting Energy

Cutting power and motor power for a machining operation from the material removal rate, the specific cutting energy of the work material and the machine efficiency.

Method: P_c = Q u; P_m = P_c/η (Kalpakjian; Groover, specific energy method)

Input parameters

Unit system: SI

Parameter	Value	Unit
Material removal rate	90.000	cm³/min
Specific cutting energy From a table for the work material (W·s/mm³ = 10⁹ J/m³); carbon steels about 2–9 W·s/mm³.	2.7000e+09	J/m³
Machine efficiency	80.000	%
Cutting speed (for the force)	180.00	m/min

Calculated results

Parameter	Value	Unit
Cutting power	4.0500	kW
Motor power	5.0625	kW
Cutting force P_c/v_c	1.3500	kN

Formula and method

$$P_c = Q\,u, \quad P_m = \frac{P_c}{\eta}, \quad F_c = \frac{P_c}{v_c}$$

Variables

Q	Material removal rate	m³/s
u	Specific cutting energy	J/m³
η	Machine efficiency	-
v_c	Cutting speed (for the force)	m/s
P_c	Cutting power	W
P_m	Motor power	W
F_c	Cutting force P_c/v_c	N

Method and standards

Energy method.

Assumptions and limits

- Sharp tool. The specific energy is taken as constant: it rises for thin chips and with tool wear, so correct the table value for your feed and allow for a worn tool.

References

- P_c = Q u; P_m = P_c/η (Kalpakjian; Groover, specific energy method)

Report details

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

This calculator online

https://calc.firecad.com/mechanical/manufacturing/cutting-power

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Reopens the calculator with the inputs of this report.