Power and Energy in Machining

- In a turning operation on alloy steel with hardness = 200 HB, the cutting speed = 200 m/min, feed = 0.25 mm/rev, and depth of cut = 7.5 mm. How much power will the lathe draw in performing this operation if its mechanical efficiency = 90%.
- Use Table 21.2 to obtain the appropriate specific energy value.

$$P_g = \frac{P_c}{E} \quad \text{or} \quad HP_g = \frac{HP_c}{E}$$

$$P_u = \frac{P_c}{R_{MR}} \quad \text{or} \quad HP_u = \frac{HP_c}{R_{MR}}$$

$$MRR = v\, f\, d$$

horsepower by dividing ft-lb/min by 33,000. Hence,

$$P_c = F_c v$$

$$HP_c = \frac{F_c v}{33,000}$$

Power and Energy in Machining

- A turning operation is to be performed on a 20 hp lathe that has an 87% efficiency rating. The roughing cut is made on alloy steel whose hardness is in the range 325 to 335 HB. The cutting speed is 375 ft/min, feed is 0.030 in/rev, and depth of cut is 0.150 in. Based on these values, can the job be performed on the 20 hp lathe? Use Table 21.2 to obtain the appropriate unit horsepower value.

$$P_g = \frac{P_c}{E} \quad \text{or} \quad HP_g = \frac{HP_c}{E}$$

$$P_u = \frac{P_c}{R_{MR}} \quad \text{or} \quad HP_u = \frac{HP_c}{R_{MR}}$$

$$MRR = v\, f\, d$$

horsepower by dividing ft-lb/min by 33,000. Hence,

$$P_c = F_c v$$

$$HP_c = \frac{F_c v}{33,000}$$

Power and Energy in Machining

- A lathe performs a turning operation on a workpiece of 6.0 in diameter. The shear strength of the work is 40,000 lb/in2 and the tensile strength is 60,000 lb/in2. The rake angle of the tool is 6°. The cutting speed = 700 ft/min, feed = 0.015 in/rev, and depth = 0.090 in. The chip thickness after the cut is 0.025 in. Determine (a) the horsepower required in the operation, (b) unit horsepower for this material under these conditions, and (c) unit horsepower as it would be listed in Table 21.2 for a t_o of 0.010 in. Use the orthogonal cutting model as an approximation of the turning process.

Material	Brinell Hardness	Specific Energy U or Unit Power P_u N-m/mm^3	Specific Energy U or Unit Power P_u in-lb/in^3	Unit Horsepower HP_u hp/(in^3/min)
Carbon steel	150–200	1.6	240,000	0.6
	201–250	2.2	320,000	0.8
	251–300	2.8	400,000	1.0
Alloy steels	200–250	2.2	320,000	0.8
	251–300	2.8	400,000	1.0
	301–350	3.6	520,000	1.3
	351–400	4.4	640,000	1.6
Cast irons	125–175	1.1	160,000	0.4
	175–250	1.6	240,000	0.6
Stainless steel	150–250	2.8	400,000	1.0
Aluminum	50–100	0.7	100,000	0.25
Aluminum alloys	100–150	0.8	120,000	0.3
Brass	100–150	2.2	320,000	0.8
Bronze	100–150	2.2	320,000	0.8
Magnesium alloys	50–100	0.4	60,000	0.15

Approximate Energy Requirements in Cutting Operations

TABLE 20.2 Approximate Energy Requirements in Cutting Operations (at drive motor, corrected for 80% efficiency; multiply by 1.25 for dull tools).

Material	Specific energy	
	W-s/mm^3	hp-min/in.^{3}
Aluminum alloys	0.4–1.1	0.15–0.4
Cast irons	1.6–5.5	0.6–2.0
Copper alloys	1.4–3.3	0.5–1.2
High-temperature alloys	3.3–8.5	1.2–3.1
Magnesium alloys	0.4–0.6	0.15–0.2
Nickel alloys	4.9–6.8	1.8–2.5
Refractory alloys	3.8–9.6	1.1–3.5
Stainless steels	3.0–5.2	1.1–1.9
Steels	2.7–9.3	1.0–3.4
Titanium alloys	3.0–4.1	1.1–1.5

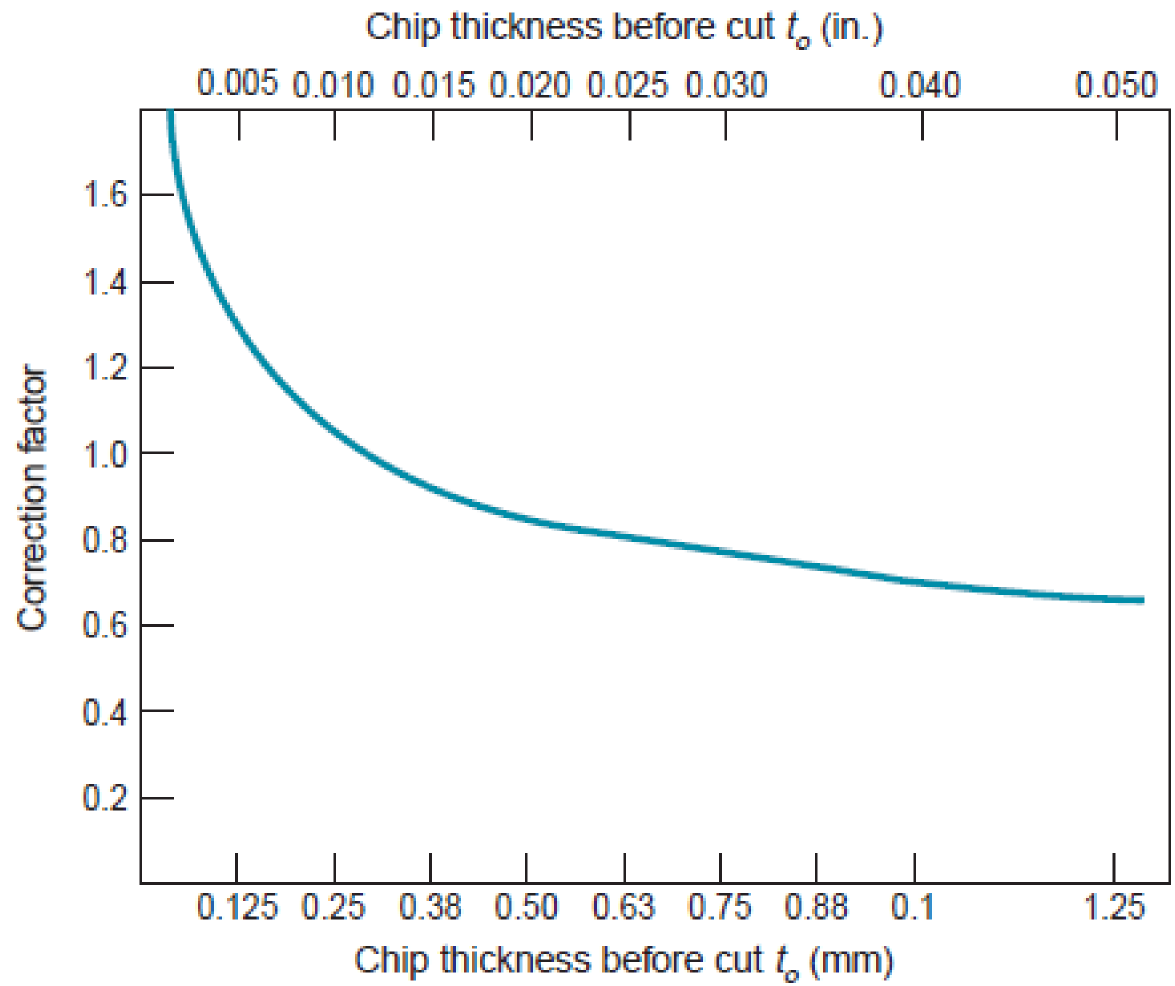

FIGURE 21.14 Correction factor for unit horsepower and specific energy when values of chip thickness before the cut t_o are different from 0.25 mm (0.010 in).

Cutting Temperature

Cooks Experimental Equation

$$\Delta T = \frac{0.4U}{\rho C}\left(\frac{vt_o}{K}\right)^{0.333}$$

Cutting Temperature

Orthogonal cutting is performed on a metal whose mass specific heat = 1.0 J/g-C, density = 2.9 g/cm^3, and thermal diffusivity = 0.8 cm^2/s. The cutting speed is 4.5 m/s, uncut chip thickness is 0.25 mm, and width of cut is 2.2 mm. The cutting force is measured at 1170 N. Using Cook's equation, determine the cutting temperature if the ambient temperature = 22°C.

Cutting Temperature

An orthogonal machining operation removes metal at 1.8 in^3/min. The cutting force in the process = 300 lb. The work material has a thermal diffusivity = 0.18 in^2/sec and a volumetric specific heat = 124 in-lb/in^3-F. If the feed $f = t_o = 0.010$ in and width of cut = 0.100 in, use the Cook formula to compute the cutting temperature in the operation given that ambient temperature = 70°F.

- An orthogonal cutting operation is performed on a certain metal whose volumetric specific heat = 110 in-lb/in3-F, and thermal diffusivity = 0.140 in2/sec. The cutting speed = 350 ft/min, chip thickness before the cut = 0.008 in, and width of cut = 0.100 in. The cutting force is measured at 200 lb. Using Cook's equation, determine the cutting temperature if the ambient temperature =70°F.