3. A slab-milling operation is being carried out on a 45-in. long, 10-in. wide metal block (u = 3.7 hp-min/in3) at a feed of 0.04 in./tooth and a depth of cut of 0.33 in. The cutter has a diameter of 5 in., has eight straight cutting teeth, is 4 inches wide and rotates at 250 rpm. Calculate the material removal rate, the cutting time, and the power required.

#3 First we need to calculate the work piece speed

$v = fNn$ = feed x rpm x # of teeth

$= 0.04 \times 250 \times 8 = 80$ in/min

now, calculate MRR

$MRR = \frac{l \times w \times d}{time} = w \times d \times$ velocity

$= 4 \times 0.33 \times 80 = 105.6$ in^3/min

MRR = 105.6 in^3/min

Cutting time = $\frac{\text{length of cut}}{\text{work piece velocity}} = \frac{l}{v}$

$l = 45 \times 3 = 135$ in

Three cuts needed, as the tool is 4 inches wide and the work piece is 10 inches wide

$t = \frac{135}{80} = 1.69$ mins $= 101.25$ sec

t = 1.69 mins

Power (max for 4" width) = $u \times MRR = 3.7 \times 105.6$

Power = 390.72 hp a huge motor

4. A 4.75-in. diameter titanium steel rod (u = 1.37 hp-min/in3) is being turned on a lathe at 2600 rpm and at a feed of 0.006 in. If the power of the motor is 50 hp, what is the maximum depth of cut that you can have before the motor stalls?

#2 Here we need to get an equation in terms of depth of cut. But remember, we use average depth of cut.

Power = speed × feed × depth of cut × (specific cutting energy)

average radius

$$r = \frac{1}{2}\left(\frac{4.75 + (4.75-2d)}{2}\right) = \frac{1}{2}(4.75-d)$$

d = depth of cut

$$\text{Speed} = 3600\ \frac{\text{rev}}{\text{min}} \times 2\pi\ \frac{\text{R}}{\text{rev}} \times \frac{1}{2}(4.75-d)$$

$$MRR = S \times f \times d$$

$$= 3600 \times 2\pi \times \frac{1}{2}(4.75-d) \times 0.01 \times d$$

Power = u × MRR

$$50 = 1.37 \times 2600 \times 2\pi \times \frac{1}{2} \times (4.75-d) \times 0.006 \times d$$

$$671\ d^2 - 3189.3\ d = 50$$

$$d = 0.16\ \text{in}$$

5. A 250-mm long, 48 mm diameter nickel alloy rod (u = 5.83 W-s/mm3) is being reduced in diameter to 43 mm by turning on a lathe. The spindle rotates at 1500 rpm, and the tool is traveling at an axial velocity of 0.05 mm/rev. Calculate the cutting speed, material removal rate, time of cut, power required, and cutting force.

Cutting speed first.

average radius $= \frac{48+43}{2\times 2} = 22.75\ mm$

$V = \omega \times r = 1500 \frac{rev}{min} \times \frac{2\pi^R}{rev} \times \frac{min}{60sec} \times 22.75$

$V = 3574\ mm/s$

MRR = Speed × feed × depth of cut

$= 3574 \times 0.05 \times 2.5 = 446.75\ mm^3/s$

$MRR = 446.75\ mm^3/s$

Time of cut = length ÷ axial speed

axial speed $= 0.05\ mm/rev \times 1500 \frac{rev}{min} \times \frac{min}{60sec}$

$= 1.25\ mm/s$

time of cut $= 250 / 1.25$

time of cut $= 200\ s$

Power $= u \times MRR$

$= 5.83 \times 446.75 = 2605$

Power $= 2.61\ kw$

$$\text{Force} = \frac{\text{Power}}{\text{speed}} = \frac{2.61 \times 10^3}{3.574} = 730\,N$$

$$\text{Force} = 730\,N$$