IE-352
Section 1, CRN: 32997
Section 2, CRN: 5022
Second Semester 1431-32 H (Spring-2011) – 4(4,1,1)
MANUFACTURING PROCESSES - 2

Sunday, Apr 17, 2011 (13/5/1432H)

Exercise: Cutting Forces and Power

Name:	Student Number: 42

Relative Energies in Cutting

In an orthogonal cutting operation, $t_o = 0.13\ mm$, $V = 120\ m/min$, $\alpha = 10°$ and the $width\ of\ cut\ =\ 6\ mm$. It is observed that $t_c = 0.23\ mm$, $F_c = 500\ N$ and $F_t = 200\ N$. Calculate the percentage of the total energy that goes into overcoming friction at the tool–chip interface.

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Name:	Student Number:
Ahmed M. El-Sherbeeny	42

Relative Energies in Cutting

In an orthogonal cutting operation, $t_o = 0.13\ mm$, $V = 120\ m/min.$, $\alpha = 10°$ and the *width of cut* $= 6\ mm$. It is observed that $t_c = 0.23\ mm$, $F_c = 500\ N$ and $F_t = 200\ N$. ~~Calculate the~~ percentage of the total energy that goes into overcoming friction at the tool–chip interface.

Indep. Variables

Depend. Variables

Given: SI units

thicknesses: depth of cut $t_o = 0.13$ mm; chip thickness $t_c = 0.23$ mm

velocities: cutting velocity $V = 120$ m/min (cutting velocity)

angles: $\alpha = 10°$

forces: cutting force $F_c = 500$ N; thrust force $F_t = 200$ N; friction force $F = ?$; $f_s = ?$; normal force $N = ?$; $f_n = ?$

Req: % of the total energy in overcoming (i.e. against, i.e. = and opposite) to friction

$$(100)\frac{U_f}{U_{tot}} = \frac{\text{Power}_f}{\text{Power}_{tot}} \times 100 = ?$$

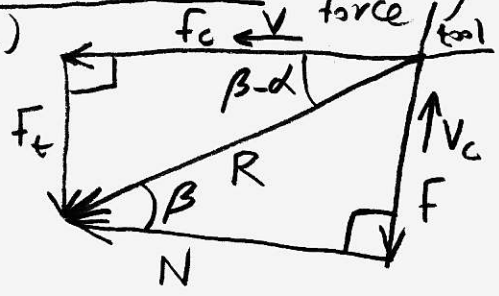
energy

also: $V_c/V = r$ (cutting ratio) $= t_o/t_c$

Sol^n:

$$\frac{\text{Power}_f}{\text{Power}_{tot}} = \frac{F V_c}{F_c V} = \frac{F r}{F_c}, \text{ where } r = \frac{t_o}{t_c} = \frac{0.13}{0.23} = 0.565$$

- since we now have: r, F_c, we need to find f (friction force)
- strategy: from force circle, we note that R (resultant) is common between F_c, F_t & F, N thus we can find R (from F_c, F_t) and use it to find F ⇒



- $R = \sqrt{F_c^2 + F_t^2} = \sqrt{500^2 + 200^2} = 538.5\ N$
- Also: $\tan(\beta-\alpha) = \frac{f_t}{F_c} = \frac{200\ N}{500\ N} = 0.4 \Rightarrow \beta - \alpha = \tan^{-1}(0.4) = 21.80°$
  since $\alpha = 10° \Rightarrow \beta = 21.8° + \alpha = 31.80°$

→ cont.

Cont:

· Now consider Δ: R-N-F:

$$\sin\beta = \frac{F}{R} \Rightarrow F = R\sin\beta$$

$$= (538.5\,N)\sin 31.80^\circ$$

$$\Rightarrow \underline{F = 283.79\,N}$$

· subst. in Power eq^n ⇒

$$\frac{\text{Power}_f}{\text{Power}_{tot}} = \frac{Fr}{F_c} = \frac{(283.79\,N)(0.565)}{(500\,N)} = \underline{0.3208}$$

⇒ % of energy in overcoming friction = 32.1 %