

ME58120320 HW#3

Due: July 20th (Thursday) at 8:50 AM before lecture

Ch9: Temperature

1. The maximum temperature along the tool face and the temperature on the newly machined surface are to be estimated for the following condition during the turning of carbon steel at a room temperature of 22°C. (26 points)

Rake angle $\alpha = 5^\circ$

Cutting force $F_P = 415$ N

Thrust force $F_Q = 80$ N

Cutting speed $v = 1$ m/s

Undeformed chip thickness $t = 0.5$ mm

Width of cut $b = 1$ mm

Cutting ratio $r = 0.67$

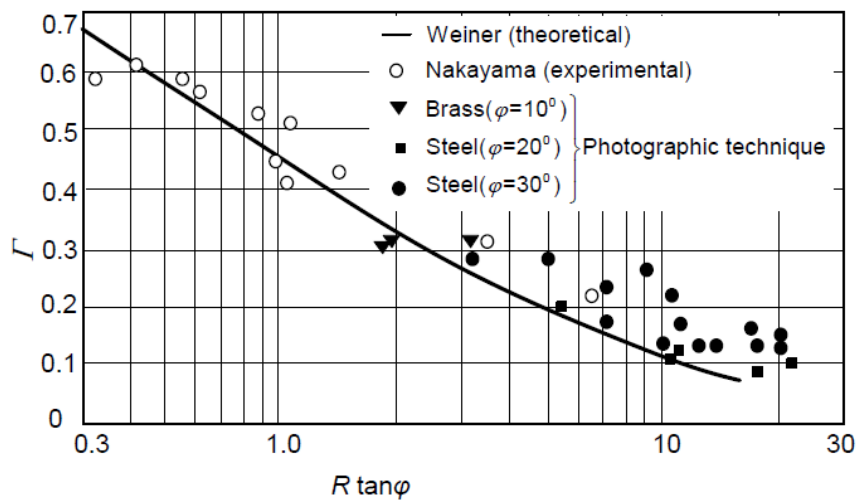
Length of contact between chip and tool face $l_f = 0.08$ mm

Width of secondary deformation zone under unlubricated condition $w_o = 0.2$

Alloy steel density $\rho = 7250$ kg/m³

Alloy steel thermal conductivity $k = 400$ W/mK

Alloy steel specific heat capacity $c = 500$ J/kgK



* For very large $R \tan \phi$, Γ can be estimated to be zero, that is, all the heat is transferred to the chip

Figure 1.

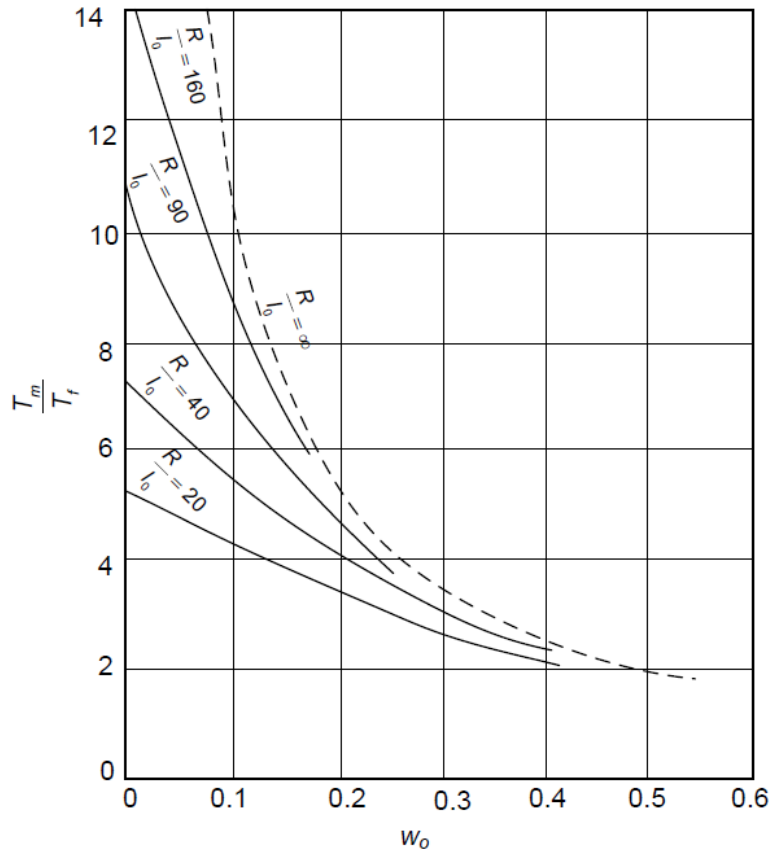


Figure 2.

Ch11: EDM

1. An experimental study is conducted to compare EDM performance between RC circuit and transistor-based generator under the same individual pulse discharge energy (E_d) and cycle frequency of 6.25 kHz. The workpiece is hardened steel and the DC power supply is 240 V.

(1) In transistor-based generator, the duty factor is set 0.5 and the measured discharge voltage and current are 30 V and 80 A, respectively. What is the individual pulse discharge energy (E_d)? (3 points)

(2) With the same E_d in (1), what R and C values should be used in RC generator to maximize the material removal? (given that $u_e = 0.73u_o$ and $t_e = 0.1t_c$ for maximum productivity). (8 points)

2. For an EDM machine with transistor circuit generator, if average cycle voltage $\bar{u} = 50$ V when discharge time $t_e = 120 \mu\text{s}$ and interval time $t_o = 30 \mu\text{s}$. It is known that discharge current $i_e = 60$ A, open voltage $u_o = 150$ V and discharge voltage $u_e = 25$ V.

For an ideal condition of isopulse series to calculate:

(1) Discharge delay time (t_d). (4 points)

- (2) Cycle frequency (f_r). (4 points)
- (3) Duty factor. (3 points)

Ch12: ECM

1. A weight reducing process will be conducted to machine a titanium (atomic weight 47.9 g, density 0.00452 g/mm³ and valence is 3) workpiece with surface area of 2500 mm² using an ECM machine. This ECM machine provides voltage of 20 volts and can afford current up to 5000 amp. The electrolyte used in this machine has electrical conductivity of 20 (S·m⁻¹).

- (a) What is the smallest possible gap distance? (6 points)
- (b) How long does it take to reduce weight by 50 g? (8 points)

Ch13: Laser and E-beam Machining

1. A pulsed laser beam machine is used to drill microholes on Zirconium (vaporization energy 42.5 J/mm³). This machine generates laser pulses with 1.5 J/pulse energy and 0.001 s pulse duration. The beam divergence of the laser is 0.002 rad, and its radiation is focused with a 30mm focal length lens. Suppose the conversion efficiency of input energy to thermal energy is 0.5%, which corresponds to material removal. How many pulses are needed to drill a 1 mm deep hole? (15 points)

2. List the material removal mechanisms, advantages and disadvantages of EDM, ECM, CHM, LBM, and EBM. (15 points)

3. Compare EDM and ECM in terms of the polarity of the workpiece, level of voltage and current, the electrical conductivity of the electrolyte, and the machined surface quality. (8 points)