Department of Mining and Materials Engineering

Faculty of Engineering, Prince of Songkla University

Midterm Examination 2nd Semester	Academic Year 2005
Subject: 237 – 302 Materials forming	Date: 10th December 2005
Time: 13.30-16.30pm	Room: R201

Instructions: 1. Only a sheet of A4 note is allowed and must be handed in.

2. Students are allowed to bring in calculator and dictionary.

3. Answer all questions in the answering sheets provided.

ทุจริตในการสอบโทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริตและพักการเรียน 1 ภาคการศึกษา

Question 1

(a) Show that the temperature rise during indirect extrusion is given by the following equation and **state any assumptions you made**. (4 marks)

$0.9\,P_o = \rho . C_P . (T_E - T_I)$

where P_o = Pressure
ρ = Density of the material
C_P = Heat capacity of the material
T_E = Exit temperature
T_I = Initial billet temperature

(b) Consider extruding an aluminum alloy billet (solidus temperature of 525°C) through a flat-faced die from a diameter of 100 mm to a new diameter of 18.9 mm. The extrusion is to be performed on a 2MN press, operating in the indirect mode, with a ram speed of 5mm/s and billet/die chamber lubrication is very good. Using the data given below **suggest** which of the following initial billet temperatures should be used prior to extrusion: 400°C, 425°C, 450°C, or 475°C and **explain your reason**. Note that the final extruded product should be free from major surface defects and must have acceptable stress corrosion and fracture toughness. It is known that acceptable stress corrosion and fracture toughness values will only be obtained in an aluminum alloy, if the substructure produced during extrusion is retained after heat treatment. From observation of compression data it is found that this occurs when the average subgrain size in the extruded materials is greater than 1.7 μm. (16 marks)

	Flow stress (MPa) for strain rate:-		
Temperature(°C)	0.1 s^{-1}	1.0 s^{-1}	10 s^{-1}
400	37	46	55
425	32	42	50
450	28	36	44
475	24	32	38

	Post deformation subgrain size(μm) for strain rate:-		
Temperature(°C)	0.1 s^{-1}	1.0 s^{-1}	10 s^{-1}
400	1.8	1.5	1.2
425	2.0	1.8	1.6
450	2.3	2.1	1.9
475	2.5	2.4	2.1

Extrusion pressure is given by $P = \sigma_o (0.8 + 1.8 \ln R)$

Where σ_o is the flow stress

Density of Al = 2700 kg/m^3

Heat capacity of Al = 1180 J/kg.K

Question 2

(a) Show that the rolling torque (T) under plain strain conditions can be given by:- (4 marks)

$$T = \chi \cdot \lambda \cdot w \cdot R \cdot (h_o - h_f) \cdot \sigma_o$$

where

χ = factor allowing for friction (~1.2 for cold rolling)

λ = lever arm (~0.45 for cold rolling)

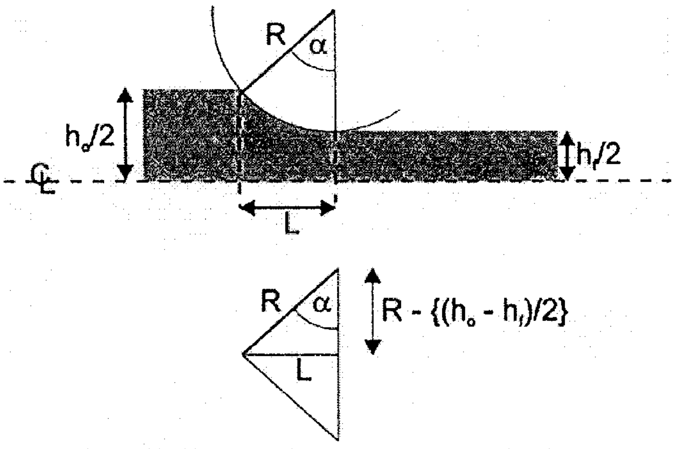
w = width of sheet

R = roll radius

h_o = initial sheet thickness

h_f = final sheet thickness

σ_o = mean flow stress of material



(b) Aluminum sheet (1m wide) is cold rolled in a 2 high mill from a thickness of 2.5mm down to 2.0mm in a single pass with a roll speed of 50 revolutions per minute. If the roll diameter is 0.55m, and the mean flow stress of the aluminum is 100 MPa, **calculate the power required by the mill** assuming there is zero friction at the roll neck bearings. (6 marks)

(c) **Describe** a typical rolling schedule that would be employed to roll as cast ingot of 400mm thick to thin sheet (~0.25mm). **Briefly discuss mill configuration** and **show how the advantages of both hot and cold rolling** are exploited. (10 marks)

Good luck!!!