Faculty of Engineering
Prince of Songkla University

การสอบกลางภาคการศึกษาที่ 1   ปีการศึกษา 2551

วัน พุธ ที่ 30 ก.ค. 2551   เวลา 13:30 – 16:30 น.

วิชา 237-511 Advanced Metal Casting   ห้อง R200

<u>คำสั่ง</u>

(1) เขียนคำตอบให้สมบูรณ์ทุกข้อเพื่อให้ได้คะแนนเต็ม

(2) ให้เอา Note ขนาด A4 ที่เขียนด้วยลายมือเข้าได้ (ห้ามถ่ายเอกสาร)

(3) ให้เอา Calculator และ Dictionary เข้าห้องสอบได้

(4) อ่านคำสั่งให้ละเอียด และตอบทุกคำถาม

<u>ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริตและพักการศึกษา 1 ภาคการศึกษา</u>

Question No.	Point	Result
1	10	
2	10	
3	15	
4	30	
5	25	
6	10	
	Total	

$$\rho g H = \frac{1}{2}\rho v^2$$

$$t = \left[\frac{\pi}{4}\left(\frac{\rho_c \Delta H_f}{T_m - T_0}\right)^2 \frac{1}{k_m \rho_m c_m}\right]\left(\frac{V}{A}\right)^2$$

$$t = \frac{\rho_m \Delta H_f r}{h(T_m - T_0)}$$

$$\mathrm{Re} = \frac{\rho V d}{\mu}$$

- Heat transfer coefficient (steel/liquid aluminium) = 2,000 $W/m^2/°C$
- Heat transfer coefficient (brass/liquid aluminium) = 3,000 $W/m^2/°C$
- Density of pure aluminum = 2,700 kg/m^3
- Heat capacity of liquid aluminum = 1 kJ/kg/°C
- Heat of fusion of aluminium = 398 kJ/kg
- Heat capacity of sand = 0.6 kJ/kg/°C
- Viscosity of pure aluminum = 0.0013 Pa-s

Name:_____   Student ID No:_____

1. Melting Processes (10 points).

Explain clearly the following melting processes. How does it melt metals? Also give a sketch or a drawing for each type.

i. Gas Reverberatory Furnace (5 points)

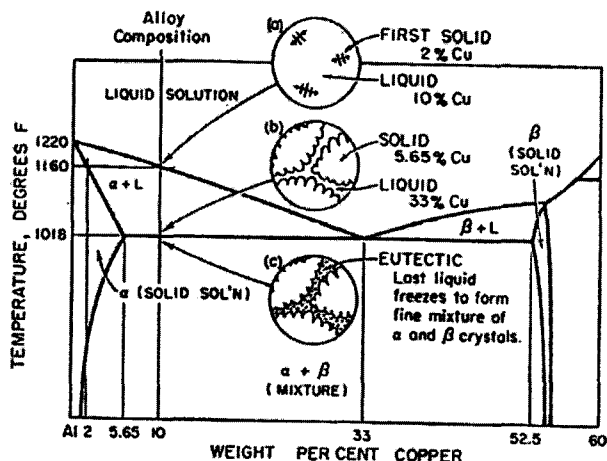ii. Gas Stack Melting Furnace (5 points)

2. Casting Processes (10 points).

Explain clearly the following casting processes.

i. Low-Pressure Die Casting (5 points)

ii. Hot Chamber Die Casting (5 points)

3. Cast Metals (15 points)

The figure is a phase diagram labeled with: Alloy Composition, LIQUID SOLUTION, (a) FIRST SOLID 2%Cu, LIQUID 10%Cu, (b) SOLID 5.65%Cu, LIQUID 33%Cu, β (SOLID SOL'N), α+L, β+L, α (SOLID SOL'N), (c) EUTECTIC Last liquid freezes to form fine mixture of α and β crystals, α+β (MIXTURE). Y-axis: TEMPERATURE, DEGREES F with values 1220, 1160, 1018. X-axis: WEIGHT PER CENT COPPER with values Al 2, 5.65, 10, 33, 52.5, 60.

a) Draw a cooling curve of <u>Al-33%Cu</u> solidifying slowly in a sand mold. Include as much detail as possible such as the melting point.
(<u>Note: There is a 5°C undercooling</u>) (5 points).

Temperature (°C)

Time (min)
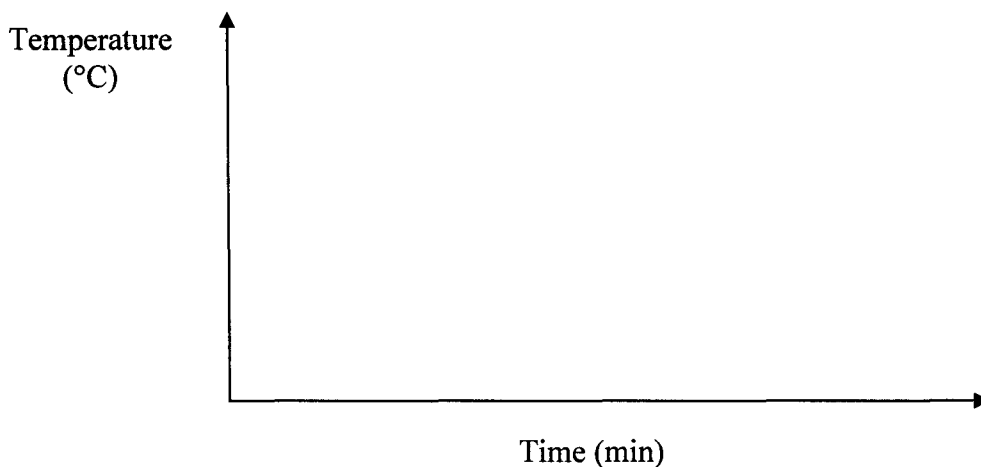
b) Draw a cooling curve of <u>Al-10%Cu alloy</u> solidifying slowly in a sand mold. Include as much detail as possible such as the liquidus, solidus, or eutectic temperatures. (<u>Note: There is a 5°C undercooling</u>) (5 points).

Temperature (°C)

Time (min)
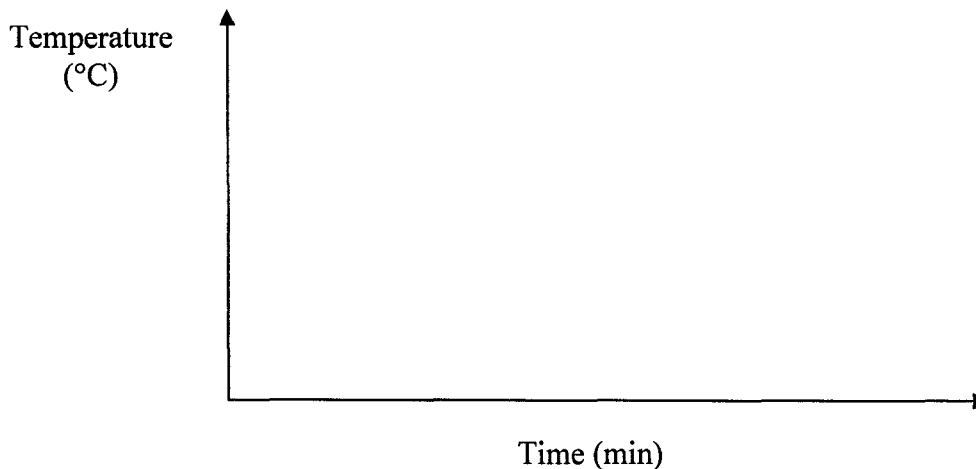
c) Give two metals that are free from oxide films (5 points)

4. Solidification of Metals (30 points)

   a) Clearly explain why there is always undercooling during casting practices. (5 points)

   b) Explain clearly how and why dendrites (not planar interfaces) are formed during normal casting conditions. (5 points)

   c) Given is the microstructure of an Al-20%Cu alloy solidified in an iron mold. (The phase diagram is given in Question #3) Answer the following equations:
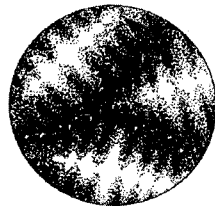

   i)   What is the solid fraction of this alloy at 560°C assuming the Scheil model? Given the partition coefficient = 0.2. Show your calculation. (5 points).

ii)   What is approximately the amount of copper near the center of the dendrite? (5 points)

iii) What is approximately the amount of copper near the perimeter of the dendrite? (5 points)

iv)   Given that the dendrite arm spacing (DAS) is 10 micron. What is the cooling rate of this casting process? Explain. (Hint: Use the diagram below and the phase diagram given in Question #3) (5 points)
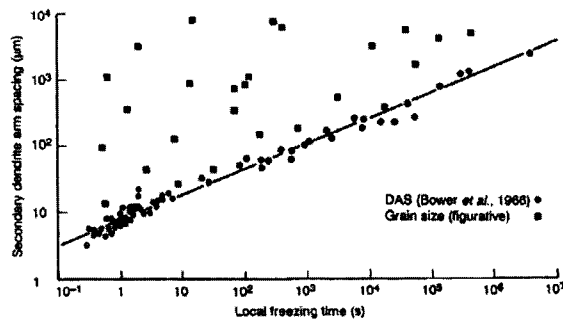
5.   Fluid Flow (25 points)

a) Explain two effects of forced convection on the dendrites during solidification. (5 points)

b) **Explain why elongation is significantly reduced if we remelt aluminum ingots several times. (5 points)**

c) **Explain 2 mechanisms for incorporation of surface films (5 points)**

d) **Which feeding mechanism has the most influence on the micro-porosity defect in a casting. Explain clearly. (5points)**

e) **From the phase diagram below. Between Pb-10%Sn and Sn-10%Pb, which alloy should have the highest fluidity. Explain your reason clearly. (5 points)**

6. Applications (10 points)

This mold is made of brass and it is at 25°C. The metal is pure aluminum. Answer the following questions:

i)   At the "Entrance," is the flow of the liquid metal <u>laminar</u> or <u>turbulent</u>? Explain your answer clearly (5 points).

ii)   If we pour the metal with the temperature 800°C, how far the metal will flow (L = ?) (5 points)?