Prince of Songkla University

Faculty of Engineering

Final Examination: Semester I **Academic Year: 2010**

Date: October 4, 2010 **Time: 9:00-12:00**

Subject: 226-304 Heat Treatment Technology **Room: S201**

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชาในและพักการเรียน 1 ภาคการศึกษา

Name ..... Last name ....student ID.....

Instruction:

1. There are 3 parts,
   - Part I 42 questions 125 points
   - Part II 16 questions 20 points
   - Bonus part 10 questions 10 points
2. Attempt all questions.
3. Only a hand-written note on two-sided A4 and a dictionary are allowed.
4. Borrowing things form other students is prohibited.

Napisporn Memongkol
Instructor

Part I: Answer all the questions (125 points)

1. (4 points) Commonly, the used of heat treatment furnaces can be divided into 4 classes. What are they?

2. (2 points) According to the source of heat, heat treatment furnaces can be divided into two classes;

.....and .....

3. (2 points) According to the type of operation, heat treatment furnaces can be divided into two classes;

..... and .....

4. (3 points) Explain advantages offered by salt-bath furnace over other heat treatment furnaces.

.....

.....

.....

5. (3 points) Give a brief account of various commercially available furnace atmospheres in heat treatment.

.....

.....

.....

6. (3 points) How many stages of inspection in heat treatment? What are they?

.....

.....

.....

7. (3 points) The inspection in heat treatment can be divided into three classes. What are they?

.....

.....

.....

8. (2 points) What are the two different methods of surface hardening?

First method is.....

Second method is .....

9. (3 points) Carburizing can be divided into three categories, what are they?

.....

.....

.....

10. (4 points) What is the purpose of $BaCO_3$ in Carburizing process?

$BaCO_3$ is used for .....

Complete the equations below and give an answer what is the source of carbon in equation 10.2?

$$BaCO_3 \rightarrow \text{.....} + CO_2 \qquad (10.1)$$

$$CO_2 + C \rightarrow 2CO \qquad (10.2)$$

$$2CO + Fe \rightarrow \text{.....} + CO_2 \qquad (10.3)$$

The carbon in equation (10.2) came from .....

11. (2 points) What are the two stages of Vacuum Carburizing?

First stage is .....

Second stage is .....

12. (2 points) As compared to conventional atmosphere carburizing, how many percent of volume of gaseous hydrocarbon is required for identical carburizing?

.....%

13. (2 points) What are the **limitations** of vacuum carburizing?

..... and .....

14. (1 points) Why are the use of a closed pot anc ventilating hood required for cyaniding?

.....

15. (2 points) Why post-carburizing heat treatment is necessary for case carburized parts?

..... and .....

16. (2 points) Why cyaniding process is **less time consuming?**

Because of ..... . and

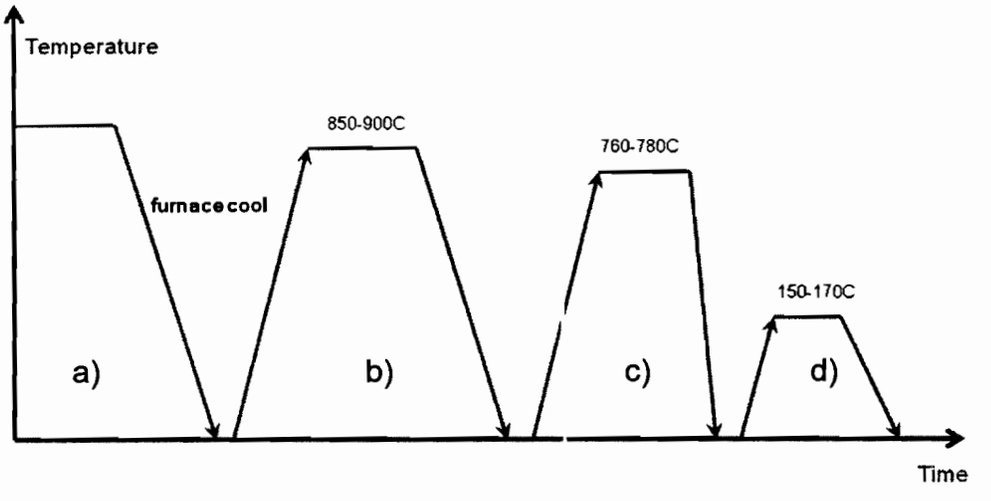
.....

17. (2 points) Compare **cyaniding** and **carbonitriding** case hardening processes

Cyaniding is ..... while **Carbonitriding** is

.....

18. (4 points) Complete the graph of post carburizing heat treatment below.



a is ..... c is .....

b is ..... d is .....

19. (2 points) What kinds of steel using carbonitriding process for improving **wear resistance?**

.....

20. (3 points) Compare to carburizing process, the carbonitriding process are better than carburizing process in ....., ...

....., and

.....

21. (1 points) What is the kind of steel using nitricing processes the most effective?

.....

22. (2 points) What is the material used to cover the portion not to be nitrided in Nitriding process?

.....

23. (3 points) What are the advantages of the Nitrocarburizing process?

1) .....
2) .....
3) .....

24. (2 points) Give two examples of the applications of boronizing process?

..... and .....

25. (4 points) What are the benefits of flame hardening?

1) .....
2) .....
3) .....
4) .....

26. (2 points) Toyota diffusion process (TDP) is also known as

..... (TD) and .....(TRD)

27. (4 points) Complete the table below

Process	Material	Typical surface hardness, VHN
Carburizing		850
Boronizing		1500
Chromizing	Carbon steel, tool steel	
Toyota diffusion process	Tool steel	

28. (2 points) what is (aluminum alloy) 6061 T651?

.....

29. (3 points) In induction hardening, the degree of current flow on the outer surface of the component depends on 1) ..... , 2) ....., and 3) ..... of the component (last two factors depend on temperature)

30. (4 points) List the disadvantages of flame hardening.
    1) .....
    2) .....
    3) .....
    4) .....

31. (6 points) Explain the three methods of flame hardening?
    1) .....
    .....
    .....
    2) .....
    .....
    .....
    3) .....
    .....
    .....

32. (4 points) The quantity of gaseous hydrocarbon using in vacuum carburizing depend on
    a) .....
    b) .....
    c) .....
    d) .....

33. (2 points) What is the basic aim of heat treatment aluminium alloys?
    .....

34. (2 points) What are the two stages of age hardening of aluminum alloys?
    .....
    .....

35. (4 points) What is the meaning of specific letter of condition or temper of Al alloy?

Letter	Condition of alloy
F	
O	
T	
H	

36. (4 points) Fill in the alloying element in the table below

4 digits series	Aluminium cast alloys
2xx.x	
4xx.x	
7xx.x	
8xx.x	

37. (6 points) Explain the natural aging and artificial aging of aluminium alloys?

Natural aging .....

.....

.....

Artificial aging .....

.....

.....

38. (4 points) Effects of alloying element on properties of Aluminum

Alloying	Properties of aluminum alloy
Copper	
Magnesium	
Manganese	
Silicon	

39. (3 points) What are the applications of Al alloy series 2xxx?

.....

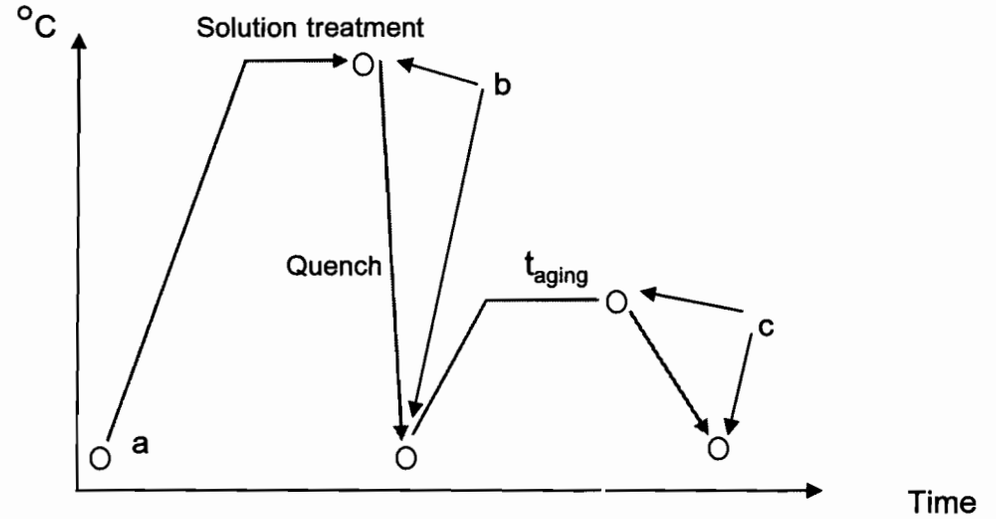
.....

.....

40. (2 points) Give two examples of non-heat treatable aluminum alloys.

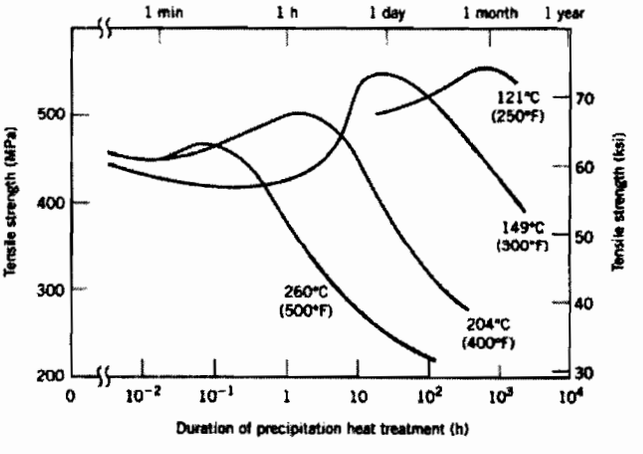
..... and .....

41. (6 points) From the precipitation hardening of aluminium graph below, draw the microstructures of aluminium at each point.



a b c

42. (4 points) From the diagram below, explain the effect of time and temperature of precipitation heat treatment



Effect of time

.....

.....

.....

Effect of temperature

.....

.....

.....

PART II: Fill in the blank using the letter (a-mm) provided in the next page that is related to the questions (1 point each) 20 points

1. Liquid carburizing is also known as.....
2. The most widely used method of carburizing is.....
3. The advantages of liquid carburizing are ..... and.....
4. In Pack Carburizing, the depth of penetration depends on .....
5. Recent development of gas carburizing technique is the use of ..... as a carrier gas
6. Main advantage of Vacuum Carburizing is.....
7. In vacuum carburizing the gaseous hydrocarbon is introduced into the furnace, give two examples of gaseous hydrocarbon ..... and .....
8. Sub zero treatment is also called "....." process.
9. In Nitriding process, ... gas is passed into the furnace at about 550°C, it dissociates into nitrogen and hydrogen
10. The Boronizing process can apply to any ferrous material but adopted for ..... **steels** and ..... **steels**
11. In Boronizing process, boron diffuses inwards and .....layers are formed
12. In ..... process, the components are packed with chromium powder and additive and put in the furnace.
13. Aluminum alloys can be divided into two forms, which are ..... and .....
14. Age hardening of aluminium is also called as .....
15. Most frequently, aluminium parts are quenched by immersion in .....
16. When annealing copper that contains oxygen, the hydrogen in the atmosphere must be kept to a minimum to avoid .....

Answers for part II

a) hot water
b) gas Carburizing
c) solid carburizing
d) ethane
e) methane
f) propane
g) heat transfer is rapid
h) freeze treatment
i) very small furnace
j) energy saving
k) warm water
l) cold water
m) hardening
n) embrittlement
o) salt bath carburizing
p) carbon
q) mild
r) alloy
s) tool
t) iron boride
u) heating time is short
v) diffusion
w) hydrogen
x) carbon dioxide
y) iron carbide
z) minus treatment
aa) cryo treatment
bb) boronizing
cc) chromizing
dd) cast
ee) wrought
ff) precipitation hardening
gg) oxygen
hh) nitrogen
ii) butane
jj) octane
kk) hydrogen sulfide
ll) ammonia
mm) rapidly cooling

Bonus Part: ใส่ชื่อเพื่อน (ทั้งกลุ่ม บางกลุ่ม 2 คน บางกลุ่ม 3 คน) ที่รับผิดชอบการนำเสนอในหัวข้อต่อไปนี้ (ข้อละ 1 คะแนน) ทั้งหมด 10 คะแนน

1. Microstructural evolution and mechanical properties of low alloy steel tempered by induction heating

   .....

2. CCT curves of low-carbon Mn-Si steels and development of water-cooled bainitic steels

   .....

3. Technological advances in steel heat treatment

   .....

4. Selection of heat treatment condition of the Mg-Al-Zn alloys

.....

5. Optimization of heat treatment parameters with the taguchi method for the A7050 Aluminium alloy

.....

6. An analyzing of heat treatment process planning

.....

7. Influence of heat treatment in sintering process on characteristics of Al_2O_3-ZrO_2 ceramics systems

.....

8. Effect of heat treatment on microstructures and mechanical properties of spring steel

.....

9. Heat treatment effects on microstructure and magnetic properties of Mn-Zn ferrite powders

.....

10. Effects of the heat treatment on corrosion resistance and microhardness of alloy steel

.....

Good Luck! to ..... From Aj. Napis