Taleen Jreouie

1. Which of these is a raw material in steel making:
a. iron ore b. coke c. limestone d) all of them
2. Which among the following is not an iron ore?
a. Hematite b. Magnetite c) Pyrrhotite
3. The removal of sulphur is based on one principle:
a. to move the dissolved sulphur from the slag to the molten iron
b. to move the dissolved sulphur from the iron to the slag
c. to move the dissolved sulphur from the iron to the atmosphere
4. Lime reacts with dissolved sulphur via the following reaction:
a. $CaC2 + S = CaS + 2C$ b. $MeO + S = MeS + O$ c. $CaO + S = CaS + O$
5. Alloying elements in Stainless steel influence:
a. stability of α-fe and γ-fe b. tendency to partition between α-fe and γ-fe
c. tendency to form carbides d) all of them
6. In order to remove S from molten steel in the BOF the basicity should be:
a. around 3 b. around 2 c. around 6 d. around 7
7. What is the process of forming a new grain structure in a material is called:
a. solidification b. sintering c. precipitation hardening d) recrystallization
8. What is the process of heating a material to a specific temperature followed by rapid cooling:
a) quenching b. tempering c. annealing d. precipitation hardening
9. What is the process of reheating a previously quenched or hardened metal to a temperature below the eutectoid temperature.
a. annealing b. solution heat treatment c. cold working d) tempering
10. For a 1.4 wt %C alloy at 800 °C what phase(s) is (are) present:
a) Austenite b) Austenite+Pearlite c) Austenite (γ)+Cementite(Fe3C)
11. For a 99.6 wt% Fe-0.40 wt% C at a temperature just below the eutectoid, determine the amount of primary ferrite (α) and pearlite:
a) 94.3 %, 5.64% b) 48.8%, 51.2% c) 7.21%, 92.79 % d) 5.64 %, 94.36%
12. For a 1.5 wt %C alloy at 500 °C what is the total amount of primary Fe3C (closest answer):
a) 0. 125 b) 0.875 c) 0.054 d) 0. 54
13. For a 1.5 wt %C alloy at 500 °C what is the total amount of Fe3C (closest answer):
a) 0.125 b) 0.875 c) 0.22 d) none of them
14. The refinement of the interlamellar spacing in pearlite steels is done by heat treatment called :
a) annealing b) normalizing c) hardening d) grain refinement
15. The phase having the highest hardness number is:
a) Fine pearlite b) Tempered martensite c) Pearlite d) Martensite
16. Plate martensite is formed in which category of steels?
a. High carbon steels b. Low and medium carbon steels c. High and medium carbon steels
d. Low and high carbon steels
17. Which one of the following statements is correct?
a) Cooling rate for formation of bainite is greater than that for pearlite
b) Cooling rate for formation of bainite is lower than that for pearlite
c) Cooling rate for formation of bainite is equal to that for pearlite
18. Hardenability of a material can be measured using _____ test.
a) Jominy b) Charpy c) Rockwell d) Izod
19. Maraging steels are:
a. low strength steels with high carbon or carbon free iron-nickel
b. high strength steels with high carbon or carbon free iron-nickel
c. high strength steels with low carbon or carbon free iron-nickel
20. To produce Maraging steel you need:
a. martensite and aging b. martensite c-aging d. annealing

21. Maraging steels have high strength due to _____
a. martensitic strengthening b. precipitation hardening c. grain refinement
d. martensitic strengthening and precipitation hardening

22. Spheroidizing heat treatment is used to:
a) transform pearlite into spheroids b) transform cementite into spheroids
c) transform ferrite into spheroids d) transforms martensite into spheroids

23. Full annealing of hypoeutectoid is accomplished by heating the steel to a temperature.
a) above A3 b) above Acm c) above A1 d) above melting temperature

24. For a material with a melting point of 980 °C the recrystallization temperatures (in °C) will be close to:
a- 490 °C b- 353.5 °C c- 626.5 °C d- 980 °C

25. The treatment of steel to get a stronger surface while maintaining a soft core is called _____
a) surface hardening b) tempering c) annealing d) tempering

26. Which of the following is not a method of carburizing?
a) pack carburizing b) gas carburizing c) cyaniding d) nitriding

Q2.(3 Points) Phase Transformations

Using the isothermal transformation diagram for iron carbon alloy of hypereutectoid composition 1.13 wt% C steel, determine the final microsructure and the amount of the different phases or microstructure of a small specimen that has been subjected to the following time-temperature treatments. In each case assume that the specimen begins at 800 °C, and it has been held at this temperature long enough time to have achieved a complete and homogeneous austenitic structure.

a- rapidly cool to 350 °C, hold for 250 sec., then quench to room temperature
b- rapidly cool to 680 °C, hold for 1 sec., then quench to 400 °C, hold for 10 sec. then quench to room temperature

a- Final microstructure: M+B, 0.83 B and 0.27 M.

b- Final microstructure: M+B+C, 0.17 C and 0.03 M, 0.04 and 0.8 B, 0.96

Q3 (3P). If a steel having a composition 0.4 wt% C is carburized in a carburizing atmosphere at 900 °C. If the carburizing is done by CO molecule decomposition through the reaction:

$$2CO \rightarrow C_{(\gamma-Fe)} + CO_2.$$

What must the ratio $(P_{CO})^2/P_{CO2}$ be in order for the furnace atmosphere be carburizing

where a C is carbon activity in austenite, T is temperature in K, and y is the wt.% of carbon in austenite at the steel surface

$$a_c = \frac{P_{CO}^2}{P_{CO2}} \exp\left(\frac{20530.6}{T} - 20.98\right)$$

$$0.8198 = \frac{P_{CO}^2}{P_{CO2}} \exp\left(\frac{20530.6}{1173} - 20.98\right)$$

$$0.8198 = \frac{P_{CO}^2}{P_{CO2}} \quad 0.0308$$

$$\frac{P_{CO}^2}{P_{CO2}} = 285.532$$

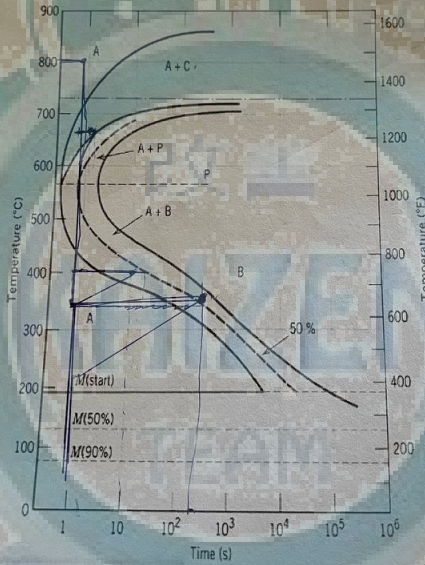
$\log a_c = \frac{3770}{1173} + 2.72 \log 1173 - 10.525 + \frac{3860 \times 0.4}{1173} + \log\left(\frac{0.4}{1-0.4}\right)$

$\log a_c = 2.177$

$a_c = 8.8198$

$$a_c = \frac{P_{\odot}^2}{P_{CO_2}} \cdot \exp\left(\frac{20530.65}{T} - 20.98\right),$$

$$\log_{10} a_c = \frac{3770}{T} + 2.72 \cdot \log_{10} T - 10.525 + \frac{3860 \cdot y}{T} + \log_{10}\left(\frac{y}{1-y}\right),$$



0.4

A+C

A+B

0.4

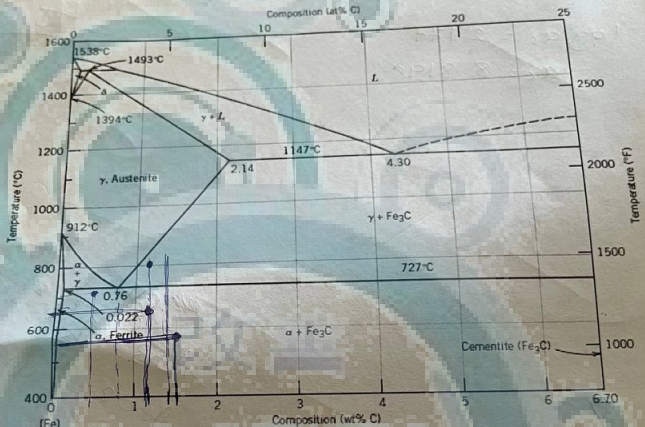
A+B

A=0.2.

C=0.6.

0.8 B

0.2 A-A+B



$$\frac{1.13 - 0.022}{6.7 - 0.022} =$$

$$\frac{1.5 - 0.76}{6.7 - 0.76} =$$

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28/30

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$$T = 900 + 273 = 1173\,k$$

$$\log a_c = \frac{3770}{1173} + 2.72 \log 1173 - 10.525 + \frac{3380 \times 0.4}{1173} + \log\left(\frac{0.4}{1-0.4}\right)$$

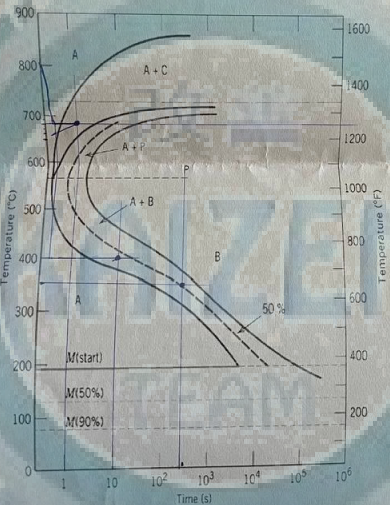
$$\log a_c = 2.18 \qquad a_c = 151.55$$

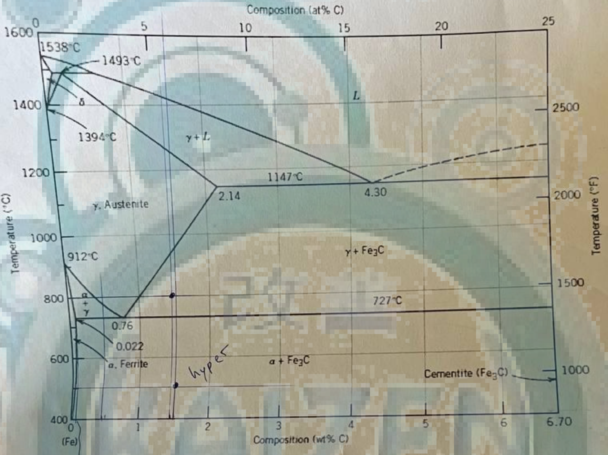
$$\frac{(P_{CO})^2}{P_{CO_2}} = 151.55 \Big/ \exp\left(\frac{20520.65}{1173} - 20.98\right)$$

$$e^{-3.5} = 0.0302 \Rightarrow 5011.6 \rightarrow \frac{(P_{CO})^2}{P_{CO_2}}$$

$$a_C = \frac{P_{CO}^2}{P_{CO_2}} \cdot \exp\left(\frac{20530.65}{T} - 20.98\right),$$

$$\log_{10} a_C = \frac{3770}{T} + 2.72 \cdot \log_{10} T - 10.525 + \frac{3860 \cdot y}{T} + \log_{10}\left(\frac{y}{1-y}\right),$$




Composition (at% C)
0
5
10
15
20
25
1600
1538°C
1493°C
L
1400
2500
δ
1394°C
γ + L
1200
1147°C
2.14
4.30
2000
γ, Austenite
Temperature (°C)
Temperature (°F)
1000
912°C
γ + Fe3C
1500
α + γ
800
727°C
0.76
0.022
600
α, Ferrite
hyper
α + Fe3C
Cementite (Fe3C)
1000
400
0
(Fe)
1
2
3
4
5
6
6.70
Composition (wt% C)

1.4 %

800°C

0.1

α