Unit 3 - Week 1

Course outline

How does an NPTEL online course work?
Week 0
Week 1
- Lecture 01 : Introduction
- Lecture 02 : Various Routes of steelmaking
- Lecture 03 : The Iron Blast Furnace
- Lecture 04 : Thermodynamics of BF ironmaking
- Lecture 05 : Thermodynamics of BF Ironmaking (continued)
- Week 1 Lecture Material
- Quiz : Assignment 1
- Week 1 Feedback Form

Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Download Videos
Assignment Solution
Live Interactive session
Text Transcripts

Assignment 1

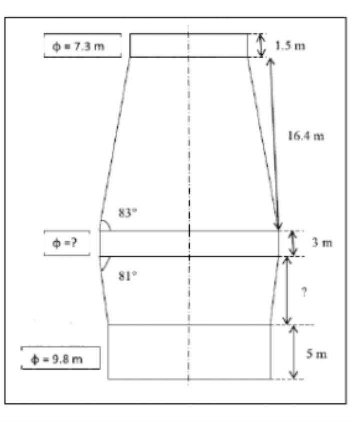
The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-09-30, 23:59 IST.

Common data for question 1 to 6

Some internal dimensions of the blast furnace are noted below.
Throat height - 1.5m
Throat diameter - 7.3m
Shaft angle - 83°
Shaft height - 16.4m
Belly height - 3m
Bosh angle - 81°
Hearth height - 5m
Hearth diameter - 9.8m
Iron notch - 1m above bottom of the hearth
Stock line - 1m below the top of the throat
The furnace produces 3800 THM/day.

Refractory lining thickness is 1m and it is made of fireclay bricks of density 2500kg/m^3. Standard brick size is: 0.23m x0.11m x0.06m and cost Rs.30 per brick.



1) The belly diameter of the blast furnace is ---------------- m

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 11.10,11.56

1 point

2) Bosh height of the blast furnace is -------------------------- m

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 4.73,4.92

1 point

3) Working height of the blast furnace is --------------------- m

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 24.23,25.22

1 point

4) Total inner height of the blast furnace is ------------------ m

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 30.11,31.34

1 point

5) Total refractory volume=------------------------------ m^3

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1010,1053

4 points

6) Calculate the total cost of the refractory lining. (2 points)

a. 24670000
b. 22567890
c. 20395000
d. 17005600

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

Common data for question 7 to 12

Given standard free energy change for the following reactions:

(a) $2Fe(s) + 3/2\ O_2(g) = Fe_2O_3\ (s)$ $\Delta G^\circ = -195450+61.38T$ cal/mol
(b) $3Fe(s) + 2\ O_2\ (g) = Fe_3O_4\ (s)$ $\Delta G^\circ = -265660 + 76.81T$ cal/mol
(c) $Fe(s) + ½\ O_2\ (g) = FeO(s)$ $\Delta G^\circ = -63200 + 15.47T$ cal/mol

7) Calculate the dissociation pressure of oxygen of Fe_2O_3 at 900°C. (3 points)

a. $3.2 \times 10^{-15}\ atm$
b. $6.6 \times 10^{-17}\ atm$
c. $4.5 \times 10^{-18}\ atm$
d. $4.6 \times 10^{-16}\ atm$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
d.

8) Calculate the chemical potential of oxygen of Fe_2O_3 at 900°C. (1 point)

a. $-82.3 Kcal/mol$
b. $-85.6 Kcal/mol$
c. $-70.5 Kcal/mol$
d. $-65.1 Kcal/mol$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

9) Calculate the dissociation pressure of oxygen of Fe_3O_4 at 900°C. (2 points)

a. $3.33 \times 10^{-16} atm$
b. $4.42 \times 10^{-19} atm$
c. $3.33 \times 10^{-18} atm$
d. $4.42 \times 10^{-17} atm$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
d.

10) Calculate the chemical potential of oxygen of Fe_3O_4 at 900°C. (1 point)

a. $-87.77 Kcal/mol$
b. $-92.13 Kcal/mol$
c. $-82.19 Kcal/mol$
d. $-76.66 Kcal/mol$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

11) Calculate the dissociation pressure of oxygen of FeO at 900°C. (2 points)

a. $1.62 \times 10^{-17} atm$
b. $4.59 \times 10^{-16} atm$
c. $3.15 \times 10^{-18} atm$
d. $4.56 \times 10^{-15} atm$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

12) Calculate the chemical potential of oxygen of FeO at 900°C. (1 point)

a. $-86.17 Kcal/mol$
b. $-90.11 Kcal/mol$
c. $-80.16 Kcal/mol$
d. $-76.66 Kcal/mol$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

Common data for question 13 to 18

Given standard free energy change data for following reactions

Reaction	Standard free energy change (Cal/mole)	
$C(s) + ½\ O_2(g) = CO(g)$	- 28200 - 20.16T	1
$C(s) + O_2(g) = CO_2(g)$	- 94250 - 0.27T	2
$2Fe(s) + 3/2\ O_2(g) = Fe_2O_3\ (s)$	-195450 + 61.38T	3
$3Fe(s) + 2\ O_2\ (g) = Fe_3O_4\ (s)$	- 265660 + 76.81T	4
$Fe(s) + ½\ O_2\ (g) = FeO(s)$	- 63200 + 15.47T	5

13) Calculate the equilibrium volume fraction of CO for the reaction $Fe_2O_3 \rightarrow Fe_3O_4$ at 900 °C. (3 points)

a. 0
b. 0.1
c. 0.15
d. 0.2

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

14) Calculate % CO utilization for the reaction $Fe_2O_3 \rightarrow Fe_3O_4$ at 900 °C. (1 point)

a. 90
b. 46
c. 84
d. 100

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
d.

15) Calculate the equilibrium volume fraction of CO for the reaction $Fe_3O_4 \rightarrow FeO$ at 900 °C (3 points)

a. 0.27
b. 0.20
c. 0.70
d. 0.73

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

16) Calculate the % CO utilization for the reaction $Fe_3O_4 \rightarrow FeO$ at 900 °C (1 point)

a. 20
b. 30
c. 73
d. 80

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

17) Calculate the equilibrium volume fraction of CO for the reaction $FeO \rightarrow Fe$ at 900 °C (3 points)

a. 0.27
b. 0.73
c. 0.37
d. 0.90

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

18) Calculate the % CO utilization for the reaction $FeO \rightarrow Fe$ at 900 °C (1 point)

a. 37
b. 57
c. 27
d. 87

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

19) Amount of carbon (in kg) required to produce one ton of iron from Fe_2O_3 for 45% direct reduction and rest indirect reduction in blast furnace is -----------------------------. (4 points)

a. 700 kg
b. 272 kg
c. 173 kg
d. 321 kg

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

20) With reference to question number 19, assess whether CO available after wustite reduction is sufficient to remove rest of the ore oxygen from higher oxides like hematite and magnetite. (2 points)

a. Yes
b. No

- a.
- b.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.