Lecture 41:Exercises on steelmaking

Contents

Lectures 3 to 5

I. What do you understand by 1 weight percent standard state? Discuss with reference to thermodynamic calculations on refining of hot metal to steel.
II. In a binary solution of Fe with an element x, what is the physical significance of ideal and nonideal behavior of the element X. Give example to illustrate the answer
III. What is the importance of slag in steelmaking?
IV. Why is there a difference in the structure of CaO and SiO_2?
V. Discuss the effect of addition of CaO to molten silica. At what percent addition of CaO the hexagonal structure of silica will be broken to independent SiO_4^{4-} ?
VI. Obtain an expression to calculate the basicity of slag which contains $CaO, MgO, FeO, SiO_{2,}\ Al_2O_3, P_2O_5$ from ionic approach
VII. What is the role of slag foaming in BOF and EAF steelmaking
VIII. Calculate the foaming index slag of composition $60\%\ \mathrm{CaO}, 35\%\ \mathrm{Al_2O_3}$ and $5\%\ \mathrm{S_iO_2}$ at 1773 K slag from the following data:
IX. $\eta_o = 3.5\ \frac{\mathrm{Kg}}{\mathrm{ms}}, \rho = 2500\ \frac{\mathrm{Kg}}{\mathrm{m^3,}}\ \gamma = 1.1\ \mathrm{N/m}$ and $\mathrm{d_b} = 0.005\ \mathrm{m}$ and 0.01m.

Lectures 6 to 8

I. Discuss the conditions to remove simultaneously carbon and phosphorus from hot metal.
II. What may be the cause of reversal of Mn from slag to metal and how can it be rectified?
III. What is the importance of carbon removal in steelmaking?
IV. What is rimming reaction?
V. Derive the conditions for removal of sulphur in iron melt containing C, Si, Mn,S, and P. Based on the conditions, discuss whether sulphur removal can be achieved efficiently in ironmaking or in steelmaking.

Lectures 11 to 20

1) Discuss the functions of a nozzle in converter steelmaking

2) Given the expressions in lecture 13, calculate for a 200 ton converter the following;

a. Diameter of a nozzle for 4 hole lance

b. Oxygen supply pressure
c. Momentum flow rate produced by the four hole nozzle
d. Jet penetration depth when oxygen is blown at (a) 3m lance distance, and (b)1.5 m lance distance
e. The effects produced by the jet on impinging the molten steel bath at distances mentioned in d

3) What is a foamy slag practice and what advantages this practice offers in electric steelmaking. How foamy slag is practiced (a) in plain carbon steelmaking and (b) in stainless steel making?

4) Increasing cost of electric energy demands to use chemical energy in electric steelmaking. In what different ways chemical energy can be used? Discuss

5) Consider 1000kg iron ore of composition $80\%\ \mathrm{Fe_2O_3}$ and 20% gangue minerals. Reduction of iron ore produces DRI in which oxygen is present as FeO.Calculate amount of free iron, amount of FeO and total gangue minerals for metallization ranging in between 85% to 95%free iron. Discuss the results with reference to usage of directly reduced iron in electric steelmaking.

6) In stainless steel making using high carbon ferrochrome, decarburization of the melt is required. Calculate the $\frac{chromium}{carbon}\ ratio$ as a function of temperature and partial pressure of CO.

7) What is a foaming slag? Explain the formation of foamy slag in EAF. What are its advantages in EAF steelmaking practice.

8) What is the role of oxygen lancing in EAF steelmaking?

9) What is an oxy-fuel burner? Describe its functions in EAF Steelmaking.

10)Explain how the metallurgical quality of DRI/HBI affects the electric power consumption in EAF

11) A EAF is operating with 100% scrap. What modifications would it be required to use chemical energy?

12) What is the equivalent carbon in DR and what is its significance?

13) Name the sources og CO and H2 generation in EAF steelmaking.

14) What are the requirements of injection of oxygen for decarburization and post combustion in EAF steelmaking?

15) Calculate the amount of CO and Oxygen required generating chemical energy 30 kWh/ton of steel.

16) Discuss the mechanism of foaming in EAF stainless steelmaking.

17) Calculate the supply of thermal energy in each case when 1000 kg scrap from 25^{o}C is heated to 250^{o}C, 300^{o}C and 400^{o}C

Llectures 21 to 40

Some problems are discussed in lecture 30. Below are some addition problems

1) What do you understand by the constitutional supercooling? Explain by taking a suitable example.

2) What are the necessary conditions for plane front solidification and dendritic solidification? Discuss with the help of a binary phase diagram by drawing concentration vs distance profile

3) What technological modifications would be required to convert a conventional slab caster of cross section 2000mm x 250mm to a high speed slab caster casting at 4m/minute. The tundish capacity may be chosen to 70 tons. Other dimensions, if required may be chosen.

4) Discuss the possibility of obtaining different microstructures when a plain carbon eutectoid steel is cooled from the austenitic region just above the eutectoid temperature

5) What does the bainite microstructure consist of? What is the microstructural difference between the upper and lower bainite.

6) Design a physical model of an industrial gas stirred ladle with an elliptical shape. Internal diameter of the ladle is 2.282m maximum and 2.082m minimum. Molten steel height is 2.46m and volume is $9.4\mathrm{m}^3$. Gas is injected at $70\ \mathrm{Nl/min}$ through the porous plug fitted at the bottom of the ladle. The scale of the physical model should be $1/3$. Bath temperature is $1600°\mathrm{C}$.

7) Design a physical model of a single strand slab caster tundish. The base length of the tundish is 3450mm, width 1100mm and height 1320mm. Tundish is rectangular shaped with slopping walls. Submerged ladle shroud diameter is 78mm. Volumetric flow rate of steel in the tundish is $224\ \mathrm{l/min}$. Scale of physical model $= 0.5$.

8) Let us design a 0.5- scale physical model to simulate the fluid flow behaviour for tapping of steel in the ladle. Molten steel is plunged from a height of 4m. Molten steel enters at velocity 15m/s velocity. The volume flow rate is $0.1\ \mathrm{m}^3$/s. The time required to fill the ladle of volume $45\mathrm{m}^3$ is approximately 8 minutes. Viscosity of steel $= 7 \times 10^{-3}\ \frac{\mathrm{kg}}{\mathrm{m.s}}$ and density is $7000\ \frac{\mathrm{kg}}{\mathrm{m}^3}$