

Full Marks: 70

Time: 3 hrs

Answer any Seven questions, taking at least Three from each Group

Group A

1. Attempt any Five questions, with brief to-the-point answers: (5 x 2)
 - a) Write the quantity of all inputs required to per THM.
 - b) What properties do these terms indicate – RDI, CSR ?
 - c) Within rotary kiln, a temperature of 1300 °C is reached, but no liquid phase forms, whereas within blast furnace, molten iron forms in this temperature. Explain.
 - d) Write the Boudouard reaction ; what are the reaction products below 1000 °C ?
 - e) Name the substances that can be injected through the tuyeres of a blast furnace
 - f) Why Mg-bearing flux is used in iron making in India along with lime stone ?
 - g) What is the usual hearth refractory and why is it used?
2. a) Describe briefly the sintering mechanism to produce fluxed sinter, clearly indicating the bond formation and the role of iron oxides.
b) Very briefly state your perception of iron making twenty years from now and the changes that you foresee in blast furnace practice. (6+4)
3. a) What is indicated by the presence of a Thermal Reserve Zone (TRZ) and Chemical Reserve Zone within a blast furnace ?
b) With the help of a diagram for reduction of wustite by CO gas, explain why 100 % indirect reduction of iron oxides to iron in the shaft of a BF is not probable ? (5+5)
4. a) Briefly explain the thermal balance in the blast furnace, and outline the influence of any two factors on thermal balance and TRZ.
b) With proper equations, describe the partition of S and Si in the blast furnace. (6+4)
5. a) Trace the changes in composition and viscosity of slag after it melts and comes down to the hearth. Name the factors that affect these properties and give the slag composition.
b) What is the scenario in front of the tuyeres of a blast furnace ? Describe briefly the thermal and chemical conditions. (6+4)
- 6 a) Outline the process flow chart in an integrated steel plant from raw materials to finished product.

b) Why blending of raw materials for ironmaking is needed ? What are the common technologies to achieve this ? (5+5)

7. Answer briefly (any Four): (4 x 2.5)

- a) Utility of process modeling and example
- b) Role of physical and mathematical modeling
- c) Modeling of system with suitable example
- d) Temkin model of Slag Theory
- e) Limitations of Blast furnace route of iron making, if any
- f) Cohesive zone in a blast furnace

Group B

8. (a) Describe briefly the pretreatment techniques to improve the coal mixture for coke production.

(b) In an integrated steel plant, a battery of tall coke ovens with dimensions 6.0m x 14.2m x 0.45m has been installed. Estimate the number of ovens required to produce blast furnace coke on the following basis:

- i) Hot metal production ----8600 tons/day
- ii) Coke rate ----- 480 kg /ton of hot metal
- iii) Coke oven useful volume---95%
- iv) Coal charge density -----1.0 ton/cum of useful volume
- v) Cycle time -----16 hrs
- vi) Yield from coal to coke ---- 70%
- vii) Yield from gross coke to BF coke--70%

(5+5)

9. (a) In what way DRI is different from sponge iron?

(b) Why degree of reduction is always higher than degree of metallization, except two points in their relationship curve.

(c) A rotary kiln is to be designed to produce 650 tons of DRI/day, using high grade haematite ore with 66% Fe on dry basis. The degree of metallization is 90%. Assuming carbon as negligible, estimate the requirement of ore per day and the kiln dimension on the basis of 0.65 tons of ore throughput per day per cu.m. of kiln useful volume and ratio of L/D as 20.

(3+2+5)

10. a) A modern blast furnace is producing hot metal at the rate of 2.5 tons/cu.m/day in terms of working volume. The working volume is 3000 cu.m and annual available days are 350. Estimate the following:

- i) Requirement of iron ore, taking 95% iron oxide as Haematite and balance

gangue. No provision has to be made for other losses (crushing, screening and LOI.)

- ii) If the rail transportation is adopted calculate the optimum combination of rake systems to be planned per month (taking 30 days). Standard box wagon with an effective volume of 35 cum will be used. The bulk density of ore is 2.0 and evacuation rates 800 tons/hr.

(7+3)

b) Explain how the charge distribution on a BF can affect its productivity.

11. (I) Describe briefly the effect of pulverized coal injection(PCI) in BF on raceway gas profiles.

(ii) Explain the implication of RR and CCP in regard to PCI.

(iii) Derive the relationship between quantity of coal injection and CCP, assuming 4% oxygen enrichment in the blast, carbon input in the raceway as 400kg/ton of hot metal(165tons/hr) and humidification of blast as 30gm/Ncum of air. Also requirement of oxygen for total combustion of injected coal is estimated as 220 K Ncu. m

(3+3+4)

12. Write short notes on any Three :

(10)

- a) Pelletization process
- b) Alkali problem in blast furnace
- c) DRI from rotary kiln – factors affecting metallization
- d) HTP -Effects on reaction equilibria and productivity
- e) Advantages of fluxed sinter as BF charge