

Advanced Master Course Process Technology of Metals (Part: Ferrous Process Metallurgy)

Prof. Dr.-Ing. D. Senk

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(1/2012)

R 223, Intzestraße 1, IEHK

Time: 10:00-11:00

Last name, first name:

Register No. (Matrikel-Nr.):

Signature: _____

Task	Points (max.)	Points	Signature	Approval date	Final points (total)
1	6				
2	8				
3	8				
4	6				
5	6				
6	8				
7	8				
Total:	50		Total after approval:		

Task 1: Pelletizing and Sintering **6 Points**

- 1.1 During the sintering process sinter bed can be divided into many zones. Which reaction takes place in burning and sintering zone? What is the temperature range of this zone? *(1.0 point)*
- 1.2 Sintering may be defined as “the agglomeration of fine particles into lump”. Give one advantage and one disadvantage of sintering process. *(1.0 point)*
- 1.3 What is the source of heat used in the sintering process of iron ore? *(0.5 point)*
- 1.4 Which factors are determining the quality of sinter and pellets?
(Give at least 3 factors) *(0.5 points)*

1.5 Water plays an important role in the formation of green pellets.

Describe 6 different formation steps between water and ore-particles.

(3.0 points)

Task 2: Blast Furnace

8 Points

2.1 What are the most important functions of coke in the blast furnace?

(Give at least 3 items)

(1.5 point)

2.2 What would happen if we run the blast furnace with cold blast in comparison to the usage of hot blast?

(Give at least 2 items)

(1.0 point)

2.3 Name at least all together six input and output materials of the blast furnace

(3.0 point)

2.4 What is typical temperature and chemical composition of

- (a) raceway gas and
- (b) top gas

which leaves the blast furnace?

(2.0 points)

2.5 What is the influence of PCI on the blast furnace process?

(0.5 point)

Task 3: Oxygen Steelmaking **8 Points**

3.1 What are the tasks of lime in steelmaking? *(1.0 point)*

3.2 a) Give the reaction of the most burned five elements of hot metal during the blowing process, and write also down the corresponding phases

(with [] = soluted in the melt

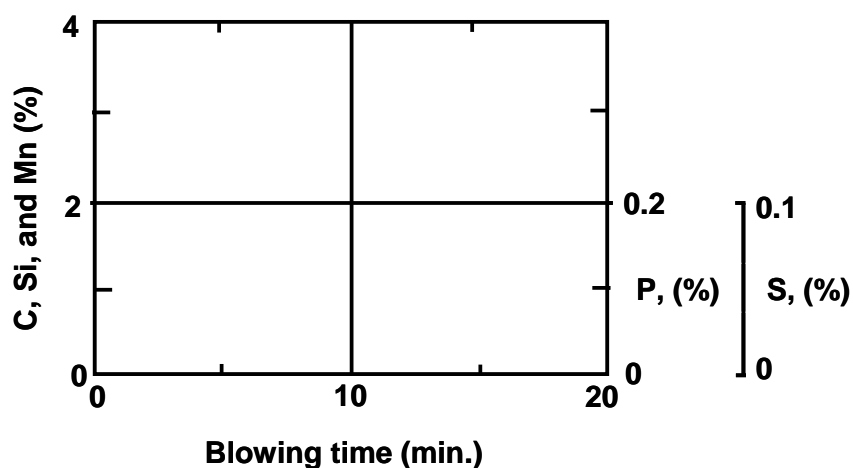
{ } = gaseous state

() = soluted in slag). *(2.5 points)*

b) Write the burning sequence of these five elements. *(1.0 points)*

- 3.3 Calculate how many kg of oxygen are needed per ton of hot metal during decarburization to remove the carbon from 4.55 wt.% to 0.05 wt.%
(2.5 points)

- 3.4 Sketch the combustion lines in the given diagram of the following elements C, Si, P, Mn and S for blowing time of 20 minutes.
(1.0 point)



Task 4 : Slags and Fluxes

6 Points

4.1 What are the metallurgical problems of slag after the viscosity is increased too much? (Give at least 2 answer) (1.0 point)

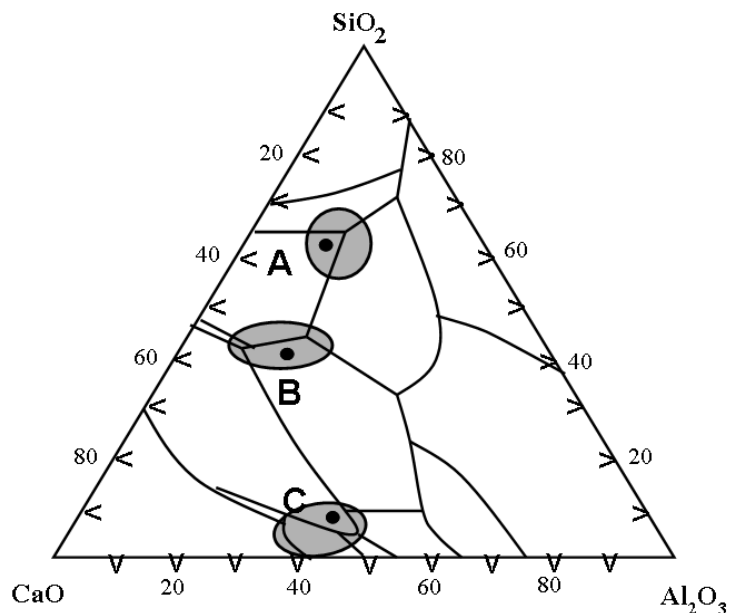
4.2 Besides increasing temperature, how can you decrease the viscosity of slag? (0.5 point)

4.3 A ternary diagram below is as a slag system composing of CaO-SiO₂-Al₂O₃:

(a) Indicate the slag composition of point A and C. (1.0 point)

(b) Estimate the slag basicity B1 at point B. (0.5 point)

(c) Which point represents the region of particular interest, e.g. desulphurization, for ladle metallurgy slag? (0.5 point)



4.4 What are the tasks of the ladle top slag? (Give at least 2 items) (1.0 point)

4.5 FeO-containing slag from EAF or BOF processes must be reduced after tapping in terms of oxygen activity. By which method can that be done?

(Give the chemical reaction formula) (1.0 point)

4.6 Why CaF_2 is sometimes used in iron- and steelmaking processes? (0.5 point)

Task 5: Electric Steelmaking **6 Points**

- 5.1 What are the advantages of steelmaking using an electric arc furnace in comparison to basic oxygen furnace?
(Give at least 2 items) *(1.0 point)*
- 5.2 How can diminish the consumption of graphite electrodes in EAF process?
(Give at least 2 items) *(1.0 point)*
- 5.3 Explain the procedure and also write down chemical reactions for generation of foaming slags in electric arc furnace process. *(1.0 point)*

- 5.4 DRI can be used as a partial substitute for scrap in electric arc furnace process.
- a) What are advantages of DRI's used? *(0.5 point)*
 - b) What are disadvantages of DRI's used? *(0.5 point)*

- 5.5 a) What is post combustion? *(0.5 point)*
- b) When the post combustion is working in the melting process, the beginning of the process or at the end of the process? *(0.5 point)*

- 5.6 What are the purposes of additional injection of oxygen or other fuel gas mixtures into the melts in electric arc furnace? *(1.0 point)*

Task 6: Secondary Metallurgy (Ladle Metallurgy) 8 points

6.1 What are the general objectives of “Secondary Metallurgy”?

(Give at least 4 items)

(2.0 points)

6.2 What are the following items meaning?

(1.0 point)

(a) VD

(b) AOD

6.3 a) What is Vacher-Hamilton equilibrium? (Give the value at 1600°C)

(0.5 point)

b) What is Sieverts’ s law?

(0.5 point)

6.4 What is the calcium treatment of steel in secondary steelmaking?

(Give at least 2 items)

(1.0 point)

6.5 What are the benefits of Ar stirring in the ladle?

(Give at least 3 items)

(1.5 points)

6.6 Designate 3 deoxidizers which are often used in the steel industry.

(1.5 point)

Task 7: Continuous Casting **8 points**

7.1 Define the term of “Microsegregation” and “Macrosegregation” and give their size range respectively. *(2.0 points)*

7.2 What is the “mushy zone” in solidification of steel? *(0.5 point)*

7.2 What is “nozzle clogging” and how can you suppress that? *(1.0 point)*

7.3 Give the origins of non-metallic inclusions in liquid steel (at least two items). *(1.0 point)*

7.4 Please term the heat transfer layers in a continuous casting mould and explain the heat transfer mode in each layer! *(2.5 points)*

7.5 What is the primary dendrite arm spacing and secondary dendrite arm spacing for equiaxed dendrites?

(Make a sketch and mark the PDAS and SDAS in the sketch) *(1.0 point)*