

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

Prof. Dr.-Ing. D. Senk

16-10-2008 (8:00-10.00 o'clock)

Hörsaal RS 4 (Rochusstraße 2-4)

(4/2008)

Last name, first name:

Register N^o (Matrikel-Nr.):

Signature: _____

Task	Points (max.)	Points	Signature	Approval date	Final points (total)
1	3				
2	3				
3	4				
4	4				
5	3				
6	4				
7	4				
Total:	25		Total after approval:		

Task 1: Pelletizing and Sintering

3 Points

1.1 Pellets production can be divided into 2 distinct stages:

Stage 1: Green pellet formation

Stage 2: Heat treatment

- (a) Give one way which can be used for every stage. *(1.0 point)*
- (b) What is the main function of bentonite in the first stage? *(0.5 point)*
- (c) Give the range of firing temperature in the second stage. *(0.5 point)*

1.2 Illustrate the difference between “Acidic sinter” and “Fluxed sinter”. *(1.0 point)*

Task 2: Blast Furnace

3 Points

- 2.1 Write the chemical reactions of (a) indirect reduction and (b) direct reduction of iron oxides in blast furnace. *(1.0 point)*
- 2.2 What is typical temperature and chemical composition of raceway gas? *(1.0 point)*
- 2.3 What is PCI in blast furnace operation? What is the influence of PCI on the blast furnace process? *(1.0 point)*

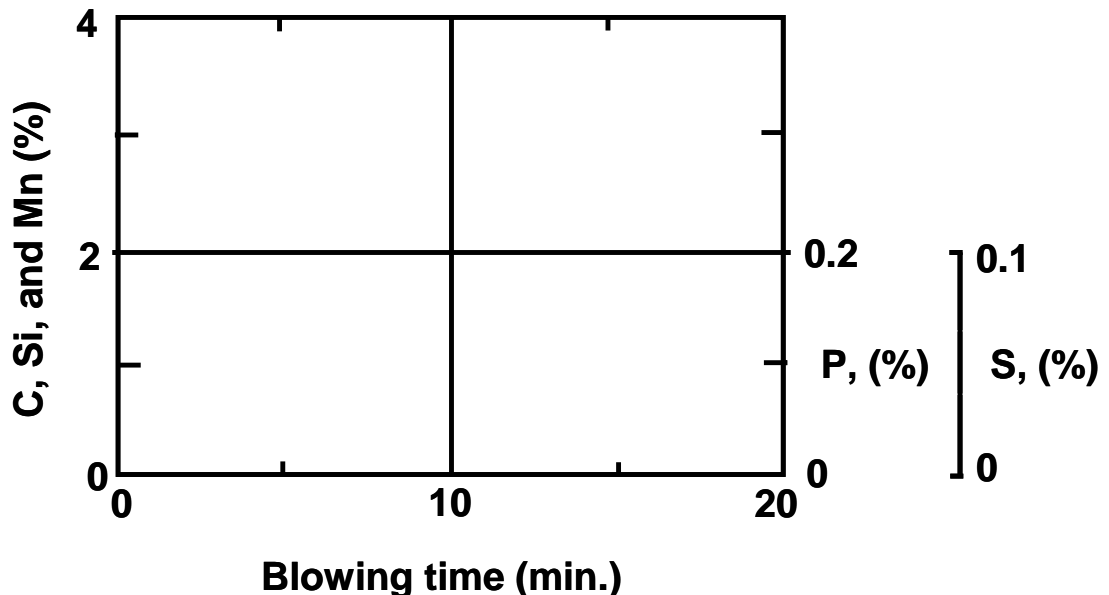
Task 3: Oxygen Steelmaking **4 Points**

In the converter hot metal is refined to steel. A charge of hot metal (HM) has the following chemical analysis:

Element	C	Si	Mn	P	O ₂
Mass %	4.45	0.32	0.34	0.12	-
kg/kmole	12	28	55	31	32

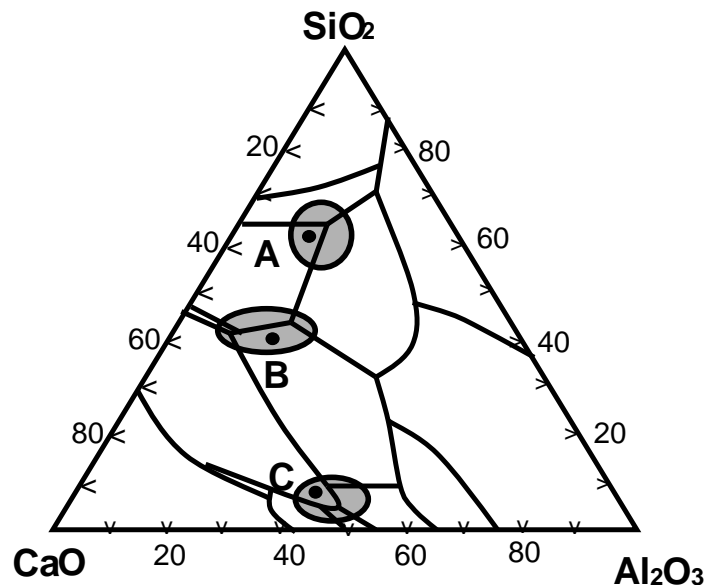
Assumptions: At the end of the blowing process the value of each element has to be 0.05%, there is no post combustion.

- 3.1 Calculate the amount in kg of oxygen per ton of hot metal needed for decarburization and write down the correspondent equations. (1.0 point)
- 3.2 During burn-off taking place in LD-converter, which element is removed from the melt as the first? Why? (1.0 point)
- 3.3 What is “manganese hump” during blowing in LD-converter operation? (Illustrate by equation) (1.0 point)
- 3.4 Draw the burn-off of the elements: C, Si, P, Mn, and S for a converter blowing time of 20 minutes. (1.0 point)



Task 4 : Slags and Fluxes **4 Points**

- 4.1 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 at point B. *(0.5 point)*
 - (c) Which point represents the region of particular interest for ladle metallurgy slag? *(0.5 point)*



- 4.2 Which component of a steelmaking slag is increasing the viscosity? *(0.5 points)*
- 4.3 What are the tasks of the ladle top slag? (Give at least 2 items) *(1.0 point)*
- 4.4 What is the main function of the so-called “Flux material” in iron and steel making? *(0.5 points)*

Task 5: Electric Steelmaking

3 Points

- 5.1 What are benefits of foaming slag in electric arc furnace process?
(Give at least 2 items) *(1.0 point)*
- 5.2 Explain the procedure and also write down chemical reactions for generation of foaming slag in electric arc furnace process. *(1.0 point)*
- 5.3 Draw a simple flow chart of the process with input and output materials of the electric arc furnace process. *(1.0 point)*

Task 6: Secondary Metallurgy (Ladle Metallurgy) **4 points**

- 6.1 What are the tasks of “Secondary Metallurgy” in view of chemical measures and in view of physical measures? (1.0 point)
- 6.2 What is the influence of calcium treatment of steel melt in secondary steelmaking? (Give at least 2 factors) (1.0 points)
- 6.3 Give the equation representing the de-sulfurization reaction of molten steel with lime and give the equilibrium constant for that equation. (1.0 point)
- 6.4 Give the equation which represents the de-oxidation reaction of molten steel with carbon and show schematically the decarburization curves at different atmosphere pressures, (use $P_{CO} = 0.1$ and 1.0 bar). (1.0 point)

Task 7: Continuous Casting (CC)

4 points

- 7.1 What are the tasks of continuous casting mould powder? (Give at least 2 items). *(1.0 point)*
- 7.2 Describe the term "negative strip time" of mould oscillation. (Sketch the figure and show equation if necessary). *(1.0 point)*
- 7.3 What is "Soft Reduction"?
What is "Liquid Core Reduction"? *(1.0 point)*
- 7.4 Classify the size range of "Macro-inclusion" and "Micro-inclusion". *(1.0 point)*