

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

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23-01-2009 (1/2009)

**Place: 1160|004 (Bibliothek 2),
Time: 13:30-15:30**

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 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

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

3.1 Write down the oxidation formula of C and P. *(1.0 point)*

3.2 Calculate the amount of oxygen in kg/tHM needed for silicon remove and write down the corresponding equations. *(1.0 point)*

3.3 What are the tasks of lime in Steelmaking? *(1.0 point)*

3.4 Where is nitrogen used in BOF or EAF and why? *(1.0 point)*

Task 4: Slags and Fluxes

4 Points

- 4.1 Give a general definition of "Slag basicity". (0.5 point)
- 4.2 What is the basicity of slag consisting of 50% CaO, 30% SiO₂ and 20% MgO? (0.5 point)
- 4.3 What are the tasks of ladle top slag? (Give at least 2 items) (1.0 point)
- 4.4 What is the main function of the so-called "Flux" in iron and steel industries? (Give the name and chemical formula of one flux) (1.0 point)
- 4.5 FeO containing slag must be reduced in terms of oxygen activity. By which method can that be done? (Give the chemical reaction formula) (1.0 point)

Task 5: Electric Steelmaking

3 Points

- 5.1 What are the advantages of foaming slag in Electric Arc Furnace process?
(0.5 point)
- 5.2 Is it possible to use hot metal as input charging materials in the AC-EAF process?
(0.5 point)
- 5.2 Explain the procedure and also write down chemical reactions for generation foaming slag in electric arc furnace.
(1.0 point)
- 5.3 What are benefits of DRI used in electric arc furnace process?
(Give at least 2 items) (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 point)*
- 6.3 How is Ca added to the melt? and what is the reason for that method? *(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 Give the size ranges of "Macro-inclusion" and "Micro-inclusion".

(0.5 point)

7.5 What is the "Leiden frost" temperature?

(0.5 point)