

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

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(2/2009)

Hörsaal H201, Intzestraße 3, IME

Time: 9:00-10:00

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				
<b>Total:</b>	<b>50</b>		<b>Total after approval:</b>		

## **Task 1: Pelletizing and Sintering**

**6 Points**

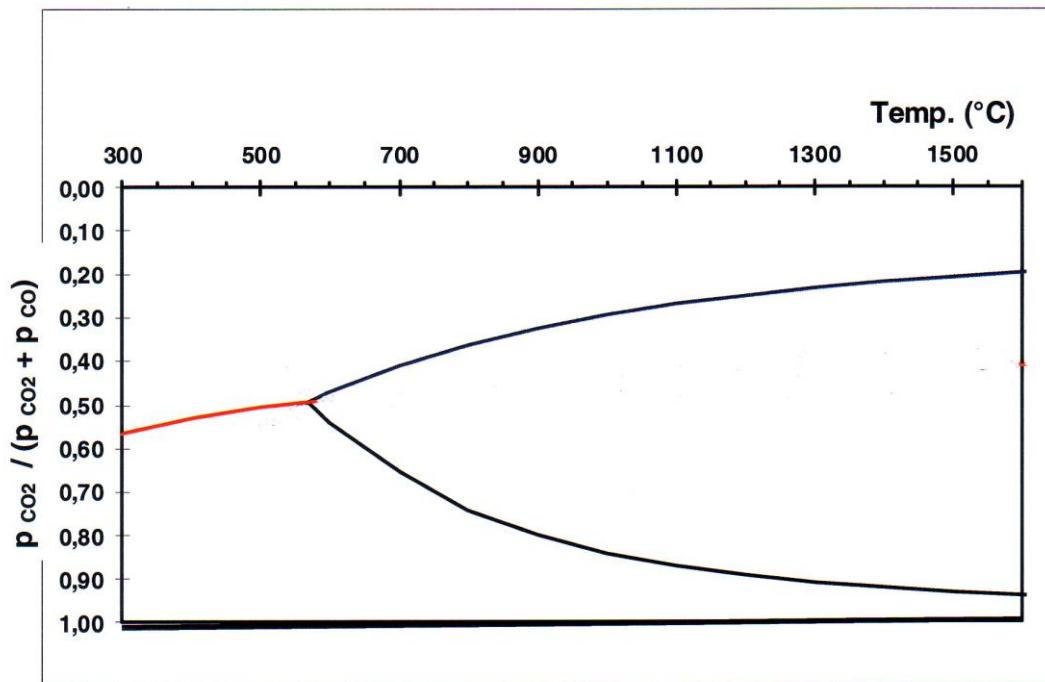
- 1.1 What are the benefits of the agglomeration processes?  
(Give at least 2 items) *(1.0 point)*
- 1.2 Water plays an important role in the formation of green pellets. *(3.0 points)*  
Describe 6 different formation steps between water and ore-particles.
- 1.3 Name three pelletizing aggregates used for firing of green pellets. *(1.5 point)*
- 1.4 What is the meaning of “Super Fluxed sinter”? *(0.5 point)*

## Task 2: Blast Furnace

**8 Points**

2.1 Below is Baur-Glaessner Diagram:

- (a) Illustrate the areas where hematite, magnetite, wustite and iron are stable. (2.0 points)
- (b) Draw a curve and give equation to represent Boudouard reaction. (1.0 point)



- 2.2 What are the most important functions of coke in the blast furnace?  
(Give at least 2 items) (1.0 point)

2.2 Define the following terms:

(a) Cohesive zone (0.5 point)

(b) Raceway gas (0.5 point)

2.3 Write down the chemical reactions of:

(a) Indirect reduction

*(0.5 point)*

(b) Direct reduction of iron oxides in blast furnace.

*(0.5 point)*

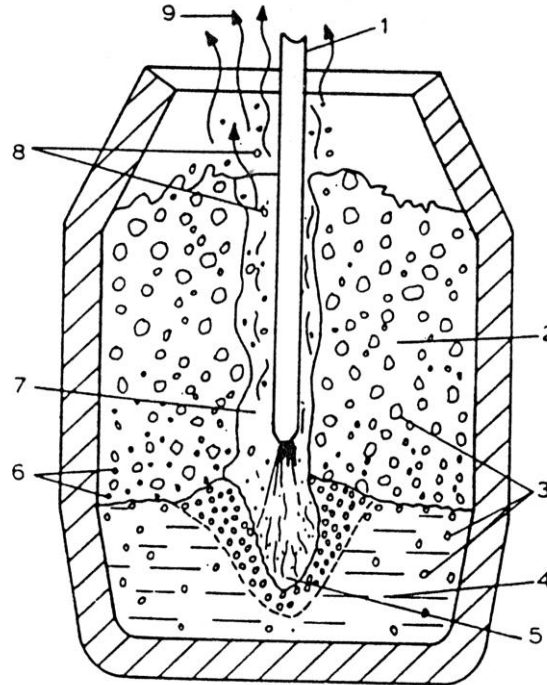
2.5 What is PCI in blast furnace operation? What is the influence of PCI on the blast furnace process? *(1.0 point)*

2.6 What is (a) the typical temperature and (b) carbon content of hot metal produced from blast furnace? *(1.0 point)*

### **Task 3: Oxygen Steelmaking**

**8 Points**

3.1 The drawing shows the converter during the main phase of decarburisation.  
Name the numbers 1-8 (4.0 points)



3.2 In which process [N] content of liquid raw steel is higher and why?

(a) BOF

(b) EAF

(1.0 point)

3.3 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 <sub>2</sub>
Mass %	4.45	0.32	0.34	0.12	-
M, 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.

(a) Write down the oxidation formula of silicon and phosphorus. (1.0 point)

(b) Calculate the amount of oxygen in kg/tHM needed for de-siliconization and write down the corresponding equations. (1.0 point)

3.4 What is “manganese hump” during blowing in LD-converter operation?  
(Sketch the behaviour of Mn and give chemical reaction) (1.0 point)

## **Task 4 : Slags and Fluxes**

**6 Points**

4.1 (a) Give a general definition of “Slag basicity”. *(0.5 point)*

(b) Give equation represent the formation of di-calcium silicate. *(0.5 point)*

4.2 Which two main factors influence the viscosity of molten slag? *(1.0 point)*

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” in iron and steel industries?  
Give the name and the chemical formula of at least 2 kinds. (2.0 points)

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** **6 Points**

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5.1 What are the advantages of steelmaking using an electric arc furnace?  
(Give at least 2 items) *(1.0 point)*

5.2 What are advantages of foaming slag in electric arc furnace process?  
(Give at least 2 items) *(1.0 point)*

5.3 Explain the procedure and also write down chemical reactions for generation of foaming slag in electric arc furnace process. *(1.0 point)*

5.4 Draw a simple flow chart of the process with input and output materials of the electric arc furnace process. *(1.0 point)*

5.5 What are benefits of DRI used in electric arc furnace process?  
(Give at least 2 items) *(1.0 point)*

5.6 What is post combustion? and how can it take place in the EAF? *(1.0 point)*

**Task 6: Secondary Metallurgy (Ladle Metallurgy) 8 points**

6.1 What goals of “Secondary Metallurgy” can be reached by:

(a) Chemical measures (0.5 point)

(b) Physical measures (0.5 point)

6.2 What are the main factors necessary to obtain low phosphorus contents in the finished steel? (1.0 point)

6.3 Which method can be used for the determination of oxygen activity of steel? (1.0 point)

6.4 Give the equation representing the de-sulphurization of molten steel and give the equilibrium constant. (1.0 point)

6.5 What is Vacher-Hamilton equilibrium?

What is Sieverts' law?

*(2.0 points)*

6.6 What are the benefits of Ar stirring in the ladle?  
(Given at least 2 items)

*(1.0 point)*

6.7 Give the name of industrial metallurgical processes that can be used to remove gases from steel melt. (Give at least 2 items)

*(1.0 point)*

**Task 7: Continuous Casting (CC)** **8 points**

7.1 Give the definitions for the following:

(a) Micro-inclusions (0.5 point)

(b) Micro-segregation (0.5 point)

7.2 What are the tasks of continuous casting mould powder?  
(Give at least 2 items). (1.0 point)

7.3 Give the main composition of the Casting Flux. (1.0 point)

7.4 What is the purpose of the mould oscillation during casting? *(1.0 point)*

7.5 Describe the term "negative strip time" of mould oscillation.  
(Sketch the figure and show equation) *(1.0 point)*

7.6 What is the "Leidenfrost" phenomenon? *(1.0 point)*

7.7 What is nozzle clogging? *(1.0 point)*

7.8 What is the meaning of “SEN” in continuous casting?

*(0.5 point)*

7.9 Which material is almost applied for the fabrication of tundish stopper rod?

*(0.5 point)*