

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

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(3/2011)

Hörsaal H 222, Intzestraße 1, IEHK

Time: 10:00-11:00

Last name, first name:

Register No. (Matrikel-Nr.):

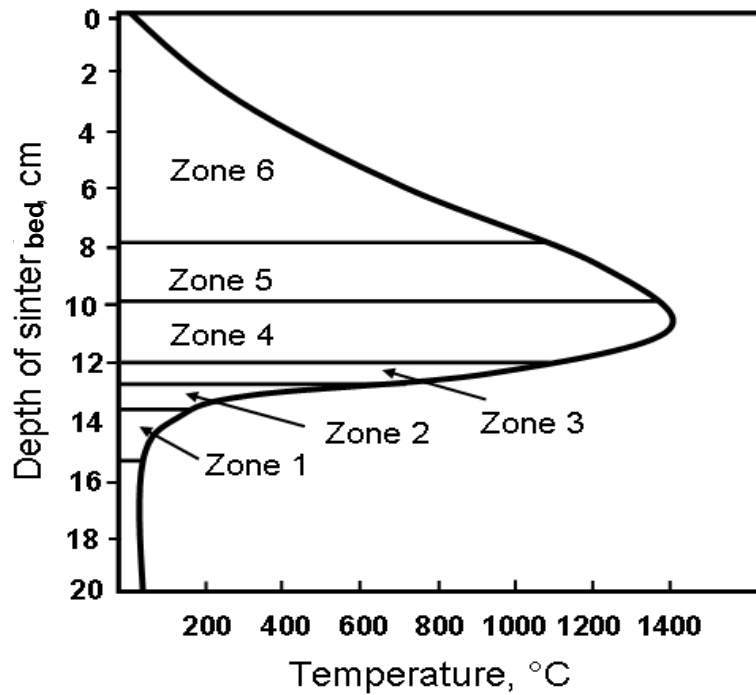
Signature: _____

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 In the following diagram you can see the zones during the sintering process and the distribution of the temperature. Give the name for these zones.

(3.0 point)



1.2 What is the meaning of “Super Fluxed sinter” *(0.5 point)*

1.3 Pellet production can be divided into 3 distinct stages:

Stage 1 – Preparation of raw materials

Stage 2 – Formation of green pellets

Stage 3 – Firing of green pellets

- (a) Give the grain size of iron ore to be suitable for pelletizing. *(0.5 point)*
- (b) Give at least one aggregate which can be used for stage 1 *(0.5 point)*
- (c) What is the function of bentonite in the second stage? *(0.5 point)*
- (d) What is the main task of the firing step? *(0.5 point)*
- (e) Give the range of firing temperature in stage 3. *(0.5 point)*

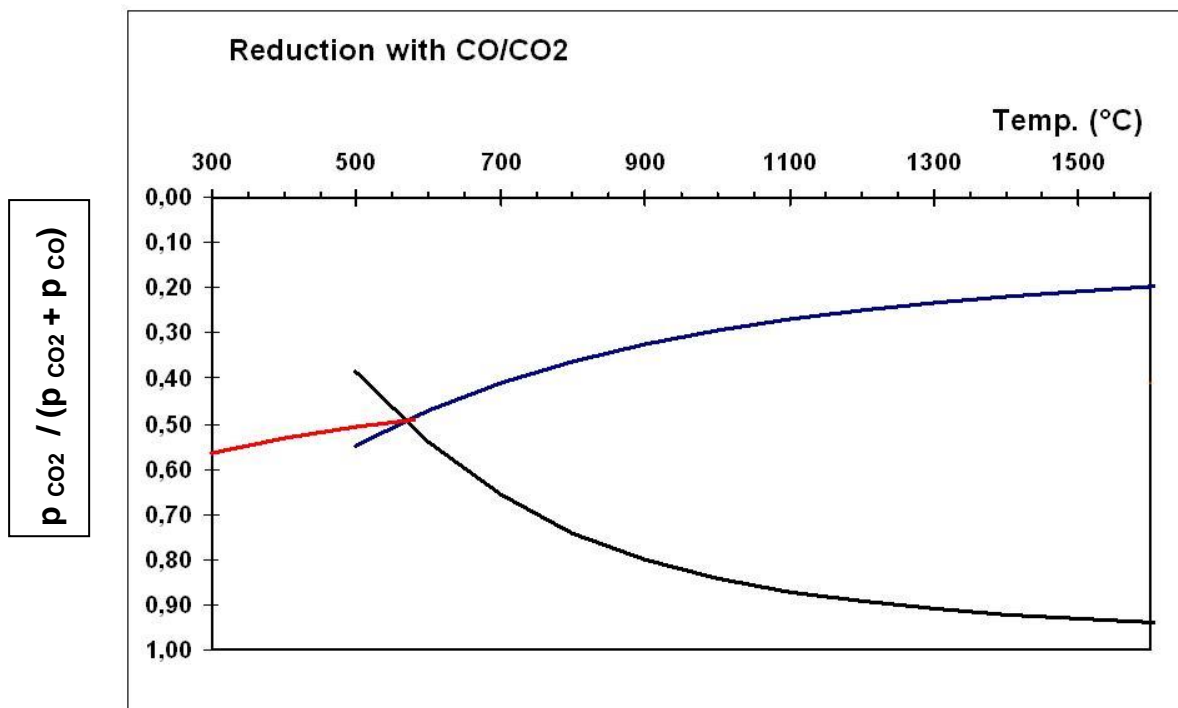
Task 2: Blast Furnace

8 Points

2.1 What is typical temperature and chemical composition of (a) raceway gas and (b) top gas which leaves the blast furnace? (2.0 points)

2.2 The Baur-Glaessner-diagram for the reduction of iron oxide by CO/CO₂ gas mixture is shown in the picture below.

(a) Please indicate and label the areas where hematite, magnetite and iron are stable! (2.0 points)



(b) Give the temperature and the CO/CO₂-pressure where iron, wustite, hematite and magnetite are coexisting. (1.0 point)

2.3 Give an example of reductions or materials that can be injected into blast furnace (1.0 point)

- 2.4 a) What is the temperature and what is the concentration of sulphur of the hot metal tapping from BF? (1.0 point)
- b) What reactions are happening between hot metal and slag during the desulphurisation? (0.5 point)
- c) Why is sulphur removal from hot metal much easier than that from raw steel? (0.5 point)

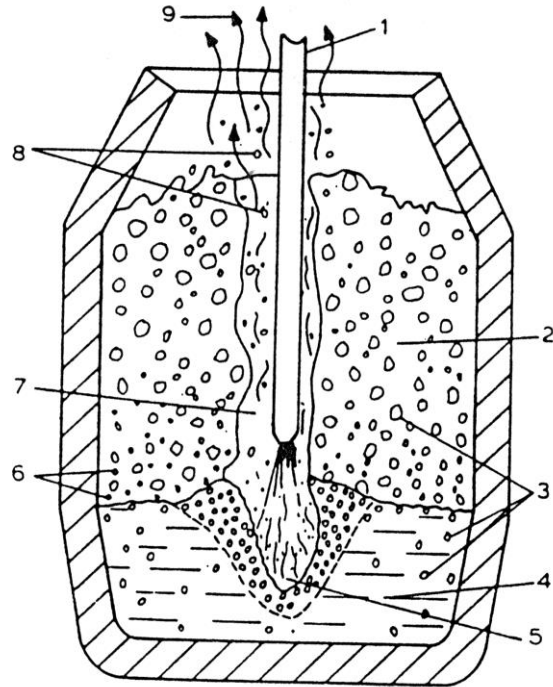
Task 3: Oxygen Steelmaking **8 Points**

- 3.1 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)*

- 3.2 a) What are the tasks of lime in steelmaking?
(Give at least 2 items) *(1.0 point)*

- 3.3 a) What is OBM process? *(0.5 point)*

3.4 The drawing shows the converter during the main phase of decarburisation.
Name the numbers 2, 3, 4, 5, 6 and 8 (3 points)



Task 4 : Slags and Fluxes **6 Points**

- 4.1 A Slag system consists of such components like P_2O_5 , Al_2O_3 , CaO , MgO and SiO_2 . Give the equation to explain the “Basicity (or Basicity Index)” of this slag system. *(1.0 point)*
- 4.2
- a) Please sketch the ternary system diagram of $CaO-Al_2O_3-SiO_2$ at 1600 °C with equilibrium (or saturation) lines. *(1.5 point)*
 - b) Draw the line where $B_1=1$ in this ternary system diagram. *(0.5 point)*
 - c) Which point represents the region of particular interest for ladle metallurgy slag? *(0.5 point)*

4.3 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 at least 2 items) (1.0 point)

4.4 (a) What happens to steel melt and slag if the slag viscosity increases?
(0.5 point)

(b) Which components of a steelmaking slag are the network builders?
(Give at least 2 components) (1.0 point)

Task 5: Electric Steelmaking

6 Points

- 5.1 Draw a simple flow chart of the process with input and output materials of the electric arc furnace process. *(2.0 point)*
- 5.2 a) What are the advantages of foaming slag in electric arc furnace process?
(Give at least 2 items) *(1.0 point)*
- b) Explain the procedure and also write down chemical reactions for generation of foaming slags in electric arc furnace process. *(1.0 point)*

- 5.3 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)*

- 5.4 What are the purposes of additional injection of oxygen or other fuel gas mixtures into the melts in electric arc furnace? *(1 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 a) What is Vacher-Hamilton equilibrium? (Give the value at 1600°C) (0.5 point)
b) What is Sieverts’s law? (0.5 point)
- 6.3 What is the [N]-activity in liquid steel under pure nitrogen atmosphere of 1 atm at 1600°C? (1.5 point)
Given: $\log_{10}K_N = -\frac{285}{T} - 1.21$

- 6.4 What is the calcium treatment of steel in secondary steelmaking?
(Give at least 2 items) *(1.0 point)*
- 6.5 a) Give the equation representing the de-phosphorization reaction of molten steel with lime and give the equilibrium constant for that equation. *(1.0 point)*
b) What are the main factors necessary to obtain low phosphorus contents in the finished steel? (Give at least 2 items) *(1.0 point)*
- 6.6 Which method can be used for the determination of oxygen activity of steel?
(0.5 point)

Task 7: Continuous Casting **8 points**

- 7.1 What is the
- (a) “SEN” in continuous casting ? *(0.5 point)*
 - (b) “Mushy Zone” in solidification of steel ? *(0.5 point)*

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

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

- 7.4 It is well known that during continuous casting the mould is oscillating.
- a) Please give a typical value of the frequency and amplitude of the mould oscillation, respectively. *(1.0 point)*
 - b) Describe the term "negative strip time" of mould oscillation and sketch the figure. *(1.0 point)*
 - c) Give the sketch of the formation of oscillation marks *(1.5 points)*
 - d) What is the influence of an increasing of "Negative strip time" on the quality of steel cast? *(0.5 point)*