Rheinisch-Westfälische Technische Hochschule Aachen

Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2008-02-07

Last name, first name: **Matrikel-Nr.:**

Signature:

Task	Points (max.)	Points	Signature	Approvaldate	Finalpoints (total)
1	5				
2	5				
3	5				
4	5				
5	5				
6	5				
7	5				
8	5				
9	5				
10	5				
Total:			**Total after approval:**		

Mastercourse

Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk   **2008-02-07**

1. Task: Pelletizing und Sintering   **5 points**

a) Please name

     1.   three targets

     2.   three methods and

     3.   two processes

of iron ore preparation.

         4,0 points

b) Where do the respective processes of iron ore preparation from a) generally take place:

     1.   at the place of iron ore mining?

     2.   at the place of iron ore use?

         1,0 points

2. Task: Metallurgical Coke   5 points

a) Give a definition and the target of the coking process.

1,0 points

b) Give the reason, why different cokes are mixed for the coking process.
(at least 2 answers)

1,0 points

c) What are the effects of charging qualitative bad coke on the blast furnace
process? Name two examples.

1,0 points

d) What are the qualitative effects of the following modifications on the specific coke
consumption (kg coke/t HM) in blast furnaces?
(For each question is only one answer (cross) allowed)

   a) Increasing of the blast temperature

   ☐ increasing specific coke rate

   ☐ decreasing specific coke rate

   b) Increasing of the blast humidity

   ☐ increasing specific coke rate

   ☐ decreasing specific coke rate

   c) Increasing the O_2-content of the hot blast

   ☐ increasing specific coke rate

   ☐ decreasing specific coke rate

1,5 points

e) Name one disadvantage for the use of coke in the blast furnace.

0,5 points

3. Task: Blast Furnace   5 points

a) What is the so called burden for the blast furnace? Name at least three
   components of the burden.

1,5 points

b) What are "direct reduction" and "indirect reduction" in the blast furnace? What is
   the temperature-limit between these reduction types?

1,5 Points

c) What is the task of nitrogen in the blast furnace?

0,5 points

d) Explain in keywords the production and feeding of hot blast in blast furnaces.
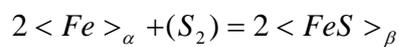
1,5 points

4. Task: Thermodynamics   5 points

a) What does the law of Heß say?

1,0 points

b) Calculate the equilibrium temperature of the reaction:

$$2 <Fe>_{\alpha} +(S_2) = 2 <FeS>_{\beta}$$

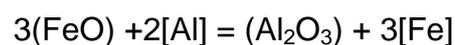when the equilibrium partial pressure of sulphur amounts to $p_{s_2} = 10^{-10}$

Given:

$$R = 8{,}3143 \, J \,/\, mol \; K$$

$$\Delta G^0 = (-300495 + 105{,}10T)\frac{J}{mol}$$

3,0 points

c) Write down the formular of the equilibrium constant for the reaction:

$$3(FeO) + 2[Al] = (Al_2O_3) + 3[Fe]$$

1,0 points

5. Task: Converter   5 points

a) Due to several reasons addition of lime during the BOF process is necessary. Name two of these reasons!

1,0 points

b) Hot metal of the following composition

Element	C	Si	Mn	P	O_2
Mass.-% in HM	4,45	0,50	0,50	0,04	---
Mole mass [g/mole]	12	28	55	31	32

is refined.

1. How much SiO_2 [kg] is generated per ton of hot metal, if 0,49 mass-% [Si] are oxidised?   (2,5 points)

2. How much lime [kg] is needed per ton of hot metal, if a slag basicity of B=3,8 is required?   (1,0 points)

3. Why is a high content of (FeO) in the slag necessary for effective dephosphorisation?   (0,5 points)

4,0 points

6. Task: Direct and Smelting Reduction   5 points

a) Explain the Midrex-Process.

   1. Facility

   2. Reduction process

   3. Gas treatment

                                                     1,5 points

b) Name three products of "alternative steel making processes".

                                                     1,5 points

c) Give one equation for the gas reforming of direct reduction processes.

                                                     0,5 points

d) In a Midrex plant gas reforming is done by the help of a catalyser.

   This catalyser of the gas reformer is:

   (only one answer (cross) is allowed!)   **0,5 points**

               ☐ nickel

               ☐ manganese

               ☐ platinum

e) Name 2 essential differences between direct reduction processes in comparison to steel making in blast furnace and converter.

1,0 points

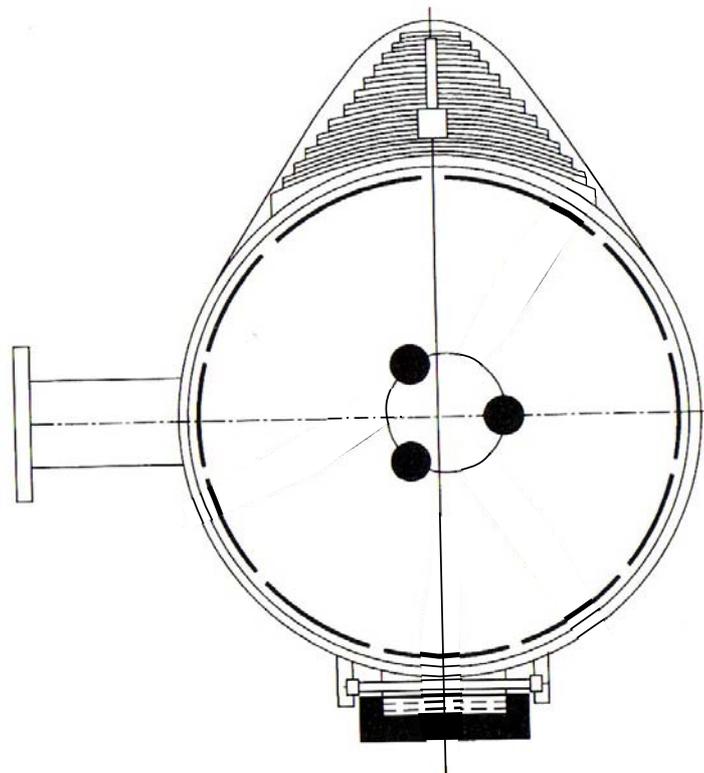## 7. Task: Electric Steelmaking   5 points

a) Name two advantages of electric steelmaking processes in comparison to
    steelmaking by blast furnace and converter.

    1,0 points

b) Electric arc furnaces can be operated by use of 4 burners. Sketch standard
    positions of these burners into the drawing below.

    2,0 points

c) There are two construction types of electric arc-furnaces: AC- and DC-EAF. Name two differences between this two construction types!

2,0 Points

	DC-EAF	AC-EAF
Difference 1		
Difference 2		

8. Task: Secondary Metallurgy: 5 points

a) Deduce the oxygen-potential in a common form, starting from a reaction between
    a pure metal [Me] and in the melt solved oxygen [O].   **3,0 points**

b) What are the tasks of slags in secondary metallurgy?
    (At least three answers)   **1,5 points**

c) Name an equation describing the pressure dependency of nitrogen solubility in
    steel melts.

                                                                   0,5 points

9. Task: Continuous Casting   5 points

a) What is the dummy-bar?

   Describe the start of a sequence in continuous casting.   **2,5 points**

b) The strands of a two-strand-continuous caster have the dimensions 1785 mm x 250 mm and a metallurgical length of 35,15 m. The casting speed is constantly 0,75 m/min. The density of liquid steel is 7 g/cm³.

   Calculate the casting constant k.

                                                                   2,5 points

10. Task: Protection of Environment, Recycling   5 points

a) Give a definition for Sustainable Development.

1,0 points

b) Name 4 potentials for the reduction of the specific energy consumption in steel making.

2,0 points

c) Name 4 residual and circulating materials produced in a steel production plant.

2,0 points