Rheinisch-Westfälische Technische Hochschule Aachen

Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2007-02-08

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   **2007-02-08**

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

a) Several binding mechanisms occur during the hardening process of green pellets made from magnetite iron ore. Fill the binding-mechanism, the atmosphere and the temperature range into the table below.

5,0 points

	Hematit	Hematit	Magnetite	Slag
Type of binding-mechanism		Recrystallisation of Hematite		
Atmosphere				
Temperature				> 1000°C

2. Task: Metallurgical Coke   5 points

a) Give a definition of the coking process.

1,0 points

b) Give the reason, why different cokes are mixed for the coking process.

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 coke
    consumption in blast furnaces?
    (For each question is only one answer (cross) allowed)

    a) Increasing of the blast temperature
    - ☐ increasing coke rate
    - ☐ decreasing coke rate

    b) Increasing of the blast humidity
    - ☐ increasing coke rate
    - ☐ decreasing coke rate

    c) Increasing the O_2-content of the hot blast
    - ☐ increasing coke rate
    - ☐ decreasing 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) In which form, iron ore can be charged into the blast furnace and what grain size (in cm) does the fraction approximately have?

2,0 points

a) Write down the oxidation reactions of the iron oxides in blast furnaces.

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.

1,0 points

4. Task: Thermodynamics   5 points

a) The pressure of one mole of an ideal gas at standard temperature is doubled.
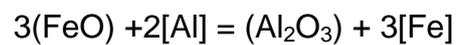   Calculate the change of the free enthalpy.

   4,0 points

 Given:

$$R = 8,3143 \ Jmol^{-1}K^{-1}$$

$$pV = nRT$$

$$dG = Vdp - SdT$$

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

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

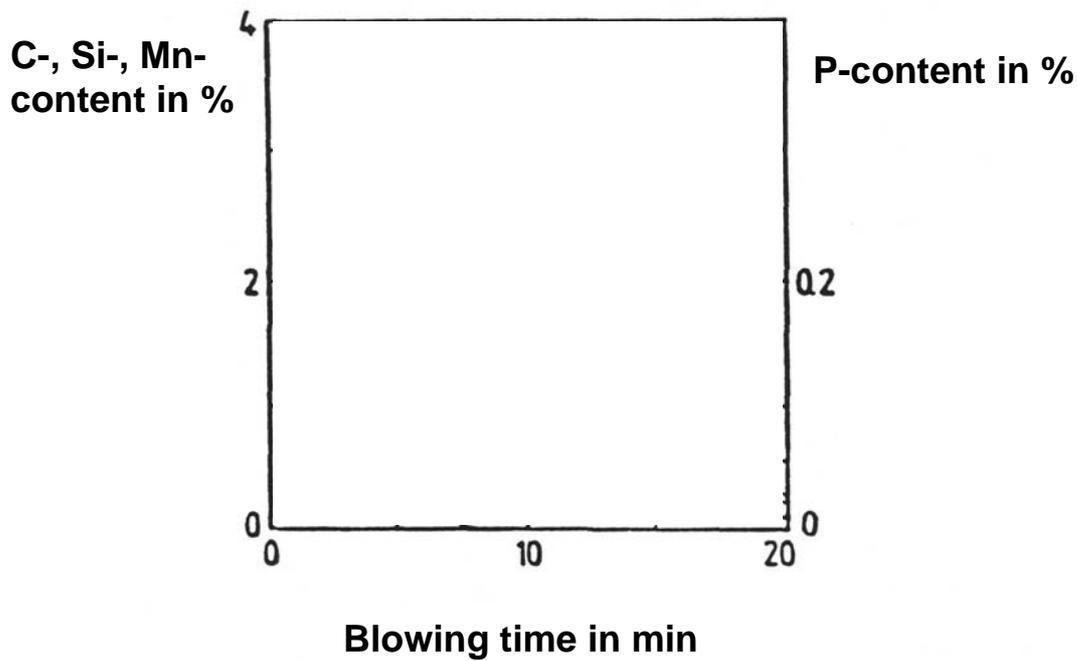   **1,0 points**

5. Task: Converter   5 points

a) Sketch the combustion lines in the given diagramme of the elements C, Si, P and
    Mn for a blowing time of 20 minutes.

2,0 points

**C-, Si-, Mn-
content in %**

P-content in %

4

2   0.2

0   0
 0   10   20

Blowing time in min

b) Sketch schematically a LD-converter and the fluid flows during blowing.

2,5 points

c) Which element is oxidised fastest at the beginning of the refining process?
(Only one answer (cross) is allowed)   **0,5 points**

    ☐ Iron

    ☐ Manganese

    ☐ Carbon

    ☐ Silicon

    ☐ Sulphur

    ☐ Phosphorus

6. Task: Direct and Smelting Reduction   5 points

a) Name 4 differences between the direct reduction process and the conventional iron and steel production in blast furnace and BOF.

2,0 points

b) Write down one equation of the gas reforming for direct reduction processes.

0,5 points

c) Give one example for a direct reduction process and one for a smelting reduction process.

1,0 points

d) Which of the following gases have a reducing and which have an oxidizing effect?

1,5 points

H_2 CO_2 Ar   CO H_2O He

7. Task: Electric Steelmaking   5 points

a) 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		

b) Hot heel is state of the art for steel making in EAF. What is hot heel? Name three
   advantages of hot heel in EAF.

1,5 points

b) An EAF with a power of 120 MW is used to melt 100 tons scrap. The efficiency of
   electrical energy during melting phase is 70%. How long will it take until 100 tons
   scrap completely melt?
   In this example only electric energy is used.
   (The needed energy to melt one ton scrap is 375 kWh).

1,5 points

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 one process for desulphurisation in secondary steel making.

                                                                         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 the 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 energy reduction in steel industry.

2,0 points

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

2,0 points