Rheinisch-Westfälische Technische Hochschule Aachen

Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2010-08-27

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:**		

For each correct partial answer: 0,5 points till the maximum reachable number of points

Mastercourse

Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk   **2010-08-27**

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

a) Please name

      1.   three targets,

      2.   two processes

of iron ore preparation.

2,5 points

b) Name three process steps of iron ore preparation.

1,5 points

c) Where do the respective processes of iron ore preparation sintering and pelletizing generally take place; at the place of iron ore mining or at the place of iron smelting?

1,0 points

2. Task: Metallurgical Coke   5 points

a)   Why is it necessary to cool down metallurgical coke after the coking process?

0,5 points

b)   Name and describe two ways to cool down metallurgical coke extensive.

2,0 points

c)   What is the average process time of the coking process?

0,5 points

d)   Give two "disadvantages" of using coke in the blast furnace.

1,0 points

e)   There are several options to reduce the specific coke consumption in blast fur-
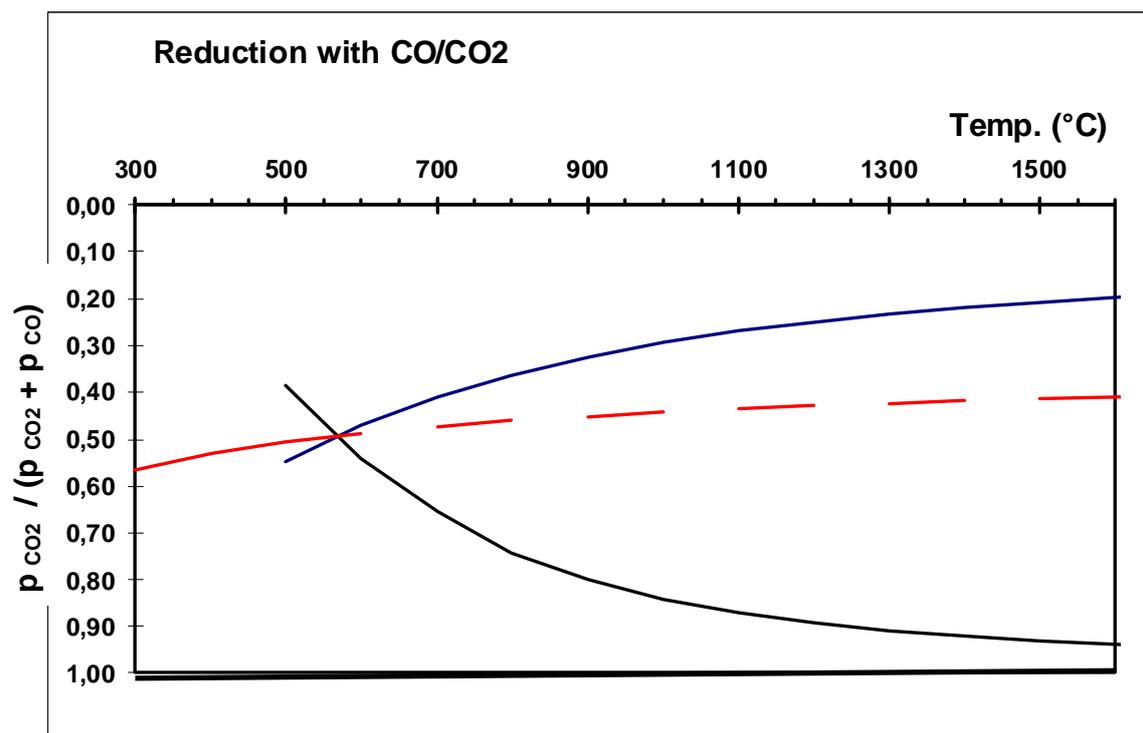   naces. Name at least two of these options.

1,0 points

3. Task: Blast Furnace 5 points

a) Enclosed you find the Baur-Glaessner-Diagram for reduction of Ironoxides with CO/CO_2-Gasmixtures.

Characterize the fields in which Hematite, Magnetite, Wustide and Iron are stable.

2,0 points

Reduction with CO/CO2

Temp. (°C)

Y-axis: $p_{CO_2} / (p_{CO_2} + p_{CO})$

X-axis values: 300, 500, 700, 900, 1100, 1300, 1500

Y-axis values: 0,00 0,10 0,20 0,30 0,40 0,50 0,60 0,70 0,80 0,90 1,00

b) Name two tasks of the blast furnace top charging device.

1,0 points

c) Where is the "cohesive zone" in the blast furnace and what happens in the "cohesive zone"?
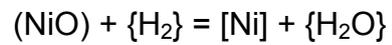
1,0 points

d) What are the so-called "coke-windows" in the blast furnace, which task do they fulfill?

1,0 points

4. Task: Thermodynamics   5 points

a) Calculate the equilibrium constant at 750°C for the reaction:

$$(NiO) + \{H_2\} = [Ni] + \{H_2O\}$$

Given:

1. $[Ni] + \frac{1}{2}\{O_2\} = (NiO)$ $\Delta G^o = -244555 + 98{,}53*T$ [J/mol]

2. $\{H_2\} + \frac{1}{2}\{O_2\} = \{H_2O\}$ $\Delta G^o = -246438 + 54{,}81*T$ [J/mol]

R = 8,3143 kJ/kmol*K

5,0 points

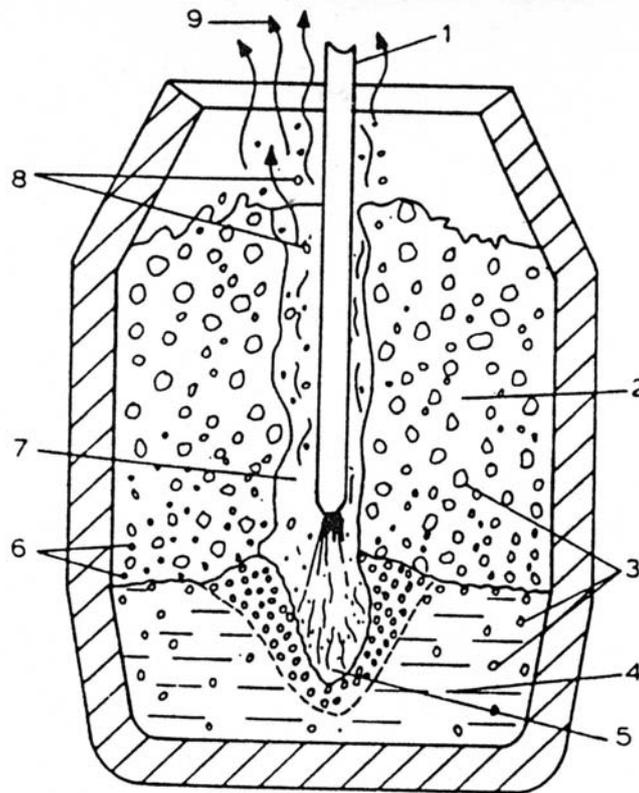## 5. Task: Converter   5 points

a) In the given diagram a blast oxygen furnace is shown. Appoint the numbers 1 to 9!

4,5 points

b) Which element will be oxidised the most at the beginning of the blowing process?

0,5 points

6. Task: Direct and Smelting Reduction   5 points

a) Which processing group belongs the hismelt process to?

0,5 points

b) Name three differences between the Corex-Process and the Blast Furnace.

1,5 points

c) Which function does Nickel fulfill in the Midrex-Process and what is its characteristic attribute?

1,0 points

d) Name four Direct- or Smeltingreduction-Processes

2,0 points

7. Task: Electric Steelmaking   5 points

a) Why are electrodes of graphite used in Electric Arc Furnaces?

1,5 points

b) In a 120 t Electric Arc Furnace for stainless steel production 15 t of slag are pro-
    duced. This slag consists of 15 wt.-% of Cr_2O_3. How much FeSi75 (Ferrous-Silicon
    mit 75 wt.-% Si) has to be added to reduce the chromeoxides totally?

2,0 points

	Fe	Si	Cr	O
M in g/mol	56	28	52	16

c) Explain the generation of foamy slag in Electric Arc Furnaces.

1,5 points

8 Task: Secondary Metallurgy   5 Points

a) A 250 tonne ladle of steel having an oxygen content of 450 ppm is to be Al-deoxidised at tap. Assuming an Al recovery rate of 60 % and an aim Al composition of 0,04 Mass-%, calculate the amount of 98 % Al alloy addition that is required.   **5,0 points**

M_O = 16 g/mol

M_{Al} = 27 g/mol

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 of "Sustainable Development".

1,0 points

b) Name at least 2 ways to prevent air pollution in the iron and steel industry.

1,0 points

c)

   1. Give at least 3 utilizations for iron and steel making slags.

   2. Name at least 3 other (beside slags) residual or waste materials in iron and steel production, which are used as secondary raw materials.

3,0 points