Rheinisch-Westfälische Technische Hochschule Aachen

Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2011-03-10

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
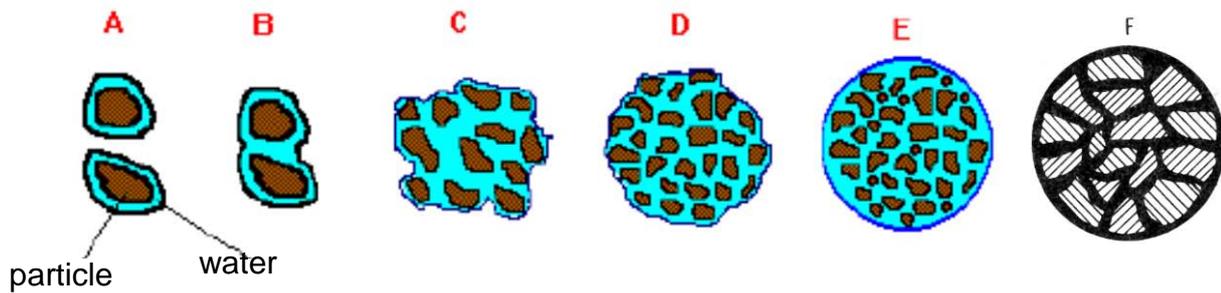
Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk   **2011-03-10**

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

  a) Explain the figures A-F!   **3,0 points**

  b) What is the effect of recyceled already sintered material on the sintering process?

2,0 points

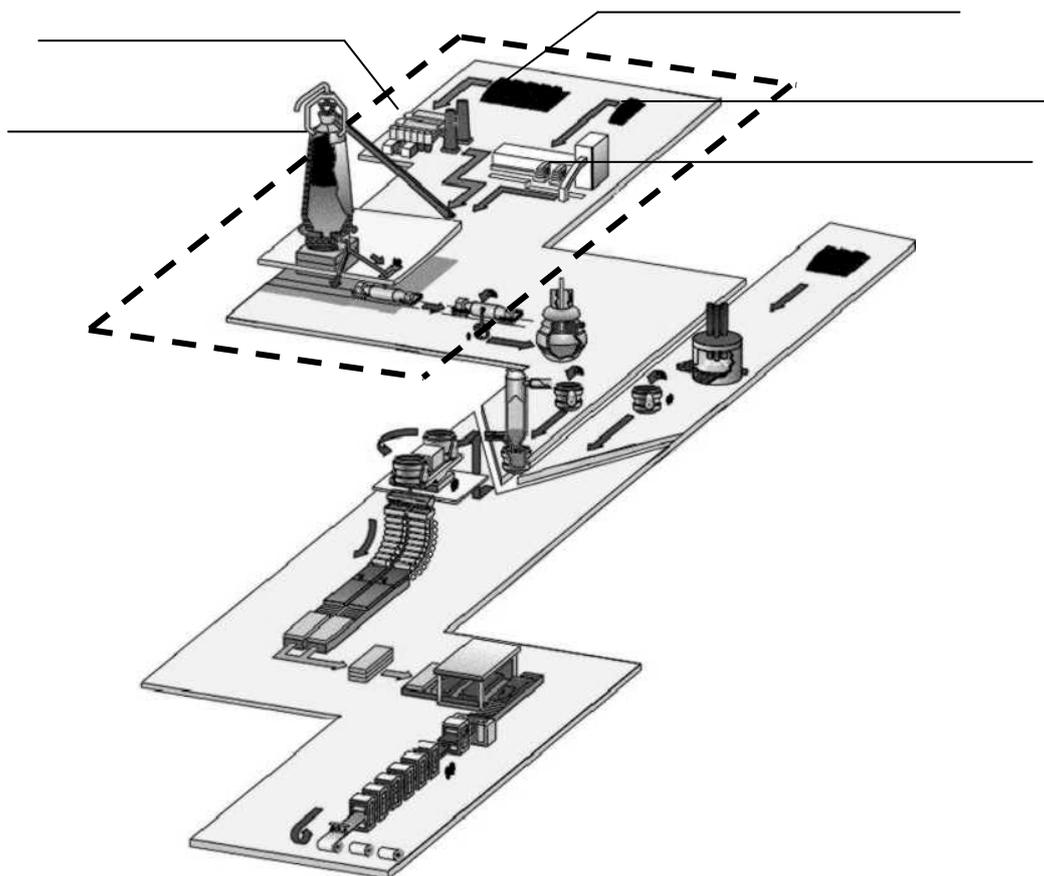## 2. Task: Metallurgical Coke   5 points

a) State three demands on BF coke!   **1,5 points**

b) Mark and name the facilities in the marked area.   **2,5 points**
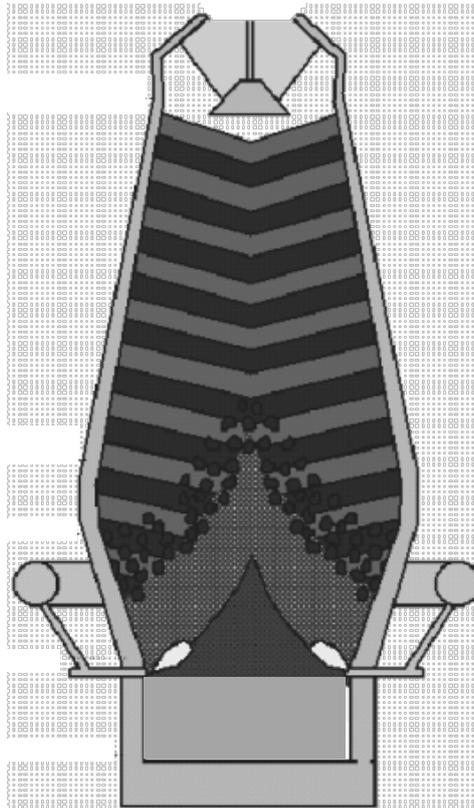
c) The coking process is only one possible treatment for coal. Name two different processes! **1,0 points**

3. Task: Blast Furnace 5 points

a) Sketch a flow-chart of the blast furnace process with 4 input and 2 output materials. Mark the flow of input and output at the right part of the blast furnace!

4,0 points

b) How is blast furnace slag generated? Name at least one task of slag in the blast furnace!

1,0 points

4. Task: Thermodynamics   5 points

a) Draw the Baur-Glaessner-diagramme in the form below and specify the temperatures as well as the areas of pure CO and CO_2-Atmosphere.

4,0 points

b) Give the equation of the equilibrium constant of the Boudouard reaction. How can the Gibbs Free Energy of the reaction be calculated, when the value of this equilibrium constant in known?   **1,0 points**

5 Task: Basic Oxygen Furnace   5 points

a) Give a definition of converter process!   **1,0 point**

b) Write down the most important exotherm oxidation reactions of the BOF refining process! Pay attention on the state of aggregation and present type of the reaction partners!   **2,5 points**

c) What is the source of the energy used for heating and melting of scrap during the converter process?   **0,5 points**

d) Name two reasons for the application of limestone during the blowing process.
                                                                 1,0 points

6. Task: Direct and Smelting Reduction   5 points

a) Explain the Midrex-process.   **2,0 points**

b) Which of the following gases are oxidizing and which are reducing?

2,0 points

$$H_2 \qquad CO_2 \quad CO \quad H_2O$$

c) Name the function of nickel in the MIDREX-process and its characteristic property!

1,0 points

7. Task: Electric Steelmaking   5 points

a) Hot heel is one of state of the art of the developments of EAF. What is the hot heel practice and what is the desired effect by the application 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? (The needed energy to melt one ton scrap is 375 kWh). **1,5 points**

c) Where are the positions of the electric arc in an AC-EAF and how does energy transfer work? **1,0 points**

8. Task: Secondary Metallurgy 5 points

a) Give name and equation of the thermo-chemical equilibrium which describes deoxidation of steel melts with carbon. What is the value of the corresponding equilibrium constant at 1600 °C? **1,0 points**

b) Write down the chemical reaction for desulphurisation of steel! **1,0 points**

c) Sketch the Richardson Jeffes-Diagramme, name the axes and fill in roughly the potential lines of Fe (II) Eisen, Mn, Si and Al. **2,5 points**

9. Task: Continuous Casting   5 points

a) What is the dummy-bar in a continuous caster?
   Describe the start of a sequence in continuous casting.   **1,5 points**

b) How many layers of heat transfer exist in a continuous casting copper mold?
   Name the heat transfer mechanism!   **2,5 points**

c) What is the meaning of the "square-root law" of solidification? Write down the
   equation of this law.   **1,0 points**

10. Task: Protection of Environment, Recycling   5 points

a) Write down several areas of interest concerning Environmental Protection!

0,5 points

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

2,0 points

c) Name the principles of the German circle economy - and waste law, after that waste should be exploited.   **1,5 points**

d) Explain the benefit of injection of recycled plastics for environmental protection. (min. 2 reasons)   **1,0 points**