



**Mastercourse**  
**Metallurgical Engineering**  
**(Ferrous Process Metallurgy)**  
**2008-10-16**

Last name, first name:

Matrikel-Nr.:

Signature:

Task	Points (max.)	Points	Signature	Approval date	Final points (total)
1	5				
2	5				
3	5				
4	5				
5	5				
6	5				
7	5				
8	5				
9	5				
10	5				
<b>Total:</b>		<b>Total after approval:</b>			

# Mastercourse

## Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk

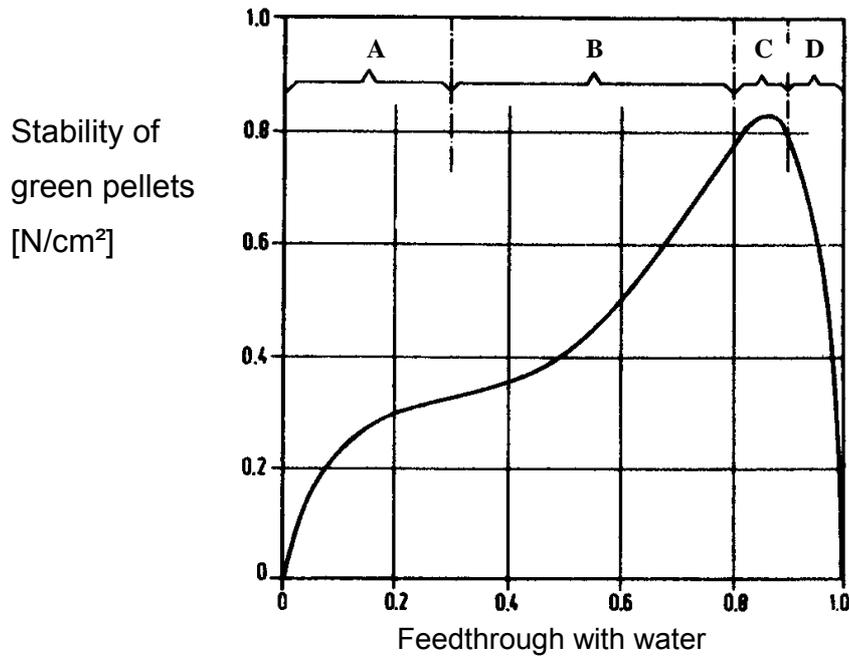
2008-10-16

1. Task: Pelletizing und Sintering

5 points

- a) The picture below shows the influence of the grade of feedthrough with water to the stability of green pellets. Explain the characteristics of the stability, which is divided in 4 areas!

2,0 points



b) Name six components of the sintering mixture!

**3,0 points**

## **2. Task: Metallurgical Coke**

**5 points**

a)

1. What are the tasks of coke in the blast furnace? (at least 5 answers)

**2,5 points**

2. Which of these tasks can be fulfilled by injected substituting reducing agents? (at least 2 answers)

**1,0 points**

b) Name the first three stages of the coking process and the corresponding temperature regions.

**1,5 points**

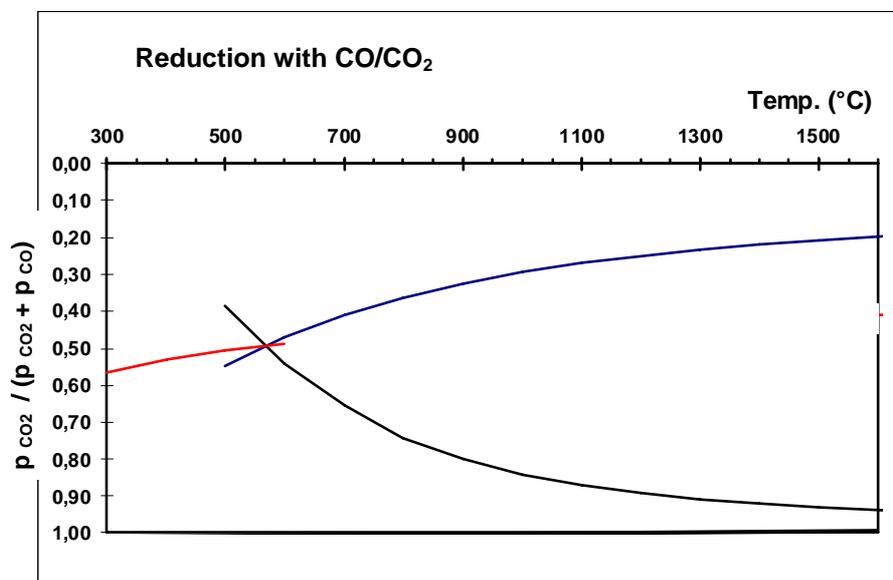
### 3. Task: Blast Furnace

5 points

a) The following figure shows the Baur-Glaessner-Diagram for the reduction of iron oxides with CO/CO<sub>2</sub> gas-mixtures.

Mark and name the regions in the diagram, where hematite, magnetite, wustite and metallic iron are stable.

2,0 points



b) Name two tasks of blast furnace top charging devices.

1,0 points

c) Where is the “cohesive zone” in the blast furnace and what happens in the “cohesive zone”?

**1,0 Points**

c) What are the so-called “coke-windows” in the blast furnace, which task do they fulfil?

**1,0 points**

#### **4 Task: Thermodynamics**

**5 points**

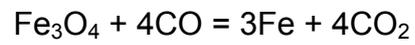
- a) Sketch the Iron-Carbon-Diagram including the most important data and mark the region of liquid hot metal in the diagram.

**3,5 points**

- b) The reduction of hematite to metallic iron by use of CO as reduction gas is running about the following reactions:



Calculate  $\Delta H_{298}^{\circ}$  for the gross reaction:



**1,5 points**

## **5. Task: Converter**

**5 points**

- a) 50 t of cooling scrap are charged into a BOF converter. Calculate the heat demand for heating-up and melting the scrap.

(Assumption: the scrap consists of 100 % iron)

Given:

Charging temperature of scrap: 25°C

Final temperature of scrap: 1600°C

$c_p = 41,9 \text{ kJ/kmole}\cdot\text{K}$

Melting enthalpy: 13832 kJ/kmole

**2,5 points**

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

**1,0 points**

- c) Oxidation of carbon in converters can be divided into 3 phases: the starting, the main and the end decarburisation phase.

Explain in short words the decarburisation velocity in these 3 phases.

**1,5 points**

**6. Task: Direct and Smelting Reduction**

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**5 points**

a) Explain the Midrex process.

**2,0 points**

b) Explain the Corex process.

**2,0 points**

c) Which products are produced in the

a. Midrex process?

b. Corex process?

**1,0 points**

## **7. Task: Electric Steelmaking**

**5 points**

- a) Name at least 2 advantages of oxygen blowing during steel production in electric arc furnaces.

**1,0 points**

- b) Sketch a material flow diagram consisting of at least 4 input and at least 3 output materials of the electric arc furnace process.

**3,5 Punkte**

- c) Give a possibility to reduce the amount of unwanted tramp elements in the main product of the electric arc furnace process.

**0,5 points**

**8 Task: Secondary Metallurgy**

**5 points**

a) Name at least two chemical treatment methods of steel melts in ladle metallurgy.

**1,0 points**

b) Name two secondary metallurgical processes which are mostly operated under vacuum metallurgical conditions and give the reason why these processes are operated under vacuum.

**1,5 points**

c) Give at least 2 ways of heating-up a steel melt in the ladle.

**1,0 points**

d) What is the meaning of the Vacher-Hamilton equilibrium? Give the thermodynamical equilibrium equation and the value of the equilibrium constant at 1600°C.

**1,5 points**

## **9. Task: Continuous Casting**

**5 points**

- a) Name the characteristic components of a continuous casting machine (facilities) by means of a sketch.

**2,5 points**

- b) What is the meaning of the “square-root law” of solidification? Write down the equation of this law.

**1,0 points**

- c) What is micro segregation? What is the reason for micro segregation?

**1,0 points**

- d) Give the name of the directed solidification structure growing into the melt during continuous casting.

**0,5 points**

**10: Task: Protection of Environment, Recycling 5 points**

- a) Name 3 different sorts of scrap and give a short definition or description for each of them.

**3,0 points**

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

**2,0 points**