



**Mastercourse**  
**Metallurgical Engineering**  
**(Ferrous Process Metallurgy)**  
**2007-07-19**

Last name, first name:

Matrikel-Nr.:

Signature:

| Task          | Points<br>(max.) | Points                       | Signature | Approval | Finalpoints<br>(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

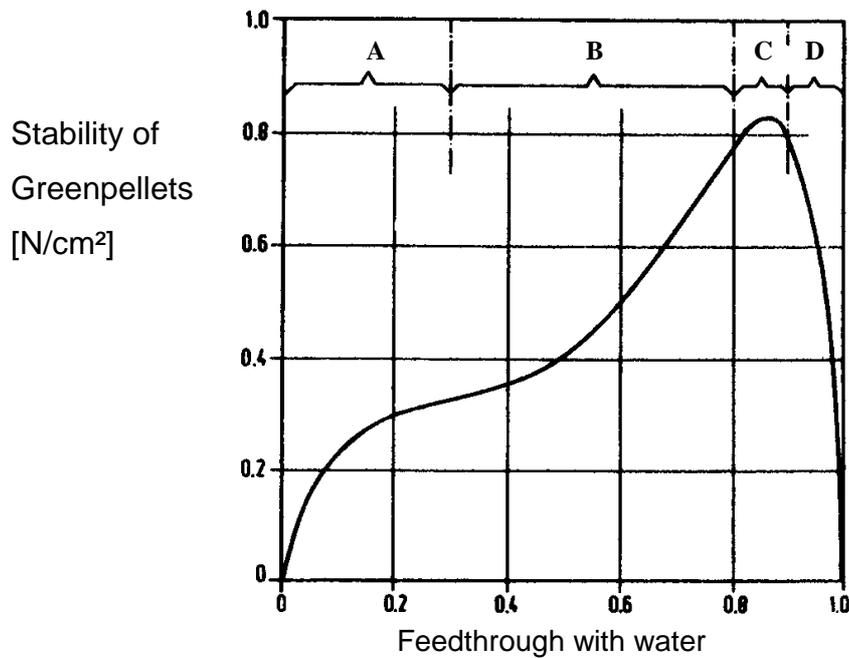
2007-07-19

### 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 greenpellets. Explain the characteristics of the stability, which is divided in 4 areas!

2,0 points



b) Name 6 components of the sinter mixture.

**3,0 points**

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

**5 points**

a) Name the phases of the coke making process.

**2,5 points**

b) What are the main components of coke oven gas? (at least 5 answers)

**2,5 points**

### **3. Task: Blast Furnace**

**5 points**

a) What are the functions of a blast furnace top charging system?

What is a rotating shout?.

**1,0 points**

b) Explain in your own words the generation and feeding of hot blast into the blast furnace.

**1,0 points**

c)

1. Is it possible to operate a blast furnace with cold blast?

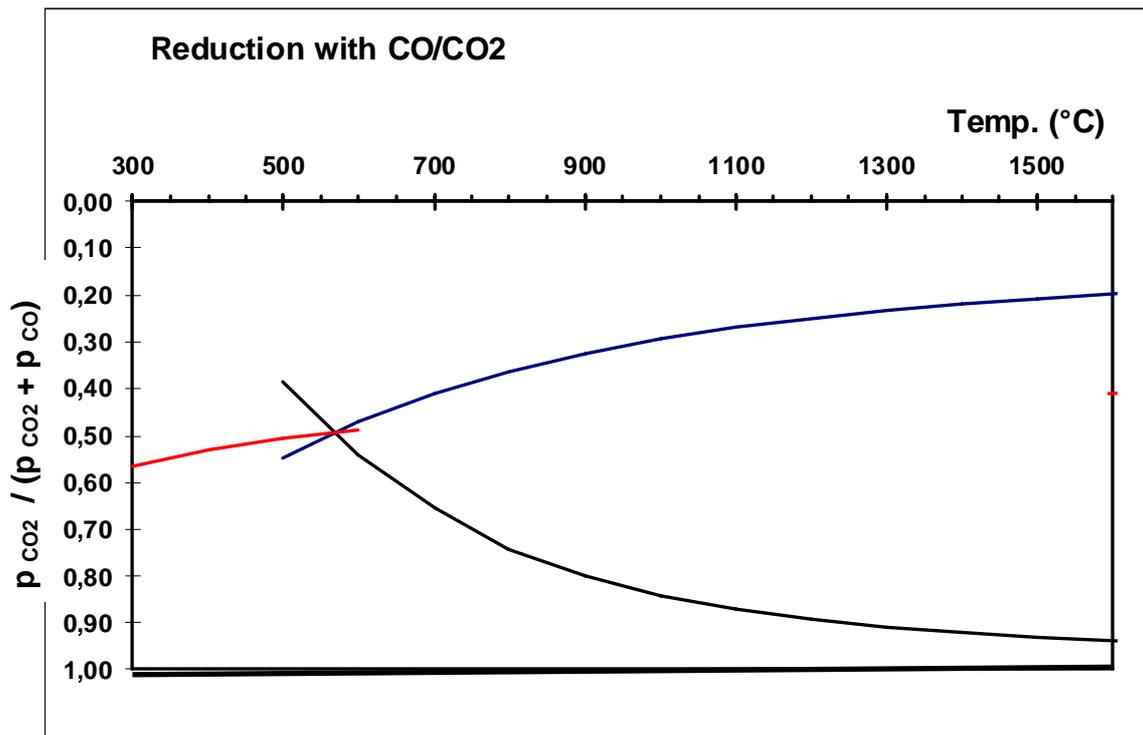
2. What is the main advantage of blast furnace operation with hot blast in comparison to cold blast?

**1,0 points**

d) Enclosed you find the Baur-Glaessner-Diagram for the reduction of ironoxides with CO/CO<sub>2</sub>-gasmixtures.

Characterise the fields in which Hematite, Magnetite, Wustite and metallic Iron are stable.

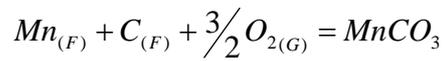
2,0 points



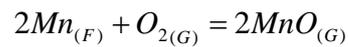
#### 4 Task: Thermodynamics

5 points

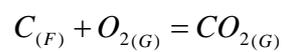
- a) Use the law of Heß for calculating the change of enthalpy of the following reaction.



Given:



$$\Delta H_{800K} = -767,083 \text{ kJ/mole}$$



$$\Delta H_{800K} = -394,153 \text{ kJ/mole}$$



$$\Delta H_{800K} = +111,395 \text{ kJ/mole}$$

2,0 points

- b) Give an example for the 1. and the 2. Law of Thermodynamics in the iron and steel metallurgy.

2,0 points

- c) Is the entropy change during gasification of carbon more or less than 0 ?  
Why?

1,0 points

## **5. Task: Converter**

**5 points**

a) Name five important chemical reactions in BOF converters.

**2,5 points**

b) What are the tasks of lime during steelmaking? (at least 2 answers)

**1,0 points**

c) What's the role of slag in converter metallurgy and why is it necessary to add scrap?

**1,0 points**

c) What's the value of the typical tapping temperature of BOF converters?

(Only one answer (cross) is allowed)

**0,5 points**

- 1400°C
- 1500°C
- 1600°C
- 1700°C
- 1800°C

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

**5 points**

a) What are “DRI”, “HBI” and “CBI”? Give a short definition for each of these abbreviations.

**1,5 points**

b)

1. Which reduction materials are used for the Midrex-process?

2. How is the reduction gas generated (reaction equation)?

**1,0 points**

c) Name for each of the following aspects an advantage or disadvantage of direct reduction in comparison to the blast furnaces process:

- economics,
- technology,
- product capacity and
- raw materials.

**2,0 points**

d) In a Midrex plant natural gas is used for the generation of the reducing gas.

The catalyser of the gas reformer is:

(only one answer (cross) is allowed!)

**0,5 points**

- nickel
- manganese
- platinum

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

**5 points**

- a) Hot heel is state of the art for steel making in EAF. What is hot heel? Name at least two advantages of hot heel in EAF.

**1,5 points**

- b) Name at least three possibilities to decrease consumption of refractory in EAF.

**1,5 points**

- c) Where are the positions of the electric arc and how does energy transfer work in

- an AC-EAF and
- a DC-EAF?

**2,0 points**

**8 Task: Secondary Metallurgy:**

**5 points**

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

**1,0 points**

b) Give a reaction for desulphurisation of steel.

**1,0 points**

c) Name three materials used for deoxidation of steel melts and sort these materials concerning their efficiency.

**2,0 points**

d) Name two processes which are nowadays mainly implemented for deoxidation in secondary metallurgy?

**1,0 points**

**9. Task: Continuous Casting**

**5 points**

a) Name at least four different, common formats of continuous casting of steel.

**2,0 points**

b) What are the tasks of mould powder? (at least 4 answers)

**2,0 points**

c) Of which material/s continuous casting moulds are made and why?

**1,0 points**

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

a) Give a definition for sustainable development.

**1,0 points**

b) Name residual materials of the iron and steel industry which can be used as important secondary raw materials. (at least 3 answers)

**1,5 points**

c) Name 3 different methods for the protection of air pollution in the iron and steel industry.

**1,5 points**

d) Give two utilisations for slags of the iron and steel industry.

**1,0 points**