



**Mastercourse**  
**Metallurgical Engineering**  
**(Ferrous Process Metallurgy)**  
**2010-10-29**

Last name, first name:

Matrikel-Nr.:

Signature:

| Task          | Points<br>(max.) | Points                       | Signature | Approval date | Final points<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> |           |               |                         |

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

# Mastercourse

## Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk

2010-10-29

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**

|                           | Hematite              | Hematite | Magnetite | Slag |
|---------------------------|-----------------------|----------|-----------|------|
| Type of binding-mechanism | Oxidation to Hematite |          |           |      |
| Atmosphere                |                       |          |           |      |
| Temperature               |                       |          | > 900°C   |      |

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

**5 points**

a) Give a definition and the target of the coking process.

**1,0 points**

b) Give the reason, why different cokes are mixed for the coking process.  
(at least 2 answers)

**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 specific coke consumption (kg coke/t HM) in blast furnaces?

(For each question is only one answer (cross) allowed)

a) Increasing of the blast temperature

- increasing specific coke rate
- decreasing specific coke rate

b) Increasing of the blast humidity

- increasing specific coke rate
- decreasing specific coke rate

c) Increasing the O<sub>2</sub>-content of the hot blast

- increasing specific coke rate
- decreasing specific 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**

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In the Blast furnace, the reduction from Hematite to metallic Iron takes place.

- a) Calculate the amount of oxygen in kg per tonne Hematite and the metallic Iron, which can be gained!

**2,0 points**

- b) Give the coupled equations for direct reduction!

**1,0 points**

- c) Calculate the amount of carbon in kg per tonne Hematite for 100 % direct reduction!

**2,0 points**

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

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**5 points**

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

**3,5 points**

b) Calculate the oxygen partial pressure above pure iron oxide at 1500°C.

Given:



$$\Delta G^0 = 63500 - 16,8 * T \text{ [cal/mole]}$$

**1,5 points**

## **5 Task: Basic Oxygen Furnace**

**5 points**

- a) Write down **four** important exotherm oxidation reactions of the BOF refining process! Pay attention on the state of aggregation and present type of the reaction partners!

**4 points**

- b) Call two reasons for the application of limestone during the blowing process.

**1 point**

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

**5 points**

- a) Name and describe the reaction vessels of the existing smelting reduction processes.

**2 points**

- b) What kind of process is the COREX-Process?

**0,5 points**

- c) Name five basic metallurgical and process-specific parts of the MIDREX-process.

**2,5 points**

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

**5 points**

a) Which ingredients are used in a modern electric arc furnace?

**1 point**

b) Which form of energy are used in electric arc furnaces?

**2 points**

c) Name four steps of development in the history of electric arc furnaces and point out the resulting advantages

**2 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**

$$M_{\text{O}} = 16 \text{ g/mol}$$

$$M_{\text{Al}} = 27 \text{ g/mol}$$

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

**5 points**

- a) Describe the solidification during the continuous casting process!  
**1 point**
- b) Describe in short terms the nucleation!  
**1 point**
- c) Name possible reasons for the contraction of the steel volume during Solidification!  
**1 point**
- d) Describe in short terms the procedure of segregation!  
**1 point**
- e) Name two types of continuous casting machines.  
**1 point**

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

**1,5 points**

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

**1,5 points**