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

Last name, first name:  
Matrikel-Nr.:

Signature:

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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

Stability of Greenpellets [N/cm²]
b) Name 6 components of the sinter mixture.
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/CO₂-gas mixtures.
Characterise the fields in which Hematite, Magnetite, Wustite and metallic Iron are stable.

2,0 points
4: Task: Thermodynamics

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

\[ Mn_{(F)} + C_{(F)} + \frac{3}{2}O_{2(G)} = MnCO_3 \]

Given:
\[ 2Mn_{(F)} + O_{2(G)} = 2MnO_{(G)} \quad \Delta H_{800K} = -767,083 \text{ kJ/mole} \]
\[ C_{(F)} + O_{2(G)} = CO_{2(G)} \quad \Delta H_{800K} = -394,153 \text{ kJ/mole} \]
\[ MnCO_3_{(F)} = MnO_{(F)} + CO_{2(G)} \quad \Delta H_{800K} = +111,395 \text{ kJ/mole} \]

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  

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 catalyst of the gas reformer is:

(only one answer (cross) is allowed!)  

☐ nickel  
☐ manganese  
☐ platinum

0.5 points
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