Rheinisch-Westfälische Technische Hochschule Aachen

Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2011-04-01

Last name, first name: **Matrikel-Nr.:**

Signature:

Task	Points (max.)	Points	Signature	Approval	Final points (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   **2011-04-01**

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

a) Discribe the difference between pelletizing and sintering in respect of size and thermal treatment.

1,0 points

b) Name two tasks of the draft air in the sintering bed during the sintering process.

1,0 points

c) The occurrence of iron in the earth crust amounts to 4,2 %. Most times it is not available in dignified form, but together with other elements and compounds, as sand and clay. Iron ores are technical useable iron compounds, most common are hematite and magnetite. Calculate the content of metallic iron of both iron ores in weight-%.

3,0 points

2. Task: Metallurgical Coke   5 points

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

2,5 points

b) What are the "volatile components" of coal?

0,5 points

c) Which 2 methods can be used to cool down hot metallurgical coke? Give a short
    description of both methods.

2,0 points

3. Task: Blast Furnace   5 points

a) Name three different types of iron oxides

                                                            1,5 points

b) Name five of the nowadays used reducing agents.

                                                            2,5 points

c) Name two tasks of the blast furnace top charging device.

                                                            1,0 points

4. Task: Thermodynamics   5 points

a) Name the temperature of the eutectic of the hot metal

0,5 points

b) Name the peritectic temperature of the steel?

0,5 points

c) Give the definition of the activity in the thermodynamic.

0,5 points

d) Sketch the Iron-Carbon-Diagramme and mark the liquidus- temperature of iron in the diagramme.

3,5 points

5. Task: Steel converter   5 points

a) During the blowing process in the basic oxygen furnace hot metal is changed into raw steel. The table below gives a rough overview over possible compounds of hot metal (exemplary composition):

Element:	C	Si	Mn	P	O_2
Mass.-% in PI	4,20	0,80	0,50	0,40	---
kg/kmol	12	28	55	31	32

1) Name the oxidation products of this process. Please pay attention to the states of aggregation.

2,0 points

2) Calculate the mass of oxygen needed to reduce the carbon content of one ton hot metal from 4,2 wt.-% to 0,1 wt.-% as well as the mass of the generated CO. Please write down your calculation steps.

3,0 points

6. Task: Direct and Smelting Reduction   5 points

a) Sketch schematically the process-diagramme of the Corex process with all input and out material.

3,0 points

b) Name two products of the alternative Steelmaking route.

1,0 points

c) Give one example for a direct reduction process and one for a smelting reduction process.

1,0 points

7. Task: Electric Steelmaking 5 points

a) You operate an 80t-Electric Arc Furnace with DRI, but want to add scrap. How much scrap can you charge, not to pass over 0.1 wt.-% of copper?

1,5 points

Gehalt in Gew.-%	Fe	C	Cu
DRI	99	1	-
Schrott	99,5	-	0,5

b) In a 120 t Electric Arc Furnace for stainless steel production 15 t of slag are pro-
duced. This slag consists of 15 wt.-% of Cr_2O_3. How much FeSi75 (Ferrous-
Silicon with 75 wt.-% Si) has to be added to reduce the chromeoxides totally?

2,0 points

	Fe	Si	Cr	O
M in g/mol	56	28	52	16

c) Of which material are the electrodes in AC electric arc furnaces? What are the
advantages of the material for this application? (at least 2 advantages)

1,5 points

8. Task: Secondary Metallurgy: 5 points

a) Write the illustrated basic operations of secondary metallurgy in the tabular below.

2,5 points

b) Name the two most important oxides for calculation of slag basicity!

1,0 points

c) What are the tasks of slags in secondary metallurgy?
(At least three answers)

1,5 points

9. Task: Continuous Casting   5 points

a) Describe the solidification structure for continuous casting (CC).

   1) A characteristic value for the solidification structure is the secondary dendrite arm spacing (SDAS). The SDAS can be empirically calculated for a Steel X after $SDAS = 14,9\ \mu m * (\theta_f)^{0,36}$, mit $\theta_f = t_f$; $t_f = t_{liq} - t_{sol}$ (local solidification time), Calculate the cooling rate to reach SDAS = 30 µm. ($T_{liq} - T_{sol}$ = 112 K)

1,5 points

   2) Please draw directional and equi-axed dendrites and mark λ_1 and λ_2

1,5 points

b) As alternative to the CC other continuous casting methods go on line.

   1) Please mention two methods for near net shape casting   **1,0 points**

   2) Please mention one advantage and one disadvantage of these compared to the slab-CC   **1,0 points**

10. Task: Protection of Environment, Recycling   5 points

a) Give a definition for sustainable development.

1,0 points

b) Name 4 potentials for reducing the energy consumption in the iron and steel industry.

2,0 points

c) Name 4 residual or circulating materials in iron and steel production.

2,0 points