Faculty of Applied Earth Sciences

Tentamen ta2210 Extractive Metallurgy (Grondstoffenverwerking)

Date : 27th March 2002
Time : 9h00-12h00

Answer all questions clearly and completely. It is an open book examination, i.e. in your possession may be your text book and the problem book. **Full marks are 40.**

General Metallurgy and Introductory Thermodynamics

1. Zinc and lead production - Crucial metals to the car industry

You are an extractive metallurgist *(Grondstoffenverwerker)* on plant that processes a concentrate that consists out of 50% ZnS, 30% PbS, 10% Fe_2O_3 and 10% SiO_2. You have to explain to a young new engineer that is starting to work on a plant somewhere in Europe (there are numerous plants in Europe that process this material e.g. England, Italy, France, Germany, Sweden) how your plant operates. Answer the following questions to assist you in formulating your introduction to the young engineer:

a) Please give a neat drawing of a general flow sheet for the Pb and Zn metal production from this material *(Assume that you can separate the Pb and Zn sulphides to produce a pure ZnS stream and a stream containing the rest)*. Give a route for both the pyrometallurgical and hydrometallurgical processing assuming that the Pb is produced pyrometallurgically and the Zn hydrometallurgically. Please describe briefly and give a drawing of the reactors and methods that you are applying in your processes.

b) Write all chemical equations that describe the processes. Also use the information in your text book to describe the roasting reactions in more detail.

c) Please use the Ellingham diagram in your textbook to support all your arguments for the pyrometallurgical route and make the work clear to the new engineer. (Typical information required would be the temperature the process should be operating at.)

d) What are the residues of your process? What happens to the residues that your process is creating? This information gives the new engineer and indication of what the environmental performance of the plant is.

e) Provide a simple mass balance for your flow sheet including the CaO and C additives for the pyrometallurgical route and sulphuric acid (H_2SO_4) for the hydrometallurgical route. Base your calculations on a process that accepts 100 000t/year feed. Where does the sulphuric acid come from?

f) If you wanted to recycle the zinc-manganese batteries how would you do this?

Data

C: 12; S: 32; H: 1; Fe: 55.8; Ca: 40.1 ; O: 16; Pb: 207.2; Zn: 65.4; Si: 28.1

15 Marks

2. ***Aluminium – One of the backbones of our Society***

This question requires you to produce metallurgical meaningful flow sheets for the each of the questions below.

(a) Give a short discussion on how the aluminium for your high-tech bicycle or car is produced. Start with bauxite and end with aluminium containing some alloying elements. Also name these elements.

(b) Your bicycle is sometimes recycled by stealing or by throwing it into a canal in a not so clear state of mind, where it eventually blocks up the way. Being a ***"grondstoffenverwerker"*** you would consider an environmental favourable approach to the recycling of your old bicycle. How would you do this? Give equations, were necessary. Remember to remove the tyres first! Why?

(c) If your bicycle where made of a high-tech titanium alloy how would you then recycle your bicycle? Give equations were necessary.

10 Marks

Mass Balances

3. ***Copper - One of the backbones of our information age***

In a copper flash smelter situated in Hamburg a dry sulphide copper concentrate is smelted by the use of enriched air (45% O_2). The oxygen utilisation is 100%, while quartz (100% SiO_2) and lime (100% CaO) are used as fluxes. Please calculate for a feed of 100 t/h of feed:

a) the amount of matte (65% Cu_2S) and slag,

b) the amount of fluxes SiO_2 and CaO to be added with the feed, and

c) the composition and Nm^3 of the produced offgas in vol%.

Data

Concentrate

30% Cu; 31%Fe; 33% S; 1% CaO; 5% SiO_2

Slag

$FeO : SiO_2 : CaO : Cu_2S = 60:30:5:5$

Molecular weights

Cu: 63.5; S: 32; Fe: 55.8; Ca: 40.1; O: 16; Si: 28

15 Marks