Examination: TA3210 Extractive metallurgy

Date: 31 March 2008
Time: 9:00 AM – 12:00 AM
Location: Zaal CT 3.98

This examination contains 3 questions with a total mark of 70, which accounts for 70% of the total evaluation of the course. The rest 30% is accounted for by 2 reports for 2 case studies.

Question 1: General questions in metallurgical processes *(25 marks)*

(1) What are the Kellogg and Ellingham diagrams? How they are used in metallurgical extraction and refining operations?

(2) What are the purposes of roasting of sulphide concentrates? What products you could expect from the sulphide roasting?

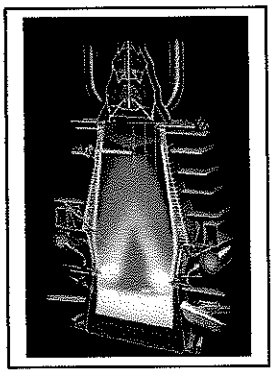
(3) What metallurgical processes are normally used to extract metals from oxide ores and sulphide ores?

(4) What are electrowinning and electro-refining, and where they are used in metallurgical industry?

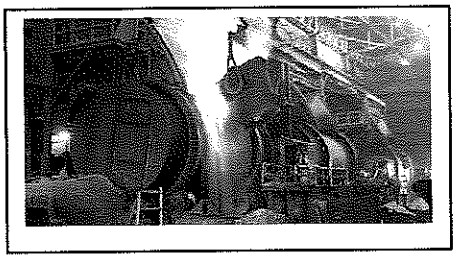
(5) What types of leaching processes are available, according to chemical reactions? What types of ore or minerals are suitable for those leaching processes?

Questions 2 *(20 marks)*

(1) ***Blast furnace ironmaking:*** Please describe how metallic iron (hot metal) is produced in Blast Furnace Process. (*Please tell raw materials, main chemical changes of feed along the movement in the furnace, various zones of the blast furnace, and different products of smelting operation*). What are the roles of metallurgical coke in ironmaking blast furnace process?

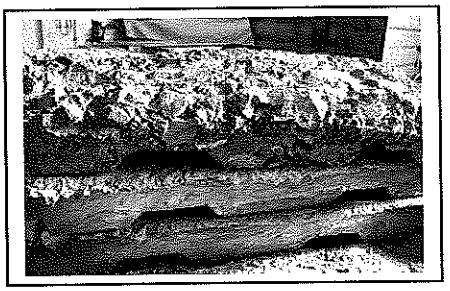


(2) ***Copper smelting and refining:*** Copper occurs in majority as sulphide ores in the earth. Please describe the main extraction and refining steps of copper-making, including their objectives and main chemical reactions.



Question 3: Refining of zinc bottom dross (Zn-Fe alloy) **(25 points)**

During hot-dip galvanizing of steel with zinc, small amount of iron dissolves into the liquid zinc at about 460°C. Iron and zinc react to form Zn-Fe alloy (94 wt% Zn + 6 wt% Fe or roughly $FeZn_{13}$,) which solidifies at galvanizing temperature and settled to the bottom of zinc bath as the "bottom dross". The formed bottom dross is the loss of the zinc metal.



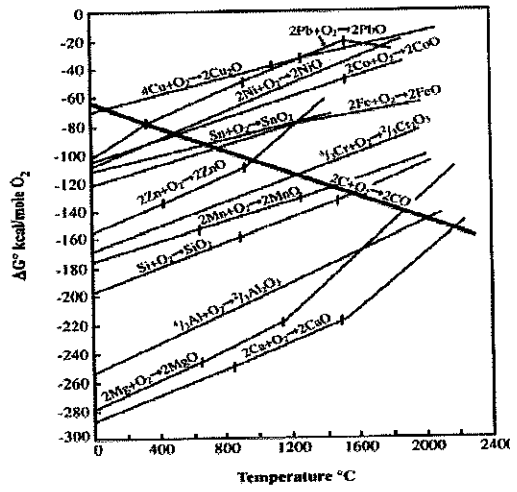
In order to recover the metallic zinc in the bottom dross, iron has to be removed from the Zn-Fe alloy. Different metallurgical refining technologies could be used to remove iron from the dross.

According to the knowledge you have learned in this course and the information given below, please propose your refining process or processes, and explain why your process(es) will work based on metallurgical thermodynamics.

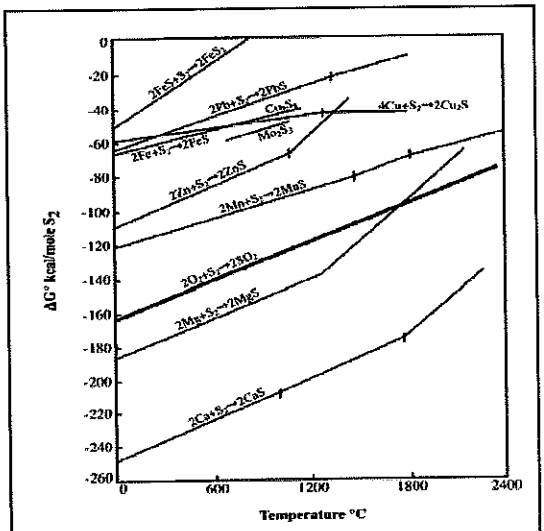
The following information is given for your reference:

(1) Ellingham diagrams, shown below.
(2) Standard reduction potentials in aqueous solutions (25°C), shown on the right.
(3) Melting point of Fe and Zn are 1538 and 419°C, boiling point of Fe and Zn are 2862 and 907°C.

$Fe^{3+} + e = Fe^{2+}$	$E^o = 0.77$ V
$Fe^{2+} + 2e = Fe$	$E^o = -0.44$ V
$Zn^{2+} + 2e = Zn$	$E^o = -0.76$ V



Ellingham diagram of metal oxides



Ellingham diagram of metal sulphides