



PROGRAM : NATIONAL DIPLOMA
ENGINEERING METALLURGY

SUBJECT : **PRODUCTION OF IRON AND STEEL 3**

CODE : **PRS302**

DATE : NOVEMBER EXAMINATION 2014
15 NOVEMBER 2014

DURATION : 08:30 - 11:30

WEIGHT : 40 : 60

TOTAL MARKS : 100

EXAMINER : DR X PAN

MODERATOR : M HENDERSON 4021

NUMBER OF PAGES : 3 PAGES

INSTRUCTIONS : ANSWER ALL QUESTIONS

REQUIREMENTS : CALCULATOR

QUESTION 1 (5 marks)

Give the names of following minerals that exist in the chrome ore used to produce ferrochrome:

1. FeOCr_2O_3
2. FeOFe_2O_3
3. FeOAl_2O_3
4. MgOCr_2O_3
5. MgOAl_2O_3

[5]

QUESTION 2 (5 marks)

Give the full names of the five control levels in the process control hierarchy

[5]

QUESTION 3 (15 marks)

Outokumpu process is one of the production processes used to produce charge chrome in South Africa. Draw the Outokumpu process flow-sheet (10 marks)

[15]

QUESTION 4 (15 marks)

Give 5 main factors and discuss how they affect the electrode penetration in a submerged arc furnace used to produce high carbon ferrochromium alloy.

[15]

QUESTION 5 (15 marks)

In the process of charge chrome production, chrome ore and other materials are fed in a closed SAF and are heated from 500 °C to 1700 °C. Some physicochemical reactions occur in the heating process. Please give 15 chemical reactions with carbon that may occur.

[15]

QUESTION 6 (45 marks)

Calculate the charge recipe for high carbon ferrochrome smelting in a submerged arc furnace, using the information of raw materials and product/slag given below in Table 1-2. The atomic

weights of some elements are listed in Table 3, and a SiO₂-MgO-Al₂O₃ phase diagram is in Figure 1.

Start with a batch of **1750kg ore**, then calculate the amount of flux (quartz) and reductant (coke), required to produce an alloy with **3-5% Si, 6-8% C** and a slag with **12-14%Cr₂O₃, 6-8%FeO**. The required liquidus temperature is 1700 °C for the slag of SiO₂-MgO-Al₂O₃.

Table 1. Raw Material Composition

Name	Cr ₂ O ₃ %	FeO%	MgO%	SiO ₂ %	Al ₂ O ₃ %	H ₂ O%	C%
Ore	39	23	10	9	14	5	0
Quartz	0	0	0	100	0	0	0
Coke	0	0	0	7	4	0	89

Table 2. Alloy and Slag Composition

Name	Cr ₂ O ₃ %	FeO%	MgO%	SiO ₂ %	Al ₂ O ₃ %	Cr%	Fe%	C%	Si%
Slag	12-14	6-8	?	?	?	0	0	0	0
Alloy	0	0	0	0	0	?	?	6-8	3-5

Table 3. Atomic Weight

Element	Fe	Cr	Si	Al	Mg	O	C	H
Weight	56	52	28	27	24	16	12	1

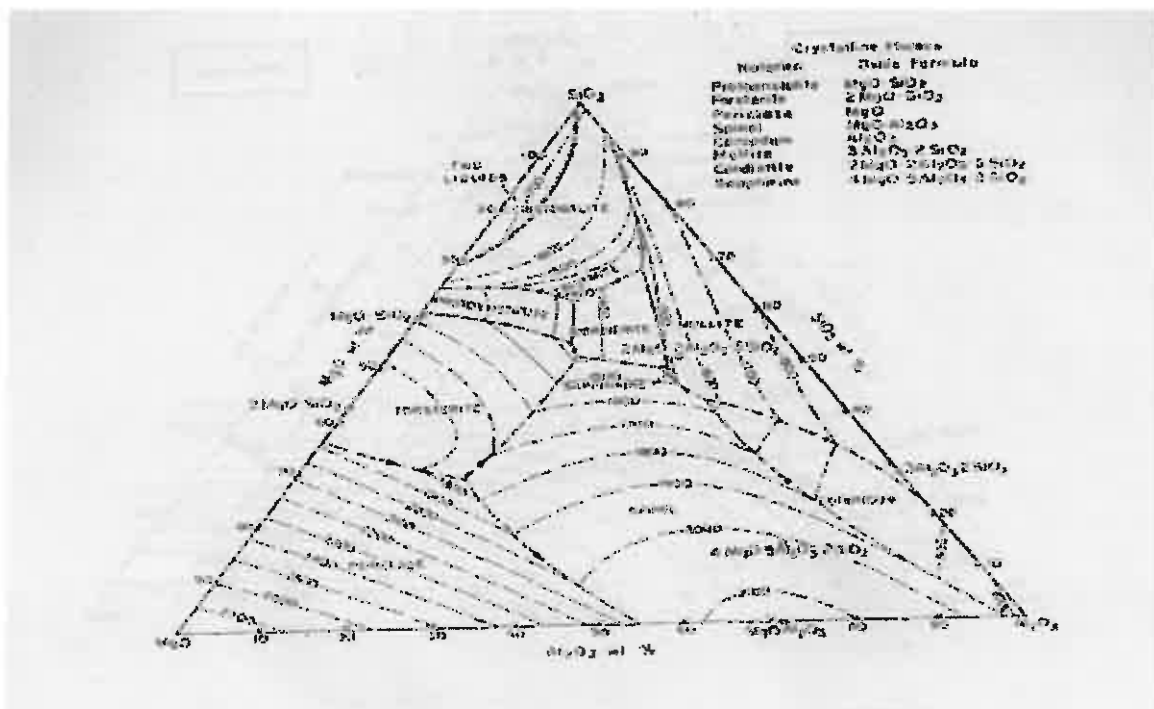


Figure 1. SiO₂-MgO-Al₂O₃ Phase Diagram