UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS TECHNOLOGIAE *EXRACTION METALLURGY*
SUBJECT	:	**FERROUS METALLURGY 4**
CODE	:	**MFM41-1**
DATE	:	WINTER EXAMINATION 2014 09 JUNE 2014
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

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MODERATOR	:	MS N NAUDE	5148
NUMBER OF PAGES	:	4 PAGES	

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
REQUIREMENTS	:	CALCULATOR

QUESTION 1 (30 marks)

1.1 Explain why the following are important for the blast furnace charge.

(a) Optimum particle size. (2)

(b) Optimum particle size distribution. (2)

(c) Blending ores from various mines. (2)

(d) Ore dressing to raise the grade from 54% iron to 62% (2)

1.2 What are the causes of the following conditions and how are they corrected?

(a) Too high silicon in hot metal. (2)

(b) Too high sulphur content in hot metal. (2)

(c) $H_2/H_2O = 2:1$ and $CO/CO_2 = 2:1$. (2)

(d) Slag does not flow easily making tapping difficult. (2)

1.3 Explain why three stoves are necessary to serve one furnace. (4)

1.4 Say whether the following statements are correct or incorrect and give reasons for your answer.

(a) Lumps blocking the slag tap hole are likely to be oversize limestone particles. (2)

(b) The shape of the furnace is designed to accommodate the expansion of the charge down the stack and formation of liquid in the hearth. (2)

(c) Steam increases temperature in the blast furnace because of H_2 and CO produced. (2)

1.5 Using thermodynamic data below determine thermal range for MnO + C = Mn + CO and indicate giving reasons this reaction predominant (4)

QUESTION 2 (40 marks)

Data obtained from an integrated iron and steel works were as follows:

Top gas analysis %	CO	CO_2	H_2	H_2O	N_2	O_2
Blast furnace	21	21	3	3	50	2
BOF (LD vessel)	28	3			3	66

Slag analysis %	CaO	SiO_2	Al_2O_3	MgO	FeO/Fe_2O_3	S	P
Blast furnace	36	30	10	9	3	2	
BOF (LD vessel)	50	20	0.5	10	20	0.2	1.2

Metal analysis %	C	Si	Mn	S	P	Tapping T°
Blast furnace	3.8	0.9	0.8	0.07	0.2	1450°C
BOF (LD vessel)	0.06		0.2	0.04	0.02	1650°C

2.1 Comment the following differences in the top gas composition of blast furnace and LD:

(a) Carbon monoxide and carbon dioxide contents. (3)

(b) Nitrogen and oxygen contents. (3)

(c) Hydrogen and water content. (2)

2.2 With reference to slag analyses:

(a) Calculate the basicity ratios and the reasons why the values are different. (4)

(b) Why are SiO_2 and Al_2O_3 contents high in blast furnace slag but low in LD slag? (3)

(c) Why is S higher in blast furnace slag while P is higher in steel plant slag? (2)

(d) Why does LD slag contain 20% FeO/Fe_2O_3 and only 3% in blast furnace slag? (3)

2.3 With reference to hot metal and blown metal analyses:

(a) Why does blast furnace slag contain 0.9% silicon in but none in LD slag? (2)

(b) Explain how 0.07% sulphur in hot metal was reduced to 0.04% in blown metal (2)

(c) Explain why tapping temperature is much lower for liquid iron than liquid steel. (2)

(d) Why is Mn in blown down to 0.2% and not oxidised completely like Si? (2)

2.4 Are the following suggestions by the metallurgists correct? Explain briefly.

(a) Slag from LD can be used in sinter making but not the blast furnace slag. (2)

(b) Coke oven gas can be injected into the blast furnace and not blast furnace gas. (2)

(c) Limestone may be charged in the LD and save the cost of calcination in lime kiln. (2)

(d) VOD and AOD are desulphurising processes. (2)

(e) The chemistry of DRI process is similar to the upper zone of the blast furnace. (2)

(f) After blowing for 15 minutes, the phosphorus content being 0.1%, the "carbon catch" may be employed to increase rate of production.

QUESTION 3 (30 marks)

3.1 A 50 tonne ladle of hot metal from mixer has a layer of 2 tonnes of slag on top of liquid iron. The hot metal contains 0.9% Si. If slag contains 36% CaO, 9% MgO, 33% SiO_2 and 12% Al_2O_3. Given that atomic weights of silicon and oxygen are 28 and 16 respectively;

(a) Calculate the lime to be added to achieve a basicity of 3 if lime is 86% pure. (5)

(b) What could have reduced the reactivity of lime? (4)

Size of particles may not be optimum

Clinker formed during calcining reducing reactivity of lime

Lime incompletely calcined

Hydration of CaO to slaked lime reduces reactivity of CaO

(c) Apart from the reasons in (b), why would more lime than calculated be added? (3)

3.2 The turndown analysis gives the composition of the metal after blowing in a 50 ton LD.

(a) If the turndown manganese is 0.25%, calculate the ferromanganese addition required to make a steel grade with 0.8% Mn if ferromanganese contains 78% Mn. (3)

(b) If after 15 minutes blow, the "carbon catch" procedure was followed giving 0.5% Mn at turndown, calculate the saving made and discuss the overall benefits. (3)

(c) If ferromanganese costs R12000 per ton, calculate the cost saving made in a day by employing the carbon catch procedure if production cycle is 45 minutes per blow. (4)

3.3 Why is it necessary to avoid the following:

(a) Desulphurising after blowing. (2)

(b) Carrying over LD slag into casting ladles. (2)

(c) Pouring liquid steel on pools of water. (2)

(d) Vessel slopping. (2)

Thermodynamic Data

$C + \frac{1}{2}O_2 = CO_{(g)}$	$\Delta G^o = -111700 - 88T$
$C + O_2 = CO_{2(g)}$	$\Delta G^o = -394100 - 0.8T$
$Mn + \frac{1}{2}O_2 = MnO$	$\Delta G^o = -403000 + 90T$

Total = 100