APPENDIX A

Ausmelt Process Design

Note: The concentrate grade and feed rate were altered part way through the study, as requested by Compass Resources. Ausmelt re-designed the smelter to treat dry injected, concentrates produced during years 1 and 2 of operation.

As substantial work had been completed, process data sheets and the process flow diagram were not re-issued by Ausmelt. Consequently, the information presented in the data sheets and process flow diagram do not directly correspond to the final process design presented in this chapter. The specific concentrate grade and concentrate, flux and reductant coal feed rates are given in tables A.1.1, A.2.1 and A.2.2. The design consumption outputs are summarised in section A.3, table A.3.1.

APPENDIX A CONTENTS

A.1 DESIGN BASIS

A.1.1 Process Concept

The Ausmelt primary smelter is designed to treat 311,525 dry tonnes per annum of Browns concentrates produced in years 1 and 2 of operation. Concentrate compositions for years 1 to 2 and 3 are shown in table A.1.1.

Table A.1.1 Concentrate Grade

Component (Dry)	**Years 1 to 2** (Design basis)	**Year 3**
Copper (%)	5.10	4.56
Cobalt (%)	1.05	0.97
Nickel (%)	0.86	0.80
Lead (%)	23.20	24.90
Zinc (%)	2.22	2.04
Iron (%)	11.80	12.40
Sulphur (%)	19.70	20.40
Silicates (%)	14.70	13.60
Alumina (%)	4.48	4.11
Graphite (%)	8.97	7.82
Carbonate (%)	3.66	4.18
Silver (g/t)	65	66
Moisture (%)	13.0	13.0
Annual (tpa)	**311,525**	**359,525**

The smelter will produce approximately 78,930 tonnes of matte, 115,140 tonnes of discard slag and 103,480 tonnes per annum of lead fume.

The matte from the Ausmelt smelter contains in excess of 95% of the cobalt, copper and nickel in the feed concentrates. The fume from the primary smelter contains in excess of 95% of the lead in concentrates.

The lead fume is processed in a secondary Ausmelt furnace to produce lead bullion. Downstream processing of the matte to produce cobalt, copper and nickel is expected to consist of a mild pressure leach stage followed by solvent extraction and electrowinning.

The Ausmelt process to treat Browns concentrates is designed to maximise the deportment of cobalt and lead to the matte and fume phases respectively. To ensure high cobalt recoveries to matte the Ausmelt furnace is operated under reducing conditions at 1300^{o}C to produce a slag containing less than 0.08% cobalt. The process is a single stage operation, with matte and slag flowing continuously into a settling furnace via a transfer weir.

A project overview and description of the Ausmelt furnace are detailed in section 2, the project overview, of the main report.

The process flow diagram describing the process is included in Appendix E, Ausmelt Drawings.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the information presented in the data sheets do not directly correspond to the final process design presented in this chapter. The specific concentrate grade and concentrate, flux and reductant coal feed rates are given in tables A.1.1, A.2.1 and A.2.2.

- Ausmelt Furnace Process Flow Diagram AUS933-15001

A.1.2 Furnace Availability

The Ausmelt primary smelter is designed to have an annual availability of 90% or 7,884 hours. With an allowance for unplanned maintenance and lance changeover, this annual plant availability translates to an operating utilisation of 84% or 7,358 hours per year.

Operating availability is based on continuous operation, comprising 3 by 8 hour shifts. The 16% downtime allowance includes planned maintenance, annual refractory replacement and unplanned plant stoppages and breakdowns.

The 84% operating utilisation is achieved by using copper cooling panels in the bottom section of the furnace and a standard Ausmelt shower-cooled system in the upper section.

Replacement of refractory will typically require a period of 20 days - 2 days to cool, 3 days to remove worn refractories, 10 days to reline and 5 days to heat up the furnace.

A.1.3 Process Chemistry

Browns concentrates, quick lime, haematite, dolomite and reductant coal are smelted continuously in the Ausmelt furnace to produce a low grade matte, a slag containing 0.08% cobalt and a fume consisting of 68 to 70% lead.

Browns concentrate is a polymetallic material consisting essentially of sulphides of copper, nickel, iron, lead and cobalt and oxides of silicon, aluminium, calcium and magnesium. Small concentrations of the primary constituents are also present as carbonates.

The energy required to melt the concentrates and fluxes, impart energy for reactions and to maintain the bath at 1300^{o}C, is provided by the sub-stoichiometric, submerged combustion of milled fuel coal, air and oxygen. The milled coal, air and oxygen are injected into the bath through the Ausmelt lance.

Sub-stoichiometric combustion conditions are achieved at the lance tip by limiting the combustion air to 80% of that required for combustion to CO_2 and H_2O. The combustion air is enriched to 40% oxygen to improve combustion efficiency and reduce the volume of off gas produced, thereby increasing the concentration of sulphur dioxide in the off gas.

The concentrates are pneumatically conveyed to the furnace and injected into the molten bath via a central annulus in the Ausmelt combustion lance. The concentrates are pneumatically conveyed at a conveying solids loading of 20 (kg of solids per kg of carrier gas).

Quick lime, haematite and dolomite are added as fluxes to control the slag composition. The composition selected will result in a slag with functional viscosity and liquidus characteristics for the process. Quick lime, haematite and dolomite are added to maintain the following component ratio and levels in slag:

$$\frac{\%Fe}{\%SiO_2} \; ? \; 0.3 \qquad \%CaO \; ? \; 20\% \qquad \%MgO \; ? \; 8\%$$

The reductant coal addition rate is adjusted to help control the oxygen partial pressure to maintain a reducing environment in the furnace. The carbonates and oxidised components are carbothermically reduced. Operating under reducing conditions ensures low cobalt, copper and nickel losses to slag. Oxygen partial pressures between 10^{-9} and 10^{-10} atmospheres are required to achieve cobalt levels in slag less than 0.1%.

The reactions governing the process are a combination of dissociation, oxidation and reduction reactions. The major reactions central to the smelting process are detailed below.

Note subscripts: (l) liquid, (s) solid and (g) gas

Dissociation Reactions

$CaMg(CO_3)_{2(s)} = CaO_{(l)} + MgO_{(l)} + 2CO_{2(g)}$ 1

$FeS_{2(s)} = FeS_{(l)} + S_{(g)}$ 2

Reduction Reactions

$Cu(OH)_{2(s)} + ½C_{(s)} = Cu_{(l)} + ½CO_{2(g)} + H_2O_{(g)}$ 3

$Co(OH)_{2(s)} + ½C_{(s)} = Co_{(l)} + ½CO_{2(g)} + H_2O_{(g)}$ 4

$Ni(OH)_{2(s)} + ½C_{(s)} = Ni_{(l)} + ½CO_{2(g)} + H_2O_{(g)}$ 5

$ZnO_{(l)} + C_{(s)} = Zn_{(g)} + CO_{(g)}$ 6

$PbO_{(l)} + ½C_{(s)} = Pb_{(g)} + ½CO_{2(g)}$ 7

$CoO_{(l)} + C_{(s)} = Co_{(l)} + CO_{(g)}$ 8

$NiO_{(l)} + C_{(s)} = Ni_{(l)} + CO_{(g)}$ 9

$FeO_{(l)} + C_{(s)} = Fe_{(l)} + CO_{(g)}$ 10

Oxidation Reactions

$Cu_2S_{(s)} + CO_{2(g)} + O_{2(g)} = Cu_2O_{(l)} + SO_{2(g)} + CO_{(g)}$	11
$CoS_{(s)} + CO_{2(g)} + O_{2(g)} = CoO_{(l)} + SO_{2(g)} + CO_{(g)}$	12
$NiS_{(s)} + CO_{2(g)} + O_{2(g)} = NiO_{(l)} + SO_{2(g)} + CO_{(g)}$	13
$ZnS_{(s)} + CO_{2(g)} + O_{2(g)} = ZnO_{(l)} + SO_{2(g)} + CO_{(g)}$	14
$PbS_{(s)} + CO_{2(g)} + O_{2(g)} = PbO_{(l)} + SO_{2(g)} + CO_{(g)}$	15
$FeS_{(s)} + CO_{2(g)} + O_{2(g)} = FeO_{(l)} + SO_{2(g)} + CO_{(g)}$	16

Oxygen Transfer Reactions

$FeO_{(l)} + \frac{1}{4}O_{2(g)} = \frac{1}{2}Fe_2O_{3(l)}$	17
$Fe_2O_{3(l)} + \frac{1}{2}C_{(s)} = 2FeO_{(l)} + \frac{1}{2}CO_{2(g)}$	18
$Fe_2O_{3(l)} + 1/3FeS_{(l)} = 7/3FeO_{(l)} + 1/3SO_{2(g)}$	19

Volatile species from the bath reactions are oxidised or afterburnt above the bath by air injected through a concentric shroud pipe that is part of the lance. The afterburn oxidation reactions are exothermic, resulting in an offgas temperature greater than the bath temperature. A proportion of the energy released by afterburning is recovered to the bath through splashing slag.

Afterburn Reactions

$CO_{(g)} + \frac{1}{2}O_{2(g)} = CO_{2(g)}$	20
$PbS_{(g)} + 3/2O_{2(g)} = PbO_{(s)} + SO_{2(g)}$	21
$Zn_{(g)} + \frac{1}{2}O_{2(g)} = ZnO_{(s)}$	22
$C_{(graphite)} + O_{2(g)} = CO_{2(g)}$	23
$S_{(g)} + O_{2(g)} = SO_{2(g)}$	24
Coal Volatiles $_{(g)} + nO_{2\ (g)} = aCO_{2\ (g)} + bH_2O_{\ (g)}$	25

where n, a and b are coal type dependent.

A.1.4 Feed Specifications

Specifications for all furnace feed materials, including concentrates, fluxes and reductant coal are detailed in Appendix F, Ausmelt Process Data Sheets.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the information presented in the data sheets do not directly correspond to the final process design presented in this chapter. The specific concentrate grade and concentrate, flux and reductant coal feed rates are given in tables A.1.1, A.2.1, A.2.2 and A.3.1.

AUS933 -15010	Ausmelt Furnace Feed Materials
	Browns Concentrates Quick Lime Haematite Dolomite Reductant Coal

A.1.5 Solid Fuel Specifications

A specification for the milled coal to be used as fuel to maintain the Ausmelt furnace at 1300^{o}C during operations is presented in Appendix F, Ausmelt Process Data Sheets.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the information presented in the data sheets do not directly correspond to the final process design presented in this chapter. Fuel requirements specific to this design are summarised in table A.3.1.

AUS933 -15013 Solid Fuel Supply

A.1.6 Gaseous Fuel Specifications

A specification for the natural gas to be used as fuel to preheat the Ausmelt furnace to the operating temperature is presented in Appendix F, Ausmelt Process Data Sheets.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the information presented in the data sheets do not directly correspond to the final process design presented in this chapter. Fuel requirements specific to this design are summarised in table A.3.1.

AUSA933 -15013 Gaseous Fuel Supply

A.1.7 Product Specifications and Recoveries

Specifications for the matte, slag and fume from the Ausmelt furnace are presented in Appendix F, Ausmelt Process Data Sheets.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the information presented in the data sheets do not directly correspond to the final process design presented in this chapter. Matte, slag and fume production rates specific to this design are summarised tables A.2.1, A.2.2 and A.3.1.

AUSA933 -15011 Ausmelt Furnace Products

Matte
Slag
Fume

The cobalt, copper and nickel content of the matte remain relatively constant during operation at 4.0%, 19.3% and 3.4% respectively. The lead concentration in fume is approximately 70%. These concentrations in matte and fume represent recoveries for cobalt, copper, nickel and lead of 97%, 96%, 96% and 98% respectively.

A.1.8 Lance and Offgas Flows Summary

Lance and offgas flows for the operation are summarised in table A.2.4.

Specifications for the combustion air and oxygen and the product offgas are detailed in Appendix F, Ausmelt Process Data Sheets.

Please note that the concentrate grade, moisture level and feed rate were altered part way through the study. Consequently, the air and oxygen requirements presented in the data sheets do not directly correspond to the final process design presented in this chapter.

AUS933 -15012 Ausmelt Furnace Offgas
AUS933 -15014 Ausmelt Furnace Air Supply
AUS933 -15015 Ausmelt Furnace Oxygen Supply

Table A.2.4 Lance and Offgas Flow Summary (Years 1 to 2)

Operating Temperature (°C)				1,300	
Lance Flows	Fuel - Milled Coal		(kg/h)	3,510	
	Oxygen Enrichment		(%)	40	
	Lance Air		(Nm^3/h)	12,240	
	Lance Oxygen		(Nm^3/h)	4,220	
	Afterburn Air		(Nm^3/h)	31,530	
	Ingress Air		(Nm^3/h)	1,000	
Furnace Offgas				wet	dry
	Offgas Volume		(Nm^3/h)	48,940	47,760
	Composition (Volume %)	N_2	(%)	72.9	74.7
		H_2O	(%)	2.4	-
		CO_2	(%)	16.3	16.7
		SO_2	(%)	8.0	8.2
		O_2	(%)	0.4	0.4
	Temperature		(?C)	1600	
	Heat Content (exit of roof)		(GJ/h)	140	
	Dust Loading		(g/Nm^3)	290	

A.2 MASS AND ENERGY BALANCES

A.2.1 Mass Balances

A detailed mass balance showing the distribution of the relevant major and minor components is given in table A.2.1. The annual summary mass balance for the major and minor components is shown in table A.2.2.

The process information presented in this section is restricted to the treatment of dry, Browns concentrates from years 1 to 2. A secondary process check was performed to confirm that the smelter and associated equipment specified to process concentrates from years 1 to 2 have sufficient capacity to process year 3 concentrates.

Table A.2.1 Hourly Mass Balance (Years 1 to 2)

INPUT:		Wgt (wet)	H_2O (free)	Wgt (dry)	Cu	Pb	Zn	Fe	Co	S	CaO	MgO	Al_2O_3	SiO_2	Ni	C (graphite)	Ag (ppm)	Other (associated O & H)
Browns Concentrates	%		0.50		5.10	23.20	2.22	11.80	1.05	19.70	2.75	2.75	4.48	14.70	0.86	8.97	65	2.42
	kg/h	42,125	210.6	42,336	2,159.1	9821.9	939.9	4995.6	444.5	8340.2	1164.2	1164.2	1896.7	6223.4	364.1	3797.5	3	1024.5
Quick Lime	%		3.10								95.96	1.50	1.00	1.00				0.54
	kg/h	2,054	63.7	1,991							1910.1	29.9	19.9	19.9				10.7
Haematite	%		3.10					63.50			0.10	0.10	2.20	4.10				2.70
	kg/h	3,225	100.0	3,125				1984.1			3.1	3.1	68.7	128.1				84.2
Dolomite	%		3.10					0.70			25.00	25.00	0.30	4.00				45.00
	kg/h	238	7.4	230				1.6			57.6	57.6	0.7	9.2				103.7
Reductant Coal	%		4.00					0.41		0.69	0.25	0.08	2.18	3.96				
	kg/h	558	22.3	536				2.2		3.7	1.3	0.4	11.7	21.2				
Fuel Coal	%		2.00					0.41		0.69	0.25	0.08	2.18	3.96				
	kg/h	3,578	71.6	3,507				14.3		24.1	8.7	2.8	76.6	138.9				
Total Input	kg/h	51,779	476	51,724	2,159	9,822	940	6,998	445	8,368	3,145	1,258	2,074	6,541	364	3,798	3	1,223

OUTPUT:		Wgt (wet)	H_2O (free)	Wgt (dry)	Cu	Pb	Zn	Fe	Co	S	CaO	MgO	Al_2O_3	SiO_2	Ni	C (graphite)	Ag (ppm)	Other
Matte	%				19.32	1.50	0.20	46.71	4.01	25.00					3.26	0.10	110	
	kg/h			10,727	2072.8	160.9	21.5	5010.5	429.8	2681.7					349.8	10.7	1	
	Dist				96.0	1.6	2.3	71.6	96.7	32.0					96.1	0.3	42.7	
Slag	%				0.48	0.05	0.05	12.48	0.08	0.20	20.00	8.00	13.19	41.59	0.08	0.10	4	
	kg/h			15,647	75.6	7.8	7.8	1952.4	12.5	31.3	3129.4	1251.8	2063.9	6508.0	12.5	15.6	0	
	Dist				3.5	0.1	0.8	27.9	2.8	0.4	99.5	99.5	99.5	99.5	3.4	0.4	2.3	
Fume	%				0.08	68.64	6.47	0.25	0.02	0.10	0.11	0.04	0.07	0.23	0.01	17.00	108	
* after post combustion	kg/h			14,063	10.8	9653.2	910.6	35.0	2.2	14.1	15.7	6.3	10.4	32.7	1.8	2390.8	2	
	Dist				0.5	98.3	96.9	0.5	0.5	0.2	0.5	0.5	0.5	0.5	0.5	63.0	55.0	
Total Output	kg/h			29,710	2,159	9,822	940	6,998	445	2,727	3,145	1,258	2,074	6,541	364	2,417	3	-

Table A.2.2 Annual Mass Balance

INPUT:		Wgt (wet)	H_2O (free)	Wgt (dry)	Cu	Pb	Zn	Fe	Co	S	CaO	MgO	Al_2O_3	SiO_2	Ni	C (graphite)	Ag (ppm)	Other (associated O & H)
Browns Concentrates	%		0.50		5.10	23.20	2.22	11.80	1.05	19.70	2.75	2.75	4.48	14.70	0.86	8.97	65	2.42
	tonnes	309,975	1,549.9	311,525	15,887.8	72,273.8	6,915.9	36,760.0	3,271.0	61,370.4	8,566.9	8,566.9	13,956.3	45,794.2	2,679.1	27,943.8	20	7,538.9
Quick Lime	%		3.10								95.96	1.50	1.00	1.00				0.54
	tonnes	15,116	468.6	14,647							14,055.5	219.7	146.5	146.5				79.1
Haematite	%		3.10					63.50			0.10	0.10	2.20	4.10				2.70
	tonnes	23,727	735.5	22,991				14,599.6			23.0	23.0	505.8	942.6				619.6
Dolomite	%		3.10					0.70			25.00	25.00	0.30	4.00				45.00
	tonnes	1,749	54.2	1,695				11.9			423.8	423.8	5.1	67.8				762.8
Reductant Coal	%		4.00					0.41		0.69	0.25	0.08	2.18	3.96				
	tonnes	4,109	164.3	3,944				16.1		27.1	9.8	3.2	86.1	156.2				
Fuel Coal	%		2.00					0.41	0.00	0.69	0.25	0.08	2.18	3.96				
	tonnes	26,331	526.6	25,804				105.5	0.0	177.1	64.0	20.6	563.6	1,021.8				
Total Input	tonnes	381,007	3,499	380,607	15,888	72,274	6,916	51,493	3,271	61,575	23,143	9,257	15,263	48,129	2,679	27,944	20	9,000

OUTPUT:		Wgt (wet)	H_2O (free)	Wgt (dry)	Cu	Pb	Zn	Fe	Co	S	CaO	MgO	Al_2O_3	SiO_2	Ni	C	Ag (ppm)	Other
Matte	%				19.32	1.50	0.20	46.71	4.01	25.00					3.26	0.10	110.00	
	tonnes			78,932	15,252.3	1,184.0	157.9	36,869.0	3,162.5	19,733.1					2,573.6	78.9	8.7	
	Dist				96.0	1.6	2.3	71.6	96.7	32.0					96.1	0.3	42.7	
Slag	%				0.48	0.05	0.05	12.48	0.08	0.20	20.00	8.00	13.19	41.59	0.08	0.10	4.10	
	tonnes			115,136	556.1	57.6	57.6	14,366.5	92.1	230.3	23,027.3	9,210.9	15,187.1	47,888.5	92.1	115.1	0.5	
	Dist				3.5	0.1	0.8	27.9	2.8	0.4	99.5	99.5	99.5	99.5	3.4	0.4	2.3	
Fume	%				0.08	68.64	6.47	0.25	0.02	0.10	0.11	0.04	0.07	0.23	0.01	17.00	108.12	
* after post combustion	tonnes			103,483	79.4	71,032.2	6,700.4	257.5	16.4	103.5	115.7	46.3	76.3	240.6	13.4	17,592.1	11.2	
	Dist				0.5	98.3	96.9	0.5	0.5	0.2	0.5	0.5	0.5	0.5	0.5	63.0	55.0	
Total Output	tonnes			218,619	15,888	72,274	6,916	51,493	3,271	20,067	23,143	9,257	15,263	48,129	2,679	17,786	20	

A.2.2 Energy Balances

An energy balance was established to equate the energy input with the energy leaving the furnace, and to determine the fuel requirement for the process. The energy balance incorporates an allowance for the following inputs and outputs:

- heat of reaction
- heat of combustion
- heat of afterburn recuperation
- sensible heat of the combustion gases
- sensible heat of the reaction gases
- sensible heat of the slag and fume
- furnace heat losses

Table A.2.3 summarises the heat inputs and outputs for the Ausmelt furnace. The terms used to define the energy balance are described below.

Combustion

The heat produced from the combustion of fuel is the product of the fuel requirement and the fuel gross calorific value.

Combustion Air Preheat

Combustion air is heated to 300?C as it passes through the lance. The combustion air heat requirement is determined from enthalpy of air (O_2 and N_2) at 300?C.

Reaction Heat

The reaction heat requirement is determined from the enthalpy of reactions (1 to 19) at the operating temperature.

Afterburn Recuperation

The heat released from afterburning is determined from the enthalpy of reactions (20 to 25) at the operating temperature. The afterburn heat recuperation is the proportion of energy released from these reactions that is recovered by the bath.

Combustion Gases

The heat content of the gaseous products of combustion is calculated from thermodynamic data for the individual components (CO, CO_2, H_2, H_2O, N_2) at the operating temperature.

Reaction Gases

The heat content of the gaseous products of reaction is calculated from thermodynamic data for the individual components (CO, CO_2, H_2, H_2O, N_2) at the operating temperature.

Slag Heat

The heat content of the product slag in the furnace is calculated at the operating temperature. The slag heat content incorporates an allowance for the heat of fusion.

Furnace Heat Losses

The heat losses from the furnace, at the operating temperature, are calculated from heat flux data for the insulated base, copper cooling panel wall section (lower), water-cooled wall section (upper), water cooled roof and transition. The heat flux calculations take into account the thermal conductivity of solidified slag, refractory bricks, backing lining and steel shell.

Dust/Fume Heat

The sensible heat of the fume/dust is calculated from the sum of the heat contents of the individual components, including the relevant heats of vaporisation, at the operating temperature.

Table A.2.3 Energy Balance

Energy Input (GJ/h)		**Energy Output (GJ/h)**	
Combustion	-91.9	Combustion Gases	26.8
Combustion Preheat	-3.7	Reaction Gases	15.1
Reaction Heat	25.6	Slag Heat	35.1
Afterburn Recuperation	-45.6	Matte Heat	8.8
		Furnace Heat Losses	24.8
		Dust / Fume Heat	5.0
TOTAL INPUT	**- 115.6**	**TOTAL OUTPUT**	**115.6**

A.3 PROCESS DATA SUMMARY

The following process data is for an Ausmelt furnace treating 311,525 tonnes per annum of dry Browns concentrates produced during years 1 and 2 of operation.

Table A.3.1 Process design data

Parameter			**Hourly**		**Annual**	
Feed Materials	Browns Concentrate (dry)		42,340	kg/hr	311,525	t/a
	Injected - Mass Solids : Gas Loading (kg/kg)		20 : 1		20 : 1	
	Quick lime (dry)		1,990	kg/hr	14,650	t/a
	Haematite (dry)		3,130	kg/hr	22,990	t/a
	Dolomite (dry)		230	kg/hr	1,700	t/a
Lance Inputs	Combustion Air		9,900	Nm^3/hr	72,817,280	Nm^3/a
	Fuel Coal Carrier Air		580	Nm^3/hr	4,300,700	Nm^3/a
	Concentrate Carrier Air		1,760	Nm^3/hr	12,980,210	Nm^3/a
	Combustion Oxygen		4,220	Nm^3/hr	31,071,970	Nm^3/a
	Afterburn Air		31,530	Nm^3/hr	231,993,730	Nm^3/a
Standby Inputs	Standby Burner Air		11,660	Nm^3/hr	5,933,320	Nm^3/a
Fuel	Operating (milled coal - dry)		3,520	kg/hr	25,800	t/a
	Mass Solids : Gas Loading (kg/kg)		5 : 1		5 : 1	
	Standby Burner (natural gas)		1,080	Nm^3/hr	547,610	Nm^3/a
Reductant	Lump Coal (dry)		540	kg/hr	3,940	t/a
Cooling water	Panels, tapping blocks, shower cooling (not consumed)		590	t/hr	4,346,950	t/a
	make-up water		10	t/hr	80,070	t/a
Furnace Outputs	Matte		10,730	kg/hr	78,930	t/a
	Slag		15,650	kg/hr	115,140	t/a
	Fume		14,060	kg/hr	103,480	t/a
Off Gas	Temperature		1600	°C		
			Wet		**Dry**	
	Volume		48,940	Nm^3/hr	47,760	Nm^3/hr
	Composition					
		N_2	72.9	%	74.7	%
		H_2O	2.4	%	-	%
		CO_2	16.3	%	16.7	%
		SO_2	8.0	%	8.2	%
		O_2	0.4	%	0.4	%