Ausmelt Limited

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Design and Costing Study Report

Ausmelt Primary Smelter for Treating Browns Concentrates

for

Compass Resources

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SUMMARY

Ausmelt was contracted by Compass Resources NL to provide engineering and estimation services in support of a design and costing study evaluating the use of Ausmelt Technology for the primary treatment of Browns concentrates in the Northern Territory.

The proposed plant configuration will use an Ausmelt furnace system to continuously process 311,525 dry tonnes per annum of Browns concentrates. The process to treat the concentrates has been designed to maximise lead recovery to fume and cobalt recovery to matte. The Ausmelt plant will produce 78,930 tonnes of cobalt-copper-nickel-iron matte, 115,140 tonnes of discard slag and 103,480 tonnes of high lead fume per annum.

The overall design and costing study managed, by Hatch, encompasses all plant unit operations including feed handling, Ausmelt furnace, product handling, off gas handling and other auxiliary services. Ausmelt's contribution is restricted to core aspects relating to the Ausmelt Primary Smelter and associated proprietary equipment.

The design and costing study completed by Ausmelt was carried out to an accuracy of ? 30%.

The estimated capital cost for the following Ausmelt plant equipment and services is **AU$11,452,050**:

- Process design and engineering
- Design of Ausmelt equipment including furnace, lances, lance handling, standby burner, instrumentation and control system
- Supply of Ausmelt equipment including the Ausmelt furnace, lances and lance handling system, lance seal device, standby burner and burner handling system, integrated process control system and lance burner flow control instrumentation
- On-site services including inspection of Ausmelt equipment installation, operator training, cold commissioning, hot commissioning and production support
- Technology license fee

The fuel coal, air, oxygen, water, power, reductant coal, maintenance and labour requirements for the Ausmelt plant have been estimated. An operating cost for the Ausmelt plant can be determined directly from these requirements.

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1 INTRODUCTION

Ausmelt was contracted by Compass Resources NL to provide engineering and estimation services in support of a design and costing study evaluating the use of Ausmelt Technology for the primary treatment of Browns concentrates.

The proposed Ausmelt furnace system will treat Browns concentrates to produce a matte containing cobalt, copper, nickel and iron, and a high lead fume. The high lead fume will be transferred to a second Ausmelt furnace to produce lead bullion (outside the scope of this study). It is expected that the matte will undergo mild pressure leaching, solvent extraction and electrowinning to recover metal values.

The overall design and costing study, managed by Hatch, encompasses all smelting plant unit operations including feed handling, Ausmelt furnace, product handling, off gas handling and other auxiliary services. Ausmelt's contribution is restricted to core aspects of the Ausmelt primary smelter and associated proprietary equipment.

This report presents design and costing data for the Ausmelt furnace, proprietary equipment and design services to an accuracy of ? 30%.

1.1 Ausmelt Technology

Ausmelt Technology is a low cost, high intensity system for smelting base metal ores and concentrates as well as recovering high value from wastes. Smelting is rapid and furnace residence times are low, yielding significantly lower capital and operating costs than alternative technologies.

Ausmelt Technology for treating Browns concentrates is based on a catalytic reaction between the oxidisable components of the concentrates and ferric oxide. Critical process phenomena (mass and energy transfer) occur in a slag layer. Feed material dissolution, reaction and primary combustion all take place in the slag layer. A schematic representation of a typical Ausmelt furnace is shown in figure 1.

Central to the Technology is a vertical suspended lance, submerged in a molten slag bath. The slag is well mixed by the injection of combustion gases (air and oxygen) and as a result the reaction rates in the furnace are high. Controlled, swirling of the combustion air in the lance provides sufficient cooling to cause a slag layer to form on the outer surface to protect the lance from attack in the highly aggressive environment.

Oxygen enriched air and milled coal are injected through the lance and combusted at the lance tip to provide heat to the furnace. The degree of oxidation and reduction is controlled by adjusting the fuel to oxygen ratio supply to the lance, and the proportion of reductant coal to feed.

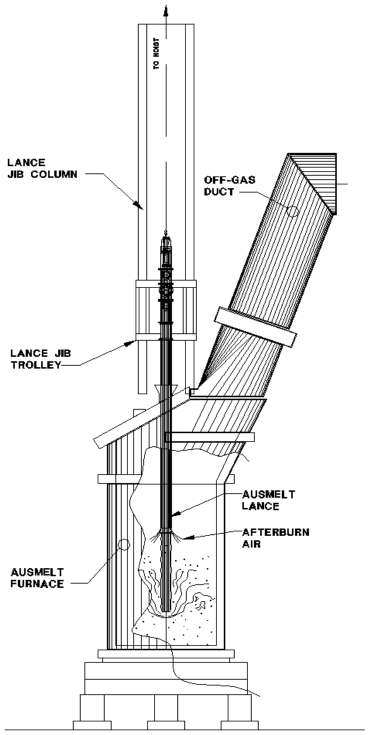

Figure 1 Schematic of the Ausmelt Furnace System

The containment vessel or furnace is a tall, cylindrical unit operated under a negative pressure, and designed to generate slag splash. Ausmelt furnaces are lined with refractory materials and depending on the application are shower-cooled, insulated or incorporate forced water or steam cooling/boiler panels to improve refractory life.

Feed material, fluxes and reductant coal are fed to the system by conveying the material to a port(s) located on the roof of the furnace and allowing it to drop into the molten bath. Fine material can be agglomerated or injected directly into the bath to minimise dust loss through entrainment by rising exhaust gases.

Ausmelt Technology has been applied to the commercial production of a broad spectrum of non-ferrous and precious metals and the high temperature treatment of various waste materials. Table 1 briefly summarises the commercial and development plants currently in operation, design and construction around the world. Further details on these plants are available at www.ausmelt.com.au.

Table 1a Commercial Ausmelt Furnaces in Operation, Design & Construction

No.	Client	Location	Starting year	ID (m)	Cont. or Batch*1	Feed type	Design Feed Rate tpa	Product	Temp Range °C	Fuel	Reductant	Air or Oxygen*2	Lance Tip*3
1	Rio Tinto Zimbabwe	Eiffel Flats, Zimbabwe	1992	1.5	B2	Leach residue	7700	Desulphurisation Ni/Cu Matte	1250–1350	Coal	Coal	0.21	(1) O (2) R
2	Korea Zinc(1)*4 F1	Onsan, Korea	1992	3.9	C1	QSL Furnace slag	100,000 *5	Zinc/lead fume	1300	Coal	Coal	0.35	N or R
3	Mitsui	Hachinohe, Japan	1993	2.4	C1	ISF slag	80,000	Zinc fume	1300–1350	Heavy oil	Heavy oil/ Coke breeze	0.21	R
4	Anglo American Corp.	Bindura, Zimbabwe	1995	2.2	B3	Leach residue	10,000	Blister copper	1250–1300	Coal	Coal	0.21	(1) N (2) SO (3) R
5	Korea Zinc(2) F1	Onsan, Korea	1995	3.9	C2	Zn leach residue	120,000	Zinc/lead fume	1250–1300	Coal	Coal	0.35	N
6	Korea Zinc(2) F2	Onsan, Korea	1995	3.2	C2	F1 slag (liquid)	100,000	Zinc fume	1250–1300	Coal	Coal	0.21	R/N
7	Metaleurop	Nordenham, Germany	1996	3.4	C1/B2	Battery paste/ High Pb conc.	122,000	Lead bullion	950–1250	Natural gas	Coal/ Petrol. coke	0.21 - 0.40	N/O/R
8	Minsur F1	Pisco, Peru	1996	3.4	B2	Sn Conc.	40,000	Tin metal	1150–1300	Bunker C oil	Coal	0.21 - 0.30	N/R
9	Consolidated Gold Fields	Tsumeb, Namibia	1997	4.4	B2	Low Pb Conc./ Pb/Cu conc.	120,000	Pb bullion/Cu matte	1150–1250	Heavy furnace oil	Coal	0.21	O/N/R
10	Portland Aluminium/Alcoa	Portland, Australia	1997	2.8	B2	Spent Pot Lining	12,000	AlF_3	1250	Natural gas	Coal	0.40	O/N
11	Hindustan Copper Limited	Ghatsila, India	1998	0.5	B2	Anode slimes	72	Silver – gold doré	1000 –1100	Light diesel oil	-	0.21	(1) N (2) O

Notes for Table I:
*1 C1 = continuous one stage, C2 = continuous two stage,
B1 = batch one stage, B2 = batch two stage, B3 = batch three stage
*2 *Oxygen fraction, Air = 0.21, Oxygen ? 0.21*
*3 *O = Oxidising, N = Neutral, R = Reducing, S Prefix = Strongly*
*4 No. in brackets = plant no.; F no. = furnace no. in plant
*5 *100,000 tpa for liquid slag, 50,000 tpa for solid slag*

Table 1b Commercial Ausmelt Furnaces in Operation, Design & Construction (continued)

No.	Client	Location	Starting year	ID (m)	Cont. or Batch*1	Feed Type	Design Feed Rate tpa	Product	Temp Range °C	Fuel	Reductant	Air or Oxygen*2	Lance Tip*3
12	Zhong Tiao Shan F1	Houma City, China	1999	4.4	C	Cu concentrates	200,000	Copper matte (60%)	1180	Coal	-	0.40	O
13	Zhong Tiao Shan F2	Houma City, China	1999	4.4	B	Cu matte	60,000	Blister copper	1300	Coal	-	0.21	SO
14	Minsur F2 (standby furnace)	Pisco, Peru	1999	3.4	B2	Sn concentrates	40,000	Tin metal	1150 – 1300	Bunker C oil	Coal	0.21 - 0.30	N/R
15	AuIron/SASE*6	Whyalla, Australia	2000	*7	C	Fe Ore	15,000	Pig iron	1450	Coal	Coal	0.60	SR
16	Korea Zinc (3)	Onsan, Korea	2000	2.8	C	Pb secondaries	100,000	Lead bullion	1000	Coal	Coal	0.40	R
17	Yunnan Tin Corporation	Gejiu City, China	2001	4.4	B	Sn concentrates	50,000	Tin metal	1150 -1250	Coal	Coal	0.21	N/R
18	Korea Zinc F2 for (1)	Onsan, Korea	2001	3.9	C	QSL Furnace slag	100,000	Zinc fume	1300	Coal	Coal	0.21	R
19	Korea Zinc (4) F1	Onsan, Korea	2002	3.9	C	Pb tailings	100,000	Lead fume	1200	Coal	Coal	0.40	N
20	Korea Zinc (4) F2	Onsan, Korea	2002	3.9	C	F1 slag (liquid)	80,000	Lead/zinc fume	1250	Coal	Coal	0.21	R
21	Amplats F1	Rustenburg, South Africa	2002	4.4	B2	Granulated Ni/Cu/PGM matte	213,000	Ni/Cu converter matte	1300	Coal	Coal	0.40/0.25	SO
22	Anhui Tongdu Copper	Tongling City, China	2002	4.4	C	Cu concentrates	330,000	Copper matte (50%)	1180	Heavy furnace oil/Coal	Coal	0.40	O
23	Amplats F2	Rustenburg, South Africa	2004	4.4	B2	Granulated Ni/Cu/PGM matte	213,000	Ni/Cu converter matte	1300	Coal	Coal	0.40/0.25	SO

Notes for Table I: *1 C1 = continuous one stage, C2 = continuous two stage, *6 SASE – South Australian Steel & Energy Project

B1 = batch one stage, B2 = batch two stage, B3 = batch three stage

*2 *Oxygen fraction, Air = 0.21, Oxygen ? 0.21*

*3 *O = Oxidising, N = Neutral, R = Reducing, S Prefix = Strongly*

Demonstration pig iron plant

*7 *Elliptical furnace = 5 m x 3 m*

2 PROJECT OVERVIEW

The proposed plant configuration will use an Ausmelt furnace system to process 311,525 dry tonnes per annum of Browns concentrates to produce 78,930 tonnes of cobalt-copper-nickel-iron matte, 115,140 tonnes of discard slag and 103,480 tonnes of high lead fume per annum.

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 Appendix A.

The information presented in this chapter is based on the process design outlined in Appendix A to treat concentrates of the grade, moisture content and feed rate detailed in table A.1.1.

2.1 Ausmelt Study Scope of Work

Ausmelt's scope of work for this design and costing study is restricted to the following core technology components of the Ausmelt Primary Smelter:

Engineering

1. Process design
2. Design of Ausmelt equipment including furnace, lances, lance handling, standby burner, instrumentation and control system

Supply

3. Ausmelt furnace
4. Lances and lance handling system
5. Lance port sealing device
6. Standby burner and burner handling system
7. Integrated process control system
8. Lance burner flow control instrumentation

Site Services

9. Operator training
10. Cold commissioning
11. Hot commissioning

12. Production support

License

13. Technology license fee

2.2 Process Summary

A detailed description of the proposed Ausmelt process is presented in Appendix A, Ausmelt Process Design. The process design incorporates elemental distribution and combustion data from recently completed pilot scale trials. The Ausmelt plant and equipment is described in Appendix B, Engineering Concept Design.

The Ausmelt process to treat Browns concentrates is designed to maximise lead deportment to fume and cobalt recovery to matte. To ensure high recoveries the Ausmelt furnace will be operated under strongly reducing conditions at 1300°C. Lead, cobalt, copper and nickel recoveries are all in excess of 95%.

The concentrates will be treated in a single Ausmelt furnace. The plant will operate continuously, with a throughput of around 42 tonnes per hour of concentrates. The dry concentrates will be injected directly into the molten slag through a dedicated annulus of the Ausmelt lance.

The heat energy required to melt the concentrates and fluxes, impart energy for reactions and to maintain the bath at 1300°C, is provided by the sub-stoichiometric, submerged combustion of milled fuel coal, air and oxygen.

Sub-stoichiometric combustion conditions are achieved at the lance tip by limiting the combustion air to 80% of that required for complete 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.

Approximately 540 kilograms per hour of reductant coal will be required to help maintain the oxygen partial pressure between 10^{-9} and 10^{-10} atmospheres in the furnace.

Quick lime, haematite and silica will be fed to the furnace at rates of 2.0, 3.1 and 0.2 tonnes per hour respectively to adjust the composition of the product slag. The flux additions will generate a slag with functional viscosity and liquidus characteristics for the Ausmelt process, whilst minimising ‘slag make’.

The product mate and slag will be continuously removed from the Ausmelt furnace and transferred into a settling furnace through an underflow weir.

3 CAPITAL COST ESTIMATE

The estimated capital cost for the Ausmelt plant equipment and services detailed in section 2.1 is **AU$ 11,452,050** (? 30%).

A detailed capital cost breakdown and methods of estimation are presented in Appendix C, Capital Cost Estimate. The capital cost estimate has been prepared based on Australian design, fabrication and construction costs.

4 OPERATING CONSUMPTION AND LABOUR REQUIREMENTS

Estimates of the operating consumption, maintenance and labour requirements are detailed in Appendix D, Ausmelt Consumption Rates and Labour Requirements.

The operating consumption and maintenance rates have been determined from the process design calculations undertaken as part of the study.