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STERLITE INDUSTRIES (I) LTD.
Sipcot Industrial Complex, Madurai Bypass Road,
T. V. Puram PO, Tuticorin - 628 002.
Tel.: (91-461) 551 2591 (10 lines) Fax: (91-461) 234 02

Regd. Office : B-10/4, Waluj MIDC Industrial Area.
Waluj, Dist.: Aurangabad - 431 133
Website: www.vedantaresources.com

Dear Sir/Madam,

We thank the Executive Board for providing us with an opportunity to respond to the requests for review raised by three EB members. The following are our replies to the requests for review:

Point 1 (addresses point 1 of Request 1 & Request 3)

Demonstration of additionality: the project participant uses an barrier analysis which is not convincing at all. The main argument is a technological barrier which outlines that the project activity shows some specific characteristics which will entail some costs in order to be overcome. This is not sufficient and should rather be part of an investment analysis showing that the total cost of the project including these elements makes it not profitable. But this is not done. The same applies for the managerial barrier. Besides that the common practice test is flawed. The PP states that no other smelter is applying the project activity while an other smelting unit uses also a waste heat recovery boiler. The statement of the PP is based on the fact that this last unit uses coal to superheat the steam from the recovery boiler while the project activity uses heavy oil. This is not acceptable as there is no direct link between the project activity and the fuel used to superheat the steam

Demonstration of additionality

In proceeding with the project activity, we have had the option of going either by the barrier analysis route or the investment analysis route as provided in the "Tool for the demonstration and assessment of additionality – Version 02 (EB 22, November 28, 2005). The costs entailed by the project activity were only those to overcome the technological barriers and they need to be associated with the technological barriers faced by the project activity.

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The ISA smelter with Waste Heat Recovery Boiler, in Sterlite Industries India Limited (SIIL), Tuticorin, was the first of its kind in India and needed technical expertise to function in a sustainable manner without any bottlenecks during its operational period. SIIL's ISA smelter was operational without a waste heat recovery system from 1997 till May 2005.

Installation of a Waste Heat Recovery Boiler (WHRB) in the ISA smelter has several associated operational difficulties which would reduce the availability of the ISA smelter and lead to production losses. The same fact has been indicated by a reputed international consultant as early as 1998 (Annex A). Further, a paper (Annex B) published at the International Copper Conference in 2003 had highlighted the plant stoppages (due to boiler leaks) and risks associated with the recent ISA Smelt (with WHB) installation in China. Though there was not any permanent solution available, we had gone ahead with the decision of taking up the project activity. The WHRB involved in the project activity had developed several technical problems and is evidenced by the data (Annexure-C) during the period July 2005 – December 2006, that lead to production losses.

Also, we have had to send a batch of our employees (operation) abroad to China for training to ensure smooth and sustainable operation of the ISA smelter with the WHRB. We also have enough documentary proof to highlight the trips made by various employees of Sterlite to China specifically to obtain training and hands on experience (Passport copies of the SIIL employees is attached as Annex D). This we have termed as managerial barrier which had to be overcome. This would not have been required if we were to resort to the alternatives that were readily available to us namely;

- Import of electricity from grid
- Electricity generation from coal based captive power plant
- Electricity generation from LSHS based captive power plant

There would be no barriers to the implementation of the above stated alternatives.

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STERLITE INDUSTRIES (I) LTD.
SIPCOT Industrial Complex, Madurai Bypass Road,
T.V. Puram PO, Tuticorin - 628 002.
Tel.: (91-461) 661 2591 (10 lines) Fax: (91-461) 234 0203

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Waluj, Dist.: Aurangabad - 431 133
Website: www.vedantaresources.com

While conducting the common practice analysis, we have presented the fact that the similar technology i.e. ISA smelting technology along with WHRB was not available in India (which appears to be interpreted otherwise by the reviewer as SIIL's smelter was the only smelter which used a WHRB). The claim is that SIIL was the only company in the host country (India) with ISA smelting technology at the time of project conceptualization and, a waste heat steam generator for this ISA smelt technology was relatively an unique concept. The other two copper smelters in India use a process known as Flash Smelting process. The technology of ISA smelting with WHRB in the off-gas circuit was developed by M/s. MIM Process Technologies, Australia and was transferred to SIIL against a license fee. As mentioned earlier, since this technology was not available in India, SIIL had to send their employees to the only other nearby licensee, which is in China. This clearly indicates that waste heat recovery boiler with ISA smelter is not available in the host country, establishing that the same is not a common practice in India.

It is also stated that "there is no direct link between the project activity and the fuel used to superheat the steam". The fuel fired to superheat the steam is related to the project activity due to the following reasons:

The waste heat recovery boiler extracts the heat content (sensible heat) from the waste gases and uses it to generate electricity. To raise the sensible heat content of the steam, it is superheated by firing fuel oils. Hence by firing these fossil fuels, we are contributing to GHG emissions and should very much be a part of the project activity since the emission reductions realized is directly proportional to the amount of fuel oils fired to raise the sensible heat content of the waste gases. The more the sensible heat content of the waste gases, higher the amount of electricity generated which would realize emission reductions.

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Point 2 (addresses point 2 of Request 1& Request 3and point 1 of Request 2)

Identification of the baseline scenario: the identification of the baseline scenario is not clearly outlined. It seems finally to be the use of an existing captive power plant (CPP) but as the project activity coincides with the increase of the capacity of the smelter the PDD should at least demonstrate that the CPP has enough spare capacity to supply this increase of demand.

Selection of Baseline Scenario

As indicated in the "Tool for Demonstration of Additionality – Version 2", the baseline scenario has to be the most economically attractive while also being conservative. Of all the 3 alternatives, it is apparent that LSHS based captive power plant is the most conservative in terms of the Baseline Emission Factor in comparison to coal based captive power generation and import of electricity from grid as per the tabulation shown below as Table 1:

Table 1 Baseline emission factors of project alternatives/ options

Alternative	**Baseline Emission Factor (tCO2/MU)**
Import of electricity from the grid	0.85
Import of electricity from MALCO (coal based power generation)	0.97
LSHS based captive power generation at Sterlite	0.60

The power demand of SIIL was met by State Electricity Board (TNEB), Coal based Captive Power plant (Malco) and LSHS based Captive Power Plant. Table 2 below clearly indicates SIIL's progressive movement towards increased use of LSHS based Captive Power generation in their total power consumption structure. Over the last 3 years, SIIL has reduced its dependence on grid and coal based power generation and used predominantly LSHS based power from its captive power plants. This clearly indicates that in the absence of the project activity, SIIL would have opted for a LSHS based captive power plant of equivalent capacity (as that of WHRB) and is therefore the most likely baseline scenario.

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Table 2 Source of Power at SIIL – 3 Year Data

Source of Power	2001-02	2002-03	2003-04
TNEB	0.40	1.72	0.31
CPP Coal - (Malco)	10.13	8.77	3.64
CPP - LSHS	89.47	89.51	96.06
	100	100	100

Therefore, it can be concluded that because of additional power requirement (due to expansion), SIIL had attractive options other than the project activity. This fact would have remained the same even if there is some additional capacity available with the existing plant. Had the project activity not been implemented, SIIL would have opted for LSHS based captive power plant of the capacity similar to that of the project activity.

Point 3(addresses point 3 of Request 1 & Request 3 and point 1 of Request 2)

Calculation of baseline emissions: the PDD uses formulae which are not part of the methodology. It seems (although this is not clear …) that the CPP is operated in a CHP mode which is beyond the applicability conditions of the methodology.

The methodology applicability criteria clearly states that the electricity generation project activities:

- Displace electricity generation from fossil fuels in the electricity grid or/and
- Displace captive electricity generation from fossil fuel fired power plants

are eligible for this methodology. Nowhere does the methodology states that the Combined Heat & Power Generation modes within the boilers are not applicable. In fact, this was taken into account with the sole intention of being conservative in arriving at the baseline emission factor.

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If the efficiency of the captive power plant reduces, the baseline emission factor would increase from 0.60 to 0.67. In which case, the revised CERs would read as 27,310 tCO_2 (an additional 4800 CERs i.e. 18% increase). The above case is tabulated in Table 3 below for better understanding: **Table 3 Comparison of Baseline emission factor due to incorporation of steam generation**

Scenario	**Baseline Emission Factor (tCO_2/MU)**	**Net CERs (tCO_2e)**
Considering Emission Reduction due to Steam generation	0.60	27,310
Considering Emission Reduction without steam generation	0.67	**22,473**

For Sterlite Industries (I) Limited

Ramesh Nair
Vice President (Operations& Commercial)

Annex A

THE WINTERS COMPANY

5151 E. BROADWAY, SUITE 900
TUCSON, ARIZONA 85711
TELEPHONE: 520-745-8477 FACSIMILE: 520-745-8470

April 22, 1998

ndyopadhyay
President
e Copper
er Works, Shed No. 2
Industrial Complex
rin, 628 002

ct: Sterlite Copper
Smelter Expansion
Project No. 175-01

Mr. Bandyopadhyay,

Our report establishing the priority engineering jobs for the expansion project is ressing well. Meanwhile, we wish to address current operating problems investigated at r request. These topics were discussed with yourself, Mr. Zutshi, Mr. Venkatraman, Mr. Singh, and various operating and maintenance employees.

Feed Preparation

- Feeders under the truck tipper hoppers are unable to convey concentrate. Changes to the drives were specified to Mr. Raju. The calculations are attached.
- Warehouse reclaim hopper requires two men to "poke it" to keep it flowing. The bottom of the hopper and skirtboards on the feeder appear unsuitable. We have not yet formulated a solution. It may be expedient for Sterlite to consult with the conveyor vendor or have The Winters Company redesign the feeder/hopper arrangement as we did for Cyprus in 1993.
- Concentrate bins do not flow. The bins are well designed and constructed, except the outlets. The Winters Company (TWC) proposes the bin cones be replaced to provide slot

outlets as shown on the attached sketch; upon approval we can quickly follow up with a detail design of this bin cone. This type design is commonly applied for concentrate bins. The cones could be replaced one at a time without disrupting production.

Dusting and spills at the two transfer towers feeding conveyors 4 and 5 is excessive due to the height of fall. Modifying the conveyors to deliver the material gently at the transfers would be a big job that could be undertaken in the course of the expansion project. The maintenance men may try to drape conveyor belting inside chutes to cushion the fall.

Dusting in general is excessive due to very dry feedstock as well as non-functional dust suppression sprays. The recent (April 1) receipt of moister concentrate may help. Activating the dust suppression system and controlling moisture content and its effects, such as build-up in chutes, will tax the resources of maintenance men and operators. It may best be undertaken as a project by a special team until operation is smooth and can be turned over to the production team.

- Dribble under conveyor 7, at the top of the pelletizer building, is wearing the snub pulley which will soon form a knife edge and rip the belt. Dribble is excessive here because the belt scraper is tilted into the direction of belt travel and is gouging the vulcanized splice. The scraper mounting must be revised so the splice can pass the scraper smoothly. The damaged splice should be re-vulcanized. More immediately, the dribble must be removed from contact with the pulley.

- Dribble and spills throughout the pelletizer building, bins building, truck tipper, and on the roadway at the truck tippers appears to amount to many tons, available to improve recovery at a cost of a couple of man-days of unskilled labor per ton of recovered spills. The cleanup should be undertaken before strong winds disperse the spills.

- The April 1st receipt of moist concentrate initiated buildup in the pelletizer bypass chute. In the absence of pelletizing, labor and maintenance effort could be reduced by modifying conveyor 7 and installing two new bypass conveyors around the pelletizer building. This concept is illustrated on the attached sketch. Again, with your approval we are prepared to initiate basic and detail engineering of this project. This should be arranged for material to bypass the pelletizer or report to it at operator discretion, by installing a flop gate at a tripper pulley on conveyor 7. A double flop gate would also provide a truck loadout option to allow calibration of the weigh feeders.

ISA/RHF

- ISA launder tip builds up off kidney block. Plant personnel hope to notch out the copper block to remove it from the proximity of the launder. The Winters Company has no alternative suggestion other than improved access to the tip may allow the buildup to be controlled.

- Swivel launder to allow tapping from either ISA tapping block into the RHF. This project was well underway during out visit and is expected to improve availability.

- Buildup in offtake throat. It is not known if the pluggage experienced during our visit is due to high (40 TPH) feed rate, un-pelletized feed, sonic spray operation or a combination of factors. The heatup ventilation fan did not provide enough draft for the workers to occupy the offtake so the ID Fan and KKK Blower ran, chilling the acid plant. It is our impression the operators discovered the ID Fan could provide adequate draft exiting the mixing chamber without running the KKK Blower. It is probably advantageous to oversize the heatup blower so the acid plant can be isolated by dampers at the ID Fan. Heatup ducts may or may not be big enough and sizing can be verified as TWC engineering and support continues.

- The ISA shell cooling recently implemented appears to be appropriate. Unfortunately the ISA is not configured to lend itself to full coverage with a film of water and areas at the support are air-cooled. This is certainly better than nothing and Sterlite's attempt to improve campaign life with shell cooling is commendable.

Gas Handling

- The hot gas electrostatic precipitators suffer contamination of the insulators and damage due to short circuit sparking. Electrical and mechanical maintenance (Mr. Gupta and Mr. Kod) intend to replace the insulator housing purge air blowers to exclude the conductive dust. There was some discussion of the Miami ESP, being downstream of the draft valve, operates at a lower pressure with less contamination. This is not the case at other smelters where the ESP's perform satisfactorily. The new purge air blowers are appropriate and should be installed.

- The PAP includes a fuel oil fired boiler to generate 24T/h process steam. The possibility of installing a waste heat boiler in the smelter to displace some of the 1300kg/h fuel oil is raised. A WHB on the ISA would generate about this much steam. The installed cost of an Ahlstrom Boiler would be of the magnitude of $5,000,000 to $10,000,000. The fuel cost savings would be about $2,000,000 per year, assuming the PAP requires the steam continuously. Additional costs would be incurred keeping the fuel fired boiler on standby for the occasions when the lance is out of the ISA and for maintenance costs for the WHB, expected to exceed costs incurred in cooling the gas with evaporative sprays. The WHB would be expected to reduce ISA availability. On the surface, the WHB is not an obvious advantage and could be a detriment. A more detailed cost-to-benefit study could be undertaken as part of basic engineering for the expansion project.

Converters

- Molten material spitting out the converter mouth is generating secondaries, fouling the mouth and eroding brick. At the request of Mr. Honda, we attach a sketch describing the location of mouth and Tuyeres for some Pierce-Smith converters. Dr. Partelpoeg suggests that several operating parameters be reviewed to determine their effect on spitting. First, there is possibility that the charge is underfluxed which leads to a high viscosity slag. Second, the source of CaO in converter slag should be determined. If it originates as calcium carbonate in flux, the decomposition of the carbonate could contribute to spitting. Third, the converters may be operating at too low of a temperature, due to the understandable goal of melting reverts. Operating too cold, however, can result in more reverts being generated than consumed.

- Sterlite wishes to explore the Codelco Hot Tuyere Line Repair Procedure. This has been advantageous in Chile and could be for Sterlite and will be addressed in the course of the expansion project.

- The motions of the E.O.T. Cranes are slow. Analysis of motor power draw could indicate if speeds can be increased. New 60t/60t cranes will be specified for the expansion project.

Hygiene Ventilation

- The lime scrubbers are reported to be discharging gas at high SO2 content. By gauging duct pressures, we note the Venturi on the ISA scrubber is inactive but this does not explain failure to scrub SO2. Inspection and testing for flow in the scrubber on the anode furnace gas revealed the pipes were plugged and lime did not exit the nozzles. Reico and Clean Gas Systems are to assist tròubleshooting and establishing maintenance procedures.

- Two stainless steel rotors in ISA hygiene fans have failed by losing one blade. Stress corrosion cracking due to chloride attack is the most likely cause. Analysis of demister wash water showed 58 PPM chlorides. Rakesh Kaul was to pursue gaining a sample of carryover water at the fan to see if chloride concentration is higher. 100 PPM is probably okay. 500 PPM is too high. Sterlite may wish to engage a physical metallurgy lab to analyze the failure.

Anode Plant

- Current casting rate is 22t/h, 48 seconds per anode. Electrical maintenance/instrument personnel will program the PLC to speed up the wheel.

- Molds are cast into a fence with the master mold as the base plate. Molds crack on the sides and corners soon after casting. The reason cracks formed was not apparent to us. H.P. Singh reported he was succeeding in casting molds without cracks so we did not pursue this further.

Sulfuric Acid Plant

- Expansion bellows are beginning to corrode and fail. A quick inspection revealed they are located in every run so none assume lateral displacement. None of them are unnecessary. Building boxes around failed expansion joints will shift loads to the nozzles of the equipment. It is preferable to try different types of expansion joints to determine which minimize maintenance rather than eliminate them. We are concerned that the corrosion of expansion bellows may be a symptom of overall corrosion occurring in the ducts and in the acid plant.

The above topics are those that caught or were brought to our attention in the course of our visit. We hope our observations contribute to resolving some of the current issues and thank you for the opportunity to investigate the operations.

Sincerely yours,

C. Montgomery

Chic Montgomery, P.E.

Attachments: Feeder Calculation
Modified Bin Cone
Pelletizer Bypass Conveyors
Converter Mouth/Tuyere Geometry

CM/skz

cc: S. Zutshi
E. Partelpoeg
R. Hanlon
File

ANNEX B

xstrata
technology

Paper Title:

ISASMELT™ – Not Just a Flash in the Pan

Paper Presented at:
Copper 2003, COBRE 2003
Santiago, Chile

Authors:
Philip Arthur & Phil Partington, Xstrata Technology

Date of Publication:
November 2003

For further information please contact us at isasmelt@xstratatech.com.au

ISASMELT™ - Not Just a Flash in the Pan

P. Arthur & P. Partington
Xstrata Technology
Level 4, 307 Queen Street
Brisbane, Queensland 4000, Australia
isasmelt@xstratatech.com.au

W. Fan & Y. Li
Yunnan Copper Company Ltd
Wang-Jia-Qiao Western Hill District
Kunming, Yunnan, 650102, P.R. China

ABSTRACT

The Copper ISASMELT™ process[i], a technology that emerged into the global metals industry during the 1990s, is now processing more than three million tonnes of concentrates and secondary copper materials each year. The submerged lance smelting technology produces either copper matte or copper metal in plants located in Australia, the United States of America, Belgium, India, Germany and China. M.I.M. Holdings Limited (MIM) [ii] licenses the process to external companies through its technology division, MIM Process Technologies. MIM, as an operating company and technology supplier, is able to provide external clients with proven process design and continuous operational improvements together with full training and commissioning assistance services from experienced operations personnel.

The Copper ISASMELT furnace at Mount Isa Mines is treating more than one million tonnes of copper-bearing feed per year. Furnace campaigns of more than two years are now standard.

This paper describes the current status of the copper ISASMELT furnace at Mount Isa and compares its performance with that of the two most recent installations in China and India. It includes a summary on development of a continuous converting process. This process will employ similar process fundamentals to ISASMELT and has the potential to replace Peirce Smith converters.

[i] ISASMELT™ is a registered trademark of Xstrata Technology
[ii] MIM is now owned by Xstrata. MIM Process Technologies is now Xstrata Technology.

INTRODUCTION

M.I.M. Holdings Limited (MIM) has almost 80 years mining and minerals processing experience, primarily in the extraction of copper, lead and zinc. MIM, operator of a large copper/lead/zinc deposit in Mount Isa, Australia, has developed a number of world-class minerals processing and smelting technologies, one of which is the ISASMELT™ process. The Copper ISASMELT process as used at Mount Isa Mines is recognised by an increasing number of companies as the most flexible, cost effective copper smelting process available in the world today. The process and some details of smelters using the process have been described in earlier published papers (1-7).

Yunnan Copper Company Limited (YCC) has been operating a copper smelter at Kunming, Yunnan Province, China, for just over 40 years. One of the current aims of the Chinese government is to increase industrial efficiency while reducing the effect of heavy industry on the environment. This is starting to be achieved through the privatisation of state owned companies. Those companies that are selected for privatisation are being encouraged to replace outdated technology. YCC chose to import new smelting technology from outside China, identifying ISASMELT as the most suitable process for modernisation of their smelter. The ISASMELT plant was commissioned in May 2002, making it the newest ISASMELT plant currently in operation.

Sterlite Industries (India) Limited (SIIL) is a relative newcomer to the copper smelting industry, commencing smelting operations in 1996. It is also one of the most successful in recent times and is the first company to construct a second ISASMELT plant. The SIIL smelter located at Tuticorin in the state of Tamil Nadu, had an original design capacity of 60,000 tpa of copper anode, and has steadily increased production until now it is producing up to 180,000 tpa of anode through the original ISASMELT furnace. Having reached the limit on the existing furnace, SIIL are currently constructing a larger furnace to replace the existing one with a capacity of 1.3 million tpa of concentrate, equivalent to 300,000 tpa of anode copper.

THE ISASMELT PROCESS

The Copper ISASMELT process is a bath smelting process utilising the unique ISASMELT lance. The lance tip is immersed in a molten slag bath contained within the stationary, vertical, refractory-lined ISASMELT furnace. The injection of air, or oxygen-enriched air, through the lance into the slag results in a highly turbulent molten bath. Feed material falling into the turbulent bath from above reacts rapidly, resulting in extremely high productivity for a relatively small bath volume. The Copper ISASMELT furnace at Mount Isa has smelted 190 tonnes per hour of copper-bearing feed (concentrate, reverts, and other internal smelter recycle materials) in a total bath volume of approximately 15 m^3. At this smelting rate the furnace has the capability to treat 1.3 million tpa of copper-bearing feed.

A layer of slag frozen on the outer surface of the ISASMELT lance protects it from the molten bath. This allows the lance to operate submerged in the slag layer for extended periods of days to weeks. The first commercial scale Copper ISASMELT furnaces were commissioned in 1992 at Mount Isa, Australia, and Miami, Arizona. Table I lists the smelters that currently treat copper feed materials in an ISASMELT furnace.

Table I- Smelters using ISASMELT furnaces for copper production

Company	Location	Rated Capacity
Mount Isa Mines	Mount Isa, Australia	1,000,000 tpa copper concentrate
Phelps Dodge Miami	Arizona, USA	700,000 tpa copper concentrate
Sterlite Copper No. 1	Tuticorin, India	600,000 tpa copper concentrate
Sterlite Copper No. 2 (under construction)	Tuticorin, India	1,300,000 tpa copper concentrate
Yunnan Copper Corporation	Kunming, China	600,000 tpa copper concentrate
Umicore Precious Metals	Hoboken, Belgium	200,000 tpa secondary copper and lead materials, plus concentrate
Hüttenwerke Kayser	Lünen, Germany	150,000 tpa secondary copper materials

DESCRIPTION OF MIM, SIIL & YCC COPPER ISASMELT PLANTS

Many improvements have been made to the ISASMELT process since MIM commissioned its plant at Mount Isa in 1992. These improvements have been captured in the design and operating practices used at YCC and are planned for the new SIIL furnace. Table II summarises key design data for the three smelters.

Table II - MIM, YCC and SIIL copper ISASMELT design data

Plant	Mount Isa	YCC	SIIL (current)	SIIL (upgrade)
Copper concentrate Capacity (tpa)	1,000,000	600,000	600,000	1,300,000
Furnace details				
Diameter, inside brick (m)	3.75	4.4	2.87	4.4
Molten bath depth (m)	1 to 2	1 to 2	1 to 2	1 to 2
Number of tapholes	1	2	1	2
Lance details				
Nominal bore (mm)	450	400	250	450
Volume % oxygen in process air	60 to 65	50	60 to 80	60 to 80
Hydrocarbon fuel	Natural gas	Diesel oil	Furnace oil	Furnace oil
Feed details				
Feed preparation	Moist, pelletised	Moist, pelletised	Conveyed direct to furnace	Conveyed direct to furnace
% copper in concentrate (%)	25 to 27	18 to 22	25 to 30	25 to 30
% H2O in concentrate (%)	9	9	7	7
Matte/slag Product				
Destination	Rotary holding furnace	Electric furnace	Rotary holding furnace	2 Rotary holding furnaces
Temperature (°C)	1200	1180	1200	1200
Liquid products after settling				
Matte grade (% Cu)	60 to 63	55	60 to 65	60 to 65
Destination	Peirce Smith Converters	Peirce Smith Converters	Peirce Smith Converters	Peirce Smith Converters
Slag SiO2:Fe	0.8	0.9	0.8	0.8
Slag Cu	2.6*	0.7	0.8	0.8
Off gas				
Volumetric flow rates (Nm^3/hr)	65,000 (excludes ingress)	60,000 (includes ingress)	60,000 (includes ingress)	77,000 (includes ingress)
$\%SO_2$	27 (at inlet to waste heat boiler)	14 (at inlet to electrostatic precipitator)	22 to 27 (at inlet to evaporative cooler)	22 to 27 (at inlet to waste heat boiler)

*The slag at Mount Isa is milled to recover the copper

Mount Isa Mines Copper ISASMELT

The Copper ISASMELT Plant at Mount Isa, initially rated at about 700,000 tonnes of concentrate per annum, was constructed at the same time as the Phelps Dodge plant located in Miami Arizona. Both plants based their design on a demonstration scale pilot plant that operated in Mount Isa from 1987 to 1991. One of the consequences of both plants being constructed simultaneously was that neither of the operations was able to benefit from the lessons learned by the other prior to startup. As a result both plants experienced numerous process upsets during the first years of operation. The difficulties associated with the Miami plant startup are described in a paper that was presented at the Copper 95 – Cobre 95 conference (3).

Mount Isa Mines encountered its own set of difficulties. These were largely overcome by about 1996 when it was decided to upgrade the copper smelter utilising the original ISASMELT furnace. The upgrade has been described in another paper (6). Since completion of the upgrade in 1998 all the copper concentrate smelted at Mount Isa has been processed in the ISASMELT furnace. The furnace now treats more than 1,000,000 tonnes of copper bearing feed per year. A schematic diagram of the Mount Isa Copper ISASMELT flowsheet appears in Figure 1.

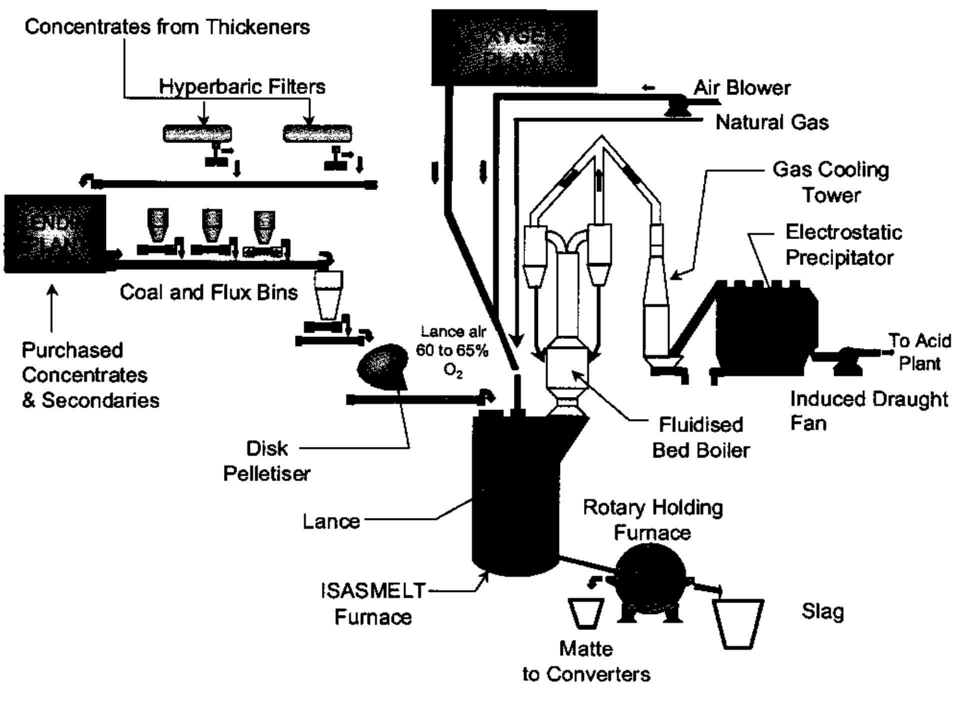

Figure 1 - Mount Isa copper ISASMELT flowsheet

Mount Isa Mines concentrate is blended with purchased concentrate from the Ernest Henry mine and stored in a 60,000 tonne blending plant. The concentrates are mixed with fluxes, reverts and some lump coal, and pelletised in a disc pelletiser, prior to being fed to the ISASMELT furnace. Bath temperature is controlled using a mixture of the lump coal added to the feed mixture and natural gas injected through the lance. Process air injected through the lance is enriched to 60-65% oxygen content. The ISASMELT lance has a nominal bore of 450 mm. Lance immersion in the bath is controlled automatically, ensuring extended lance life, which averages about 8 days. The lance changing operation, which takes place during maintenance stoppages, typically lasts 40-60 minutes.

The furnace produces copper matte with a copper content of approximately 60%. There is a single tap hole, through which matte and slag are tapped into a rotary holding furnace that is used both for separation by gravity settling, and as a holding vessel. This furnace is a horizontal cylindrical vessel that is stationary during normal operation, it can be rotated in one direction to pour off slag and rotated in the other direction to pour matte. The matte is poured into ladles and transferred to the Peirce-Smith converters for converting into blister copper. The slag is poured into ladles and removed by 'Kress' hauler truck. Slag is subsequently milled for copper recovery.

Offgas from the ISASMELT furnace passes into a circulating fluidised bed waste heat boiler for cooling, before being cleaned in an electrostatic precipitator and gas cleaning plant and passing to a sulfuric acid plant.

Refractory campaigns of more than two years are now standard on the Copper ISASMELT furnace at Mount Isa. As of May 2003 the current campaign is in its 31st month.

Sterlite Industries Copper ISASMELT

The SIIL copper ISASMELT at Tuticorin was commissioned with a design capacity of 60,000 tonnes per year of copper in matte. Production has increased each year, mainly through provision of additional oxygen, bringing the annual capacity to 180,000 tonnes of copper, equivalent to 600,000 tonnes of concentrate. The process flowsheet is shown schematically in Figure 2.

The plant was constructed on a greenfield site and includes Peirce-Smith converters, anode furnaces, anode casting facilities, sulfuric acid plant and a phosphoric acid plant. Concentrates are imported through the port facilities at Tuticorin and stored in a purpose built storage facility. After blending, concentrates are fed directly to the ISASMELT furnace by belt conveyer along with petroleum coke and fluxes. Fuel oil is injected through the lance for fine control of bath temperature. The oxygen content of the process air injected through the ISASMELT lance is 75-80%. The matte grade is controlled between 55 and 65% copper. Matte and slag are tapped from the ISASMELT furnace through a single taphole into a rotary holding furnace, where they separate by gravity settling. The slag is skimmed intermittently from the rotary holding furnace and granulated for discard. Matte is poured into ladles and transferred to the converters.

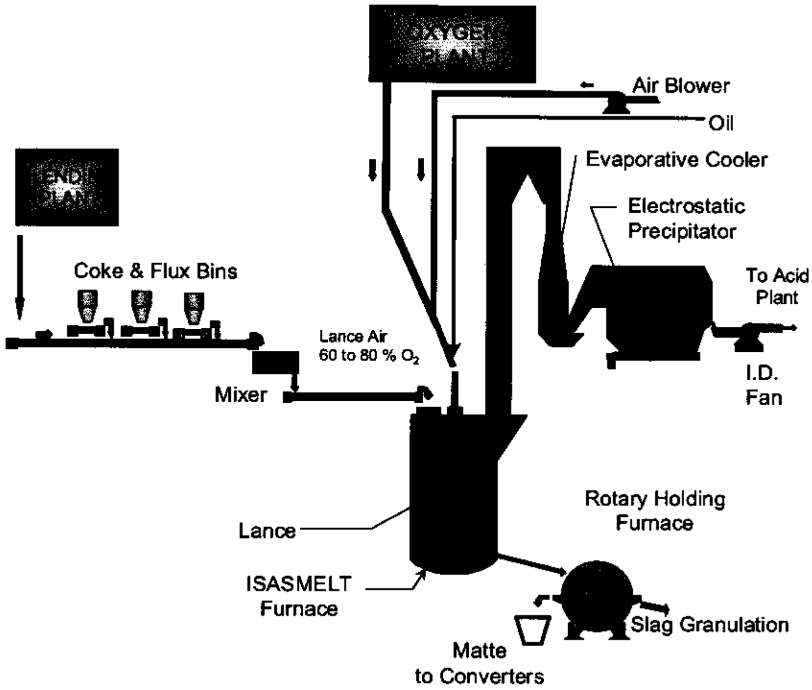

Figure 2 - SIIL copper ISASMELT flowsheet

Offgases from the ISASMELT furnace pass into a water-cooled offtake and spray cooler and are quenched, prior to passing into an electrostatic precipitator for cleaning. The cleaned gases pass to the sulfuric acid plant.

Yunnan Copper Company Copper ISASMELT

The design capacity of the YCC Copper ISASMELT furnace is 600,000 tonnes of concentrate per year. The process flowsheet for the plant is shown schematically in Figure 3. A number of different concentrates, mostly brought by road or rail from mines within Yunnan province, are blended with flux in a blending plant. The majority of the coal required for the process is added to the blended mix. The feed mix is pelletised and a further small amount of coal and silica is added to the pelletised mix before it is fed into the ISASMELT furnace. Oxygen enriched air is injected into the bath through the ISASMELT lance. Oil can be injected through the lance, if necessary, for fine adjustment of the bath temperature. The molten slag and matte is tapped intermittently from the ISASMELT furnace through one of two tap holes into an electric settling furnace. The slag and matte separate by gravity in the settling furnace. Matte is subsequently transferred by ladle to Peirce-Smith converters for further processing. Slag is granulated and removed for disposal. Converter slag is returned to the electric settling furnace for reduction and slag cleaning.

The process offgas is directed to a sulfuric acid plant after passing through a waste heat boiler and electrostatic precipitator to lower its temperature and remove the dust. The dust collected in the waste heat boiler is crushed and returned to the electric furnace. The dust collected in the electrostatic precipitator is conveyed to the electric furnace.

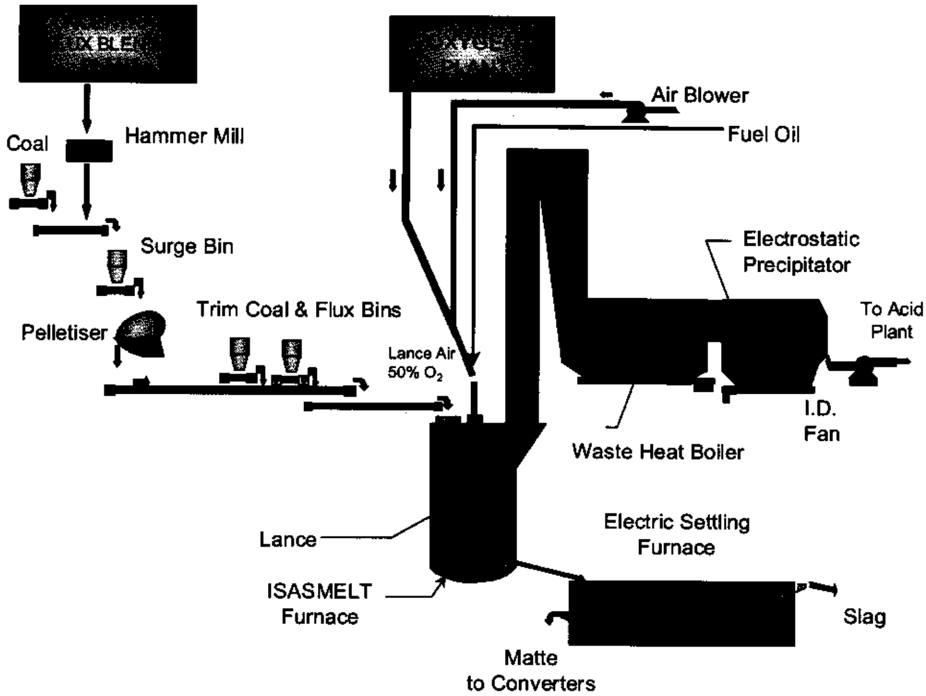

Figure 3 - YCC copper ISASMELT flowsheet

In contrast to the SIIL plant, the construction of the YCC plant resulted in a number of unique challenges, because of its location within the existing smelter. The ISASMELT furnace and waste heat boiler had to be installed in a very restricted area between existing plant facilities. It was necessary to construct the ISASMELT furnace adjacent to the electric furnace, so that the electric furnace could be used as the settling furnace once the ISASMELT furnace started operation. The available space was restricted by the converter aisle on one side and the electric furnace offgas bag filter building on the other. The compact nature of the ISASMELT furnace enabled it to be constructed within such a confined space without interrupting operation of the smelter. A furnace elevation is shown in Figure 4.

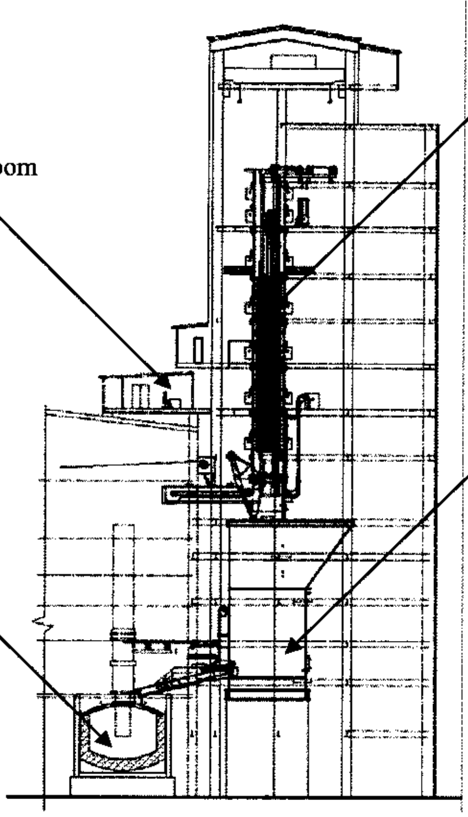

Figure 4 - YCC ISASMELT building elevation

YCC OPERATING RESULTS

The first year of operation at YCC was very successful. Within a week of charging of the first feed to the furnace the plant was running smoothly. In recent months the main difficulty for YCC has been obtaining sufficient concentrate to feed the ISASMELT furnace, with the current tight concentrate market limiting the amount that is available.

Production

The production rate at YCC quickly ramped up to design capacity after plant startup. Figure 5 shows the daily feed tonnages to the furnace and the annualised weekly sum for the month of July 2002. Within two months of first feed on 19th May 2002, the plant had demonstrated the design capacity averaged over a period of one week.

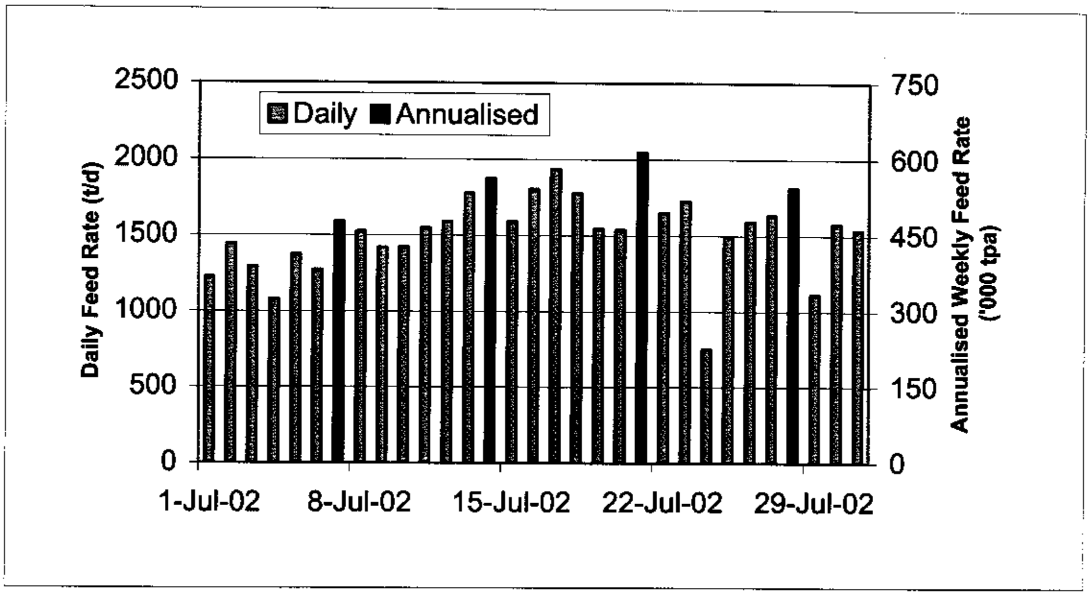

Figure 5 - YCC ISASMELT feed rate July 2002

The plant has continued to perform well in recent months apart from occasional plant outages, principally caused by leaks in the waste heat boiler. Figure 6 shows the feed rates for February 2003. The plant was shut down for five days in the middle of the month for repairs to the waste heat boiler.

In the first twelve months YCC have smelted 446,000 tonnes of dry copper concentrate in the ISASMELT furnace.

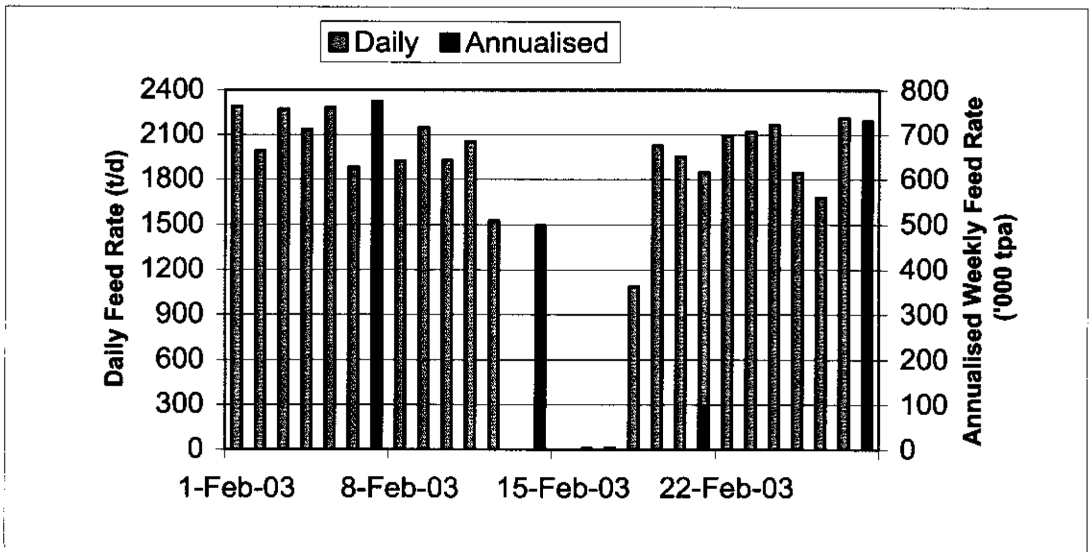

Figure 6 - YCC ISASMELT feed rate February 2003

Plant Availability

The YCC plant achieved high plant availability within weeks of initial heat up. MIM provided an extensive training program for key YCC personnel resulting in them having a detailed knowledge and appreciation of process operation prior to plant startup. YCC personnel independently operated the Mount Isa furnace during their training, thus providing them with an instinctive feel for the process before they took responsibility for control of their own plant. The training program is detailed in another paper (7).

Figure 7 shows the average monthly availability for the ISASMELT. These figures do not take into account time when the furnace was offline for problems with the waste heat boiler or process air blower.

In October 2002 blower air supply surging made it difficult to maintain steady operation of the ISASMELT furnace. This surging was due to incorrect set up of the diffuser vane. Once this was corrected the diffuser vane acted according to the controller output signal and the surging was eliminated.

The waste heat boiler experienced leaks in the convection section boiler tube wall on three occasions in October 2002, February 2003 and March 2003. The ISASMELT furnace design allows YCC to isolate the boiler for carrying out repairs. During this time the furnace temperature is maintained by using the holding burner. On each occasion the boiler was repaired to return to production as quickly as possible. YCC is working with the boiler supplier to implement a permanent solution.

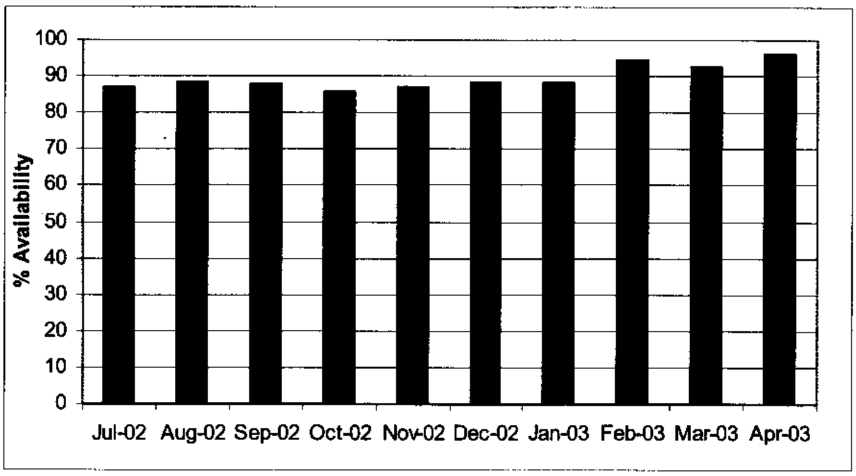

Figure 7 - YCC ISASMELT availability

Refractory Life

One of the key performance indicators for YCC's project was to achieve at least 12 months for the first refractory campaign on the ISASMELT furnace. At Mount Isa it had taken several years to establish the optimum refractory materials and operating methodology to obtain extended campaigns in the ISASMELT furnace. This underpinning knowledge was passed onto YCC during the design, construction, training and commissioning phases of the project. Generally the refractory wear during the first campaign on any furnace is expected to be higher than subsequently experienced because the operators are in the process of learning how to control the new plant. However, YCC's operators took full advantage of their training program at Mount Isa to learn how to control the process and consequently there has been very low refractory wear during the first year's operation.

Figure 8 shows the refractory wear trend since start up. After 50 weeks of operation, 100 mm of brick was worn. This refractory life has been achieved without the use of any water-cooling of the bricks.

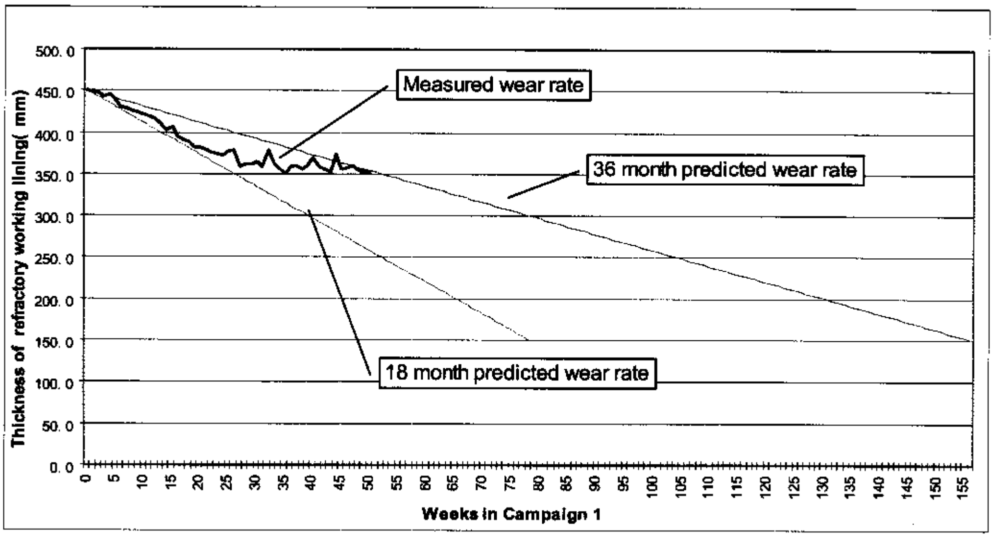

Figure 8 - YCC refractory wear trend

Lance Life

Another of the key performance indicators for YCC was quality and performance of the ISASMELT lances and achievement of long lance life. Advanced lance control algorithms developed at Mount Isa by MIM were incorporated into the YCC control system software and YCC were instructed in lance operating and maintenance procedures. As a result, YCC have experienced good lance life virtually from the start of operation with average lance life of about seven days and maximum life of 18 days has been achieved. Lances are returned to service after repair of the lance tip. Figure 9 shows the lance life over a six month period.

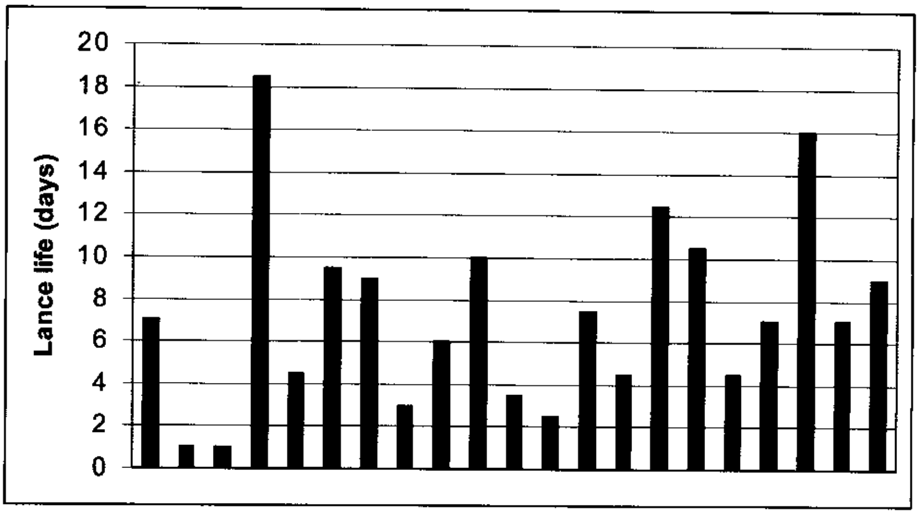

Figure 9 - YCC lance life

Electric Settling Furnace and Copper Loss

The electric settling furnace is used primarily for gravity settling of the matte and slag from the ISASMELT furnace to achieve low copper losses in the discard slag. Converter slag is also returned to the settling furnace for reduction. Figure 10 shows the typical copper content of slag tapped from the electric furnace since startup. From May 2002 a gradual decrease in copper in slag was experienced to a low value of 0.6% in September 2002. From start up of the ISASMELT furnace build up occurred in the electric furnace, reducing the settling volume and hence the residence time required to achieve a low copper in slag. To counteract this YCC adjusted the slag composition in the ISASMELT furnace and converters to decrease the magnetite level and therefore the buildup. As a result of this copper in slag values returned to low levels as shown in Figure 10.

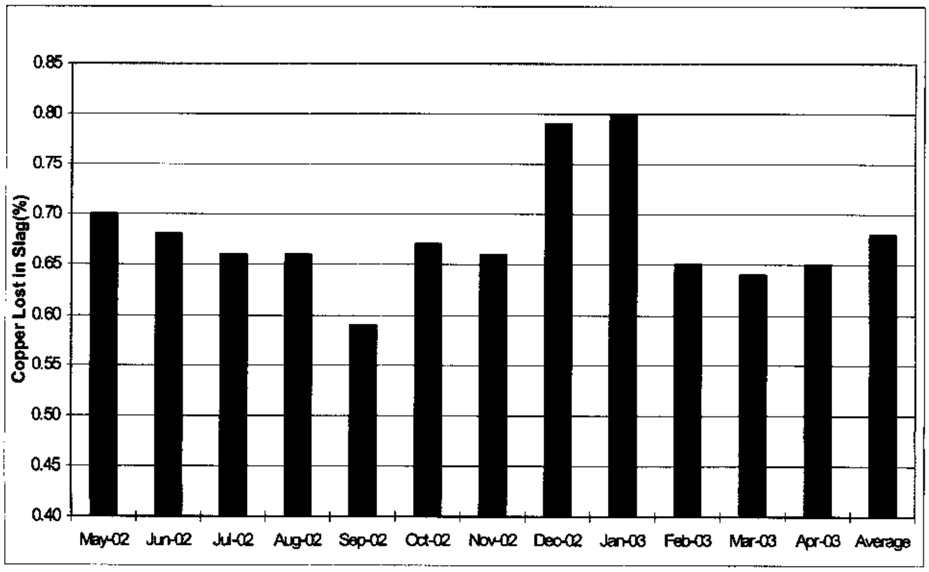

Figure 10 - YCC typical copper content of electric furnace slag

INCREASING PRODUCTION OF ISASMELT FURNACES

Oxygen enrichment of the process air injected through the ISASMELT lance is a relatively cost effective way to increase production in an ISASMELT furnace. This has been adequately demonstrated at Mount Isa and Tuticorin, with Mount Isa Mines and SIIL achieving a significant increase in production capacity by increasing the amount of oxygen enrichment. Figure 11 shows the amount of concentrate treated by Mount Isa and SIIL since 1992. Since commissioning the ISASMELT plant at Mount Isa there has been a steady increase in the amount of concentrate treated.

SIIL have achieved consistent increases in concentrate treatment rate since 1996. They have now reached the limit for concentrate throughput for their existing furnace and are therefore currently constructing a new, larger ISASMELT furnace.

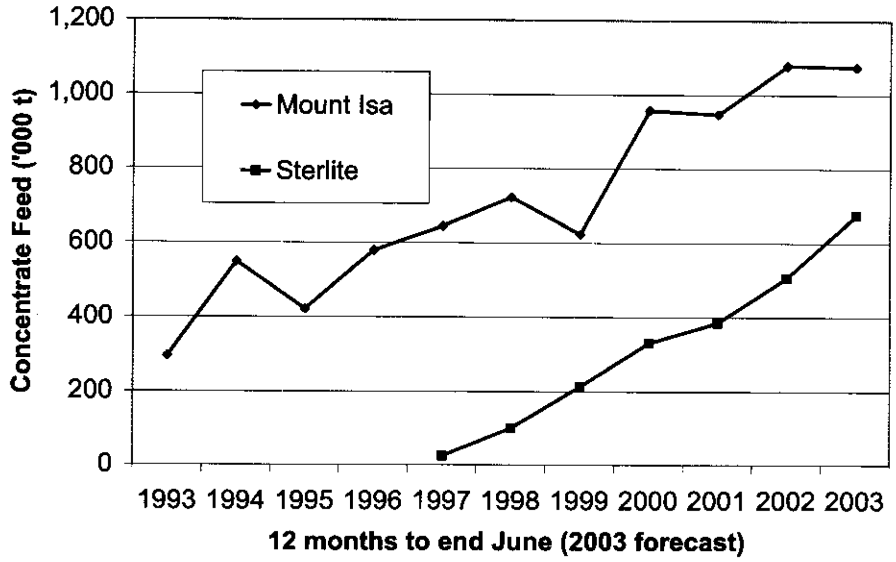

Figure 11 - Mount Isa and SIIL feed rates

SIIL's new ISASMELT furnace, scheduled to be commissioned in 2004, will have the largest capacity of any built to date, enabling the smelter to produce 300,000 tonnes per annum of copper anodes. It will replace the existing furnace. The process flowsheet will be very similar to that of the existing plant, with two major changes being the installation of a waste heat boiler and the installation of a second settling furnace. Figure 12 shows an elevation of the new furnace.

Belt conveyors will feed concentrates, petroleum coke and fluxes from bins directly to the ISASMELT furnace. Although petroleum coke will be used as the main fuel, some fuel oil will be injected through the ISASMELT lance for fine control of bath temperature. The oxygen content of the air injected through the ISASMELT lance will be 60-80% depending on the type of concentrate processed. The matte grade will be approximately 60%. Matte and slag will be tapped into two rotary holding furnaces for gravity settling and separation. The slag will be granulated for discard. Matte will be transferred to Peirce-Smith converters. The offgas will pass to a waste heat boiler for cooling prior to cleaning in an electrostatic precipitator. The clean gas will pass to a sulfuric acid plant.

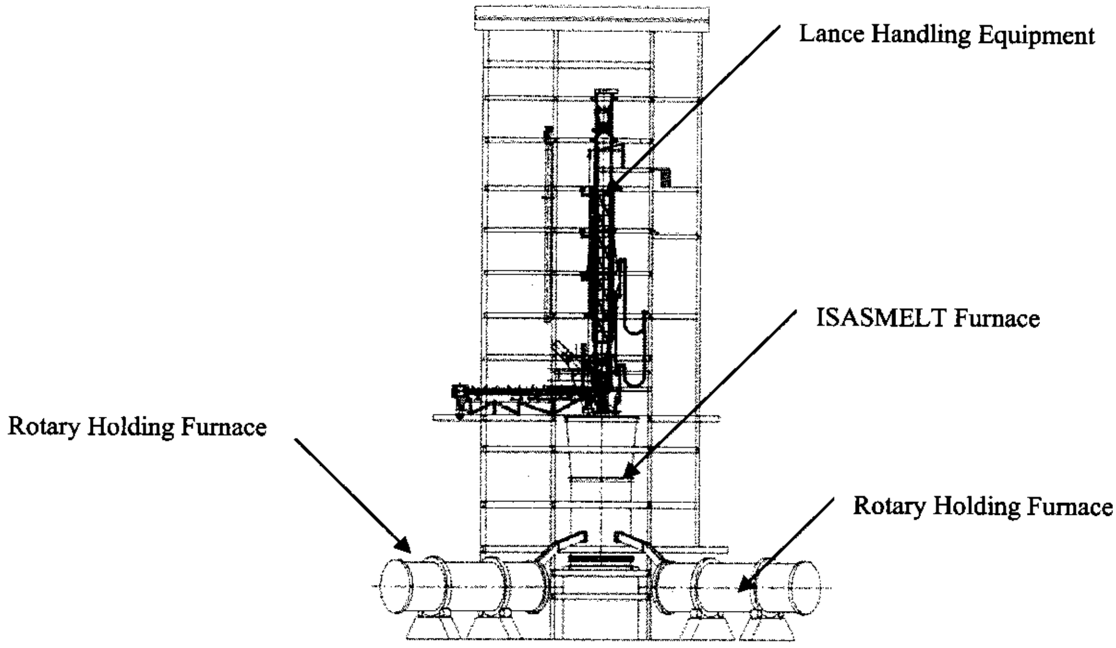

Figure 12 - Future Sterlite Industries copper ISASMELT furnace elevation

CONTINUOUS CONVERTING

The ISASMELT process offers the potential of an alternative to batch copper converting operations, such as Peirce-Smith converting. It is an attractive option due to its flexibility to treat solid feed, efficiently capture sulfur dioxide and reduce in-plant fugitive emissions.

MIM has confirmed, through extensive pilot scale testing, that continuous converting of copper matte into low sulfur blister can be achieved. The majority of pilot scale testing to date has concentrated on converting crushed copper matte produced in the ISASMELT smelting furnace.

A two stage smelting and converting process is being considered for future installation at Mount Isa. It is envisaged that solid matte, from a stockpile, would be fed to the converting furnace. This would decouple the smelting and converting operations; thus removing the dependency on each other giving improved operating flexibility compared with the existing plant. Plant availability will be maximised, as the smelting operations will be independent of converting operations. The smelting furnace will be able to operate at its optimum throughput while stockpiling the matte for subsequent treatment in the converting furnace. On the other hand, the converting furnace will be able to continue operating at the optimum matte feedrate independent of smelting furnace operation.

Before proceeding with a commercial scale installation MIM is planning to install a large-scale pilot plant. An eighteen-month test campaign is planned to investigate key process issues. MIM has carried out detailed engineering for the installation of the pilot plant. Figure 13 is a schematic diagram of the plant.

The main drivers for developing and considering the installation of a large scale operation at Mount Isa are:

- Increased copper production;
- Simplified smelter operation;
- Improved environmental and safety performance;
- Reduced operating costs; and
- Low capital cost.

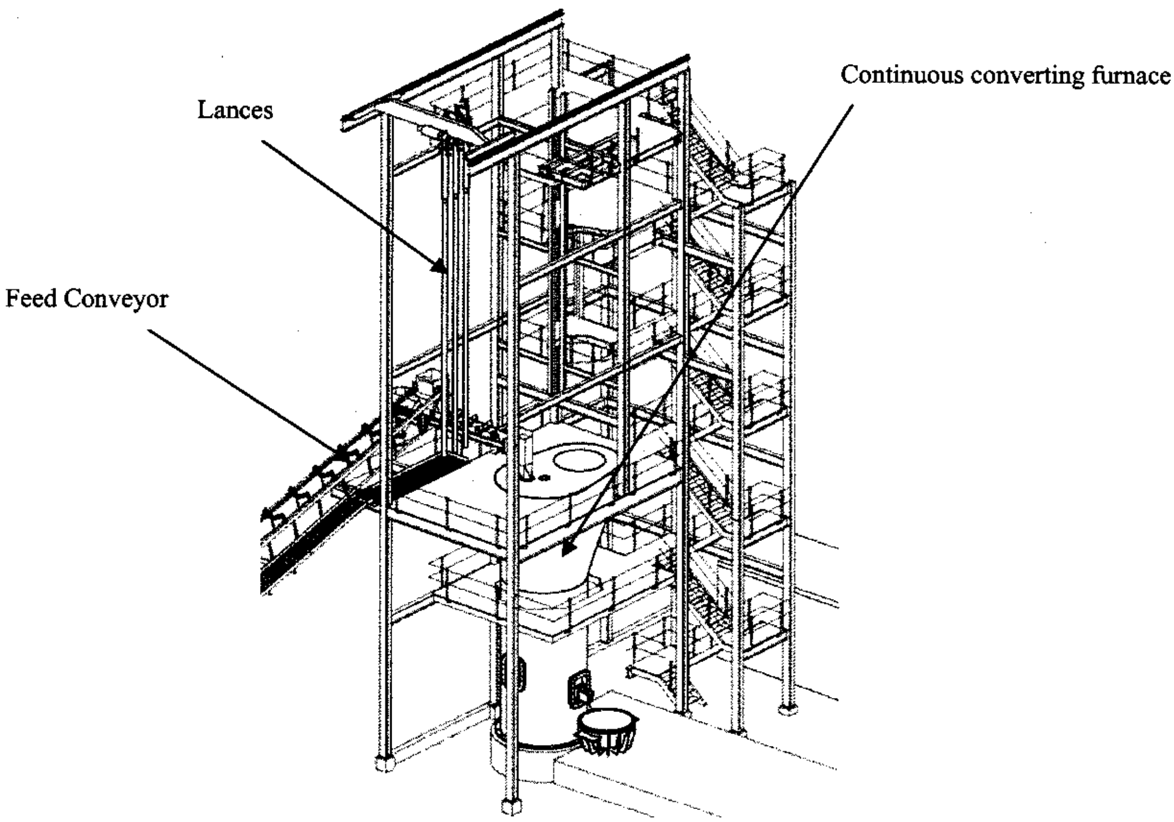

Figure 13 - Continuous converting pilot plant

CONCLUSIONS

The ISASMELT process has successfully been installed in smelters around the world. A combination of high intensity, simple design and ease of operation make the process ideal for new copper smelting installations. The success of the first year's operation in the most recently constructed plant in China has demonstrated the robustness of the technology, with availabilities of over 85% and refractory life of more than 12 months achieved in the first campaign and design throughput achieved within two months of startup. Refractory campaign life of more than 2 years is now standard at Mount Isa. Experience at Mount Isa over the past 11 years and in India over the past 7 years has demonstrated how the throughput of the furnace can be increased significantly by increasing the oxygen enrichment of the process air injected through the ISASMELT lance.

Training programs held at the Mount Isa copper smelter allow operating personnel to learn to operate the process prior to commissioning of their own plant, dramatically improving the understanding of the process and facilitating optimum technology transfer.

A large-scale demonstration plant for continuous copper converting has been designed for installation at Mount Isa. The converting process has the potential to provide a much simpler alternative to existing converting technologies. ISASMELT technology has proven that it certainly is more than just a flash in the pan.

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ANNEX C

Production loss due to the Project Activity (11.2 MW WHRB at ISA Smelt Furnance)

Month	Reason	Cu Feed lost in MT	Time		Time Lost in Hrs	Loss in Rs due to 1 MT cu feed Lost	Total loss in Lakh Rs
			Smelter stop	Smelter Start			
Jul-05	Evaporator Bundle Cleaning	3220	13th @18:00	17th @6:00	84	14,211	457.58
Aug-05	Nil					12,411	
Sep-05	Evaporator Bundle Removal	1600	27th @23:08	29th @16:08	41	22,098	353.57
Oct-05	Evaporator Bundle Leak	550	18th @16:00	19th @6:00	14	25,660	141.13
	Cleaning of Evaporator Downcomer	630	19th @6:00	19th @ 18:16	12	25,660	161.66
	Cleaning of Evaporator Downcomer		22nd @ 12:10	22nd @ 15:50	4		
Nov-05	Evaporator Cleaning	495	12th @15:15	12th @20:15	5	23,460	116.13
			13th @4:30	13th @6:00	2		
			14th @6:00	14th @12:00	6		
Dec-05	Evaporator Bundle Leak	2395	27th @23:00	29th @19:15	76	27,874	667.57
			30th @14:47	31st @17:50& from 1:43 to 6:00			
Jan-06	Boiler Evaporator Tube Bundle leak	2577	01st @ 6:00	03rd @ 17:06	65	25,183	648.96
Feb-06	Nil					27,829	
Mar-06	Super heater to TG vent line bulged	412	16th @7:00	16th @17:45	11	31,029	127.84
Apr-06	Nil					49,149	
May-06	Nil					47,142	
Jun-06	Boiler Cooling water pump discharge flange leak	1527	02nd @ 19:50	04th @9:56	38	41,326	631.04
	Evaporator casing damage and gasket failure	1510	04th @17:28	06th @6:00	37	41,326	624.02
	Boiler evaporator DCC motor changing	232	14th @22:03	15th @4:10	6	41,326	95.88
	Heat up after boiler Problems	103	4th @ 09:56	04th @ 14:54	5	41,326	42.57
Jul-06	ISA Boiler roof leakage	3059	13th @00:40	18th @11:09	106	35,827	1,095.94
Aug-06	Nil					41,560	
Sep-06	Nil					34,062	
Oct-06	Boiler Evaporator baffle plate header leakage	778	2nd @ 10:40	3rd @ 1:35	15	28,117	218.86
Nov-06	Nil					27,420	
Dec-06	Nil					32,057	

ANNEX D

सत्यमेव जयते

इसके द्वारा, भारत गणराज्य के राष्ट्रपति के नाम पर, उन सब से जिनका इस बात से सरोकार हो, यह प्रार्थना एवं अपेक्षा की जाती है कि वे वाहक को बिना रोक-टोक, आज़ादी से आने-जाने दें, और उसे हर तरह की ऐसी सहायता और सुरक्षा प्रदान करें जिसकी उसे आवश्यकता हो।

THESE ARE TO REQUEST AND REQUIRE IN THE NAME OF THE PRESIDENT OF THE REPUBLIC OF INDIA ALL THOSE WHOM IT MAY CONCERN TO ALLOW THE BEARER TO PASS FREELY WITHOUT LET OR HINDRANCE, AND TO AFFORD HIM OR HER, EVERY ASSISTANCE AND PROTECTION OF WHICH HE OR SHE MAY STAND IN NEED.

भारत गणराज्य के राष्ट्रपति के आदेश से दिया गया
BY ORDER OF THE PRESIDENT OF THE REPUBLIC OF INDIA

पासपोर्ट अधिकारी
Passport Officer,
तिरुच्चिराप्पल्ली
Tiruchirappalli

Govt. of India

भारत गणराज्य REPUBLIC OF INDIA

टाइप /Type
राष्ट्रीय कोड /Country Code: IND
पासपोर्ट नं. /Passport No.: B3705854
उपनाम /Surname: RATHNA GOPALAN
दिये गये नाम /Given Names: JANARTHANAN
राष्ट्रीयता /Nationality: INDIAN
लिंग /Sex: M
जन्मतिथि /Date of Birth: 06.10.1976
जन्म स्थान /Place of Birth: TUTICORIN
जारी करने का स्थान /Place of Issue: TRICHY
जारी करने की तिथि /Date of Issue: 08.09.2001
समाप्ति की तिथि /Date of Expiry: 07.09.2011

R. Janarthanan

中华人民共和国签证
CHINESE VISA

A1087906

签证种类 CATEGORY	F	次数 ENTRIES	01(壹)
请于此前入境 ENTER BEFORE	04.08.25	入境后可停留 DURATION OF EACH STAY	030 天 DAYS AFTER ENTRY
签发日期 ISSUE DATE	04.05.25	签发地点 ISSUED AT	新德里
姓名 FULL NAME	J. RATHNA GOPALAN		
出生日期 BIRTH DATE	76.10.06	护照号码 PASSPORT NO	B3705854
备注 REMARKS			

VFCHNRATHNA<GOPALAN<<JANARTHANAN<<<<<<<<<<<<

B3705854<3IND7610064M0408259192QIBDAAONBFM56

भारत गणराज्य REPUBLIC OF INDIA

राष्ट्रीय कोड/Country Code: IND

पासपोर्ट नं./Passport No.: B3317913

Jaipur

02-2-2001

01-2-2011

सत्यमेव जयते

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भारत गणराज्य के राष्ट्रपति के आदेश से दिया गया
BY ORDER OF THE PRESIDENT OF THE REPUBLIC OF INDIA

MINISTRY OF EXTERNAL AFFAIRS · विदेश मंत्रालय · PASSPORT OFFICE, JAIPUR · पासपोर्ट कार्यालय जयपुर · 2

Gurdev Singh

GURDEV SINGH
गुरदेव सिंह
अधीक्षक/Superintendent
पासपोर्ट कार्यालय
Passport Office
जयपुर/JAIPUR

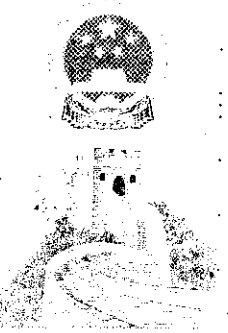
18 वीज़ा / VISAS

06.24 DGBA

中华人民共和国签证
CHINESE VISA

A1087907

签证种类 CATEGORY	F	次数 ENTRIES	01(壹)
请于此前入境 ENTER BEFORE	04.08.25	入境后可停留 DURATION OF EACH STAY	030 天 DAYS AFTER ENTRY
签发日期 ISSUE DATE	04.05.25	签发地点 ISSUED AT	新德里
姓名 FULL NAME	S. KURHADKAR		
出生日期 BIRTH DATE	80.01.01	护照号码 PASSPORT NO	B3317913
备注 REMARKS			



VFCHNKURHADKAR<<SANDEEP<SADASHIV<RAO<<<<<<<<
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