Reply to the Requests for Review regarding the Project activity 0683

by TUV Industrie Service - TUV Rheinland Group (DOE)

We thank the Executive Board for providing us an opportunity to respond to request for review raised by the three EB members. The request for review has been on three main points. Our reply all the three points is as follows:

1. Demonstration of additionality

Additionality of the proposed project activity has been projected on basis of latest version of the 'Tool for demonstration and assessment of additionality'. As per this tool, the project proponent has been given an option to chose step 2, (Investment Analysis) or step 3 (Barrier Analysis) before moving to step 4 (Common Practice Analysis). Thus, the choice of barrier analysis (step 3) is well within the means provided by EB to prove additionality. In the present case, the DOE has been presented the following arguments to indicate that the proposed project activity faced barriers:

a. SIIL has been operating copper smelter plant based on ISA smelting technology since 1997. However, there was no provision for recovery of waste heat from smelter till the year 2005 when proposed project activity was implemented. Prior to the project activity, waste gas was treated with a system of sonic spray, gas cooler, and other associated equipments, which were rather than producing electricity were net consumers of electricity.

The project proponent had sought an expert view on possibility of establishing waste heat recovery unit for the plant prior to conceptualization of the project activity. The expert view (The Winter Company, April 22, 1998, Sterlite Copper Smelter Expansion, Project Number 175 - 01 Annexe I) was against any such unit and the proposed project activity was potential hindrance to the core business activity of copper production. The view of the expert was (Page 4 of the letter):

- WHB would be expected to reduce ISA availability
- On the surface, WHB is not an advantage and could be detriment

Further to above, even the technology supplier has not been able to give any affirmative disclosure on production stoppages associated with introduction of waste heat recovery boiler. The main reason for non-availability of the ISAsmelter has been sighted as problems associated with the waste heat recovery boiler (Please see Page 7 of the article, Philip Arthur, November 2003, Xstra technology, Not Just a flash in the pan, Annexe II http://www.isasmelt.com/downloads/XT_ISASMELT_Paper_ArthurCu2003.pdf). It is note worthy that the article was published November 2003, much later than the date of starting of the proposed CDM project activity on April 10, 2003.

It may be noted that any difficulty in the waste heat recovery boiler would ultimately lead to stoppage of the production process itself. This can shake the very business on which the project activity is resting. Especially when it has an option of going to a less risky option.

The project proponent had an option of using existing three sources of electricity i.e, captive power generation from FO fired engine generator set, import from

MALCO or import from southern region grid of India. None of these plausible alternatives posed any problem to the core activity of copper production for the project proponent.

In spite of this easy way, the project proponent chose to select a route that could hamper core business of production of Copper. In effect, loss of one hour of production stoppage would result in loss of about 35 tonnes of copper production as per installed capacity of the ISAsmelter. Thus, against a potential advantage of 11.2 MWh of electricity generation by the project proponent, which would give an advantage of INR 34,284 (By considering cost of supply of electricity as INR 3.07), SIIL was expected to loose production loss worth 5,32,000/-per hour (By considering a conservative gross margin at INR 14000/T).

Above statistics are not considered to show the barrier but are in effect presented the financial implication of the technical barrier faced by the proposed project activity. Thus, by facing barrier due to technology the project proponent has also taken great financial risk.

b. The validation team considered, common practice analysis presented by the project proponent in step 4 of the ‘Tool for demonstration and assessment of the additionality’. It was noted that copper smelting was at only three places in hsot country, India Birla Copper, Hindustan Copper and Sterlite Industries India Limited in the host country of India. Out of these three, SIIL is the only smelter, which is applying ISASmelt technology. The other two smelters are applying flash smelting and other technologies. Thus, going by the guidance of the additionality tools, the technology measures are not comparable. In addition to above, the population of copper smeters is too low to give a meaningful conclusion on the issue.

   Here, the views of the technology supplier with respect to the project activity are quite interesting. They have stated that the proposed project activity is unique in nature and a technological challenge on account of the following factors (Please refer to page 10 of Annex II):

   1. Will have largest capacity of any ISA furnace built to date
   2. With two major changes in the process design being installation of waste heat boiler and installation of second settling furnace

   These publicly available documents suggest that the project activity is not a common practice for not only the host country but also for the ISAsmelter technology itself.

c. Further more, the validation team has taken into account the fact that in spite of SIIL operating the ISAsmelter since 1997, they had to send their personnel to China for training WHRB Operations. The need for training on ISA smelt technology with arrangement for waste heat recovery unit is also reiterated by the technology suppliers (Please see Annexe II, page 12).

   The training for the YCC plant in China is a point to be considered here. The plant had similar situation as SIIL. It was an existing copper smelting unit. However, while shifting to ISAsmelt furnace with provision of waste heat recovery, it needed very extensive training for its employees. The report has stated that ‘The total tuition time was 430 hours where 200 employees were involved.' In addition to this training in China, selected employees were also trained in Australia. (Please refer to http://www.isasmelt.com/downloads/XT_ISASMELT_Paper_YCCTMS2003.pdf, Annex III). Thus, the process is complex and requires extensive training on operation including the operation of waste heat boiler.

Above consideration and the fact that training had to be imparted on the SIIL employees in China indicates helped the validation team to arrive at an opinion that the proposed project activity indeed faced managerial barrier.

As DOE, we have considered the reasons and explanations given in the preceding paragraphs rather than accepting the one reason of PDD that Furnace oil is used as fuel for superheating the steam against coal.

2. Baseline Scenario

The baseline scenario is identified as per guidance of ACM0004/Version 02. The methodology has suggested the following:

'Among the alternatives that do not face any prohibitive barriers, the most economically attractive alternative should be considered as baseline scenario. In the present case, all the alternatives were compared for their cost of production of 1 kWh electricity as determined in the internal calculations of SIIL. The analysis has suggested that power generation from CPP is economically most attractive option compared to all the other plausible alternatives. This is clearly indicated on page 14 of the Revised Draft CDM PDD (September 2006). The same comparison table is reproduced herewith for information of the EB. The values in the table are varified by the validation team.

Alternative	Cost / kWh (In INR)	Significant Aspects	Other Considerations
1) Import of Electricity from the state grid	19.60	Less capital intensive, purchase cost is high	No clearances / Approvals are required
2) Import form MALCO	2.90	No capital investment is required, purchase cost is high	No clearances / Approvals are required
3) Power generation from captive power plant of Sterlite Industries India Limited	2.89	Higher capital investment, capital cost is low	Clearances / Approvals are required In-house expertise is available to implement this alternative
Combination of 1, 2 & 3	3.07	Capital intensive / Cost is high	Clearances / Approvals are required

Column 2, is the economic analysis which is used as guiding tool for determination the baseline of the methodology. The lowest cost or most attractive economic parameter for the project activity is INR 2.89/ kWh. While, it is evident that this is the lowest cost alternative the additional points to consider power generation from captive power plant are

- More than 85 per cent of power is obtained from this source and
- This is also the lowest emitting source as already mentioned on page 26 of the validation report.

Above analysis suggests that selection of the baseline is in line with the guidance of ACM0004/Version 02.

The project proponent would have opted to select the baseline as per guidance of the methodology where no distinction is made on type of Captive Power Plant. Selection of baseline purely on basis of the electricity generated without attributing any emission to steam generation would have in that case would have certainly not violated the letter of the methodology. However, it would have been at the expense of cardinal principle of CDM, which is based on conservative estimate of emission reduction. The baseline selected is LSHS fired generator set with additional provision to recover heat from the waste heat of the exhaust gas. This plant could have operated without any waste heat recovery and would have still generated the necessary electricity with the same fuel consumption and hence, same power generation.

However, in order to have an estimate that is more conservative than the guidance by ACM0004/Version 02, the project proponent has chosen to deduct the emission that would have occurred due to steam generation. The fuel is considered as LSHS for this purpose. Thus, the project proponent has been conservative in using these formulas and has estimated lower amount emission reduction. In effect, this measure has lowered the emission reduction by about 18 per cent.

Furthermore, we would like to indicate that the project proponent has followed the guidelines of additionality tool. The tool has asked for 'plausible, realistic' alternatives to the project activity. There is no need to have actual spare capacity. The fact that prior to the project activity as well as expansion, FO fired engine generator met major proportion of the electricity needs of SIIL, indicates that it is indeed a 'plausible, realistic' scenario.

3. <u>Calculation of Baseline Emissions</u>

ACM0004/Version 02 has indicated that the methodology is applicable to:

Electricity generation project activities

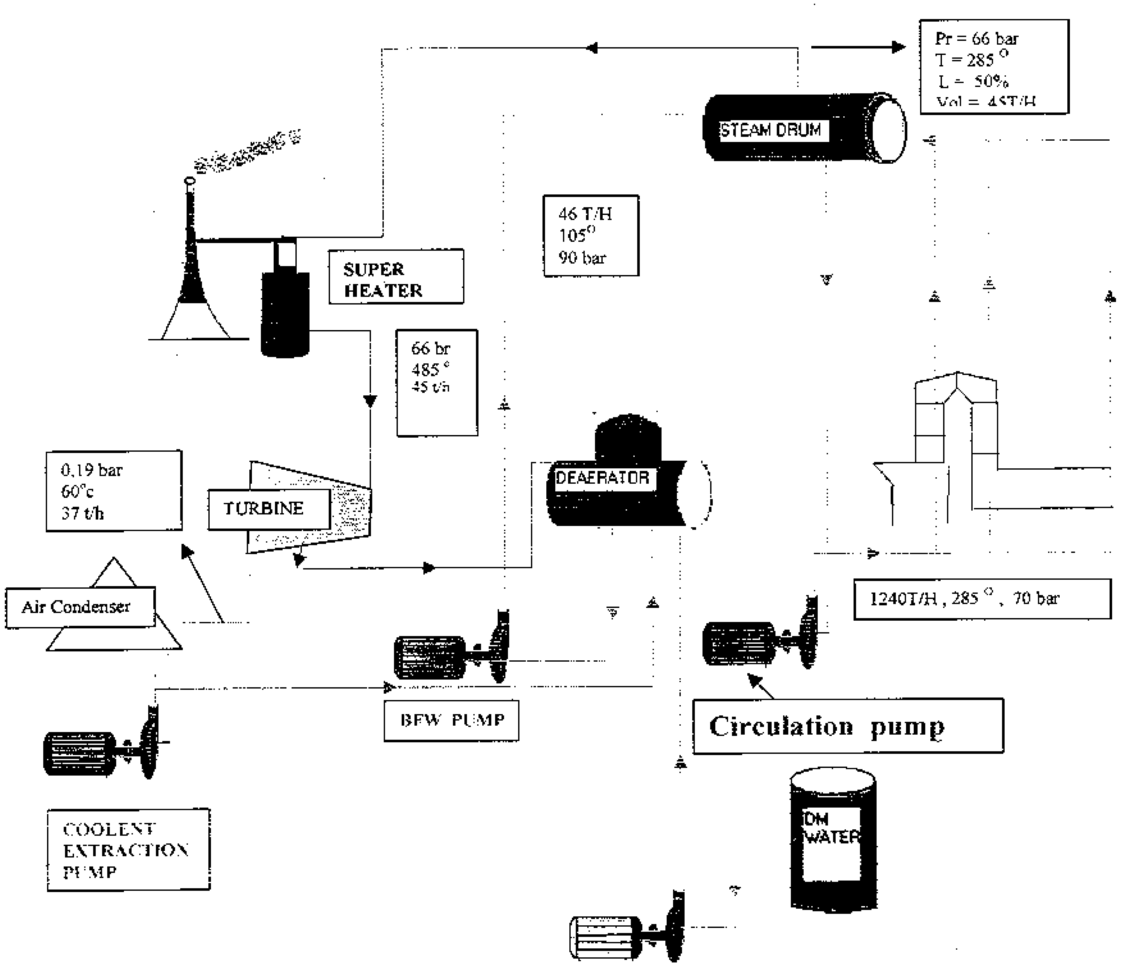
- That displace electricity generation in the fossil fuels in the electricity grid <u>OR</u>
- Displace captive electricity generation from fossil fuels

The present power-generating unit comprises of a waste heat recovery boiler, a turbogenerator set of 11.2 MW and a condenser. All the steam generated in the boiler pass through the turbine and is going to a condenser. Thus, the steam is not used in the process at all. This is very much a part of the ACM0004/Version

02 applicability criteria. A schematic diagram of the system is shown below for greater clarity.

The methodology has stated that the baseline electricity generation should be from fossil fuels. It has never stated that a combined heat and power generation cannot apply the methodology. The project proponent could have applied formulae given in the methodology. However, in order to be 'realistic and conservative' the project proponent has applied additional formulae to determine the baseline.

WASTE HEAT RECOVERY BOILER FLOW DIAGRAM



Annexe I:

Opinion By Experts of The Winter Company

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

April 22, 1998

...yopadhyay
...dent
...opper
...orks, Shed No. 2
...strial Complex
...528 002

Sterlite Copper
Smelter Expansion
Project No. 175-01

...Bandyopadhyay,

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

...Preparation

...eeders under the truck tipper hoppers are unable to convey concentrate. Changes to the ...rives 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 ... Cyprus in 1993.

...oncentrate bins do not flow. The bins are well designed and constructed, except the .... The Winters Company (TWC) proposes the bin cones be replaced to provide slot llets as shown on the attached sketch; upon approval we can quickly follow up with a ll design of this bin cone. This type design is commonly applied for concentrate bins. e cones could be replaced one at a time without disrupting production.

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

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

[IS]A/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 troubleshooting 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.

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

Sincerely yours,

C. Montgomery

Chic Montgomery, P.E.

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

...M/skz

S. Zutshi
E. Partelpoeg
R. Hanlon
File

Annexe II

ISASMELT – Not Just Flash in the Pan

Paper Title:

ISASMELT™ – Not Just a Flash in the Pan

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

Authors:
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Date of Publication:
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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.

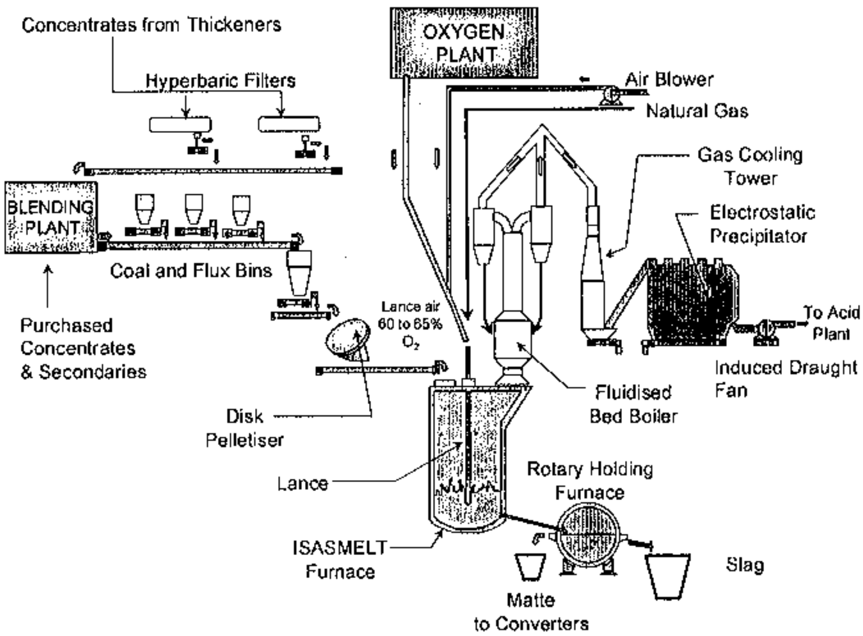

Figure 1 - Mount Isa copper ISASMELT flowsheet

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.

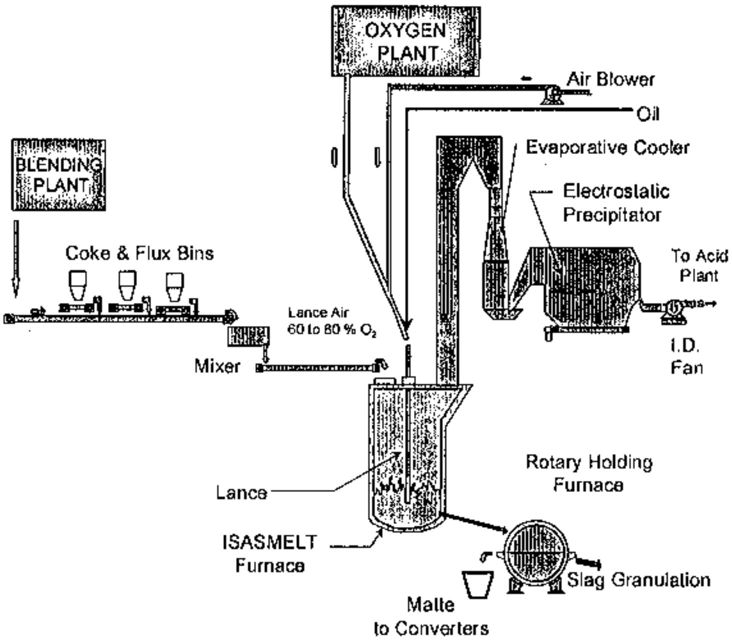

Figure 2 - SIIL copper ISASMELT flowsheet

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.

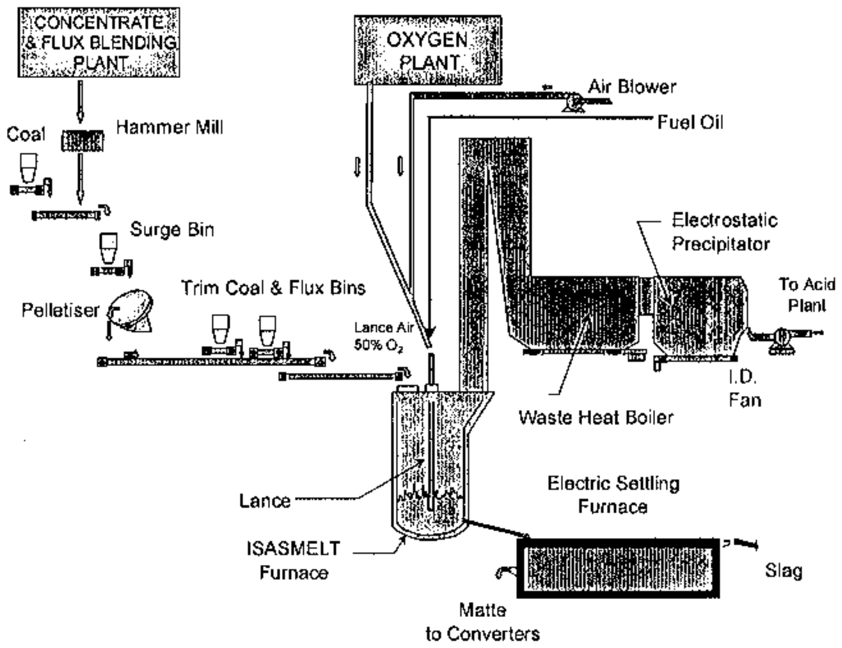

Figure 3 - YCC copper ISASMELT flowsheet

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.

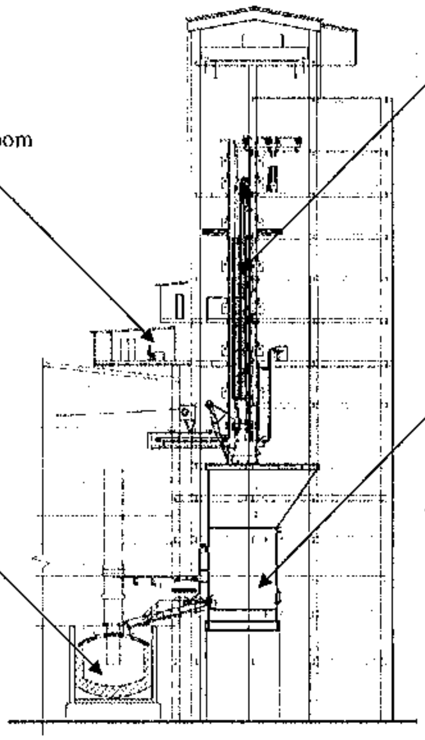

Figure 4 - YCC ISASMELT building elevation

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.

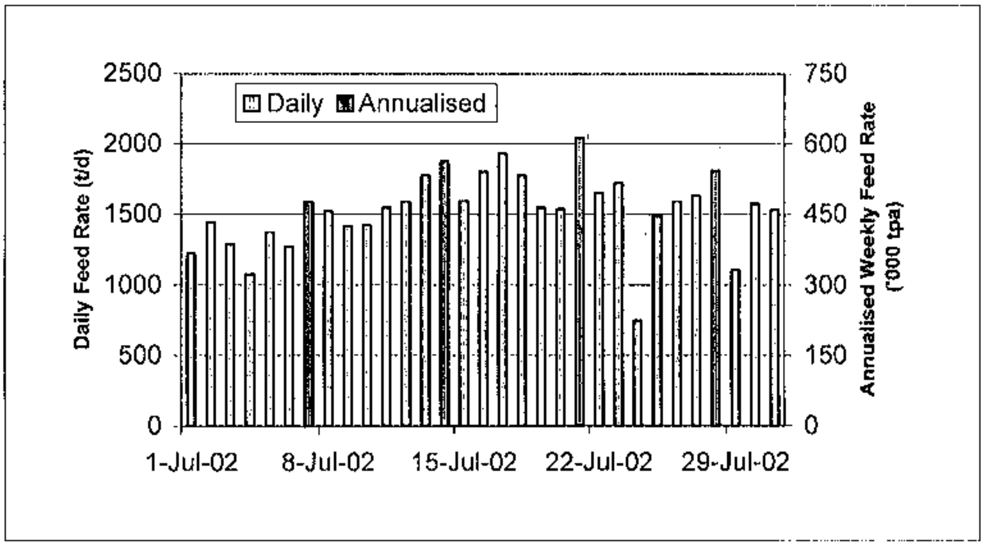

Figure 5 - YCC ISASMELT feed rate July 2002

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.

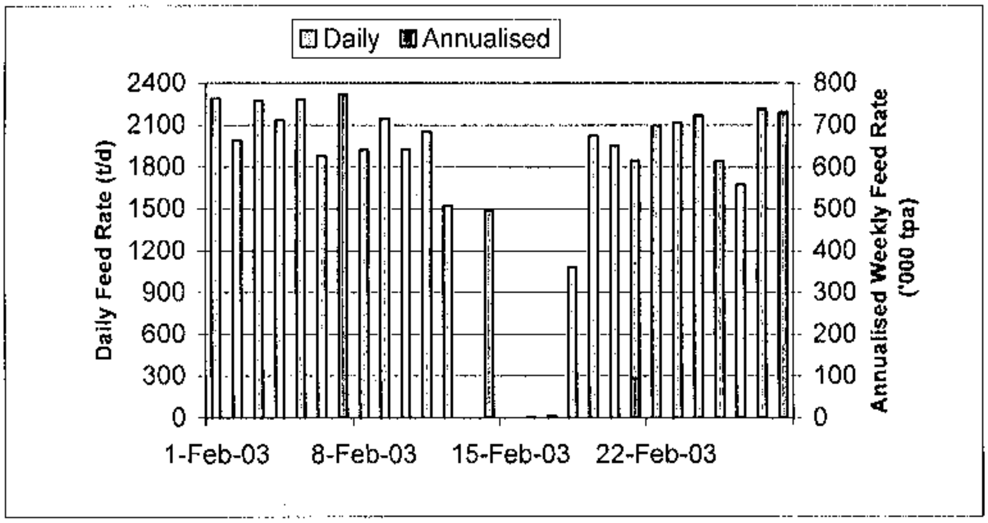

Figure 6 - YCC ISASMELT feed rate February 2003

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.

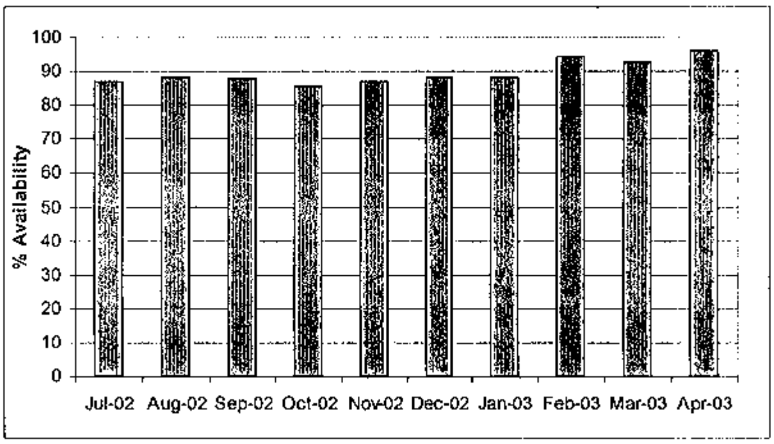

Figure 7 - YCC ISASMELT availability

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.

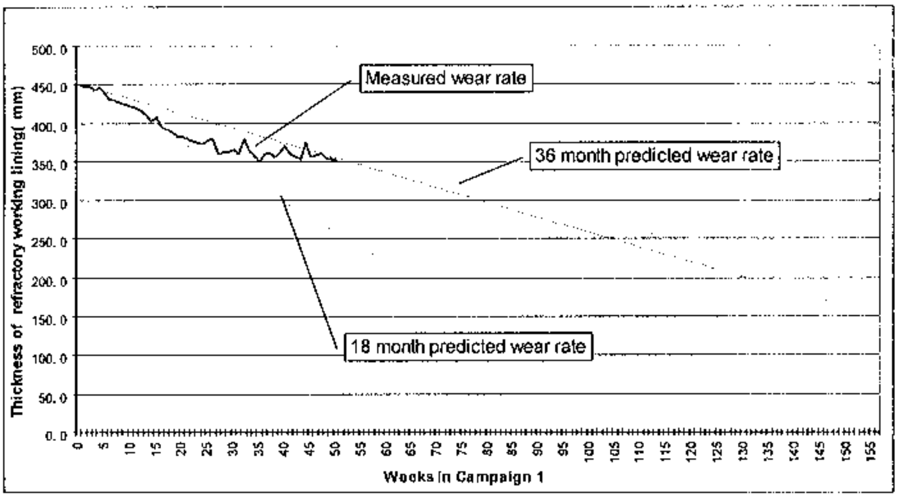

Figure 8 - YCC refractory wear trend

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.

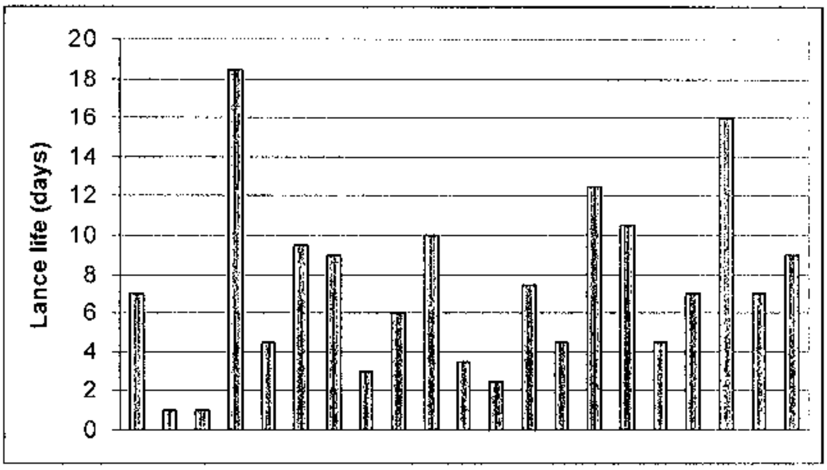

Figure 9 - YCC lance life

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.

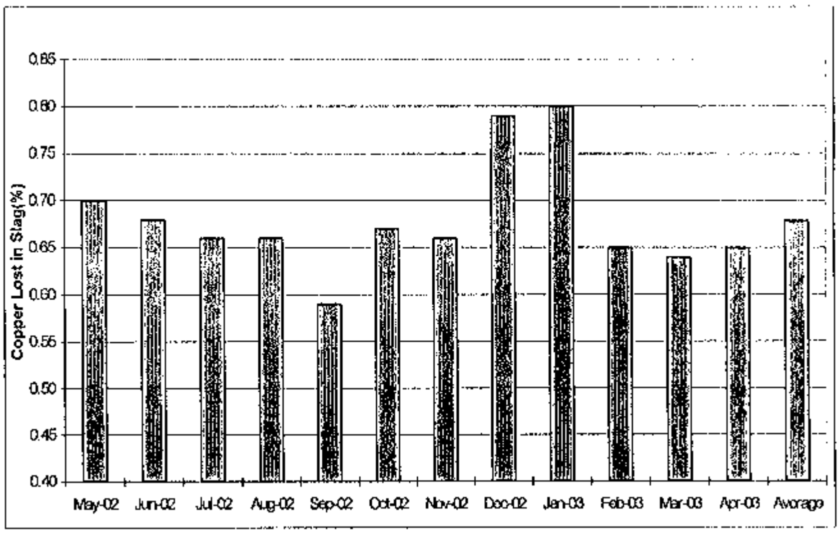

Figure 10 - YCC typical copper content of electric furnace slag

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.

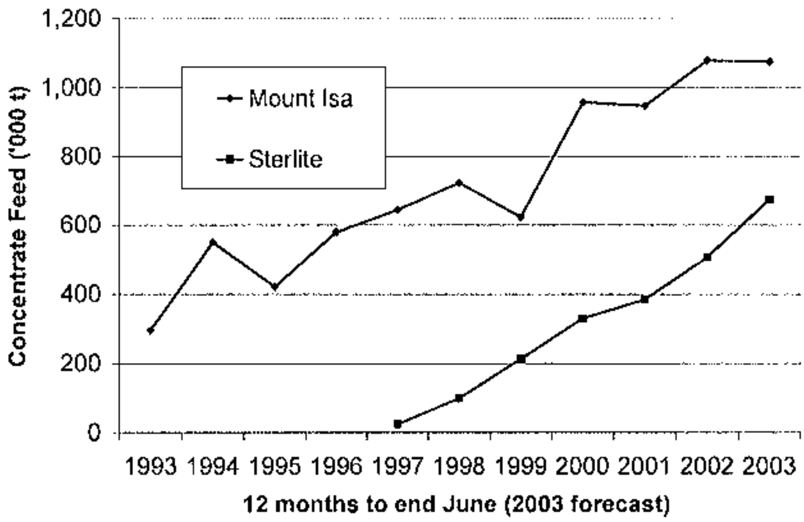

Figure 11 - Mount Isa and SIIL feed rates

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.

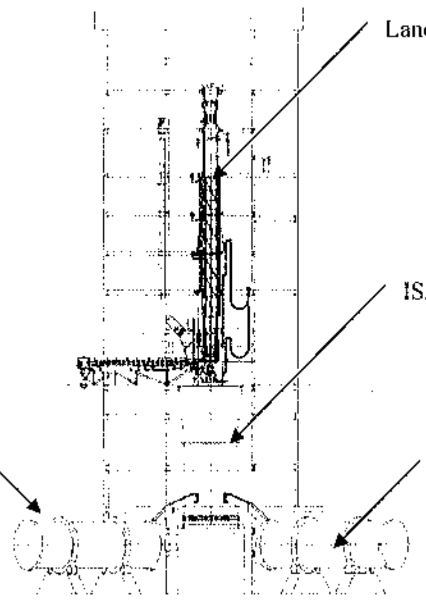

Figure 12 - Future Sterlite Industries copper ISASMELT furnace elevation

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.

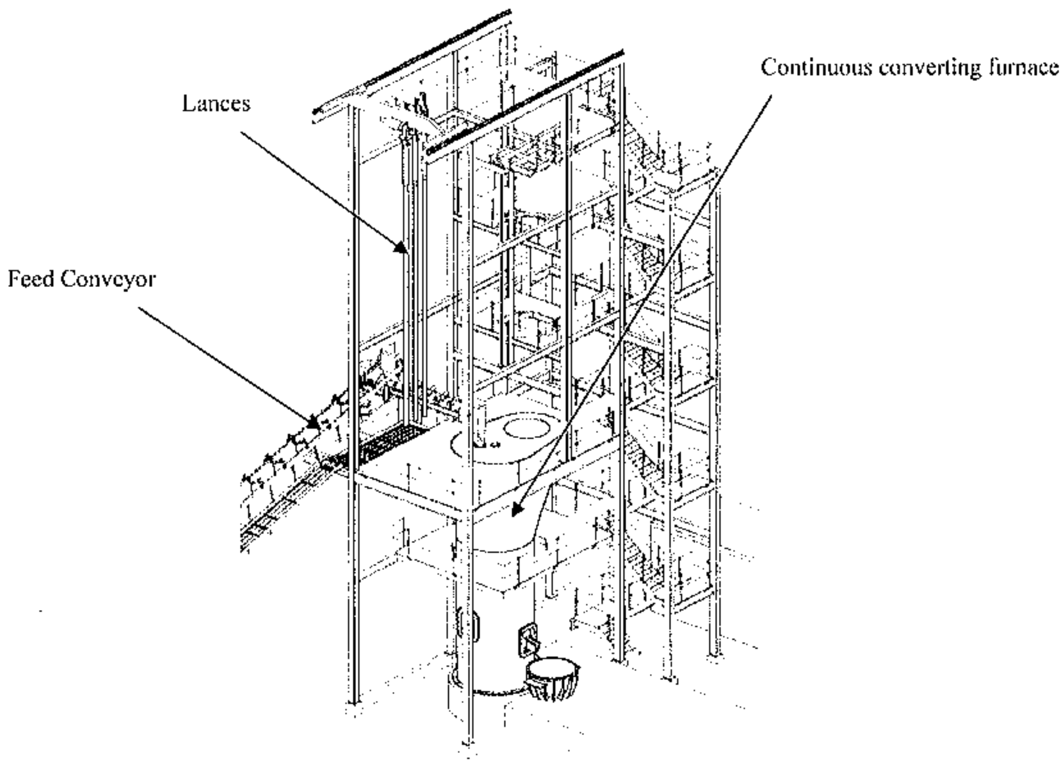

Figure 13 - Continuous converting pilot plant

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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Annexe III

YUNAN Copper Corporation's new smelter
China's first ISASMELT

xstrata technology

Paper Title:
YUNNAN COPPER CORPORATION's new smelter China's first ISASMELT™

Paper Presented at:
Yazawa Symposium, San Diego

Authors:
Philip Arthur, Xstrata Technology
Yun Li, Yunnan Copper Corporation

Date of Publication:
March 2003

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YUNNAN COPPER CORPORATION'S NEW SMELTER

CHINA'S FIRST ISASMELT™

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Abstract

In 1999 Yunnan Copper Corporation (YCC) decided to modernise their copper smelter and change the existing sinter plant / electric furnace process to a combination of ISASMELT[i] and electric slag cleaning furnace. The main aim of the project was to improve the environmental performance and decrease energy consumption.

Generally the project has been successful, partly attributable to the selection of a reliable and fully demonstrated technology. The design capacity for the ISASMELT furnace is 600,000 tonnes of dry copper concentrate per year. The furnace has been running smoothly since heatup in May 2002. YCC expended considerable effort in the preparation for plant operation. An extensive training program for key YCC personnel at the Mount Isa Copper Smelter improved their understanding of the process significantly and ensured successful hand-over of the technology. This paper describes the project history and summarizes initial operating results.

Introduction

The Chinese metallurgical industry is facing a number of challenges as it enters the twenty first century. First there is a desire to increase industrial efficiency and this is starting to be achieved through the privatization of state owned companies. Secondly the government is committed to reducing the impact of heavy industry on the environment. It is therefore encouraging those companies that are selected for privatization to modernize the existing metallurgical complexes, replacing outdated technology with modern technologies, either developed within China or imported from overseas. YCC is one company that chose to import new smelting technology from outside China.

Yunnan Copper Corporation

The YCC copper smelter is located in the Western Hills District of Kunming, Yunnan Province, China. It is a company with 44 years of copper manufacturing history. Annual production is 200,000 tonnes of high purity copper cathode, 450,000 tonnes of sulfuric acid, 200 tonnes of silver, 2 tonnes of gold and 60,000 tonnes of copper rod for use in electrical applications. YCC was listed on the stock market on June 2, 1998, and was subsequently selected to be part of the American Dow Jones Composite Index on April 1, 1999 and to be part of the Shenzheng Composite Index on October 8, 1999.

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[i] ISASMELT™ is a registered trademark of Xstrata Technology

Prior to listing on the stock market a smelter modernization project was started. Process modifications were identified and evaluated from 1993 to 1996 with the aim of saving energy and improving the environmental performance of the plant. The ISASMELT process was identified as the most suitable process for the upgrade and work related to process selection was completed during 1997-1998 culminating in the signing of an ISASMELT copper smelting technology licence agreement with MIM Process Technologies (MIMPT) on March 21, 1999. The project Kick-Off Meeting was held from September 28 to October 8, 1999. Construction and equipment installation began in 2001. The furnace heat up commenced on May 9, 2002 and feeding of raw material commenced on May 15. From the start of production to September 30, 2002, production availability was 75.8%, or 87.1% once scheduled shutdowns and shutdowns attributable to other plant areas were allowed for. A successful start-up was achieved from day one.

ISASMELT Process

The copper ISASMELT process used at YCC is a bath smelting process developed by Mount Isa Mines in Australia over approximately 20 years. The process has been described in a number of technical publications.[1-7] Oxygen enriched air passes down the specially designed lance into the molten slag, producing a highly turbulent bath that expedites chemical reactions and uses the heat produced by oxidation of sulfur and iron contained in concentrate for smelting, producing a high grade matte and a fayalite slag. Coal is used as additional fuel if the heat of reaction from the concentrate is insufficient to maintain the heat balance.

The design capacity of the YCC ISASMELT furnace is 600,000 tonnes of dry concentrate per year. The process flowsheet for the plant is shown schematically in Figure 1. A number of different concentrates, mostly from mines within China, are blended with flux in a blending plant. The majority of the coal required for the process is added to the blended mix after it has passed through a squirrel cage crusher to remove large lumps. This feed mix is pelletised on up to four disc pelletisers. 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 is also added through the lance to fine tune the bath temperature. The molten slag-matte mixture produced by smelting is tapped intermittently from the ISASMELT furnace into an electric settling furnace. The slag and matte separate by gravity in the settling furnace. Matte is subsequently transferred to Peirce-Smith converters for further processing. Slag is granulated and removed for disposal. 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.

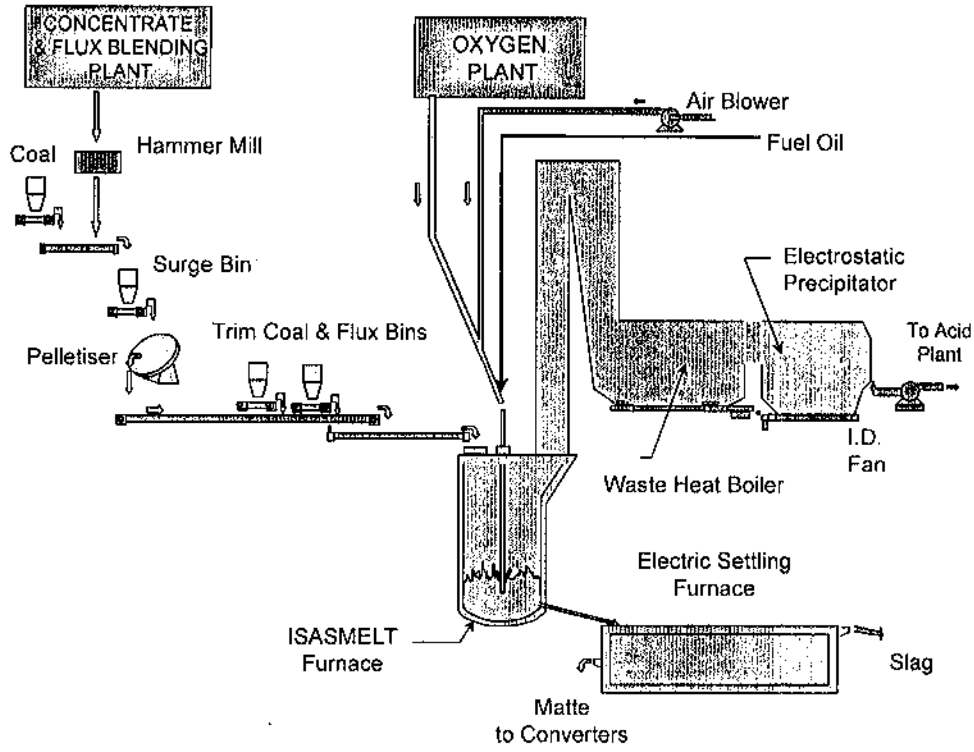

Figure 1: Process flowsheet

Engineering and Construction Management

The modernization project commenced in early 1999. YCC had a number of associated plant modifications in addition to the ISASMELT plant itself. In order to coordinate direction and speed up plant construction, YCC divided the project into four project areas according to the various fields they belonged to: smelting, sulfuric acid, oxygen production and power.

In smelting the main focus was the ISASMELT Furnace. MIMPT was responsible for the basic design of the ISASMELT plant and related interface design, as well as the detailed design of the core items associated with the ISASMELT Furnace. Oschatz from Germany was responsible for the design of the Waste Heat Boiler associated with the ISASMELT Furnace, while the remaining engineering design was undertaken by the Beijing Engineering & Research Institute for Non-ferrous Metallurgy (ENFI). YCC coordinated the design work of all parties. The engineering design was essentially complete following the basic engineering review meeting held in April 2000 in Brisbane and the detailed engineering review meeting held in August 2000 in Kunming.

Project construction was executed by local Chinese construction companies. The piles of the ISASMELT Furnace main building were installed by Kunming Non-ferrous Foundation Engineering Company, and the piles foundation test was performed by the Science and Technology Development Company of Kunming Prospecting Institute. The ISASMELT Furnace foundation and related civil work was completed by No. 14 Metallurgical Construction Company.

Yunnan No.1 installation company was the contractor for the ISASMELT Furnace installation, their work including manufacturing of the furnace shell, ISASMELT building steelwork, ISASMELT furnace system equipment, piping work, electrical components and instrumentation. This work was effectively complete by March 2002. The ISASMELT furnace bricking was completed by the No. 14 Metallurgical Bricking Company under the supervision of site service personnel from RHI Refractories of Austria. Anti-corrosion work was undertaken by Yunnan Smelter Construction Company in April 2002. It included sand-blasting for rust removal, followed by application of chlorinated rubber primer and surface coating.

Subsidiary projects that related to the ISASMELT furnace system included the smelting vessel itself, feed preparation, control room and staff facilities, emergency flux and coal bins, lance and lance handling equipment, heat up burner, holding burner, dip bar, clay gun and tapping machine, molten matte and slag tapping area, air conditioning systems (slight positive pressure ventilation), hygiene ventilation systems (pollution-free venting), reverts handling, pulverized coal, brick unloading, after-burning air, air and oxygen piping, oil piping, cooling water circulation, plant water and potable water supply and draining, cranes and personnel elevator.

The projects related to the waste heat boiler system included the waste heat boiler, boiler water supply, forced circulation, natural circulation, steam piping, emergency cooling, drag chain conveyors (dust removal), crusher, dust conveying, offgas discharge and heat preservation.

Further projects included electrical power supply, instrumentation, ISASMELT Distributed Control System (DCS) and waste heat boiler DCS, and building structures.

Plant Design

As with any "brown field" project, the construction of the plant resulted in a number of unique challenges, because of the location. The ISASMELT furnace and waste heat boiler had to be installed in a very restricted area surrounded by existing plant facilities. It was necessary to construct the furnace adjacent to the existing electric furnace, so that it could be used as a settling furnace once the new plant started operation. The available space was restricted by the converter aisle on one side and the electric furnace offgas bag filter on the other. One of the advantages of the ISASMELT process is that it could be constructed within such a confined space. Figure 2 shows the limited space available for the plant once unnecessary buildings and equipment had been demolished.

Figure 2: Plant site

Construction was made more complicated by the fact that Kunming is in an earthquake prone region, and as a result the foundations had to be designed with particular care. MIMPT provided data on the static and dynamic loads that would be expected during operation and the foundation and furnace support were designed based on that data.

Feed mix was brought to the plant from the existing feed preparation plant that had previously been used for feeding the sinter plant. A new conveyor bridge was constructed to the ISASMELT building. The ISASMELT Furnace is located as close as possible to the electric furnace and two tapholes and two launders are used for tapping the molten products. The waste heat boiler is installed on the opposite side of the furnace. The boiler comprises a radiation section, with uptake above the furnace offgas outlet and downcomer, followed by a convection section. A new duct was installed to convey the cooled gases to a pair of existing electrostatic precipitators, that were upgraded for use with the new plant.

The ISASMELT Furnace has an internal diameter of 4.4 metres. It is lined with high quality chrome-magnesite refractory bricks. The roof of the furnace is made of boiler tube and forms part of the waste heat boiler. The ISASMELT lance has a diameter of 400mm and is lowered and raised in the furnace on a specially designed lance carriage. Figure 3 shows an elevation of the ISASMELT building.

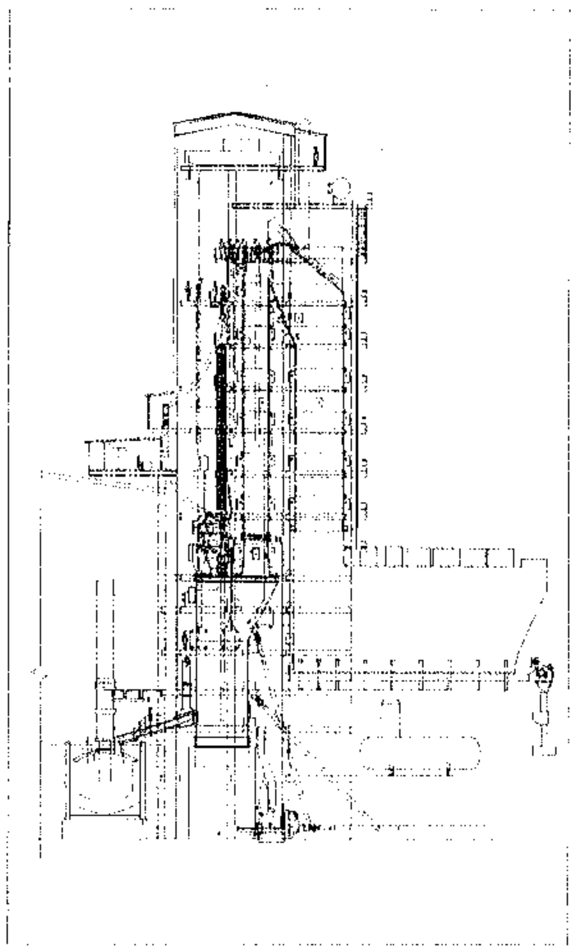

Figure 3: ISASMELT building elevation

Preparation for Production

An ISASMELT process team was established in 1998 to commence preparation for production. This group participated in selection of the best technical solution for the YCC upgrade. Additional technical personnel joined the team to prepare for the procurement of equipment, plant installation and plant commissioning. YCC set up a special management team for preparation of production, with the task of coordinating all work around the ISASMELT plant. One key issue that was identified was that effective training and preparation of personnel would be the most important means for minimising risks to the project and future production. YCC management therefore decided to accept MIMPT's proposal for an extensive training program to take place at the Mount Isa Mines copper smelter.

<u>Personnel Training</u>

An ISASMELT process team was established in 1998 comprising metallurgical engineers who concentrated on learning about the ISASMELT process. They gave instructions to the staff of the existing smelting plant on ISASMELT process principles from 1999 to 2001. The total tuition time was about 430 hours with about 200 smelting plant employees being involved. YCC management then chose a group of reserve staff for the heatup of the ISASMELT Furnace based on the competency demonstrated.

YCC management used a more detailed selection process for nominating metallurgical, electrical, instrumentation and mechanical engineers, control room operators and tapping operators who would go to Mount Isa for training. The successful candidates gained further profound understanding of the ISASMELT process, equipment, safety and related management issues during the training program in Mount Isa. This training, arranged and supervised by MIMPT, took place over a 7-month period during 2001. Tutorial sessions were held on a wide range of issues and the trainees gained extensive "hands-on" experience as part of the regular shift crews. By the end of their training on the Mount Isa plant, YCC personnel were able to operate the ISASMELT Furnace under supervision of MIMPT staff. They were then ready to put the theoretical and practical training into practice on their own plant.

Figure 4: YCC training in Mount Isa

On their return from Mount Isa to Kunming, new operations personnel from the reserve staff were recruited for heating up and operation of the ISASMELT plant. Further training occurred on site and all reserve persons joined in the installation and commissioning of equipment in order to become as familiar as possible with the equipment before heat up.

Personnel training also occurred on the waste heat boiler. Thirteen staff took part in the training during 2000. Engineers and operators participated in the installation, inspection and commissioning.

The end result demonstrated that YCC reaped many benefits from this comprehensive training program.

Compilation of Operating Procedures

The compilation of the operating procedures for the ISASMELT plant commenced in May 2001. The related safety and management procedures were compiled in July. The operating procedures were translated for MIMPT personnel to review. After modification according to MIMPT's recommendations, YCC organized new training sessions based on the modified procedures to unify the understanding of operations personnel.

Risk Analysis, Planning and Training

YCC analysed the predicted list of possible risks during heating up and production in the ISASMELT plant based on questions that had arisen during preparation from January to February in 2001. The final HAZOP and risk analysis plan was completed with the assistance of MIMPT site service engineers and was distributed to all operators.

Preparation of Equipment Inspection Sheets

Inspection sheets were prepared for everyday running and maintenance indicating the inspection requirement for equipment.

- The requirements of inspection content, range and method
- The requirements for inspection personnel and training
- The requirements for inspection frequency
- The requirements for recording and handling

Participation in Installation and Commissioning

YCC set up teams to monitor progress on site for specific disciplines such as process engineering, mechanical engineering, instrument and control engineering, electrical engineering, thermal engineering, and water reticulation systems. Their tasks included learning about the plant and process, inspecting, feedback, presentation of proposals and recording of progress.

The inspections were divided into two steps. The team members carried out the first pass inspection. The team leader carried out the second inspection or so-called general inspection. If there were any problems different groups became involved. Related groups exchanged ideas, cooperated and found solutions to complex problems.

To minimize the impact of the language barrier on project progress YCC established a special translation group to complete translation work parallel to the establishment of the project. Two groups of ten young employees received English tuition during 2000 and 2001. These employees became the site interpreters, having dual roles of engineer and interpreter. This initiative decreased the difficulties arising from the language barrier.

Cold Commissioning and Modifications Required Based on Problems Encountered

YCC's strategy for commissioning was that the startup should occur smoothly and efficiently, all items should be commissioned completely and hot commissioning should lead to stable operation as quickly as possible. Commissioning represented the final stage of the long road to implementation of ISASMELT technology at YCC. Issues resolved during the cold commissioning included:

- Some problems on the feed system such as the conveyor belt drift, feeding port blockage, final conveyor belt modification.
- Some problems with imported equipment and their installation such as the tapping machine drill bits that could not drill to the design drilling depth, rotation of swivel joints, a malfunctioning load pin and lance replacement difficulties related to dimensional problems with expansion joints.
- Some problems with domestic equipment and their installation such as oil pumps not supplying the required oil flow rate and pressure, and some domestic belts support structure not meeting requirements.
- Modification of items that were not compliant with production and safety requirements such as the relocation of a burst disc and some thermocouples, removal of ramming material under the splash block.
- The number of vents on the lower furnace shell was increased to allow moisture to escape from the refractory lining during furnace heatup.

Preparation of Operating Tools and Equipment

Preparation of operating tools and equipment had commenced at the end of 2001 and included personal protection equipment, tapping floor material and tools, other special tools, production material, spare parts, stationery, and rain and dust protection equipment.

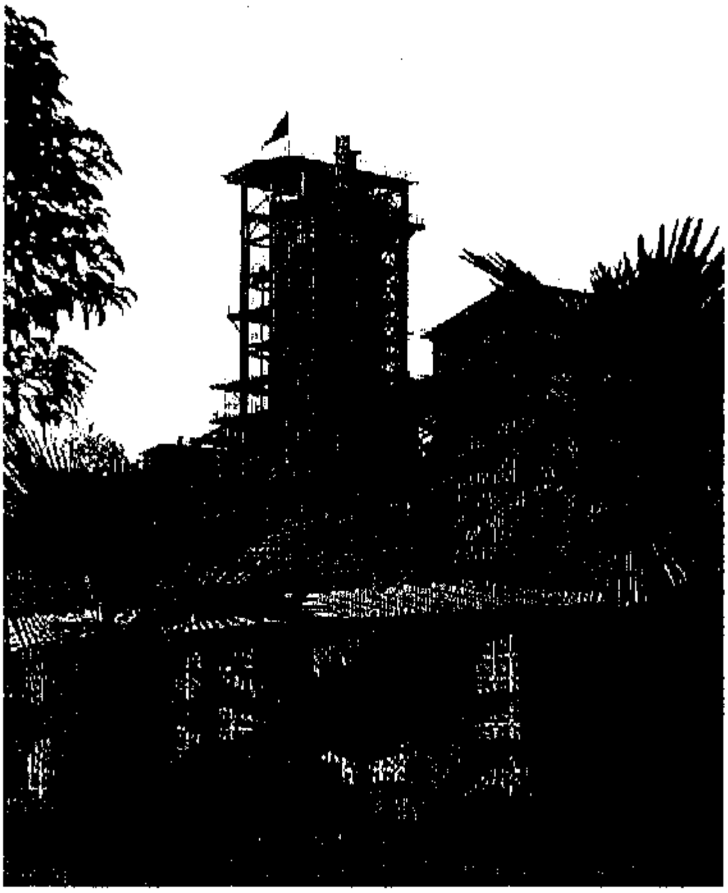

Figure 5: YCC ISASMELT plant

Heatup and Commissioning

Arrival of MIM Operations Personnel

A team of experienced operations personnel from the Mount Isa Mines copper smelter arrived at YCC site just prior to furnace heat up. These specialists assisted YCC personnel on shift roster throughout the first weeks of operation of the plant. In accordance with YCC's requirements, the MIM personnel assumed an observation role, allowing YCC personnel to take charge of the operation, and only stepping in to assist when necessary.

Preparing the Heatup Schedule

YCC sent the primary heat up and production schedule to MIMPT for review in March 2002 and then modified it based on MIMPT's suggestions. Further amendments occurred to the heat up program through discussion between MIMPT site service engineers and YCC. A layer of granulated slag was placed in the base of the furnace. Initial heating occurred with a wood fire together with an oil-fired heat up burner, with subsequent secondary heating by holding burner. This method allowed precise control of refractory temperature through the critical range up to operating temperature. Temperature monitoring allowed confirmation of the heat up curve and heat up speed, with recording of heatup data on spreadsheet software.

Start of Shift Operation

YCC decided to adopt a 12 hour shift roster for the commissioning period, similar to that practised at the Mount Isa copper smelter. Personnel were appointed to the shift work crews, including foremen and control room operators. All of the foremen, main control room operators and some of the tapping floor operators had been to Mount Isa for training. The shift crews commenced shift work one month in advance of furnace heat up.

Issue and Performance of Safety Regulations Around ISASMELT Plant

YCC set up special safety regulations for the ISASMELT plant at YCC based on safety regulations supplied by MIMPT. These regulations included executing the requirement for wearing personal protection equipment, danger tagging, label usage and field isolation regulation for controlling the production area.

Management of Heatup of ISASMELT Furnace

According to the heating up schedule team members inspected the heat up progress around the ISASMELT plant. Each member reported progress to his supervisor. The management team was responsible for general coordination and control.

Initial Production Data

Following heat up the plant quickly increased production to satisfactory levels. During initial operation the furnace operated in parallel to the existing sinter plant, and the matte grade was maintained at lower levels to allow converter operations to gradually become used to operating with the higher matte grades. Once YCC felt satisfied that the new ISASMELT furnace was operating stably the sinter feed to the electric furnace was stopped and the new plant increased throughput up to design capacity.

Table 1 summarizes key operating data for the first few months of operation. The data demonstrate the speed at which the process came under control, with operation stabilizing as plant personnel became more familiar with the process.

Table I – Key operating data

Month (2002)	May	June	July	August	September
Average Feed Rate (dry t/h)	61.8	70.6	70.3	61.9	58.8
Average Oil Consumption (L/d)	7,184	4,285	2,016	2,078	1,846
Average Matte Grade	48.4	55.7	64.3	60.1	58.6
Average SiO_2:Fe	0.98	0.84	0.88	0.88	0.92
Average Lance Life (days)	1.4	2.0	3.7	6.6	10.5

Commissioning Problems

As with any new plant, a number of problems occurred during plant commissioning. The main problems, and the respective solutions, are described briefly below.

Heatup Burner

A heatup burner was used for the initial heat up of the furnace from ambient temperature to operating temperatures. This oil-fired burner was capable of very precise control to ensure that the refractory heat up curve could be followed throughout the heating period. During the latter stages of the heatup, however, the burner tip was damaged. YCC shift operators removed the burner from the furnace and the heatup continued using the holding burner. YCC and MIMPT agreed on actions required to ensure the problem would not occur in future heatups.

Lance Operation

During the first few weeks of operation lance life was relatively short and the lances tended to bend during operation. Over time the YCC operators became more experienced with operating the furnace, and as a result the furnace temperature became more stable. Stable operation has reduced lance bending and increased the lance life significantly.

Some problems occurred with the oil nozzles and oil pipes dislocating from the lance body in the first couple of weeks of operation. MIMPT established that the cause was a minor design error that was corrected and the existing lances were modified, thus alleviating the problem.

Feed Surges

Initial problems were encountered with surges in the feed to the ISASMELT Furnace. These feed surges led to difficulties controlling the furnace operation, with wide swings in the air and oxygen rates and resulting variations in the bath temperature. The solution was to enhance the monitoring and control of the feed system and modify the control logic in the DCS.

Refractory Brick Wear

Some refractory bricks were spotted by tapping operators during the first weeks' operation of the furnace. Although this is a normal occurrence with a new lining, as the refractories bed in and exposed corners spall off, operators were nevertheless concerned about ongoing refractory wear. The control room operators therefore focused on lowering the operating temperature and stabilizing the furnace temperature control in line with the operating practice learned at Mount Isa.

Conclusion

The engineering design, construction and commissioning of the first Chinese ISASMELT copper smelter has been carried out smoothly and successfully as a result of the cooperation between YCC and companies inside and outside China including MIMPT, Oschatz and ENFI. YCC has shown that its decision on technology selection was correct. The decision to choose a smelting technology provider with operations experience and to take full advantage of access to the operations at Mount Isa for the extensive training program has paid significant dividends to YCC.

This novel bath smelting technology has been implemented successfully at YCC, with stable operation achieved within the first five months of production. YCC looks forward to a secure future, in the knowledge that it is set to take full advantage of this efficient, modern smelting technology.

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