

TANK HOUSE EXPANSION AND MODERNISATION OF COPPER REFINERIES LTD, TOWNSVILLE, AUSTRALIA

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1.0 INTRODUCTION

Mount Isa Mines was originally founded on a series of Lead, Silver and Zinc ore bodies in 1923. In 1955 significant adjacent copper orebodies were defined. The unique polymetallic nature of the Mount Isa Mines operations commenced.

In September 1959 a subsidiary copper refinery company, Copper Refineries Pty Ltd commenced conventional “starting sheet” production and export of 40,000 tonnes per annum. A series of two major expansions lead to operating capacity of 80,000 tonnes per annum in 1966 and 150,000 tonnes in 1975.

The first commercial introduction of the “ISA Process” permanent stripping technology was commissioned in 1978. Cathode production capacity was also increased to 170,000 tonnes per annum. The vastly improved electrode alignment and accuracy inherent with the Permanent Stainless Steel Cathodes of the ISA Process then allowed the capacity of the Refinery to be increased to 210,000 tonnes per annum by 1996.

The 1997 commissioning of the 51% Mount Isa Mines owned Ernest Henry Mine and the concurrent expansion of operations at Mount Isa afforded the opportunity to expand and modernise the Copper Refineries operation.

After 20 years of ISA Process tank house operation and 15 years experience in exporting the ISA Process technology Copper Refineries was in an enviable position with respect to design options for a world class facility. Experienced gained in tank house layout, machine design and operational philosophies was easily applicable.

The Refinery upgrade activities commenced in December 1996 and were completed in April 1999. An annualised capacity of 270,000 tonnes per annum was achieved by July 1999.

2.0 PROCESS SELECTION

2.1 LAYOUT

Various combinations of tank house layout and design have been implemented in ISA Process tank houses. Copper Refineries was constrained in many cases due to the fact that a full retrofit had to be conducted with a minimum of disruption to the existing operation. For example the location of receipt and delivery services for anodes and cathodes were fixed. The layout selected incorporates one crane per aisle feeding to and from a centralised machinery bay.

2.2 DESIGN CRITERIA

Design objectives were related to:

- Long Term Production forecasts.
- Customer requirements.
- Copper Refineries Pty Ltd Operations Survey.
- Construction in an existing operating plant.
- ISA Process technology developments.

2.2.1 Long Term Production Forecasts

With the commissioning of the Ernest Henry mine and the expansion of the Mount Isa Copper Mine into the Enterprise orebodies an annual operating capacity of 270,000 tonne per annum was required.

Concurrent with these mine expansions the Mount Isa based copper Smelting facilities have been upgraded. Improvements include, an extra oxygen plant to provide increased primary smelting throughput, stacker reclaiming concentrate blending facility, a fourth Pierce Smith converter together with a new anode casting wheel and rotary holding vessel.

2.2.2 Customer Requirements

Accredited with ISO9002 in 1994, Copper Refineries has a proven quality system to ensure the satisfaction of our customer base. Modernisation of the cathode stripping machines allowed the introduction of improved cathode bundle appearance handling and shipping. Requirements in terms of individual cathode weight, labelling, sampling and corrugation were highlighted.

2.2.3 Operations Survey

An extensive series of surveys was conducted with all operating personnel to ensure that problem areas with the existing operation were addressed. Operational improvements were identified in material movement, machinery access, slimes handling and reagent dosing. Over 350 suggestions were logged into a database to provide for key design criteria.

2.2.4 Construction in an Existing Plant

The requirement to minimise production disruption dictated that new electrode handling equipment be commissioned prior to removal of the superseded equipment. Conversion of the electrolyte and cell systems was conducted in a series of intensive shutdowns that were coincided with planned shutdowns at the Mount Isa Copper Smelter. A key design element in the electrolyte and bus bar systems was ease of installation.

2.2.5 ISA Process Technology Improvements

The Cathode Stripping Machines have provision for improvements in the edge masking system utilised in the ISA Process. These improvements relate to the elimination of bottom wax on the stainless steel cathode blanks. This concept is now marketed as ISA Process 2000.

2.2.6 Final Process Selection

The expansion and modernisation of the Copper Refineries tank house was implemented with the following items:

- Replacement of 1024 lead lined cells with 1162 polymer concrete cells.
- Total replacement of electrolyte, slimes and DC electrical reticulation.
- Installation of section switches
- Installation of Decant Filtration and "Quick-Fill" operation.
- Centralised reagent batching and distribution.
- Replacement of Anode Scrap Machine with new machinery that incorporates single piece washing.
- Replacement of Anode Preparation Machine with new machinery incorporating lug milling and buffered storage capacity.

- Replacement of Cathode Stripping Machines with new machinery incorporating inline bundling, weighing and strapping.
- Replacement of six manually operated cranes with two automated cranes utilising pyramid based locating devices.
- Installation of a real-time cathode weighing , loading and despatch computer system

3.0 PROCESS DESCRIPTION

3.1 Modernised Refinery Operating Statistics

Capacity	270,000 tonnes per annum
Cells	1162
Electrolyte Temperature	63 ⁰ c
Cell Flow Rate	25-30 litres per minute
Anodes	45
Cathodes	44
Electrode Pitch	95mm
Maximum Anode Weight	410 kg
Maximum Cathode Weight	115 kg
Anode Cycle	21 days
Cathode Cycle	3 x 7 day or 10/11 day
Number Rectifiers	4
Current Density	305 A/M ²
Electrical Circuits	3
Electrolyte Circuits	3
Number of cranes	2

3.2 TANK HOUSE LAYOUT

The Cathode Stripping Machines were relocated from their positions at the extremities of the building to be centrally located. The anode and scrap handling functions are also located in the centre of the building.

A machinery annex was added to the building to locate all of the electrode handling machines. This design was required to meet the same side anode receipt and cathode, anode scrap despatch design requirement. Six aisle trolleys transport electrodes into and out of the machine annex. The machinery annex has two small auxiliary cranes installed to allow for heavy equipment maintenance, reject cathode plate removal and transport of stripping machine consumable items.

The incorporation of the machinery annex into the layout designs meant that the tank house only needed to be extended by one bay to accommodate the extra 138 refining cells. The extra bay was also required to facilitate the introduction of the new overhead cranes and the removal of the redundant cranes.

3.3 OVERHEAD CRANE OPERATION

Two Kunz fully automated overhead cranes handle all refinery stripping operations. These utilise a locating bale onto a fixed pyramid to achieve accurate electrode alignment. The capacity of the cranes will allow for lifts of 45 anodes at 410 kg each. The crane is capable of multiple tasks. Individual lifts of anode, anode scrap or cathode plates are possible with a dual lifting bail arrangement.

A laser-based device communicates via a central supervisory logic controller the operation status of all cranes and electrode handling machines. This communication linkage allows for safe and efficient stripping operations to be conducted and scheduled with a minimum of down time and operator intervention. Programmed sequences for all stripping operations are installed in the cranes scheduling logic controller.

3.4 ANODE PREPARATION MACHINE

Anodes are received at the Townsville Refinery from Mount Isa via rail and road. The new Anode Preparation Machine was supplied by Finland's Outokumpu Oy. The anodes as received are loaded via fork lift to the preparation machine for weighing, blade pressing, lug offset pressing and milling

Milling is both face and underside to provide improved anode verticality and current distribution. When combined with lug offset pressing it is possible to present a high weight, vertically aligned anode to the automatic Kunz crane.

The prepared anodes are then transported to a live storage facility via two automated trolleys. From the live storage area the anodes are either fed directly to the tank house Load-Out beams or placed into an assigned storage location.

The live storage feature of the installation allows the anode preparation function to be independent of the refinery stripping operations. This gives enormous flexibility to scheduling of anode receipt labour and a vast reduction in anode double handling.

3.5 ANODE SCRAP MACHINE

Anode Scrap is remove from the refinery for subsequent remelt at the Townsville site. The new Anode Scrap Machine was supplied by Mesco, Japan. Anode scrap bundles are presented to a fork lift interface for removal to the anode casting operation.

The new machine incorporates single blade washing with a three stage washing process. Three separate settling tanks are used to maximise recovery of slimes with wash water volume make-up supplied via a final rinse station. An innovative "grizzly" arrangement is located below the traverse conveyor to allow safe and efficient removal of any fallen scrap. This arrangement is serviced by one of the machinery annex auxiliary cranes.

3.6 CATHODE STRIPPING MACHINES

Two new Cathode Stripping Machine were supplied by Mesco, Japan. The new machines incorporate all features identified from customer surveys. Features that have been introduced are cathode corrugation, automatic sampling, inline sworn weighing, bundle labelling and strapping. Fully prepared cathode bundles are presented to a forklift interface.

Control of these features has been linked to an existing commercial scheduling and invoicing computer system to ensure cathode bundles are prepared to Customer Specification. Despatch and invoicing documentation is also produced by the same system.

3.7 ELECTROLYTE CIRCULATION

The operations survey identified many deficiencies in the existing circulation systems. The replacement of all the old lead-lined concrete cells afforded the opportunity to upgrade the circulation system. Polymer concrete cells were supplied by CTI Pacific Pty Ltd.

For operation at increased current densities a higher cell electrolyte flowrate is required. New circulation pumps and larger diameter piping was installed. The electrolyte piping installed is a fibre reinforced vinyl ester resin base supplied by FibreTec Australia. Over 3,500 metres of piping was installed. Individual cell feed valves provide for quick-fill operation on each refinery cell.

Decant collection and filtration has been introduced to the refinery operation. Separate decant collector boxes and Scheibler filters have been installed.

3.8 ELECTRICAL RETICULATION

The original electrical bus bar system installed at Copper Refineries Pty Ltd was not suitable for any further increase in operating current density. A 4 copper plate laminated bus bar system was installed together with full load section switches. The section switches were supplied by Hundt and Weber, Germany and are capable of full load switching at 30,000 Amps. Over 400 tonnes of copper bus bar were installed.

4.0 CONSTRUCTION

In all cases the scheduling of construction activities was dictated by cathode production requirements. This meant that cell, electrolyte circulation and bus bar system replacements had to be conducted in intensive shutdown periods, that coincided with planned production shutdowns.

The major construction milestones are listed below:

- | | |
|-------------------|--|
| ▪ April-June 1997 | Crane runway beams strengthened. |
| ▪ Sept-Oct 1997 | Replacement of two electrolyte circuits – 600 cells |
| ▪ Feb-May 1998 | Construction of Machinery Bay Annex and machine runways beams. |
| ▪ May-June 1998 | Installation of Mesco supplied CSM's and ASM |
| ▪ Aug-Sept 1998 | Removal of old Cathode Stripping Machines. |
| ▪ Aug-Sept 1998 | Installation of Kunz cranes and replacement of crane rails. |
| ▪ Sept-Oct 1998 | Replacement of one electrolyte circuit - 424 cells. |
| ▪ Sept-Oct 1998 | Installation of Outokumpu supplied Anode Preparation Machine. |
| ▪ January 1999 | Removal of old APM and ASM. |
| ▪ February 1999 | Installation of additional 138 Refining Cells |
| ▪ April 1999 | Removal of six old overhead cranes |

The activities were conducted with minimal production losses and over 500,000 Contractor Manhours without a lost time injury. This was only made possible due to the close cooperation and teamwork between the refinery and construction personnel.

5.0 COMMISSIONING

A dedicated commissioning team was setup to ensure a smooth transition from old to new equipment. Successful completion of several construction activities required a timely commissioning schedule for the major electrode handling machines.

The key commissioning milestones are listed below:

- | | |
|------------------|--|
| ▪ July 1998 | Commissioning of Mesco supplied machines commenced. |
| ▪ September 1998 | Acceptance tests for two Cathode Stripping Machines and Anode Scrap Machine completed. |
| ▪ October 1998 | Partial commissioning of Kunz cranes commenced. |
| ▪ November 1998 | Commissioning of Anode Preparation Machine commenced. |
| ▪ November 1998 | Full-load Commissioning of Kunz cranes commenced. |
| ▪ December 1998 | Acceptance tests for Anode Preparation machine completed. |
| ▪ January 1999 | All Production operations converted to Kunz Cranes. |
| ▪ February 1999 | Acceptance tests for Kunz cranes completed. |

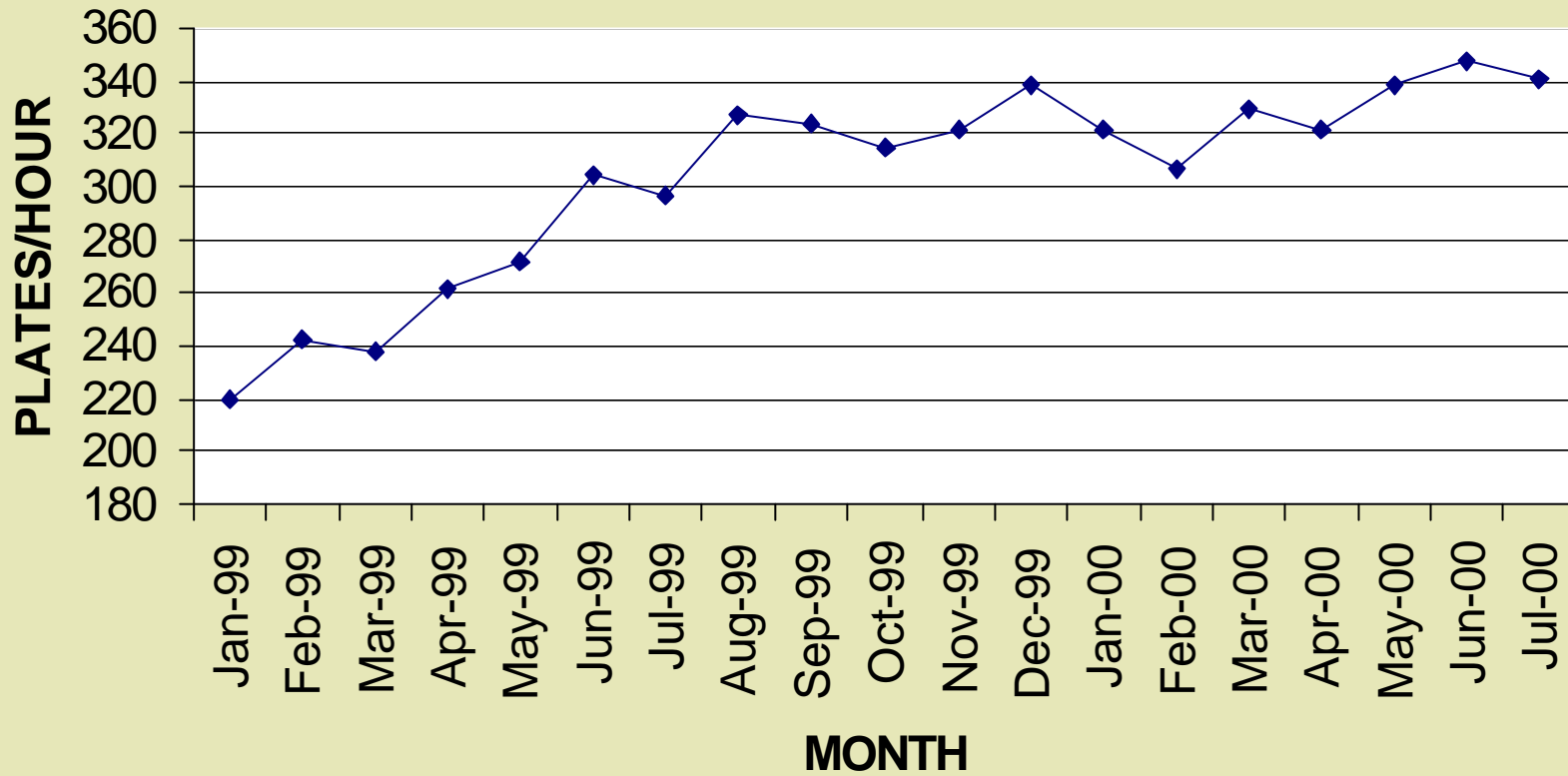
Commissioning engineers were provided by the three suppliers, Mesco, Outokumpu, and Kunz. Refinery Operating and training schedules were also developed by the Commissioning group to ensure that the overall construction schedule could be achieved.

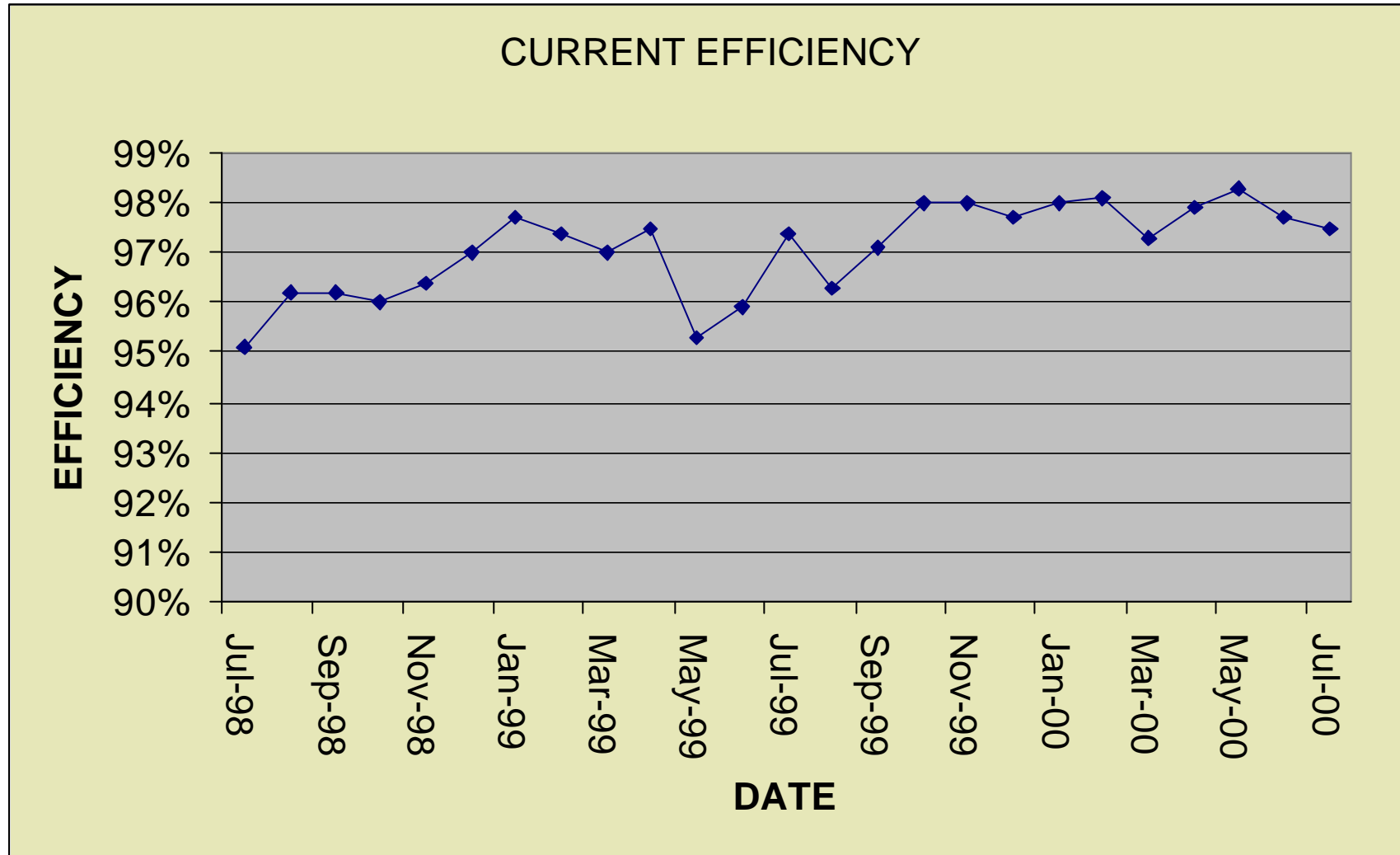
6.0 PRODUCTION AND OPERATIONAL IMPROVEMENTS

The tables below detail the production performance of the new refinery since 1998. The step change improvement in early 1999 came about by the simultaneous introduction of milled anodes and the Kunz cranes to the refinery.

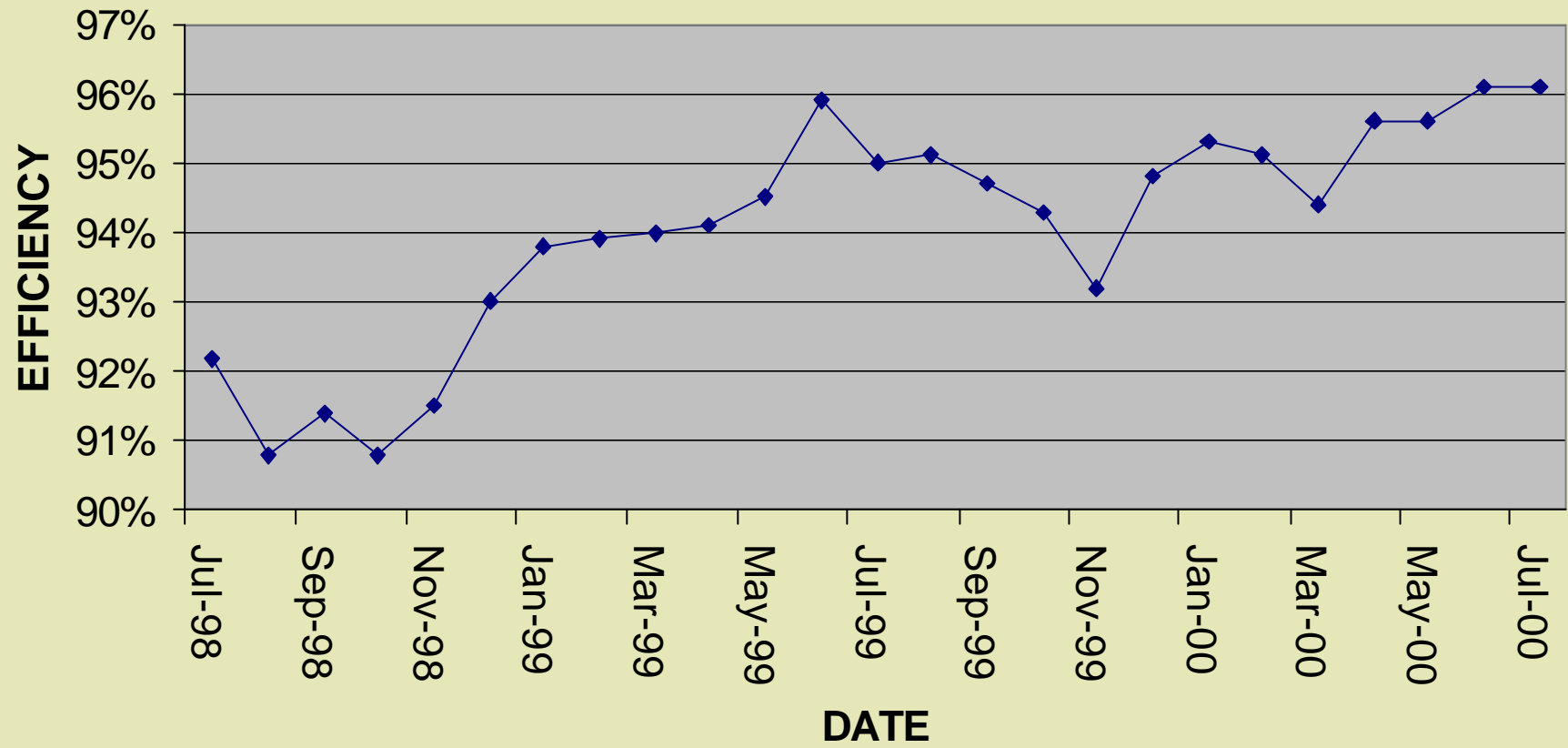
Further increases in output have been due to refining intensity increases. These increases are now possible due to the removal of previous anode weight constraints. Future intensity increases are planned as the Mount Isa Copper Smelter increases output to 270,000 tonnes per annum.

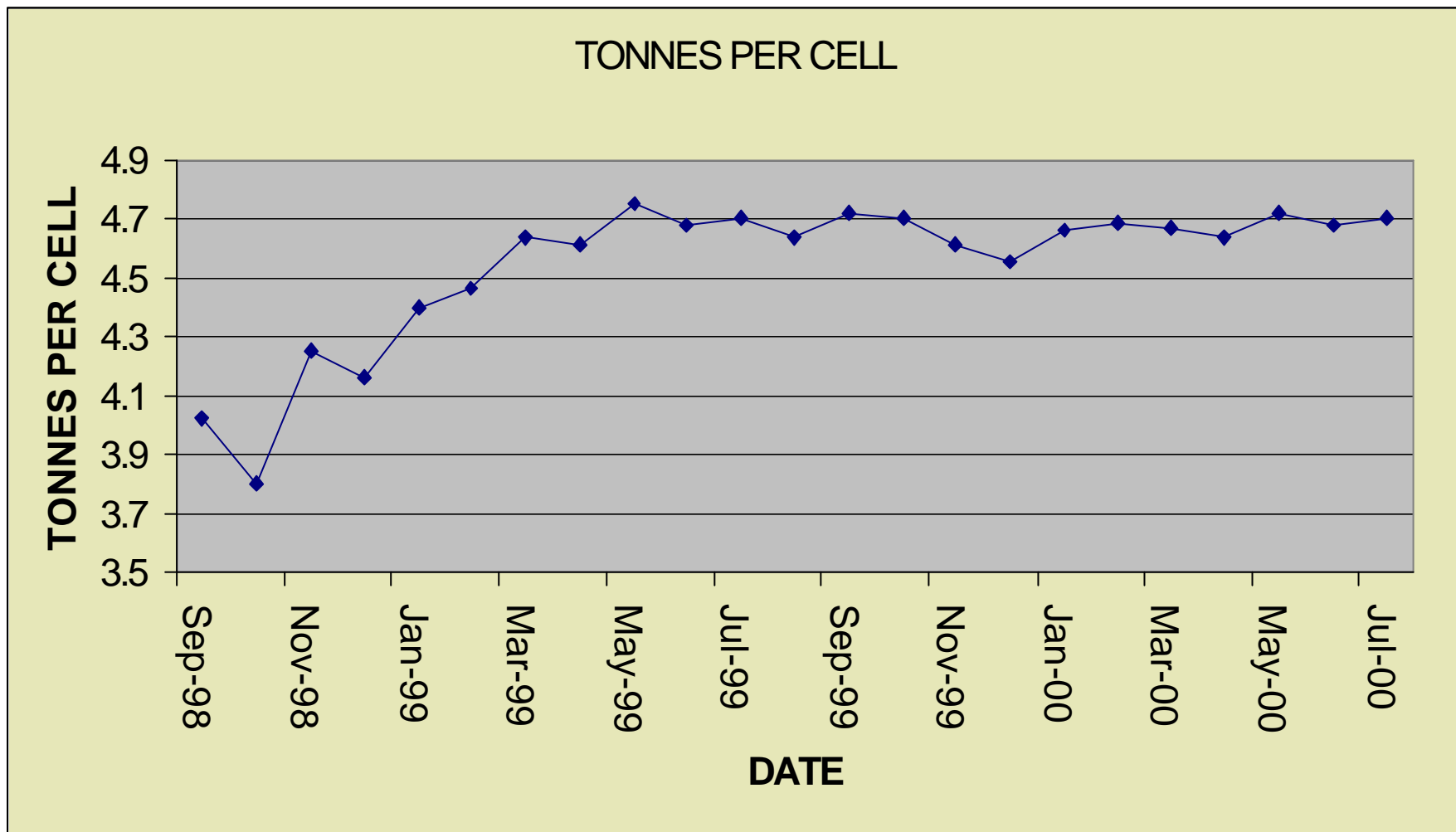
PLATES PER HOUR - PER MACHINE





TIME EFFICIENCY





7.0 REFERENCE

1. M Landan, H Traulsen, "The New Copper Tank House at Norddeutsche Affinerie", Copper 91/Cobre91 Volume III, Hydrometallurgy and Electrometallurgy of Copper, W C Cooper, D J Kempk, G E Lagos and K G Tan, Eds., Pergamon Press, Oxford, England, 1991, 517-526.
2. R Dobner, M Schwill, "Modernisation and Extension of a Conventional Tank House," Erzmetall, Vol 48, 1995.
3. J O'Kane, "ISA Process – Benchmarking Copper Refining Electrolysis," Paper presented at the GDMD 33rd Metallurgical Seminar, Lunen, Germany, November 19-21, 1997.
4. B.O'Rourke, "Copper Refineries Limited – Refinery Expansion," Paper presented at the 6th ISA Process Users Conference, Townsville, Qld Australia, June 20-22 1999.
5. W Armstrong, "ISA Process 2000", "Paper presented at the 6th ISA Process Users Conference, Townsville, Qld Australia, June 20-22 1999.
6. B.O'Rourke, "Tank House Expansion and Modernisation of Copper Refineries Limited," Paper presented at Copper-Cobre 99 Conference, Phoenix, United States, October 9-12 1999.