OPERATIONS CONTROL IN XSTRATA TECHNOLOGY TANK HOUSES

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ABSTRACT

This paper outlines opportunities provided for enhanced management and process control by Xstrata Technology (XT). XT has the core advantage of offering the potential for vastly improved electrode handling systems. This fundamental characteristic has enabled XT to develop management and process control systems that are modular, minimalist in their complexity and tailored to a tankhouses operating environment. A review will be presented on the current status of management and process control in XT tankhouses covering the central issue of electrode handling as well as electrolyte circulation systems, voltage monitoring, cathode plate tracking, and product tracking. Particular reference will be made of the recent development by XT and their technology partners, VRT Systems, of a Radio Frequency Identification (RFID) based solution for tracking permanent cathode plates. The system encompasses fixed readers identifying plates passing through the stripping machines, and the use of sophisticated tracking and database software enabling the development of cathode asset management and operational strategies. The performance of individual plates and batches of plates can be tracked through a full service history.

INTRODUCTION

Xstrata Technology (XT) has the core advantage of offering the potential for vastly improved electrode handling systems. This fundamental characteristic has enabled XT to develop management and process control systems that are modular, minimalist in their complexity and tailored to a tankhouses operating environment. This modularity enables control systems to be tailored to the tankhouses operating environment and customer requirements.

TANKHOUSE MANAGEMENT

XT tankhouses deliver high intensity refining, maximum time efficiency and maximum current efficiency via managing and integrating all aspects of the process. Xstrata Technology Tankhouse Management System (XT-TMS) covers:

- Assets
- Energy (i.e. efficiency, etc…)
- Safety & occupational hygiene
- Environment (i.e. green house gases, etc…)
- Costs

PROCESS CONTROL

Within the XT-TMS the central issues of process control require monitoring and control specifically include:

- Electrode handling
  - Cranes
  - Anode preparation
  - Anode scrap washing
  - Cathode stripping
  - Cathode preparation
  - Anode scrap remelting
- Product tracking
  - Bundling
  - Copper cathode
  - Batch labelling
  - Packaging
  - Slimes
- Electrolyte circulation systems
  - Laboratory analysis
  - Online analysers
  - Circulation systems
  - Slimes preparation
  - Reagent management
  - Cell voltage and condition monitoring
  - Auxiliary – boilers, power, steam etc…
- Asset management
  - Cathode plate tracking
  - Maintenance

The XT-TMS centralises control from a single point irrespective of the level of automation. It can provide basic control over general operations or enable sophisticated interlocking control over the entire system encompassing machines and processes. External information from laboratory testing and product sampling is also available to complete the control loop.

Another sophisticated feature is the maintenance of historical records enabling reporting and performance tracking over time, a key feature of the system.

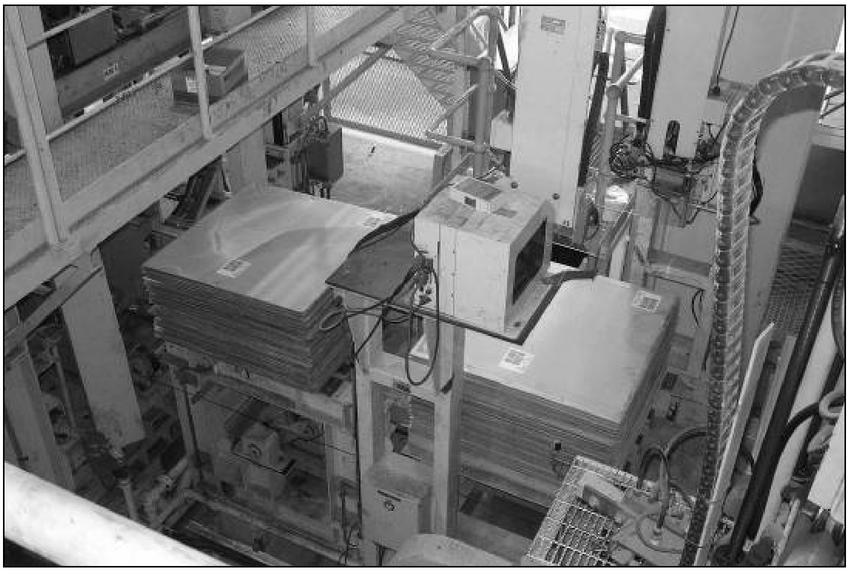


Figure 1 – Copper cathode labelling station

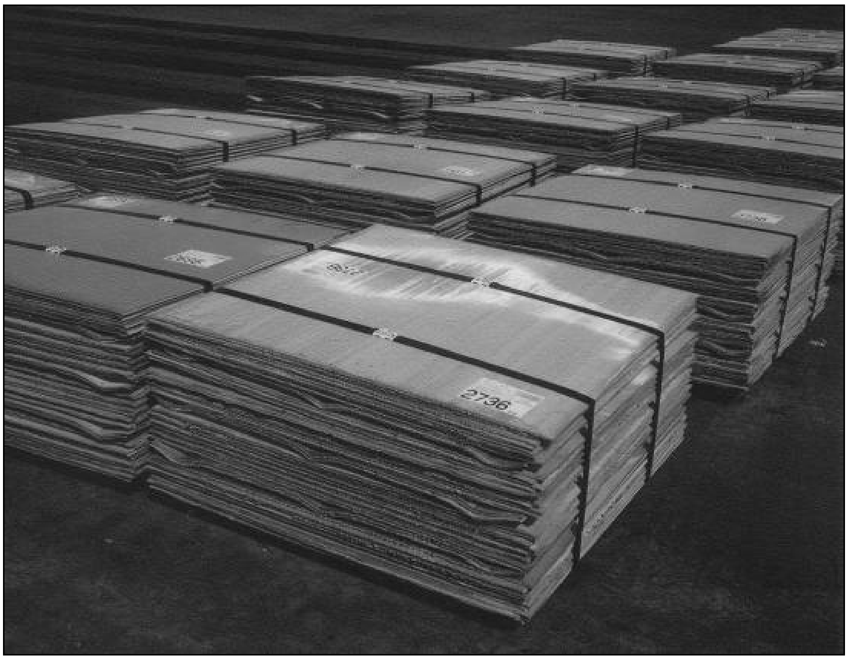


Figure 2 – Copper cathode bundle strapped and labelled

Distributed Control Systems

The Distributed Control System (DCS) monitors and maintains the operational parameters of the tankhouse. It is an automated system that will continue to operate the tankhouse effectively, without human input, while all aspects of the operations are functioning. The DCS is a computerised system that enables operational parameters to be maintained. Changes to the operation parameters, shutdown, start up and monitoring of the refining process can be done from Visual Display Units (VDUs) in the Tankhouse Control Room. Figure 3 shows an example of a graphic screen from a VDU. The DCS is made of three components:

(1) Process Control Unit (PCU),
(2) Distribution Control Unit (DCU), and
(3) Operator Stations (VDUs).

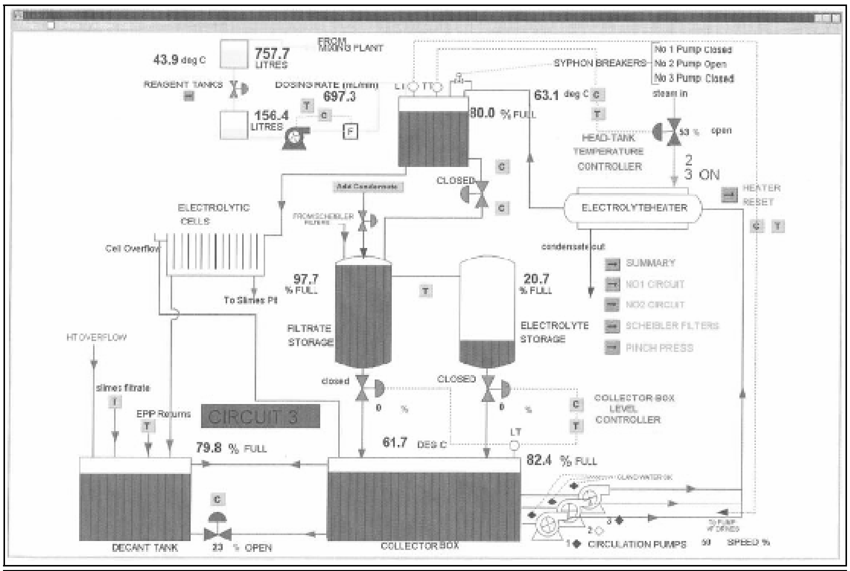


Figure 3 – Graphic screen from a Visual Display Unit

Tankhouse Machines

The major tankhouse machines comprise the Cathode Stripping Machine (CSM), see Figures 4 and 5, Anode Preparation Machine (APM), see Figure 6 and the Anode Scrap Machine (ASM), see Figure 7. Although these machines communicate and operate in line with other tankhouse units such as the overhead crane, their modular setup enables each machine to operate as a stand alone unit without affecting other operating units. Throughput capacities and automation levels for these machines can be designed to suit individual customers.

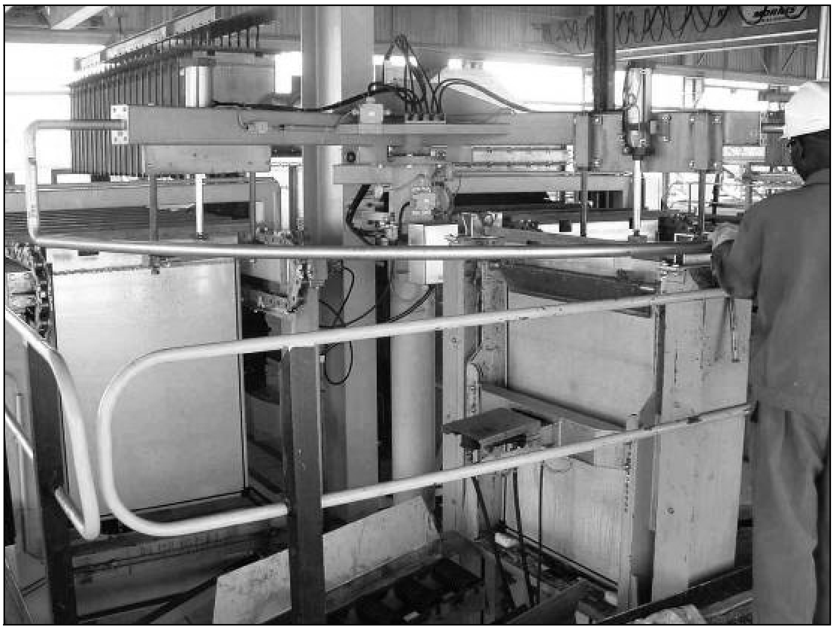


Figure 4 – Low automation Cathode Stripping Machine

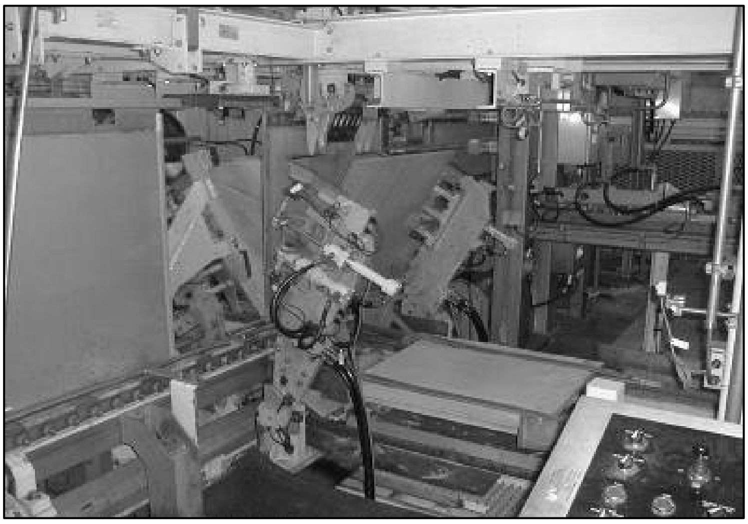


Figure 5 – High automation Cathode Stripping Machine

Figure 6 – Anode Preparation Machine

Figure 7 – Anode Scrap Machine

Tankhouse Overhead Crane

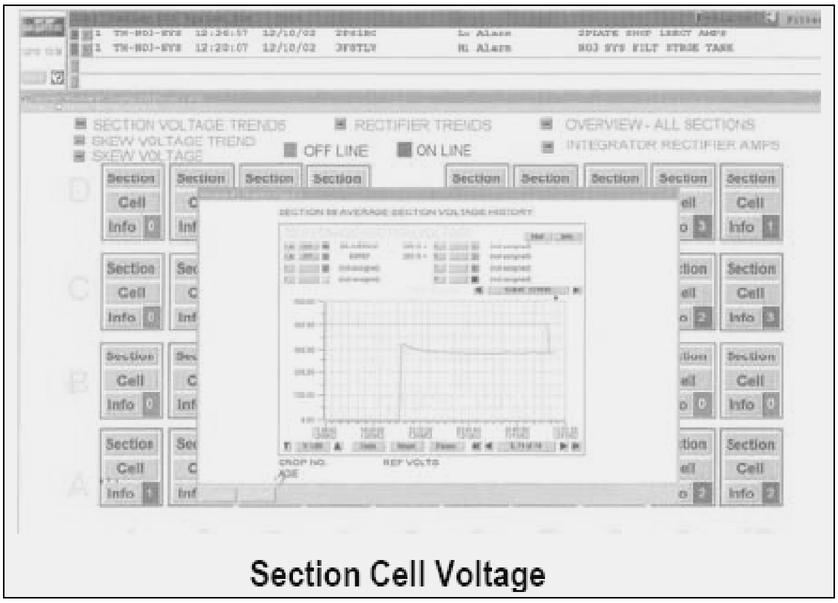
The cranes can be operated in either manual mode or automatic mode. In automatic mode, programs are stored in the crane's DCS and the crane will move automatically to either perform strip operations or strip and scrap operations for the programmed sections. The key function of the overhead crane provides reproducible results with respect to superior electrode handling and alignment. In manual mode, the operator overrides the automatic controls to operate the crane to fix problems encountered during an automatic operation. Manual mode is also used to perform other routine lifting operations in the Tankhouse.

Figure 8 – Tankhouse Overhead Crane

Voltage Monitoring

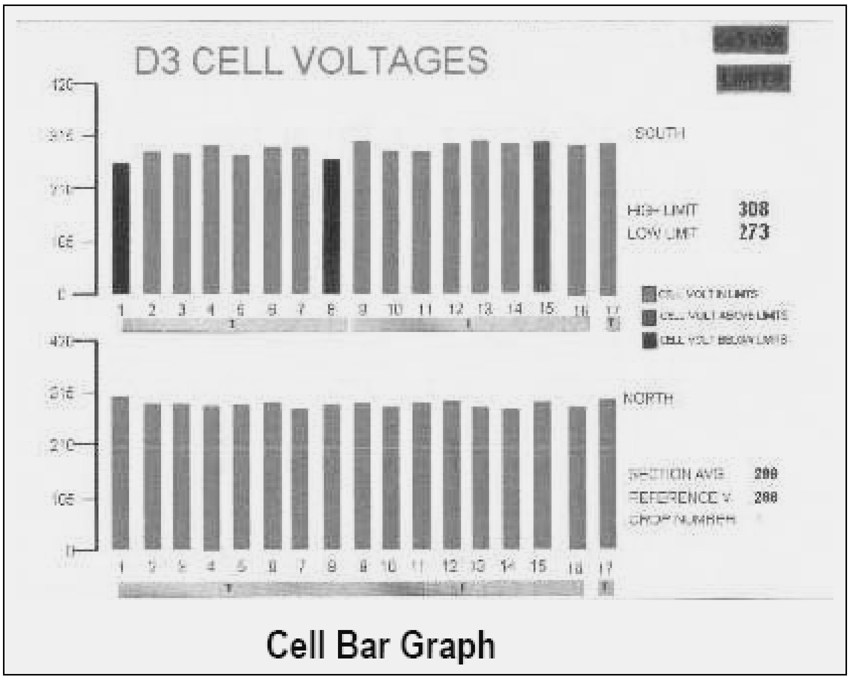
In order to achieve an efficient refining operation in a tankhouse, it is important to detect all abnormal cell voltages and take corrective action as soon as possible. There are several methods to detect short circuits; these include Gauss and Hall-Effect Meters, multimeters, thermal imaging and computer cell voltage monitoring. These methods can be used individually or in combination with each other. The type of short circuit detection method required is generally dependant on labour cost versus plant capacity, and losses due to current efficiency.

XT offers all the above mentioned methods for shorts detection. The Cell Voltage Monitoring System (CVMS) XT offers is used to measure, record and monitor the voltage across each cell. Each cell voltage is measured and compared against preset limits. If the voltage is out of limits an indication is given. Each CVMS is individually designed to match the specific requirements of the particular tankhouse application and is available as a complete package. Figures 9 and 10 are graphic displays from the XT-TMS extracted from a CVMS showing section and cell voltages.



Section Cell Voltage

Figure 9 – Graphical display of section cell voltage



Cell Bar Graph

Figure 10 – Bar Graph of section cell voltage

RADIO FREQUENCY IDENTIFICATION (RFID) SYSTEM

Introduction

XT and their technology partners, VRT Systems, have developed an RFID based solution for tracking permanent cathode plates. The system encompasses fixed readers identifying plates passing through the stripping machines and the use of sophisticated tracking and database software enabling the development of cathode asset management and improved operational control strategies, see Figure 11. The performance of individual plates and batches of plates can be tracked through a full service history.

Some of the opportunities that have been identified are:

- Tracking current efficiencies for individual and groups of cathode plates.
- Tracking weights of individual cathodes with significant implications for improvements in tankhouse operations.
- Tracking edge strip performance and failure rates.
- Tracking cathode quality by means of cathode to anode positioning (in EW operations where anodes are fixed).
- Distinguishing between old and new plates.
- Tracking cathode plate performance in segregated circuits.
- Tracking cathodes plates requiring the use of plate repair facilities.

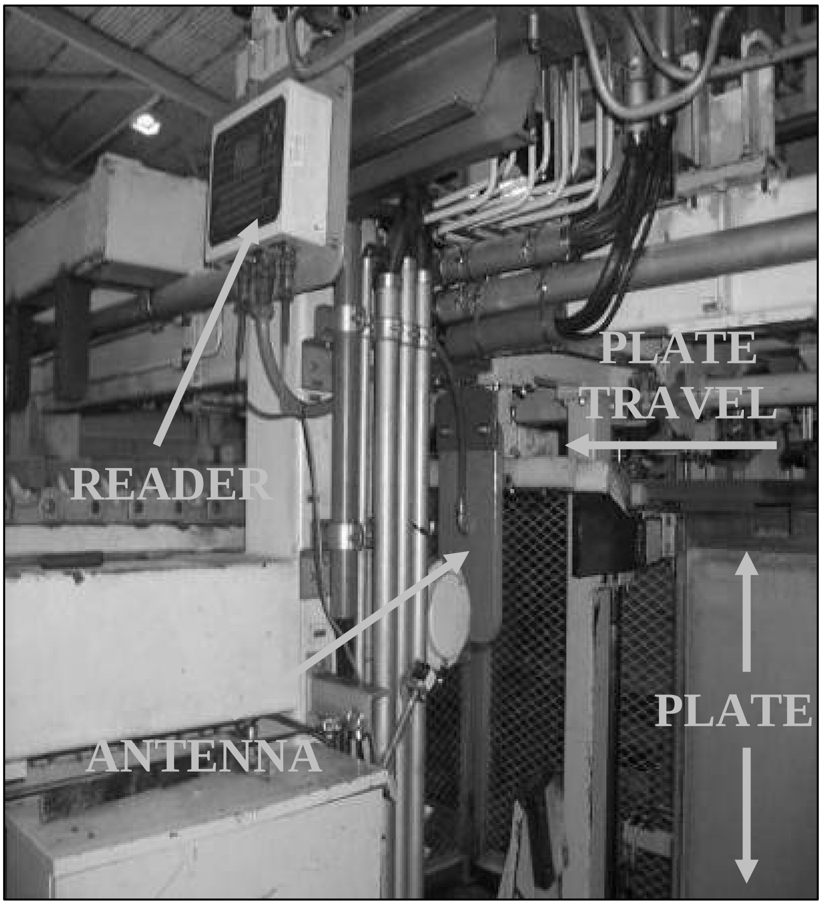


Figure 11 – RFID reader mounted to a Cathode Stripping Machine

Development Phases / Methodology

The extreme operating environment resulted in a focus to date on resolving the issues around reliability of hardware associated with readers, tags and tag housings.

Early development work has centred on configuration of the readers to ensure that all necessary data is captured. Positioning of the readers on the Cathode Stripping Machine (CSM) will be dependant on individual layout/setup of the machine. The aim is to achieve a closed loop system such that every individual cathode plate can be traced to a particular location.

Ideally there would be one reader on the inlet of the machine to read every plate that passes through the CSM, one reader to capture the plate once it has been stripped and transferred by the transfer conveyor and ready to go back into the tankhouse, one reader on the reject conveyor to capture all plates that are rejected for any particular reason, such as damaged edge strips or sticky copper.

New plates or repaired plates that are returning to the tankhouse need to be read before going into service. This can either be done by feeding the plates through the CSM (which is required if it is a bottom wax operation), or the plates can be read using another fixed or handheld reader and the information transferred onto the database.

Various tag designs with respect to tag housing material and tag profile have been trialled to determine the most suitable design. The tag housing most suitable will be one that fits the following criteria: ease of fitting to the cathode plate, material suitability to handle the corrosive and harsh tankhouse environment, and longevity of tag life.

Tag Position on Plate

Environments with high levels of metal pose specific challenges for RFID implementation and generally require special metal-capable RFID tags. Metal-capable RFID transponders usually rely on a surface field-effect to operate and have specific mounting position and orientation requirements to achieve sufficient read reliability. In contrast, the RFID solution developed by XT and VRT allows tags to be mounted in a hole punched in the plate, enabling a single tag to be scanned from either side of the plate. Additionally this reduces the overall tag profile and provides maximum flexibility in tag placement on the plate surface.

XT has identified several locations on the cathode plate to insert the tag. Location will be dependant on individual layout of the CSM. Tags can either be fitted to the centre of the plate just below the copper plating extended from the hanger bar (this is the ideal position, however, this may not suit all CSM layouts), see Figure 12. The position of the tag can be modified to suit both the CSM layout and cathode plate configuration of individual customers.

Since the plates operate in a closed system and no data needs to be stored on the actual tags, a read-only tag inlay has been selected. These have a guaranteed globally-unique 16 digit number which is assigned at time of manufacture. The tag inlays are mounted in a protective housing specifically designed for the conditions found in acidic electrolytic processes.

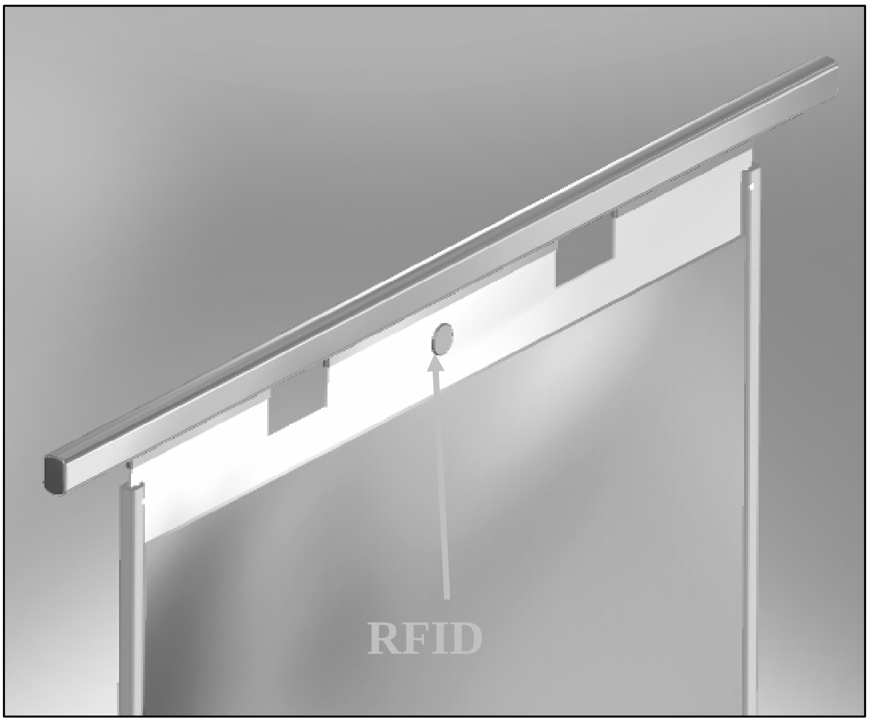


Figure 12 – Schematic of RFID tag positioned on stainless steel cathode plate

The System

The RFID readers and tags form part of a broader plate tracking and asset management system under development by XT. The system comprises RFID tags and readers, coupled with a controller running Plate Asset Management Software to provide a complete tracking and asset management solution. The system is intended to offer asset owners the means to analyse plate performance through life, identify and locate problematic or under-performing plates, determine the optimal end-of-life time for plate batches, and trace plates through offsite or contracted maintenance.

Tracking Functionality

The plate tracking system incorporates a number of key capabilities:

- Identity Preservation – Fundamental to whole-of-life tracking is the preservation of plate identity. The system separates the plate ID from its RFID tag so that tags can be replaced and the tracking system retains a consistent plate identity (serial number) for analysis purposes.
- State Tracking – The system can be configured to record plates in any number of states, (e.g. “in service”, “stripping”, “rejected – awaiting repair”, “quarantined”, “in repair”, “awaiting return to service” and so on). This enables analysis of duty cycles and overall asset utilisation.
- Location Tracking – The system tracks individually identified plates through any number of discrete logical locations. The locations are configurable to support various tank house capacities and layouts, and other on-site and off-site maintenance locations, including mobile locations such as vehicles. Locations are defined in a hierarchy and can be configured to the resolution required – for example: site/tank-house/section/cell, or site/area/workshop.

- Plate Grouping – As plants use plates of various ages (and sometimes of slightly different types as improvements to plate design are made), it is beneficial to compare plates with similar age or type. The system tracks plates by plate batch/group, so that queries and analysis can be performed by each batch of plates within a plant.

<u>Additional Data Capture</u>

RFID readers and tags provide essential data for tracking of plates through the system, but can only reveal limited statistics surrounding cycle times and failure rates. In order to provide further value, the plate tracking system is designed to allow additional qualitative data to be captured along with associated key process elements:

- Plate characteristics: manufacture date, batch number, material thickness, edge strip type etc.
- Cell conditions: profile of electricity consumption, electrolyte details etc.
- Plate transfer details (e.g. removal of plate from cell): weight of copper (when removed at stripping machine).
- Inspection and maintenance details: Reason for rejection, maintenance carried out etc.

The capture of this data is enabled by providing interfaces to external data capture systems:

- Facilities for interfacing to a range of PLC, DCS and instrumentation systems via optional embedded supervisory control and data acquisition (SCADA) software. This provides opportunities for interfacing to automated and semi-automated crane handling systems to provide cell-level plate tracking in the tank house.
- Screen based manual input (console and web browser based).
- Interfaces to wired and wireless field devices (PDA and mobile RFID scanners) for plate inspection and maintenance activities.

Equipment

The RFID readers are purpose-built industrially hardened, sealed units with onboard data logger, onboard keyboard and screen, and a serial interface to the tracking system. The units support a read range of 200mm, read speed of 70 milliseconds, and operating temperature range of -30 °C to 70 °C.

Additional handheld RFID scanners are being used for manual plate scanning, for survey and pilot system verification. These are battery-operated units designed for the tank-house environment and all-weather outdoor use (-30 °C to 70 °C). They can support RF wireless, cable or blue-tooth connectivity.

Xstrata Copper – Townsville Operations Configuration

The current development system is operating on two stripping machines; each fitted with fixed RFID readers on the CSM inlet and reject ports. The tracking software infers plates returned to the tank-house (those scanned on the inlet port, but not rejected).

The plate tracking software is currently running on an industrial PC server, connected to the fixed RFID scanners via serial line drivers.

Performance

The RFID readers are modified from existing industrial process application, so are already field-proven in harsh environments. The RFID tag inlays have proven reliable and read rates in the current configuration are high for an RFID application of this type.

The current RFID tag housing under trial is a single-piece "snap-in" polymer design that does not require adhesive or fasteners to affix to the plate. There have been some issues with material deformation causing a small number of tags to come away from the plate. This is due to in-process degradation of the polymer used to manufacture the prototype units, however, other materials with known resilience in a tank-house environment are now being tested. Further developments underway may see the configuration of the tag housing change.

The plate tracking and asset management software is still being refined, but has proven to be stable and reliable.

The read reliability of the system is exceptional with a readability of 99.95% to date. It is believed this a significant improvement on other systems currently available on the market with quoted accuracies of >95%, [1].

Development

The most price-sensitive component in the plate asset management system is the RFID tag, and is consequently an area of continuing development and refinement. Improved tag housing designs and materials are being tested, with the goal of minimising installed cost, while at the same time maximising tag longevity.

The plate asset management software is being refined and tailored to suit the requirements for plate asset management and process improvement in XT tankhouses. This will likely be an area of ongoing development as further opportunities for improvement are identified.

Further development work is being undertaken to improve the system packaging. The system may be available as a server based solution, but efforts are being considered to package the tracking engine software in a rugged appliance-based form factor:

- Suitable for rack or DIN-rail mounting in electrical control cabinets.
- Ethernet connectivity, removable non-volatile memory card for configuration storage, network backup and/or remote database.
- Zero- or minimal- configuration to set up – allow tracking engine to be swapped out by field staff for easy maintenance and repair.
- Web browser based user interface for configuration and operation.
- Facilities for Open Database Connectivity (ODBC) for ad-hoc analysis and reporting capabilities. Acknowledgments

CONCLUSIONS

Xstrata Technology has developed management and process control systems that are modular, minimalist in their complexity and tailored to a tankhouses operating environment. XT offers a complete tankhouse management system with respect to electrode handling as well as electrolyte circulation systems, voltage monitoring, cathode plate tracking, and product tracking.

Developments by Xstrata Technology and their technology partners, VRT Systems, of an RFID based solution for tracking permanent cathode plates have proven to be highly successful. The read reliability of the system is exceptional with a readability of 99.95% offering a significant improvement on other systems currently available on the market.

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