THE APPLICATION OF A PLANNED CUSTOMER-SUPPLIER ALLIANCE AT ALCOA'S KWINANA REFINERY: IMPLICATIONS FOR PRODUCTIVITY, PROFITABILITY AND OH&S

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Abstract

Alcoa's Kwinana Refinery, as part of its continuous improvement process, recently introduced new filter media guidance systems into their oxalate/hydrate buildings, where liquor is washed from aluminium hydrate on rotary vacuum belt filters prior to processing of the finished product.

A series of trials were conducted on site over a period of twelve months. Comparisons of baseline and subsequent measures reveal that significant improvements in the performance of the oxalate/hydrate filters were achieved. Belt change out times have, in some cases, more than halved, belt life has more than doubled and tracking of belts has improved significantly. Dryer and whiter cakes on the hydrate and dryer cakes of oxalate were also achieved as a result of improved vacuums. These and other improvements have been achieved progressively over a 12-month period through a planned customer/supplier alliance, initiated to address both process improvements and O.H&S issues.

The 'Trak' guidance concept, described here has also been extended to address the O.H&S issues associated with the caulking of filter media into pan (table), drum, and disc filters.

The current paper examines the implications of new filter media and guidance systems on plant efficiencies, cost structures and product quality for Alcoa and the Alumina Industry generally. Detailed information on the performance of filters is included, demonstrating the successful application of mutually beneficial customer-supplier alliances in this process.

1. Definitions

Monofilament: A single fibre yarn that has been extruded to a predetermined diameter e.g. Nylon fishing line.

Multifilament: Very fine monofilaments that are twisted together to form a single yarn. There are at times, several hundred fibres in a single yarn. This is also known as continuous fibre yarn because each fibre is the entire length of the yarn.

Various combinations of monofilament and multifilament yarns are employed to manipulate the filtration properties of a given cloth.

2. Introduction

Alcoa World Alumina Australia (Alcoa) operates three refineries in Western Australia between the capital city, Perth, and the port of Bunbury 200km to the south. The Kwinana Refinery, the fifth largest in the world, was commissioned in 1963 with a design capacity of 1 million tones per year. Since commissioning, the plant has increased its production to 1.7 million tones with 8.6% of this being chemical grade Alumina.

Kwinana, like most other refineries, employs the Bayer process to produce alumina from bauxite. The basic principle underlying this process is that alumina hydrates, when dissolved in a caustic soda solution at elevated temperatures, recrytallise at a lower temperature to produce alumina, or aluminium oxide.

The rotary vacuum drum filters in Kwinana's oxalate/hydrate building play a crucial role in the aforementioned process. The objective of these filters is to remove oxalate rich impurities that build up in the caustic solution during the leaching process. As organic impurities build up over a period of time, the effectiveness of the caustic solution is diminished resulting in increased operational costs and a possible reduction in plant yield. Moreover, because these filters are an essential part of a continuous process they can also constrain process flows, plant efficiency and production rates if poorly managed.

3. Background

A number of factors including premature cloth failure due to mechanical damage, loss of vacuums and poor filtrate clarities were found to be adversely affecting performance of the hydrate belt filters (HBFs) and oxalate belt filters (OBFs) at the Kwinana refinery, prior to 2001. High labour and OH&S costs associated with fitting and maintaining belts were also evident, which in conjunction with varying product quality created a bottleneck in the system.

In order to overcome these and other related problems such as bogged filters and damaged tracking arms and drum grids, Alcoa and Madison Filter embarked on a joint continuous improvement program with the following key objectives in mind:

1. Increase cloth life
2. Improve filtrate clarities
3. Improve vacuums
4. Design multipurpose cloth for use on both oxalate and hydrate filters
5. Reduce labour costs through a reduction operator involvement and;
6. Reduce costs associated with belt cleaning i.e. use less caustic and reduce time off line.

The improvement program involved a series of trials, designed to measure the effectiveness of cloth, equipment and work practice improvements. Each of these improvements and their effects on filtration performance is detailed in the sections below.

4. Improvements to Filter Media Guidance Systems

The first phase of the improvement program involved the development of an elastomeric rubber tracking system for use on rotary vacuum drum filters. The previous tracking system used a thick fabric pocket to attach the body of the belt to the edge track (refer to Figure 1).

Figure 1 — Traditional Fabric Edge Tracking Design

This design was problematic for several reasons. Firstly, the folded pocket at the edge of the belt was thicker than at other areas of the cloth, which reduced the surface area available for filtration. Secondly, the use of a fabric pocket caused a build up of solids to occur between the layers of cloth. This build up caused the seal at the edge of the drum to be broken resulting in a loss of vacuum. In order to reduce the amount of solids building up in this area, more frequent caustic washes were required. Thirdly, significant time and effort was required to fit the new cloths and to ensure that they tracked consistently throughout the life of the cloth.

In an effort to overcome these problems Madison Filter developed a new edge tracking system called NuTrak™. NuTrak™ features a single layer of fabric embedded into an elastomeric rubber edge track as illustrated in Figure 2. The body of the belt is then welded to the layer of embedded fabric, eliminating the need for the folded, sewn edge.

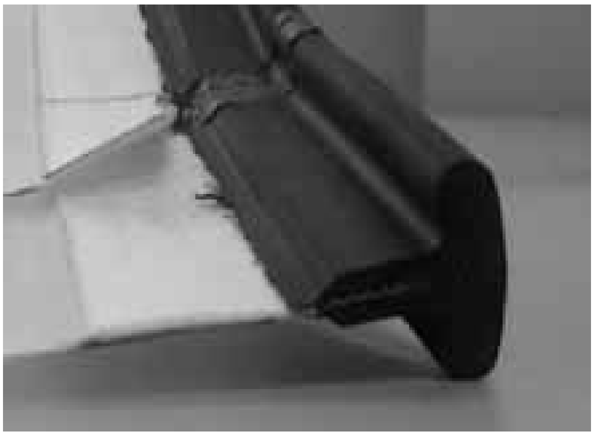

Figure 2 — Improved Edge Track Design

A series of trials were conducted to determine its effect on vacuum levels. The original trial of the NuTrak™ butt (welded together on site) did not prove successful due to the conditions on site and the type of welding technique used. It was at this point that Madison Filter and Alcoa looked at other alternatives and subsequently developed the idea of the knuckle joint (illustrated in Figure 2). The knuckle joint proved a successful means of joining the two ends of the edge track and was later modified to give additional radial movement thereby improving performance on small rollers.

The installation of NuTrak™ resulted in an immediate increase in vacuums on the HBFs, from –40kpa to –60kpa as a result of improved sealing around the edges of the drum, with targeted bath levels.

5. Modifications to Cake Discharge Methods

The de-mooning bar was also identified as a factor that adversely affected the performance of the drum filters. The de-mooning bar is a solid bar, which pivots on mounting blocks on the sides of the filter and is used to break the cake as it comes to the discharge section of the filter. This was constantly getting fouled with scale causing cloth damage. Also, because it is a static bar, it had a tendency to rub the cloth, causing premature wear.

The de-mooning bar was replaced with a 100mm-diameter roller, mounted on plumber block bearings as illustrated in Figure 3. In contrast to the original practice, the roller system now allows the belt to roll over it, thus reducing abrasion.

This modification has played a major role in the success of this project, reducing maintenance, OH&S problems and premature belt wear.

6. Improvements in Filter Media and Belt Design

Attention then moved to the development of a new generation, mono/mono cloth to replace the existing mono/multi cloth, which was found to yield sub-optimal filtrate clarities and promote scale growth. The objective was to develop a single cloth that improved cloth life, cake release and filtrate clarities on both the oxalate and hydrate filters. The HBF cloth trials started approximately September 2000 (two filters) and the OBF cloth trials started June 2001 (seven filters).

After a series of bench tests it was decided to trial the mono/mono material and at the same time introduce an under-flap in addition to the existing top flap to protect the underside of the clipper seam.

The belt was installed on the Hydrate circuit, which saw the following improvements: a) easier and less time consuming installation, b) improved filtrate clarities and c) better tracking.

After 10-12 weeks it was found that the new cloth had performed exceptionally well however, the flap issues still needed to be addressed. It was then decided to remove the top flap altogether and retain only the bottom flap.

This modification further improved the performance of the cloth and increased belt life to over 5 months. Moreover, the introduction of the mono/mono material on the Hydrate circuit led to the same type of belt being trailed on the Oxalate filters. Once again, after a period of 10–12 weeks, the belt continued to perform well above expectation in all aspects.

Figures four and five illustrate improvements in filtrate solids on the HBFs, and vacuum composites on the OBFs, respectively.

Cloth life was further improved by redesigning the clipper seam itself. The seam was made of multi-filament cloth and a piece of felt, folded into a ‘sandwich’ and sewn to the main body of the belt. The idea behind this design was to give the clipper teeth something to bite into. However, because the belt material was monofilament and the seam multi-filament, the multi-filament fabric started to shrink and also retained fine product causing the seam to concertina and go hard. The operators attempted to rectify

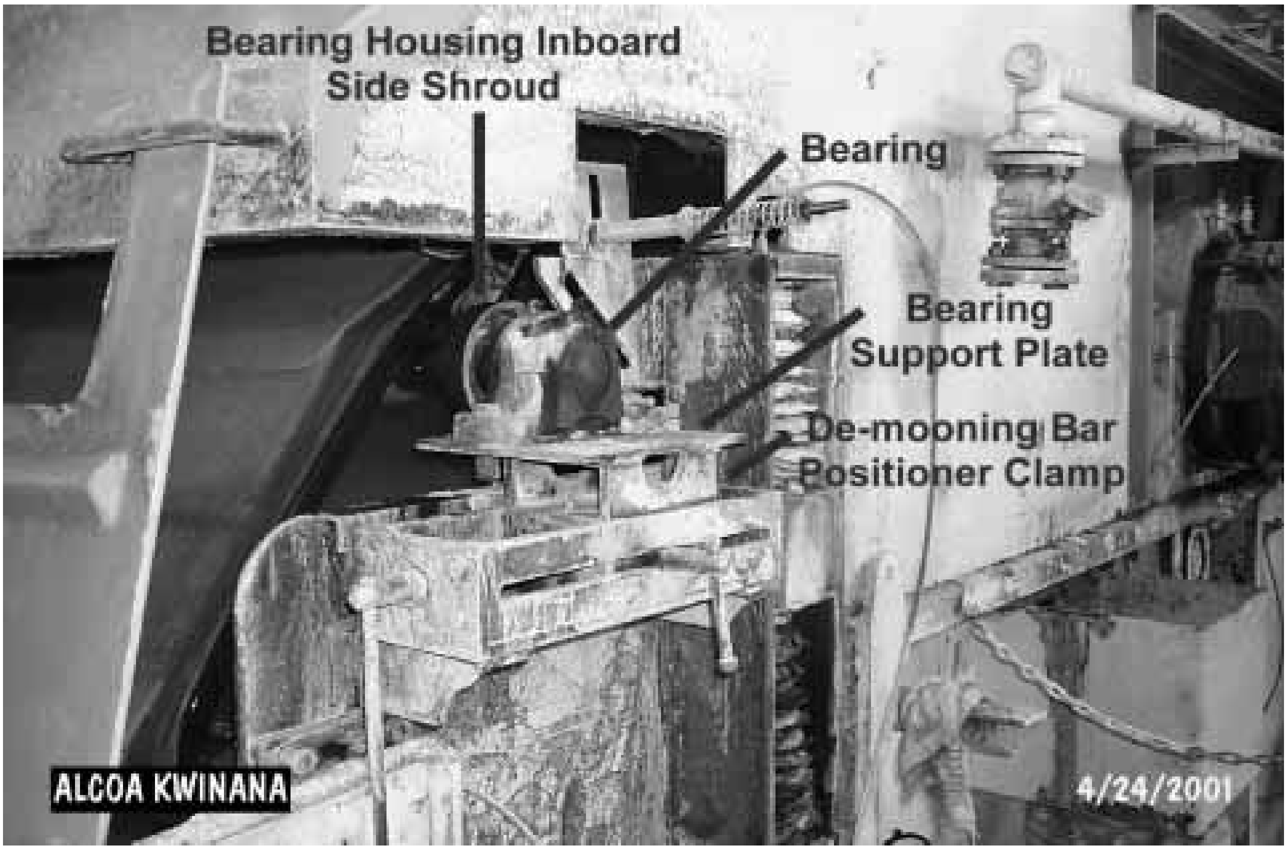

Figure 3 — New Discharge Roller System

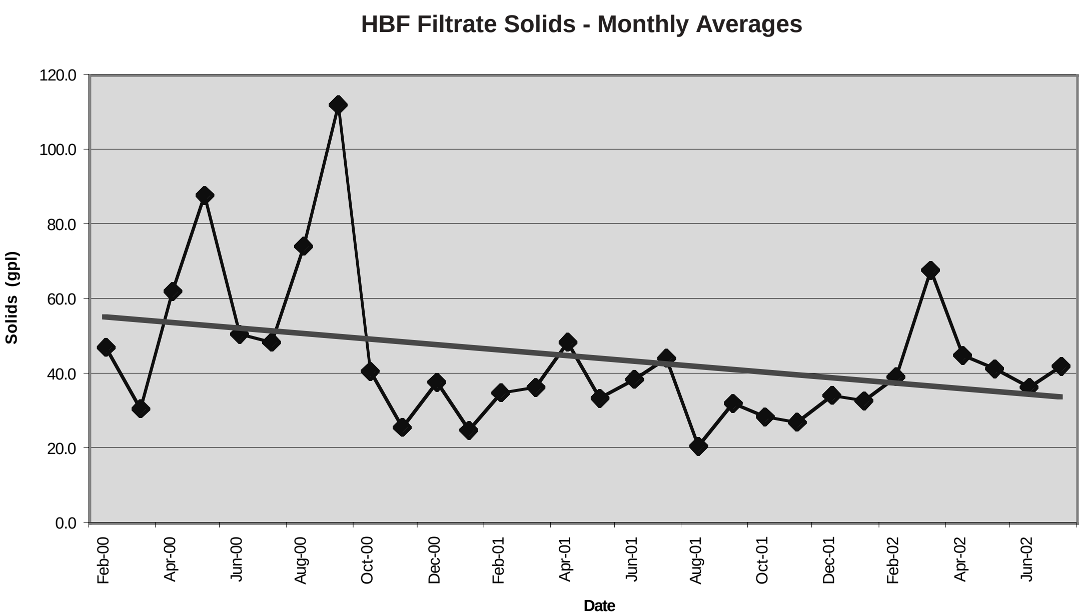

Figure 4 — Improvements in Filtrate Solids for HBFs

this by initiating more frequent caustic washing however, after a period of time belt failure was experienced.

The seam area was re-designed to incorporate a simple method of folding over three layers of the belt fabric at each end, sewing this into place and then attaching the clipper teeth. This saw an immediate improvement. A smaller clipper tooth was also employed, which allowed the cake to form over the seam eliminating what is commonly referred to as a wet patch around the seam area.

Because mono/mono cloths are more dimensionally stable and less prone to stretching than multi/multi cloths, the need for operators to relax and re-tension the rollers before and after wash cycles has also been eliminated.

The other major savings were a 65% reduction in the time taken to fit the lightweight belts to the filter, reduced operator involvement as a result of improved belt tracking, an increase in cake thickness, and a reduction in cake moisture levels.

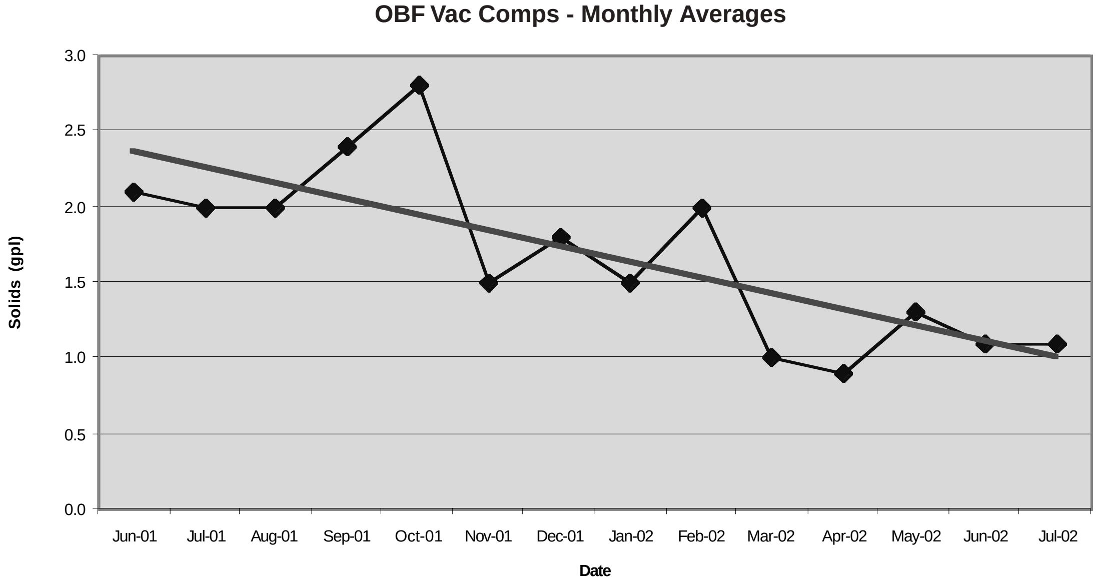

Figure 5 — Improvements in Vacuum Composites for OBFs

Finally, a combination of the aforementioned improvements saw the number of caustic washes decrease from every 25-30 hrs based on the operator judgment to a controlled standard wash time of every 50 hrs. In some cases this was extended to 72 hrs for the Hydrate Belt Filters, and 48 hrs, peak at 72 hrs providing there are no process upsets with the OBFs. This has reduced washing times by 66%, further reduced the level of caustic required for washing and greatly increased time online.

NuTrak™ belts have now been fitted to all vacuum drums at the Kwinana and Pinjarra refineries and are currently being trialed at the Wagerup refinery.

7. Summary of Key Improvements

1. The new elastomeric guidance system (Nu-Trak™) was developed by discussion with Boss Rubber and Madison Filter Pty Ltd and then presented to Alcoa for approval and trial at Kwinana Refinery. The new design improved the vacuum levels of the rotary drum filters, which in turn contributed to improved filtrate clarities.
2. Replacing the de-mooning bar with the new roller method reduced maintenance, OH&S problems and premature belt wear.
3. Replacing the mono/multi cloth with a lighter mono/mono cloth, suitable for use on both the HBFs and OBFs resulted in increased cloth life, improved filtrate clarities, easier and less time consuming belt installation, lower cake moistures and an increase in cake thickness.
4. The improved clipper seam has seen improvement in belt life, better caking and no wet areas at the seam.
5. A combination of improvements saw a decrease in the number of caustic washes required, thereby increasing time on line and reducing costs associated with the use of caustic.

8. Conclusions

1. Without a doubt the major contributing factor to the improvements seen in the hydrate/oxalate buildings was the customer/supplier relationship that evolved during this time. If this had not developed it is doubtful as to whether any of the improvements would have been achieved.

   The willingness of both teams to develop new ideas and strategies and then implement them was the key to the success of this project. It was very noticeable that ownership of the project was quickly established from the shop floor to the management teams, each having input into how the whole system was developed.
2. It was important to measure and monitor the effects of the changes being made to establish cause and effect as well as the magnitude of the change observed. Only by implementing adequate controls can one determine which change is associated with the manipulation of each variable.
3. Poor practices inevitably develop over a period of time. The willingness of all parties to continually question the status quo and search for new ways of approaching a problem was also key to the success of the project. One must also employ appropriate skills and resources to resolve the problems identified.
4. An integrated and total solutions approach to filtration tends to yield better results than a fragmented approach in which individual components of the system are examined in isolation. It is therefore important to take interrelationships between equipment, filter media and work practices into consideration.
5. Develop the customer/supplier relationship for these types of projects and your chances of success are virtually guaranteed.

Acknowledgements

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