Improved Current Efficiency and Anode Life using Edge Stiffening Anode Fittings

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One of the major problems in the electrowinning industry is the short circuits occurring between the anode and the cathodes. While a large number of factors contribute to this, – not least of which being poor housekeeping and irregular cell cleanouts – uneven spacing between the anodes and cathodes plays a significant role in this.

While spacing at the top of the cell is usually well maintained by the capping boards, the situation at the bottom of the cell is quite a different issue. Warped anodes or cathodes will reduce the spacing in some areas, resulting in accelerated nodule growth and eventually short circuits.

A large variety of spacers are available on the market, but the common problem with most of these is that they are easily damaged or displaced during re-inserting of the cathode into the cell after stripping.

Idemin anode spacers address these problems by providing multiple fixing points, making the spacer very difficult to dislodge. The shape of the spacer is designed to guide the cathode into the ideal position between the anodes without damaging the spacer. The spacers stiffen the bottom third of the anode, reducing warping and are effective at extending the usable life of anodes by up to 20%. An additional vertical insulator is fitted to the middle of the anode to further protect the centre section of the electrodes from short circuits.

Manufactured of durable polypropylene, Idemin anode spacers are designed to last for the duration of the anode lifespan.

The spacers are in use in major EW plant in Chile, Spain and the DRC. They have proven to be reliable, durable and effective at improving current efficiencies.

INTRODUCTION

Any electrowinning operation has to maximize its current efficiency. Short circuits and nodulation of the cathodic deposit are major culprits causing decreases in current efficiency. These two problems are caused by a number of factors, such as the condition of the anodes, uneven and/or high current density, irregular cell cleanouts, impurities and the spacing between the cathodes and the anodes. Of these factors the physical ones are the easiest to address.

Housekeeping and cell cleanouts are purely operational issues. The spacing between the electrodes is, however, an aspect which can be addressed by choosing suitable anode spacers or insulators.

There is a large variety of such spacers being marketed into the electrowinning industry. Some of most commonly used are anode buttons or stars and winglet spacers shown Figure 1.

Figure 1: Typical anode spacers in common use in EW plants

These spacers are cheap and easy to install. The problem with this type of spacer is that it is easily dislodged and damaged when cathodes are loaded after stripping. It is common to see pictures such as those in Figure 2 in most EW plants using such spacers.

Figure 2: Dislodged and damaged anode spacers.

While the commonly use stars or button are not dislodged as easily, they do tend to get sliced when cathodes are reinserted after stripping. The result is that spacers have to be replaced regularly. In plants with poor housekeeping this tends to be neglected and so the electrode spacing will not be well maintained.

Idemin anode fitting eliminate this problem and provide a reliable, durable solution to the problem of maintaining anode spacing, lasting for the lifespan of the anode.

IDEMIN ANODE FITTINGS

Idemin is a Chilean Company based in Antofagasta, which specializes in producing innovative plastic products for the mining industry. Over the past 6 years, Idemin has been developing, producing and marketing a range of anode fittings which strive to eliminate the problems experienced with conventional spacers. Idemin works closely with its clients to continuously improve the design of their product. The result is that Idemin has developed a system of anode fittings which not only maintain electrode spacing, but also extend the usable lifespan of anodes by stiffening the edge of the anode and thereby reducing warping of older anodes.

Development
The initial spacers designed by Idemin where aimed at ensuring that the spacing at the bottom of the anode was fixed. The resultant spacer was affixed to the bottom corner of the anode (Version "A" in Figure 3 below).

This design was very successful. In November 2010 Xstrata's Lomas Bayas gave a seminar on improvements realised in their EW plant (Sepúlveda, N.M., 2010), and stated that changing their anode spacers from the common winglet spacer (as shown in Figures 1 & 2) to the version "A" fittings resulted in a 2 % increase in current efficiency and an expected benefit of US$ 756 000 additional revenue per annum.

Idemin did, however, get feedback from some clients who found that the "feet" went out of alignment if the anodes were warped or the capping board were not well aligned.

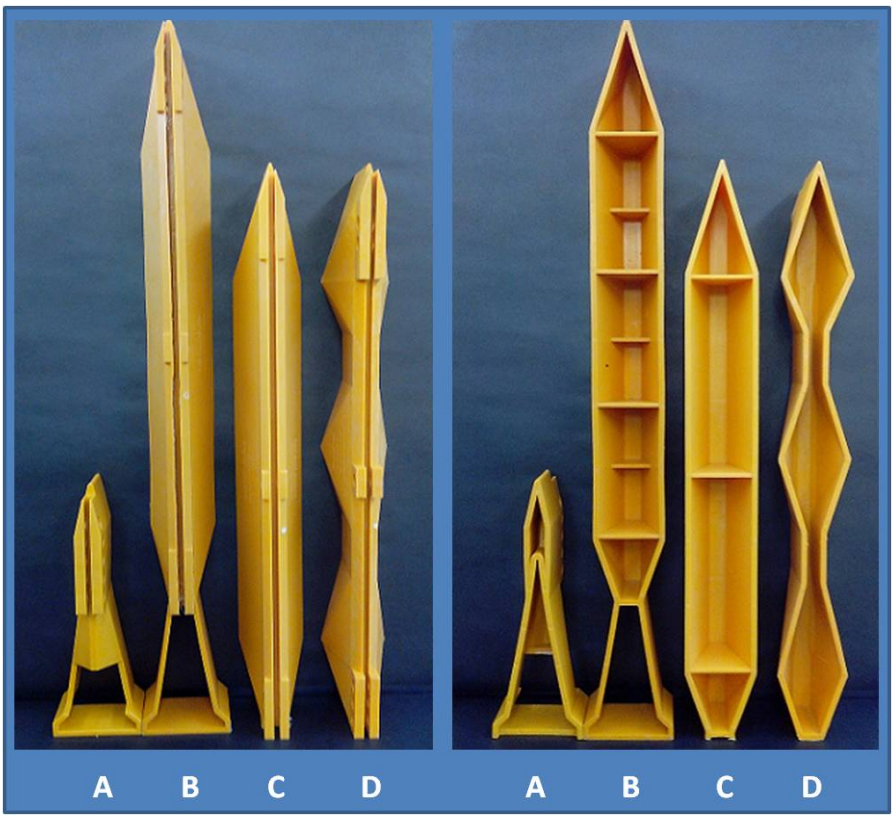

Figure 3: The progressive development of Idemin anode fitting.

The focus thus shifted to stiffening the anode to reduce warping, and to provide an extended spacer which would keep the cathode centered. This design ("B" in Figure 3) was a significant improvement, as the long stiffening section meant that older anodes, which already showed warping, could be salvaged and have their useful lifespan extended by installing the fittings. It soon became apparent, however, that with the introduction of the long stiffener part of the fitting, the lower "foot" section had become redundant. This led to design "C".

This version reduced manufacturing costs as it required less polypropylene. The removal of the "foot" had the added advantage that installation of the fitting no longer required precise, vertical positioning along the side edges of the anode. A few centimetres higher or lower made no difference to the effectiveness of the stiffener. This development work has resulted in the design shown in Figure 4.

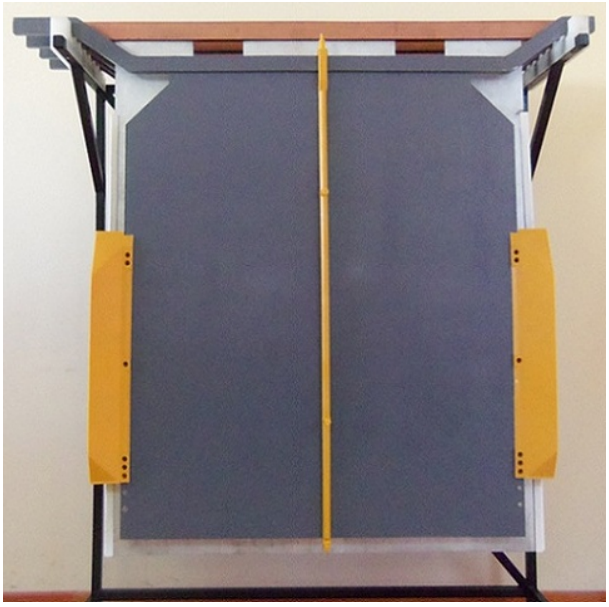

Figure 4: Idemin anode stiffeners and central insulator

The central insulator shown in Figure 4 is used to prevent short circuits in cases where older cathodes or anodes bulge in the central section of the plate.

Version "C" has been readily accepted by Idemin's clients and has been found to further improve the current efficiency.

Freeport McMoran have been using Idemin fittings at Tenke Fungurume in the DRC since 2011. Initially starting with the version "A" of the fittings, Tenke conducted extensive trials with design "C" during 2014. The fitting were installed in a number of test cells and the current efficiency over these cells and quality of the copper produced were monitored. Tenke found that they were able to achieve additional improvements in current efficiency.

Ongoing discussions with operating staff at various clients have led to a further design revision ("D" in Figure 3). The feedback from Anglo's Mantoverde operation was that mist suppression spheres were getting trapped on the ledges of the Version "C" design. This problem has been eliminated in Version "D", and the design is also less restrictive of electrolyte circulation within the cell. This eliminates shadow effect along the vertical cathode edges which were noted in some cases where cathode to cathode spacing was 95 mm rather tan 100 mm.

Advantages
Both designs "C" and "D" have the following advantages:

- The long edge stiffeners are attached with up to 6 lugs each, making the installation very stable and difficult to dislodge.
- The edge stiffeners are very effective at stiffening the lower part of the anode. This reduces warping, particularly in the case of older anodes.
- The central insulator prevents short circuiting resulting from the central bulging of older anodes or cathodes.
- The sloping top of the stiffeners guides the cathodes into a centralised position between the anodes.
- The wedge-like shape of the edge stiffeners ensures that the cathode is kept in that position.
- The fittings are designed to minimise any shadow effect on the cathode.
- The fittings are manufactured from polypropylene and will typically outlast the lifespan of the anode.

- Fittings are available to suit 6 mm and 8 mm anodes
- Cathodes spacings of 95 to 100 mm can be accommodated. For other spacings Idemin is able to modify their design to suit.
- By reliably maintaining even cathode spacing, the anode fittings promote a homogeneous current density distribution throughout the EW cell.

The fittings are easy to install and are usually added to the anodes during routine cell cleanout, as shown in Figure 5. They can be retrofitted to old anodes and even be used to keep warped anode straight and extend their lifespan.

Figure 5: Installation of Idemin anode fittings at Lomas Bayas, Chile

Benefits

Over the past 6 years Idemin has established a solid client base, as shown in Table I.

Table I. Idemin client base

EW Plant	Company	Location	Since
El Abra	FreePort – McMoran	Chile	2010
Quebrada Blanca	Teck	Chile	2010
Lomas Bayas	Glencore/Xstrata	Chile	2010
Zaldivar	Barrick	Chile	2010
El Tesoro	Antofagasta Minerals S.A.	Chile	2011
Pu Cobre	Sociedad Ounta del Cobre	Chile	2011
Mantos Verde	Anglo American	Chile	2011
Los Bronces	Anglo American	Chile	2011
Enami	Empresa National de Minería	Chile	2012
Minera Caserones	Lumina Copper	Chile	2014
Tenke Fungurume	FreePort – McMoran	DRC	2011
Cobre Las Cruces	FQML	Spain	2013

Based on the feedback from these clients, the installation of Idemin anode fittings has consistently had the following benefits:

- Current efficiency improved by a minimum of 1 to 2%

- Production of copper harvested increased by 2 to 4%
- Rejection rate of copper cathode due to nodulation reduced by between 1 & 2%
- Anode life is extended by over 20% (where in use long enough to monitor)

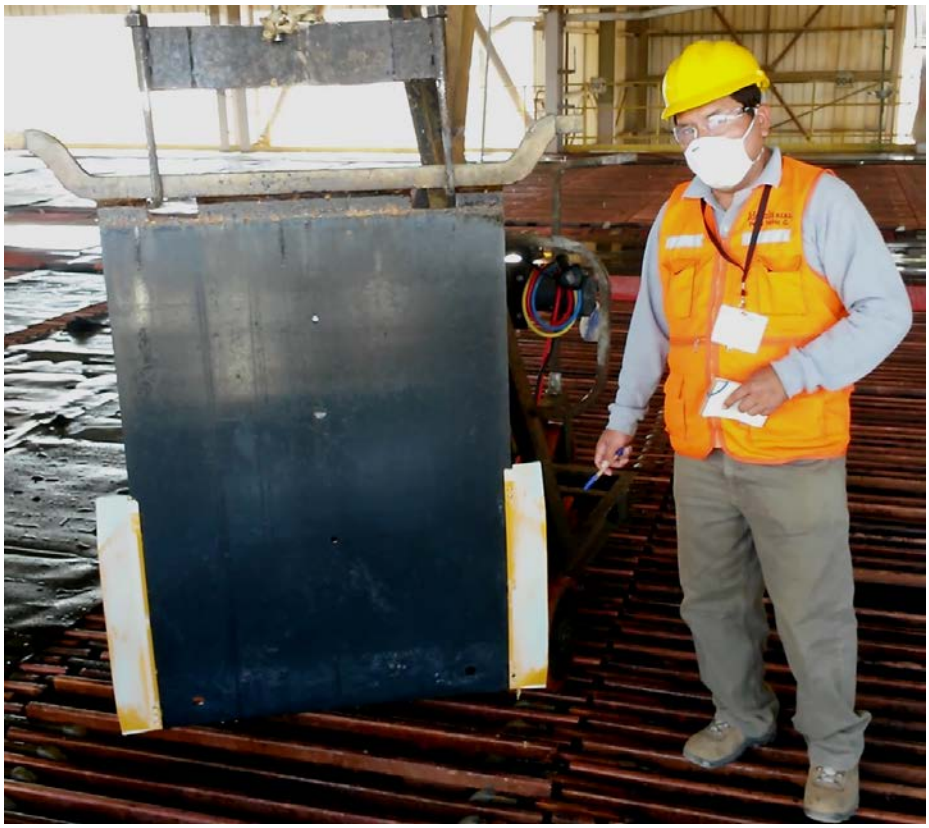

Figure 6: Co-author Percy Yañez at Tenke Fungurume with an anode equipped with anode stiffeners

During the last 6 month Idemin has supplied samples for evaluation trials at FQML's Kansanshi, Glencore's Mutanda and MMG"s Kinsevere EW plants.

Figure 7: Illustration of an EW cell with Idemin anode fitting

COST BENEFIT ANALYSIS

All of the benefits reported by Idemin's clients would have a significant financial impact on any EW plant. For simplicity sake the cost benefit can be evaluated on the basis of improved current efficiency translating directly into extra copper tonnage. As this does not take into consideration the other benefits, it does approximate a worst case scenario. Table II illustrates the projected payback period for three different Copper EW plants with varying production rates, cell quantities and numbers of anodes per cell.

Table II. Cost/Benefit for Idemin anode fittings

Annual copper production (t/a)	% increase in current efficiency	Copper price (USD/t)	Extra copper revenue generated (USD/month)	No. of cells	No. of anodes/cell	Cost of installing anode fittings (USD)	Payback period (month)
220 000	1	6000	1 100 000	480	70	1 680 000	1.5
220 000	2	6000	2 200 000	480	70	1 680 000	0.8
200 000	1	6000	1 003 750	748	49	1 832 600	1.8
200 000	2	6000	2 007 500	748	49	1 832 600	0.9
60 000	1	6000	300 000	156	70	546 000	1.8
60 000	2	6000	600 000	156	70	546 000	0.9

As can be seen, while the initial expenditure for the anode fitting may seem high, a payback period of under two months is the norm. Typically the cost would be spread out as the fittings would be installed gradually, concurrent with cell clean-outs.

CONCLUSION

The Idemin system of anode stiffeners provides a reliable means to maintain electrode spacing while at the same time extending anode lifespan. The system has been proven to improve current efficiency, copper production and reduce nodulation. As the stiffeners are very difficult to dislodge, the system is a "once-in-the-anode-lifespan" investment with an extremely fast payback.

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