RECENT DEVELOPMENTS AT ZINCOR

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ABSTRACT

The dramatic strengthening of the rand against the dollar as well as a decline in quantity and quality of locally available concentrates have had a dramatic impact on Zincor's operations during the previous two years. Zincor has responded with the implementation of a number of technical improvements to the process to decrease cost and increase revenue and plant flexibility. Among the initiatives is the pre-leaching and pelletising of the zinc concentrate, de-bottlenecking and process improvements in the leach and purification circuits, the introduction of cathode washing and automated cathode stacking in the cell house and the installation of a new furnace to produce pre-alloyed jumbos. This paper will describe these initiatives and others that Zincor have recently taken to stay competitive in changing global base metals market.

1. OVERVIEW OF ZINCOR

Zincor operates an integrated roast-leach-electrowinning zinc production circuit near Springs in the Republic of South Africa (Van Niekerk & Begley, 1991). Zinc sulphide concentrate is roasted in four Lurgi fluo-solids roasters to produce zinc oxide and sulphur dioxide gas. The SO_2 gas is fed through two Monsanto double absorption acid plants to produce sulphuric acid.

The zinc oxide (or calcine) undergoes a three stage leach with spent electrolyte from the electrowinning section. The zinc sulphate is then purified in a two- or three stage purification process, depending on impurity levels. The main impurities that are precipitated are copper, cobalt, cadmium and lesser amounts of nickel, germanium and arsenic. The purified zinc sulphate solution is subjected to electrowinning during which the zinc is plated onto aluminium cathodes. The anodes are constructed from a lead alloy. Cathode zinc is manually stripped every 24 hours where after it is melted and cast into either 25 kg slabs, 1 ton or 2 ton jumbos. Various zinc grades are produced ranging from SHG (99.990% Zn) to Zn4 (containing 1.35% Pb as an alloying element) depending on customer requirements.

2. CURRENT SITUATION

Profitability at Zincor has come under increased pressure in recent times due to lower production volumes (Figure 1) and increased cost. The cost increases are mainly related to a weak LME zinc price along with a dramatic strengthening of the rand (Figure 2) in 2003. The main cause of the lower production volumes has been a decrease in concentrate quality. Figure 3 shows the decline in zinc grade and Figure 4 shows the increase in impurities. This is partially due to the closure of two local mines, Pering and Maranda that have traditionally supplied high quality concentrates. The remaining local mines, Black Mountain and Rosh Pinah have also produced concentrates that were higher in impurities.

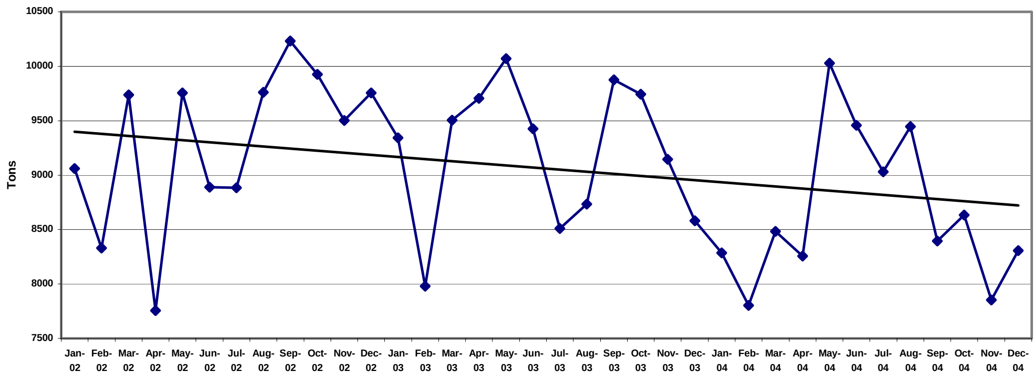

Figure 1. Zinc slab production at Zincor since January 2002.

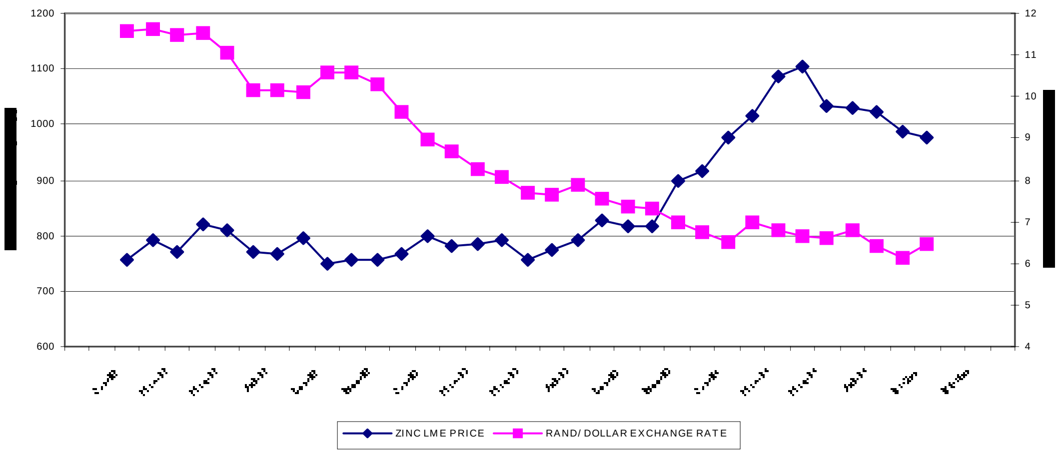

Figure 2. The LME zinc price and rand/dollar exchange rate trend since January 2002.

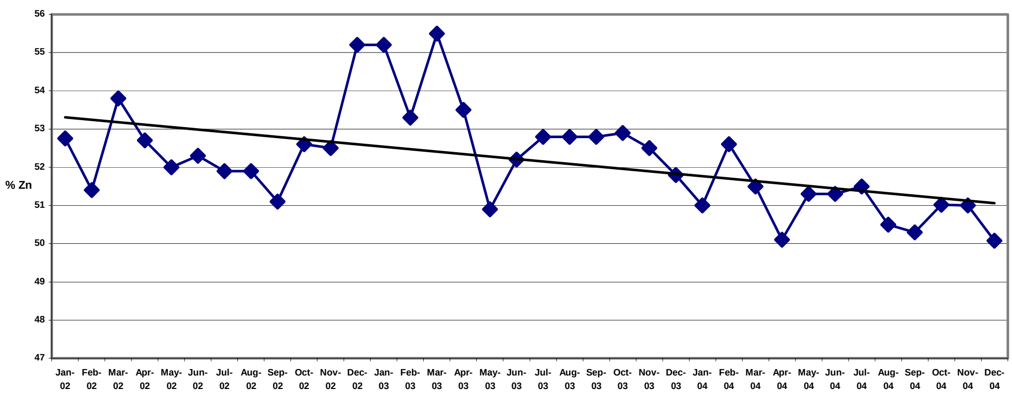

Figure 3. The grade of zinc concentrate treated by Zincor since January 2002.

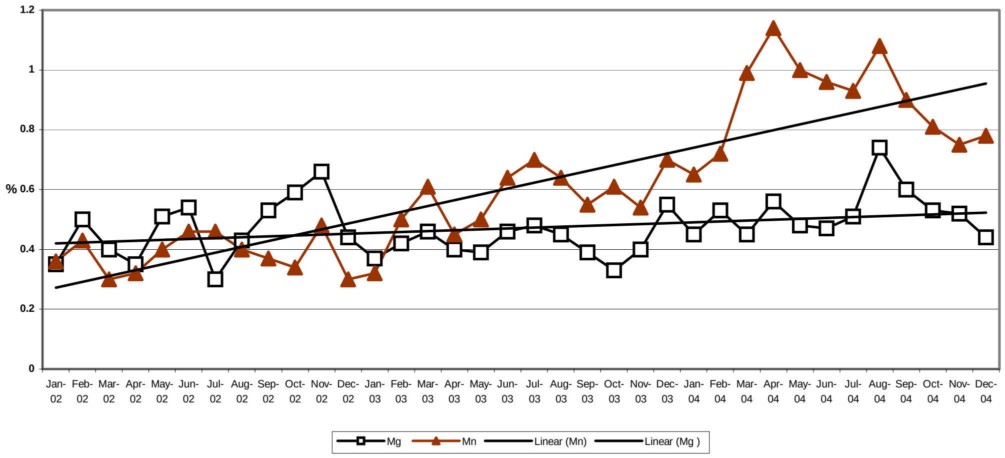

Figure 4. The levels of manganese and magnesium the in concentrate treated by Zincor since January 2002.

The decline in concentrate quality did not only impact on throughput, but also reduced zinc recovery (Figure 5). This is occurred despite an expenditure of R 40 million in 2002 to improve the residue treatment section of the plant (Claassen et al., 2002). The expenditure was intended to increase zinc recovery to the industry benchmark of 95%. Higher quantities of impurities means more waste residue is produced and this increases the absolute quantity of soluble and insoluble zinc losses associated with the residues. The impurities also have an additional negative effect in that it decreases the operating window of process parameters in the zinc plant. This increases the possibility of plant instability and can result in spillages and associated zinc losses.

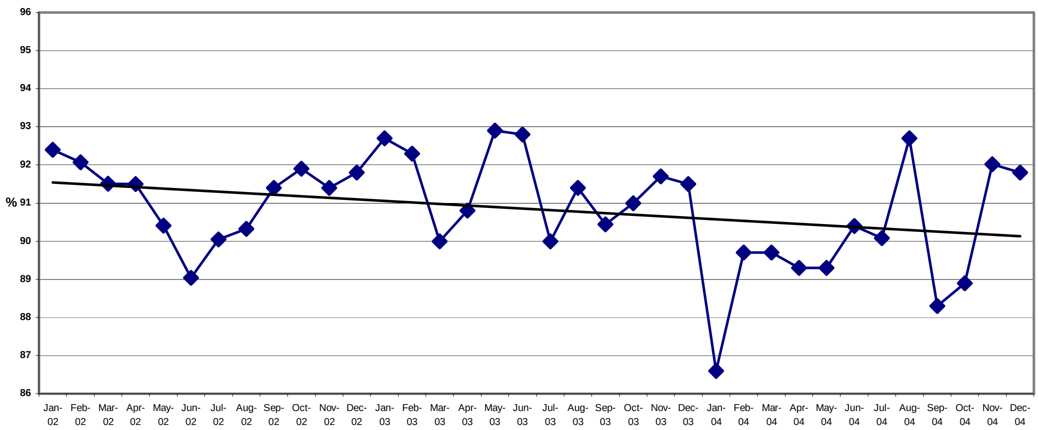

Figure 5. Zinc recovery at Zincor since January 2002.

In response to these challenges Zincor embarked on short, medium and long term actions to address the problems.

3. ACTIONS TAKEN IN RESPONSE TO DECLINING CONCENTRATE QUALITY

The actions taken in response to declining concentrate quality are summarised in Table 1.

Table 1. Actions taken by Zincor in response to declining concentrate quality.

Short term actions	Medium term actions	Long term actions
Revised operating philosophy	Recommissioning of the Magnesium pre-leach plant	Establishing long term concentrate supply contracts
Increased solution bleed	Optimising the Gypsum removal process	
Increased pipe maintenance program	Sourcing imported concentrate parcels	
	Upgrading the Neutral Leach Thickeners	

The short-term actions have focused on handling the build up of magnesium and manganese in the leach circuit by revising the operating philosophy to allow for a reduction in the zinc content of the leach solutions. This prevents the solution to increase in density to a point where the cell house ceases to function properly. The solution bleed capacity through the existing bleed plants was also increased from around 250 m^3 to 320 m^3 per day. This lowers the impurity build up in the circuit to an acceptable level, but is a very costly way to reject impurities as large quantities of lime is required to neutralize the solution that is bled from the plant. The increased amount of sulphates in the circuit associated with impurities such as Ca, Mg and Mn also causes other problems. The calcium saturation level in solution is reached at much lower levels of calcium than normal and this causes gypsum to precipitate in pipelines in the plant where the solution temperature drops below the saturation limit. The build up of gypsum in the pipelines restricts the flow of solution to the cell house and limits the amount of zinc that can be produced. As a short-term measure an intensive pipe maintenance program was introduced to limit the down time associated with this phenomena.

The medium term actions have focused on reducing the impurities in the concentrate. Imported concentrates parcels were sourced that have lower levels of impurities. The quality of the concentrate to the plant has been improved by blending this material with the local concentrates. Other actions that are in progress include the recommissioning of magnesium pre-leach plant by the end of April 2005 and the optimisation of the gypsum removal circuit through the installation of a purified solution heat exchanger by June 2005 to prevent chokes in the pipelines to the cell house. The Neutral Leach thickeners will also be upgraded by June 2005 to handle the higher quantity of gangue minerals that are present in the concentrates. The upgrade will include the installation of Larox peristaltic pumps on the thickener underflows. These pumps are capable of handling slurry densities up to 1.8 t/m^3.

As a longer term action Zincor engaged in discussions with various parties to secure an additional source of high grade zinc concentrate.

4. ACTIONS TAKEN TO DECREASE PRODUCTION COST

A re-engineering exercise was initiated in July 2003 to reduce the cost of production. The project had as a target a reduction of R40 million per annum in production cost and the generation of R20 million per annum of additional revenue. To achieve these targets a number of initiatives were launched. The main technical initiatives are summarised in Table 2.

Table 2. Actions taken by Zincor to decrease production cost.

Initiative	Impact
Concentrate pelletisation project	Decreased oxygen consumption
Recommissioning of the Cadmium upgrading plant	Reduction of the circulating zinc load
Upgrading purification plant	Reduction of the circulating zinc load
In house production of copper sulphate	Reduced copper sulphate costs
Cathode washing	Increased zinc conversion from cathode to slab
Automatic stacking project	Reduced labour requirement
Calcium carbonate project	Decreased lime consumption
Clarifier project	Decreased water consumption

Initially the re-engineering initiative focussed on optimising the labour complement. This led to significant savings in mainly the service departments. To reduce costs further it was necessary to introduce changes in the production process. Oxygen injection into the roasters was introduced in the mid 90s at Zincor to increase production (MacLagan, et al, 2000), but oxygen is an expensive commodity. To reduce the oxygen consumption and still retain the increased levels of production through the roasters it was decided to introduce a micro pelletisation process to increase the particle size of the concentrate. This project has been demonstrated successfully by producing pellets on a pilot plant pelletiser and feeding the pelletised material through one of the Zincor roasters. It resulted in a 60% reduction in oxygen consumption for the same roaster throughput. The full scale unit will be commissioned in August 2005.

Three of the projects focussed on the purification plant. The first project was the recommissioning of the existing cadmium upgrading plant. This plant had been used in the past to re-leach and the zinc and cadmium containing cake and then to precipitate the cadmium again from the leach solution. This resulted in an increase in the cadmium content of the cadmium cake to about 60% cadmium. The plant has not been in operation for a number of years while the magnesium pre-leach plant was used to upgrade the cadmium cake. With the recommissioning of the magnesium pre-leach plant as indicated earlier it was necessary to reuse the old cadmium upgrading plant. This opportunity was used to improve the cadmium upgrading process. The main change was a conversion from continuous process to a batch process. This improved the process kinetics significantly. The improvements have made it possible to produce an upgraded cake that contains 80%+ cadmium. This plant currently running at 50% of capacity. It will be running on full capacity by September 2005. At full capacity all currently horizons of cadmium cake will be treated through this plant. Future expansion of the plant may incorporate the production of electrolytic cadmium, depending on market demand for the product.

The second project in purification focussed on improving the solids seeding system that is in use in the cobalt precipitation circuit. Currently 6-8 bags of cobalt cake are added to the No1 Co tank to acts as seed material in the precipitation process. This results in a large recirculating solids load on system. The idea is to replace the manual addition of seed material with an automated system where cyclones are used on a recirculating line on the No 1 Co tank to produce seed material. The underflow from the cyclone will provide the seed while the overflow will proceed to the No 2 tank. Solids will periodically be transferred from the No 1 tank to the No 2 tank through the cyclones. The main benefit will be increased plant stability and reduced solids loading on the presses, but trials with a test cyclone unit in the plant has shown that zinc dust consumption can be decreased from 70kg/ton zinc to less than 40 kg/ton zinc. The cyclone seeding system will also be implemented on the cadmium removal side where no seeding is currently done. Completion of this project is expected in July 2005.

The final project in purification focussed on the in house production of copper sulphate. Copper sulphate was previously bought in crystal form and added to the cadmium removal circuit to reduce the cadmium particle size during cementation. To reduce this expense it was decided to produce copper sulphate from the copper cement product that is produced in the first stage of the purification process. An existing tank was used to leach the copper using spent electrolyte with air agitation. The copper sulphate solution is then fed into the No 1 Cd tank once a batch has been completed. This project has been fully implemented by July 2004 and no copper sulphate was subsequently bought for this purpose. The effectiveness of the copper sulphate addition has also improved significantly and the period between tank dig outs have increased from quarterly to annually.

Two projects were launched in the cell house. In the first project a pressurised cathode washing system was introduced in December 2004 to wash the electrolyte from the cathodes before melting. Manual washing of cathodes was previously practised. This reduced the formation of dross in the furnaces and increased the recovery of zinc in this process step from 90 to 92.3%. The water used for washing also decreased by 50%. Another benefit of this system reduced dust emissions due to dross formation in the melt house.

The second project focussed on automated stacking of the cathode sheets. Four stacking machines were designed based on those used at the Kidd Creek plant. These machines will stack the cathode zinc automatically once it has been manually stripped. The main benefits of this technology are a reduction in labour complement, improved safety (less hand injuries will result due to handling of cathode sheets & fewer chokes in furnace chutes due to poorly stacked cathodes) and the possibility to move to a round the clock stripping cycle. Currently the whole cell house is stripped once every 24 hours.
This project will be fully implemented by August 2005.

5. OTHER INITIATIVES

Other recent initiatives at Zincor are summarised in Table 3.

Table 3. Other major initiatives under taken by Zincor.

Initiative	**Impact**
Construction of a new slimes dam	Increased plant life
Re-treatment of existing slimes dam	Decreased environmental liability
Pre-alloyed jumbo facility	Increased product flexibility

The slimes dam that Zincor uses to deposit its residues will come to end of its useful life in 2007. A new dam will have to be built to allow Zincor to continue with its operations. A site has been selected and is currently awaiting approval from local authorities. The dam will comply with latest environmental standards and should extend Zincor's operations for at least the next thirty years.

The existing slimes dam will have to be rehabilitated once the new dam has been built. A number of options are currently under investigation including, capping the dam and removing contaminated solution via boreholes from the ground, retreating the slimes to recover zinc and recovering gold from the underlying gold slimes.

Zincor currently produces two ton jumbos for continuous galvanising. Aluminium is added to the galvanising process by the galvanisers to inhibit the formation of a brittle inter metallic layer between the zinc coating and the steel. To allow for better control in the galvanising bath Zincor has decided to produce pre-alloyed jumbos containing 0.6% aluminium. A facility has been constructed to produce a master alloy containing 20% aluminium that will be added to a new holding furnace with molten zinc from the existing melting furnace. Once the required composition has been achieved the zinc will be cast into jumbo form. This facility is currently being commissioned and will be in full production by the end of May 2005.

6. CONCLUSIONS

Several factors have impacted negatively on Zincor's performance over the past two years including a decline in concentrate grade and a dramatic strengthening of the rand's exchange rate against the US dollar. To counter these factors and to improve profitability Zincor has introduced a number of technical improvements. These improvements are specifically geared towards increasing the flexibility in the plant to allow sustained production levels despite declining concentrate quality and to decrease production cost. At this stage it is not yet clear whether the initiatives will yield the required results, but the expectation is that Zincor's ability to with stand external challenges will be improved once these initiatives are implemented.

7. REFERENCES

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