

# A proposal for accurate consistent continuous feed into electric arc furnaces in the platinum industry

J. KIRSCH

*Clyde Material Handling Africa (PTY) LTD*

## Introduction

The current technology used in the Southern Africa for the feed and distribution of concentrate into platinum group metal electric arc furnaces dates back to the late 1980s when fine dry concentrates were first produced in flash dryers. This concentrate was needed for the feed into top entry submerged lance (TESL) style furnaces which were being trialled at the time.

On the conclusion of the TESL trials there was a need to see how this concentrate could be fed into the existing electric arc furnaces, which at the time were using dried pellets derived from scraper dryers and pelletisers. These were then dropped into the furnace in 1–2 ton batches across a matrix of feed points by a system of crane driven skips (also known as kibbles).

The system which was eventually introduced to feed the fine dry concentrate was the screw feeder/rotary valve working with airslides, divertor gates and finally double flap valves.

This system has remained unchanged since the 1990s.

As a result of the ability to feed fine solids into the furnace, the industry has been using spray dryers and flash dryers to produce fine dry concentrate as the furnace feed material.

It is now twenty years on since the introduction of these systems. These systems essentially led to an improvement in the material handling and feed control of the concentrate into the furnace. Following the introduction of these systems there was a significant improvement in the rate of smelting and hence the increase in tons concentrate smelted per MW power used.

Following twenty years of the operation of these systems, the problems that these systems experience are now clearly seen and the effect that they have on the smelting environment can be identified.

New systems are available to perform the same function as the existing systems and are able to demonstrate improved performance in relation to the shortcomings of the existing systems.

Clyde Materials Handling Africa in conjunction with parent company Clyde Process Solutions has demonstrated their furnace feed technology in numerous metallurgical feeding situations. This has given our group immense experience and has shown that our technologies are rugged and precise and well suited to the furnace environment.

Clyde Materials Handling have had a primary element of their system running in the feed system into electric arc furnaces in the platinum industry since 2004 and the system has shown the required industrial integrity to deal with the duty required.

The purpose of this paper is to

- Outline and clarify the remaining Clyde elements which need to be added to the system to supercede the existing technologies with improved feed integrity
- To identify the losses that existing systems are subject to
- Estimate an annual revenue generation improvement through the installation
- Show how the system can be installed with minimum furnace downtime.

The technology of feeding concentrates into furnaces has made significant strides in the last decade. Along with the changing energy landscape in Southern Africa and the volatility that has been experienced in broader commodity and metal markets worldwide, there is a need to review traditional technologies and where feasible replace these with those which provide much needed advantages. This will result in increased production and reduced energy costs.

## Description of existing systems

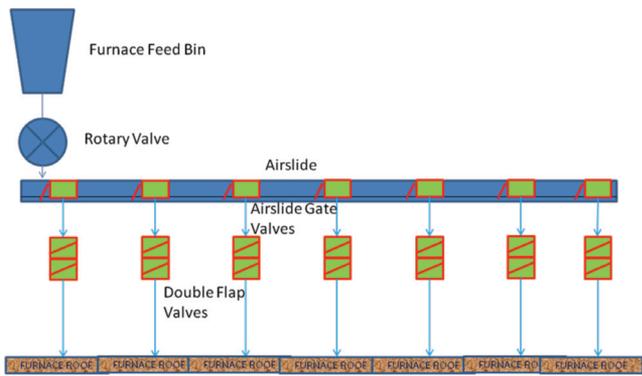
Existing systems fall into two main categories. These categories are driven by the furnace design. Furnaces are generally either six inline as in the Anglo Platinum and the Impala furnace stocks or the majority of the remaining companies which use triple electrode systems. A newly demonstrated furnace technology called CONROAST also uses a furnace feeding system which is closely aligned to the triple electrode systems.

The feed systems used on the triple electrode systems are generally pure gravity drop systems. This usually means that the feed storage silos are located immediately above the furnaces and that the feed drops through a basic feed device from the silo into a gravity drop pipe directly into a targeted hole in the furnace roof usually located within the electrode area. Often the feed points will be in a similar pattern to those of the electrodes and hence there will be three feed points.

These systems rarely require that the feed is moved horizontally any great distance and generally each feed unit is servicing only a single feed port. Hence the major area of concern is the feed device which historically has been in the form of a rotary valve, a screw feeder, a double flap valve, a vibratory feeder or in some rare cases a weigh belt feeder.

The common method, which is a rotary feeder, suffers from the same problems that rotary feeders suffer from in the six inline feeders, namely

- Rapid wear and runaway through wear clearances specifically when used with hot fine dry concentrates
- Susceptibility to blockage through tramp getting stuck in the rotor



**Figure 1. Graphic representation of existing feed system flow sheet**

- Leakage from rotating seals and bearings on the horizontal shaft leading to significant spillage on the furnace roof or in many cases the feed storage level floor if the storage is located a floor higher (not often the case).

Six inline furnaces have a significant length and there is the need for significant horizontal material movement to reach the feed ports in the roof of the furnace. This horizontal transport is generally brought about by using airslide technology (also known as aeroslide).

The airslides are equipped with gates which then ‘cut’ the material and allow the material to be dropped at different points along the length of the airslide.

These systems suffer from the following problems:

- The cutting gates wear out and damage the airslide membrane
- The cutting gates get stuck and do not control the flow of material correctly

- The worn membrane allows concentrate to block the air plenum leading to massive failure of the airslide
- Hot gas seepage from the furnace causes damage to the airslide membrane.

The above-mentioned failures cause a reduction in the overall feed to the furnace but do not necessarily result in a furnace shutdown. In an effort to minimize these failures the following additional aspects have been added to furnace feed systems:

- Double flap valves are used on the drop legs from the airslide to the furnace feed point on the furnace roof
- Furnace over pressure valves are used to try and prevent pressurization of the furnace.

Both of the above additional systems have led to additional maintenance on the furnace, although rarely to a complete shutdown of the operation of the furnace.

Although the matters outlined above contribute to a loss of feed to the furnace, which in turn results in lost production, rarely do these lead to a complete shutdown of the furnace.

Table I is an estimate of lost production time related to the type of failures that are expected from the existing feed systems. All of these have been observed on clients’ sites and occur regularly.

### A further operational problem?

In many situations the failures caused by the airslide and the gate valves on the airslides lead to significant changes in distribution of the feed of concentrate into the furnace.

As many of the problems that occur are not detectable except by visual inspection, membrane failure, the gate valve blade is loose or broken or bent, the bad distribution of concentrate into the furnace can go on for many days and weeks without notice.

An added issue to all of these problems is that the identification of these problems will have to be done

**Table I  
Estimated lost production**

Stoppage	% Reduction in Feed	Time to identify Hrs	% Reduction in feed to Correct	Time to correct Hrs	Incidents per month	No of Units	Total Lost T/month @ 60 T/hr feed rate
Rotary Valve Failure	1	1	1	5	0.1	2	66
Divertor valve failure	0.5	5	0.5	4	0.5	14	915
Airslide membrane failure	1	2	1	10	0.2	2	264
<b>Total</b>							<b>1245</b>

Expected Production							
MW	T/MW	T/hr	Hours/day	Ton/day			Days/Month
38	1.3	49.4	20	988			1.26
							15.12

Average Price/Ounce					
Pt	Pd	Au	Others	Ave	
50%	25%	3%	22%		
\$ 1 500.00	\$ 433.00	\$ 1 200.00	\$ 400.00	\$ 982.25	

Plats g/ton	180
Grams/day	177840
Grams/Ounce	28.349
Ounce/day	6273.24
Days/year (80 % of total )	292
Dollars/Day	\$ 6 161 887.19
Rand/day	R 46 214 153.94
Safety Factor	50%
Revenue Lost per year	R 349 412 682.11
Assuming a 30 % Gross	R 104 823 804.63

visually by opening the airslide which requires significant downtime (related to figures reported in the tables above) and mechanical work.

Furthermore the equipment is located in an area in the furnace which is hot, dusty and often has the highest concentration of SO<sub>x</sub> fumes making working in this environment extremely uncomfortable. Hence workman and artisans will avoid the environment until the situation has become critical.

This can result is in the majority of the feed of concentrate to a point in the furnace where it will begin to build up. There is clearly a school of thought that the concentrate spreads very well as it is hot and fine and hence behaves similarly to a fluid.

In reality, although it cannot be excluded that the material flows well, if the material is continuously fed preferentially to a single point there will be a build-up and concentrate dams can form in surface slag formations. It is the belief of this author that these uncontrolled and undetected concentrated feed events to single areas in the furnace encourage and initiate serious overheating furnace scenarios, leading to significant furnace failure.

A serious furnace failure such as a sidewall burn-through could make the figures that I have presented above for the existing systems almost insignificant in relation to the loss in revenue.

### Proposal for a new system

The Clyde Materials Handling system proposal is based on the use of our ROTOFEED feeding system. Most importantly, a large number of platinum smelters are already using our ROTOFEED system. These units have clearly shown the ability to operate for extremely long periods between failure and are able to show that they can withstand the duty without concentrate passing through them in an uncontrollable manner.

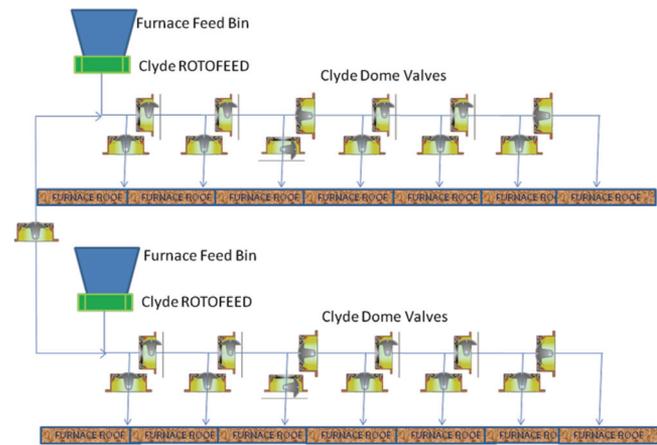


Figure 2. Proposed feed system

The proposal that we are suggesting is that the airslide distribution system and the divertor gates along with the double flap valves are replaced with our pneumatic distribution techniques. This system uses the Clyde dome valve to direct the feed into the various feed ports see Figure 2.

The proposed feed system has various advantages. These are summarized in the list below.

- Significant reduction in moving parts
- Condition monitoring of all aspects of the distribution system
- Positive pressure sealing ensuring no furnace gas leakage
- Extremely accurate measurement of furnace feed quantities
- Accurate knowledge of amount of feed in any feed port
- Long maintenance cycles on system components

Table II  
Components needed for the proposed system

Stoppage	% Reduction in Feed	Time to identify Hrs	% Reduction in feed to Correct	Time to correct Hrs	Incidents per month	No of Units	Total Lost T/month @ 60 T/hr feed rate
ROTOFEEDER failure	1	0.25	0	5	0.05	2	0.75
Dome valve failure	0.5	0.25	0.5	2	0.5	14	423.75
Airslide membrane failure	0	0	0	0	0	0	0
<b>Total</b>							<b>424.5</b>
<b>Expected Production</b>							
MW	T/MW	T/hr	Hours/day	Ton/day			Days/Month
38		1.3	49.4	20	988		0.43
							5.16
<b>Average Price/Ounce</b>							
Pt	Pd	Au	Others	Ave			
50%	25%	3%	22%				
\$ 1 500.00	\$ 433.00	\$ 1 200.00	\$ 400.00	\$ 982.25			
Plats g/ton	180						
Grams/day	177840						
Grams/Ounce	28.349						
Ounce/day	6273.24						
Days/year (80 % of total )	292						
Dollars/Day	\$ 6 161 887.19						
Rand/day	R 46 214 153.94						
Safety Factor	50%						
Revenue Lost per year	R 119 137 095.22						
Assuming a 30 % Gross	R 35 741 128.57						
Difference in gross income	R 69 082 676.06						

- Built in redundancy for cross feed between opposite sides of the furnace
- Significant improvement of the available feed time.

In regard to the components needed for the proposed system, Table II has been compiled.

It can be clearly seen that there is great opportunity for a significant increase in revenue generation.

An argument that could be suggested is that the above analysis does not take into account any downtime for the installation of the system. What does need to be clearly noted is that the proposed system can be installed with a furnace shutdown or without the need for the removal of the existing system. Hence there is no need to take the installation time of the proposed system into the equation.

Estimates that have been done by our company indicate that this system can be installed for approximately R45 M. (Depending on the actual furnace layout and the environment. This figure is a worst case figure.)

Given the improvement in available feed time and hence revenue generation, this system exhibits excellent payback opportunities and has the ability to get the benefit within the period of a single financial year.

### Conclusion

The platinum processing industries in Southern Africa have generally used spray drying and flash drying over the last twenty years for the production of fine dry concentrate feed into the furnace. Flash dryers have started to represent the future of the industry in as much that are proving to be more rugged and are able to support a growing aspect of the

industry, which is toll smelting. This prevents the requirement of repulping concentrate, which would be necessary if a spray dryer was being used.

Flash dryers are, however, more prone to the transport of a wide range of tramp which does pass through this into the dry concentrate conveying and handling system.

It is this tramp which causes the problems described above and if the correct techniques to deal with this are not put in place, the gains in furnace through put will not be fully realized. The installation of furnace feed systems described above will allow the operators to overcome the problems caused by tramp.

In conclusion we believe that premise that we set out to show, namely:

- Outline and clarify the remaining Clyde elements which need to be added to the system to supersede the existing technologies with improved feed integrity
- To identify the losses that existing systems are subject to
- Estimate an annual revenue generation improvement through the installation
- Show how the system can be installed with minimum furnace downtime.

Our group is convinced that there are significant production losses, which are avoidable, taking place due purely to the feed distribution on existing feed systems.

We believe that the application of updated proven systems such as ours will be able to show significant economic benefit to the companies who intend to use the system.



### Jeremy Philip Kirsch

*Executive Director, Business Development, Clyde Materials Handling Africa (Pty) Ltd*

Mr Kirsch has over 22 years of extensive experience in process design, control strategy, commissioning, training, long-term support, sales and marketing, which he applied to this demanding role. In Sub Saharan Africa alone, he has excelled in designing, selling, installing and commissioning projects for blue chip companies such as Sappi, Nestle, Anglo Platinum, Colgate, BHP Billiton and Impala Platinum, ensuring all planning and design methods meet the highest international standards.

In 1982 he graduated with a BSc in Mechanical Engineering, [BSc Eng (Mech)] from the University of the Witwatersrand. It was also at Witwatersrand that he studied towards an MSc in Mechanical Engineering in 1986. The field of study was the application of Nuclear Physical techniques to the field of mechanical wear. Areas researched included Nitrogen ion implantation as a means to reduce wear rates in steels and the irradiation of steels to form Cobalt 56 to measure wear rates remotely.

Mr Kirsch joined Clyde Bergemann Africa in 2001 as a member of the Management team and since then he has seen the Company grow from strength to strength. In his role as an Executive Director, he is heavily focussed on Business Development using his vast expertise in new technology and sales.