Journal Comment

Refractories and Sulphuric Acid

'What counts in life is not the mere fact that we have lived.
It is the difference we have made to the lives of others.
That will determine the significance of the life we lead'

Nelson Mandela

The paper by M. Nyoka, D. Brazier, T. Courtney, and RA. Parry from Vereeniging Refractories, (Pty) Ltd, refers to andalusite as a key mineral resource. I am sure the staff of Vereeniging Refractories will join me in paying tribute to the staff of the Ore-Dressing and Mineralogy divisions of the Government Metallurgical Laboratory (now Mintek), Pieter Overbeek, Jack Levin, and Joe Liebenberg, in establishing, some 60 years ago, andalusite, sillimanite, and magnesite as high-quality and strategically important minerals.

As described in this paper, it is fascinating to take note that well into the 21st century, andalusite is still the key mineral product to ensure the survival of the refractory industry in this country. It is of concern to note the manipulations among the big players to restrict the supply of the most commonly used refractory mineral, bauxite, in an attempt to prevent competition from others to ensure added value for maximum local employment opportunities.

Is this a case of what is sauce for the goose is sauce for the gander, particularly if the gander is a much bigger trading partner? The answer lies in collaboration and exchange of problems and solutions, which is part of the function of this Journal and the reason for the choice of the quotation heading this Comment.

Having said this, it is equally salutary to recognize the complexity of the scientific and technical expertise as evident in the paper 'Recent advances in refractories aluminate binders and calcium aluminate' by C. Parr *et al.* from Kerneos SA, Paris, France.

Such scientific and technical expertise would be needed if our refractory minerals such as andalusite were to enter the global market in a fully processed form. For example, the addition of stainless steel fibres to provide additional strength and resilience to refractory linings was, for me, one of the several novel features that were mentioned.

One has only to note the demands on the refractory used in the interface zone in a platinum furnace handling UG2 concentrates to recognize the extent of the experience that has been called upon. For well over 50 years, we have been basking in the knowledge that, with our ultra-low cost electric power, we could dominate the market for electrometallurgical products such as ferrochrome and ferromanganese.

Today it is necessary to operate smelting and other high-temperature melting and alloying furnaces with outstanding efficiency and top-level servicing to remain competitive costwise.

To appreciate this better, one must refer to the paper 'Sidewall design for improved lining life in a PGM smelting furnace' by I. Mc Dougall. This remarkable paper describes the highly complex theoretical and pragmatic design procedures used to overcome what must have seemed an insuperable refractory problem. This occurs in the so-called 'tidal zone', where the worst corrosion due to the high temperatures of the slag and matte above and below the tidal zone is regularly encountered.

The ultimate solution was found by using a graphite interface layer indirectly cooled by copper cooling arrays at the slag zone. This has to be one of the most notable exercises in smelter design.

The smelting of the UG2 concentrates in South Africa is one of the most operationally challenging and costly smelting operations in the world, placing heavy demands on the manufacturers of the furnaces and the refractories required at the extreme temperatures and corrosion conditions encountered.

If we aim to cash in on our resources of andalusite and other similar materials for creating added value for job creation, we need to also recognize the advances made in calcium aluminate casting materials and the use of refractories compatible with the different forms of fluorinated polymers in autoclaves and other complex equipment for hydrometallurgical applications and use with corrosive chemical products at temperatures higher than previously encountered. Such demands are not out of the question in the near future as regards pressure leaching in our gold and platinum operations. Such topics are discussed in two papers: 'Refractory lining design fundamentals for hydrometallurgy autoclaves', by A. Koning (Hatch Associates) and 'Linings made from fluorinated melt-extruded thermoplastics in off-gas pipelines on sulphuric acid production plants and in tailor-made equipment for sulphur oxide and sulphuric acid handling' by M. Lotz (Quadrant EPP AG, Switzerland).

It seems that the use of refractories is proliferating. Maybe our mineral beneficiation protagonists should look at the other aluminum and calcium silicates and our magnesites as deserving greater priority in the R&D portfolio crusades that are so vital for job creation.

By far the most intriguing idea in terms of creating new uses for our uniquely prolific mineral resources, as well as earning carbon credits for avoiding global warming, is from a new centre of expertise in South Africa. It is in a paper on 'SO_2 – an indirect source of energy' by R.J. Kriek *et al.* of the PGM Group, Research Focus Area for Chemical Resource Beneficiation (CRB), North-West University, Potchefstroom.

The paper was written in collaboration with the Centre for Atomic-scale Materials Design (CAMD) in the Department of Physics,Technical University of Denmark.

To explain the basis of my comments, I must summarize what I understand to be the main outcomes of the work described in the paper as it concerns South Africa. By using platinum anodes in an electrolytic cell containing an aqueous

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solution of SO_2, hydrogen can be produced at the cathode for use in a platinum fuel cell, which generates a net excess of electrical power. An extra bonus point can be obtained, since by the removal of SO_2 from power station emissions the formation of nitrogen oxides (deleterious greenhouse gases) can be avoided. A further advantage would be the development of additional uses for platinum to alleviate the current oversupply situation. The paper is in the nature of a progress report. The authors conclude that what is needed is a means to improve the catalytic properties of platinum for the conversion of SO_2 to SO_3 on the surface of an electrode so that the process is attractive economically. The paper contains some very profound basic electrochemical thermodynamics and molecular reaction physics, which in reading I recalled a great deal. This prompts me to suggest that there could be other options that might improve the probability of success in achieving the ultimate objectives, not the least being new uses for platinum.

Another paper in this issue reports on the conversion of SO_2 to SO_3 – 'Integrated production of liquid sulphur dioxide and sulphuric acid via a low-temperature cryogenic process' by M. Verri and A. Baldelli of Desmet Ballestra S.p.A.

The paper describes the evolution of a sulphuric acid plant with some of the same motivations as the electrolytic process, namely to produce sulphuric acid from a sulphur-burning plant with minimum discharge of SO_2 and NO_X into the atmosphere but with maximum co-generated power. The success of the concept is evident in the ultimate commercial plant, which incorporated a cryogenic refrigeration system to first condense the SO_2 as a liquid. The outlet gases from this step, containing approximately 4% SO_2, are dealt with by sending them to the first stages of a conventional vanadium catalyst acid plant. This provides a discharge to atmosphere virtually free of SO_2 and NO_X. The details of the optimization make intriguing reading.

The question is whether the same would apply to a pyrite-burning acid plant feeding a plant utilizing acid to leach uranium from the narrow gold reefs, or to the recovery of acid from smelter gas discharges.

Maybe more options for the R&D portfolio quest for job creation strategies?

R.E. Robinson