Written by RE Robinson
Wednesday, 01 June 2011 02:00

"Science is built of facts, as a house is built of stones; But an accumulation of facts is no more a science Than a heap of stones is a house Henri Poincaré 1854–1912

Once again, the Journal presents a miscellaneous group of papers, rather than a collection from a colloquium or conference. All of them represent facts and footsteps forward in areas of importance in Mining and Metallurgy, rather than the final chapters in a new plant or mining enterprise . I mention only some of these in the order in which they caught my attention.

The first was: 'Evaluation of Reductants Used for Ilmenite Smelting Based on CO2 Reactivity (Boudouard Reaction) Measurements' by P. Jordan, Senior Scientist, Exxaro Resources.

This choice may raise eyebrows. The dominant role in beach sands processing that South Africa enjoyed some decades ago suggests that there is not much more to be learned on the smelting of ilmenite. The reason for my interest is not only the remaining ilmenite processing plants, but because of the vast quantities of iron and titanium oxides in the Bushveld Complex. These have been rated as the largest iron ore and titanium oxide resources in the world. Many authorities believe this also applies to resources of vanadium, which is also present in sections of the deposits.

Although there is a big difference between the reactivity of magnetite, hematite, and ilmenite, there is little doubt that the processing of these materials will depend on the reduction of iron oxides by carbon, probably derived from anthracite or coal. The reactivity of such forms of carbon is the topic of this paper. There are some most interesting results reported. Already there have been claims for viable process methods based on carbon reduction of titaniferous magnetite, not to mention the operations of the Highveld Steel and Vanadium plant, which has been in business for nearly half a century. With the seemingly neverending increase in electric power costs, the efficiency of the reactions thermodynamically is critical if the hoped- for global developments are to be forthcoming. I am sure that there will be many more thermodynamic and gravimetric footsteps (as in this paper) in the road ahead.

Associated with this paper is the contribution on the hydration of magnesium refractories in submerged arc furnaces, with recommended precautions and operating safety measures to avoid costly re-linings.

My second choice of paper might also surprise you. It is the paper from Greece: 'Rock Drillability Prediction with in situ determined unconfined Compressive Strength of Rock', by Vassilios C. Kelessidis.

Rock drilling has surely been one of the most utilized activities of the mining and mineral exploration industries for many centuries if not millennia. There must be very few aspects left unexplored. I was curious to find out if this could be an area where our materials engineers were at the forefront so as to take the global lead in supply of equipment, particularly in the light of the potential for ultra-deep gold mining, where high pressurized rock must be unique.

But this paper provides a great deal of evidence that the predictability of drilling parameters is not as well under control as I imagined. I am under the impression that there is much more experimental and statistical variability work to be done. The paper suggests that the friction coefficient and the efficiency of energy transmission to the rock and the latter's UCS properties are the most effective parameters for design and predictability. This paper could be of great value if special focus is to be given to alternative methods of blast hole drilling and a move away from the hand-held rotary percussion rock drills. New materials are becoming available as evidenced by the several papers describing the use of laser techniques for hardening the surfaces and for binding the ultra-hard materials such as diamond and tungsten carbide drilling bits, and for the high strength drilling rigs that are among the new approaches to pursue.

The papers in this and the May issue last month on the benefits to be achieved by the addition of titanium and the laser treatment of the surface properties, could well provide the technology innovations to create the ultra-high performance drill steel and drill bits to form a global market for such products.

Another sequence of forward foot prints is the progress report from Mintek: 'Review of the Development Work of the Mintek Thermal Magnesium Process (MTMP)' by Masud Abdellatif

It is encouraging to learn that hundreds of kilograms of magnesium ingot were successfully produced on a pilot scale. The commercialization of a home-grown competitive process for the production of this member of the group of light metals is an important step in the establishment of cluster manufacturing industries making components for the automotive industries. Such components have high added value, allowing for high level salaries for the workers, and it seems we can be assured of a worthwhile market.

The challenge is to produce the magnesium metal at a price competitive to that of magnesium currently being imported from China. The process is clearly sensitive to the cost of electric power and to the cost of heat energy for calcining the dolomite, and we know that these are increasing steadily in South Africa. Thus a high level of process efficiency will have to be the target.

The next paper on my priority list was: 'Reducing Water Consumption at Skorpion Zinc' by H. Bhikha, A.E. Lewis and D.A. Deglon, of the Minerals to Metals Research Initiative, Department of Chemical Engineering, University of Cape Town.

The Skorpion Zinc plant and process have been hailed as a major advance in hydrometallurgy. The deposit is in Namibia and water is a critical input and cost item. The paper is an excellent example of the Aspen material balance and process optimization programmes. The process follows the pattern of the majority of hydrometallurgical processes, incorporating a sulphuric acid leach followed by filtration and precipitation of the impurity metals and recovery of the main product, zinc, by solvent extraction and electrowinning. Not surprisingly, the conclusion is reached that the optimum saving in water consumption is achieved by recycling all the effluent water in a purified form. I am sure that this is a well justified conclusion, and the use of reverse osmosis to purify the recycled water is now contemplated.

However, whether this is the future approach for the many other acid leaching processes in the desert and arid areas which abound in Southern Africa, and particularly for uranium deposits in

Namibia and Angola, (which will probably require water from seawater desalination plants), justifies further evaluation of alternative options. A complete recycle of effluent water is a bit of a mirage. The disposal of the waste leach residues onto slimes dams requires about 20% of effluent, and the disposal of the reverse osmosis concentrate containing metal and other impurities also has a water demand which will be lost by evaporation to the atmosphere at inland plants.

Recent advances and concepts in countercurrent mixed-bed resin in pulp ion exchange de-ionization methods, and the growing insistence on non-toxic long term waste disposal, could justify further examination.

The use of advances in molecular microbiology to improve energy efficiency of photosynthesis in plants, leading to acceptable biomass co-production of power and food using effluent water promises to be a future option for economic sustainability.

This topic could well form future footsteps along the pathway to optimum hydrometallurgical plants where water is a costly requisite.