Containerised continuous electrowinning plant relocates to Impala's base metals refinery for commercial benchmarking

South African process-engineering start-up, Free Radical Process Design, recently completed an industrial benchmarking exercise on its Rotowinner® containerised demonstration plant, and installed the demonstration plant at Impala Refineries' base metals refinery in Gauteng.

This marks the first steps towards commercialising this novel continuous-electrowinning technology, which combines electrowinning and cathode stripping into a single continuous operation by reshaping existing parallel-plate electrodes into a rotating cylinder configuration. Successful implementation of the technology will increase the production rate of electrochemically extracted metals, decrease electrical costs, and improve plant safety.

The Rotowinner® "Continuous Metal Electrolysis" technology was a brainchild of a University of Pretoria (UP) PhD Chemical Engineering graduate, Dr Ryno Pretorius. Dr Pretorius, the founder and MD of Free Radical Process Design, said: "The aim of this project was to produce a modular, transportable, demonstration plant capable of showcasing the commercial possibility of our in-house Rotowinner® technology."

The Rotowinner® technology emerged from a project managed by the University of Pretoria (UP) and seed-funded by the Technology Innovation Agency (TIA) — the implementing agency of South Africa's Department of Science and Innovation. The UP Technology Transfer Office (TTO) evaluated the technology for intellectual property protection and filed a provisional patent application. Currently, Dr Pretorius and UP have concluded a technology licence agreement for his company to commercially exploit the technology. The TIA awarded R10 million in technology development funds to the company, to construct the plant and demonstrate the technology's economic feasibility to potential industry clients.

"With the support from UP and TIA, we were able to demonstrate the commercial and process possibilities of the technology, to such an extent that we were invited to operate our demonstration plant at Impala Refineries, in parallel with its existing Base Metals Refinery circuit. We hope to prove improved performance and safety in a commercial environment," said Dr Pretorius.

Brian Mphahlele, Commercialisation Executive at TIA, said: "With the decline in the productive capacity of the South African economy, the country needs sufficiently differentiated innovations, such as the Rotowinner®, which have enormous potential to compete on a global scale. We are also particularly pleased at the responsiveness from big business — particularly Impala Refineries — to the call to collaborate in demonstrating the commercial potential at scale."

Wilhelm Botha, Technical Manager at Impala Refineries, adds: "After some initial teething problems, the demonstration plant was able to continuously produce thin strips or flaked metallic product from the plant feeds provided. Internal analysis of the products indicated it to be of similar quality to the metals currently produced in our commercial plant. The technology has the potential to produce final product on a continuous basis, on a small footprint, and with limited interaction required by operators. The basis of the technology - electrowinning of metals - gives it scope to produce various metals. We

focussed on copper production specifically, as well the purification of process streams by removing the unwanted residual metals present."

Maarifa Kidoge, project manager at Free Radical Process Design, said: "The technology has been developed from a bench-scale, proof-of-concept model through several iterations to become the modularised plant it is today. The plant is designed to produce approximately 30 tonnes of copper per year. The compartments of the plant contain all equipment required to receive a leach solution from the client, maintain temperature and recirculate solution as required. Products are continuously returned to the client as a metallic slurry. Electrical and air connections are conveniently placed outside the plant, making connection and disconnection simple and fast. The plant was designed to be mobile and containerised, as the company plans to shift the plant to remote locations in Africa to beneficiate metals in remote locations. The Democratic Republic of the Congo is targeted specifically, as it is an ideal location to add value to the cobalt concentrate produced in the region."

Free Radical Process Design plans to supply Rotowinner® plants internationally as fit-for-purpose plants, designed to client specifications, or to offer toll-treatment options to clients who want to make use of a containerised plant for short-term beneficiation.

The use of a mobile electrowinning plant disrupts the current standard practice requirement of limited financial deployment in the mining industry due to life-of-mine being too short to justify capital investment. By using a mobile Rotowinner® plant, low life-of-mine reserves can be beneficiated until depletion. The electrowinning plant can then be moved to the next site for use on a new resource.

Free Radical Process Design plans to directly integrate the Rotowinner® plant with solar PV to further enhance its remote operational possibilities and drive down the cost of production. Future developments for the Rotowinner® include using it for continuous water-softening and metals-removal, thus removing metals and hardness from mine tailings or acid mine drainage, powered by solar and producing hydrogen and oxygen as by-products.

Once industrial trails are completed, steps will be taken to commercially expand and implement the use of Rotowinner®.

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