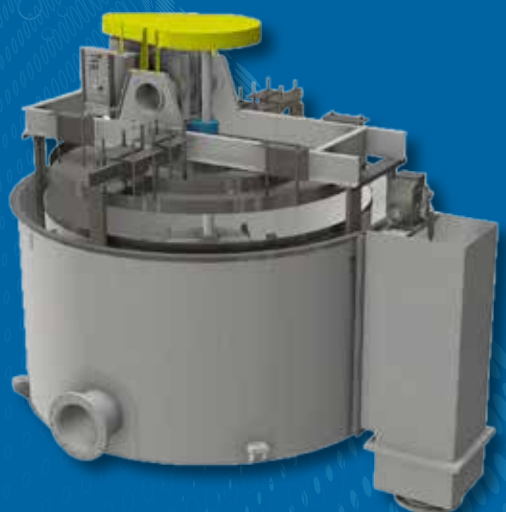


IMPROVEMENTS IN FLOTATION TO REDUCE ENERGY

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HydroFloat™



StackCell™

As the worldwide mining enterprise moves to processing ore bodies with lower head grades, the volume of ore that must be ground and floated to produce the same amount of product increases by at least an equivalent amount. Using existing technology, this means that the energy requirement for grinding and flotation will increase as well. As an innovative flotation equipment manufacturer, the Eriez Flotation Division is developing and commercializing new products based on metallurgical first principles that will actually allow the energy requirements to be dramatically decreased. These are not the kind of incremental second order improvements achieved by simply making bigger unit operations based on current technology, but major first order improvements that are possible through a major re-think of the flotation process, which hasn't changed fundamentally in 100+ years.

The first of these is the HydroFloat™, a high-efficiency, aerated, fluidized-bed flotation cell that is capable of recovering coarse, semi-liberated particles. Benchmarking the performance of the HydroFloat against a conventional stirred tank cell in a number of studies has shown a dramatic improvement in the flotation of coarse particles, as an example see the recent paper by Mehrfert*. This approach allows for recovery at a much coarser size (and rejection of a coarse tail) which results in a significant reduction in grinding; the major energy consumer in the concentrator. The potential benefit to reduce comminution energy consumption are now well accepted, and major mining companies are now looking at the HydroFloat as a type of ore sorter to develop a coarse throwaway tail.

Another technology that is being commercialized for base metals is the StackCell™, which was introduced a decade ago into the U.S. coal industry. Developed by Dr. Michael Mankosa and Dr. Gerald Luttrell (U.S. Patent No. 8,960,443), the StackCell is a two-stage flotation device. A cross-section of the StackCell is shown in Figure 1 on page 2. The first stage (center of tank) is an energy intensive, low residence time chamber consisting of a rotor-stator (4) that creates high turbulence to mix air and feed slurry together (1). In this stage, the kinetics for particle-bubble collection are maximized in a zone that can flow in one direction into the second stage, with no short circuiting. The second stage is a settling tank with overflow launders (2) and wash water (7) that allows for bubble-particle separation from the pulp into the froth phase in a fluid environment that allows for froth washing and minimizes particle bubble detachment.

A campaign using a train of three 0.60-metre diameter StackCells in series for a low grade copper ore was reported at the 2016 Denver SME conference (Christodoulou, 2016). A photograph of a similar installation is shown in Figure 2. The objective was to evaluate the StackCell as a low-energy, high-capacity alternative for a multi-stage rougher application for slow-floating ores and to compare the kinetics (recovery and grade) with a Denver lab cell, which is the industry-accepted standard for scaling up conventional stirred flotation cells.

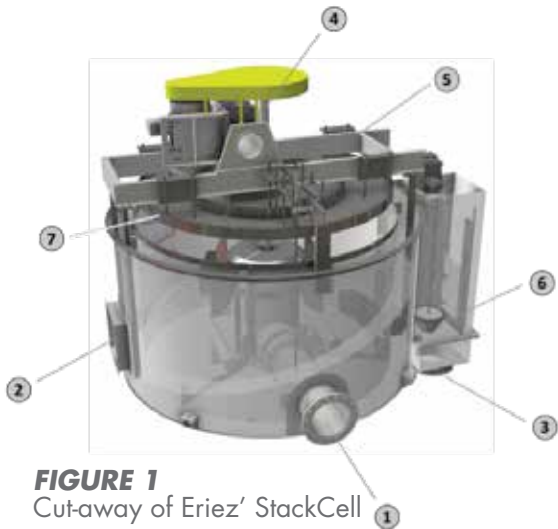


FIGURE 1
Cut-away of Eriez' StackCell

1. Feed Inlet
2. Froth Outlet
3. Tails Discharge
4. Rotor
5. Main Supporting Structure
6. Dart Valve
7. Wash Water Pan

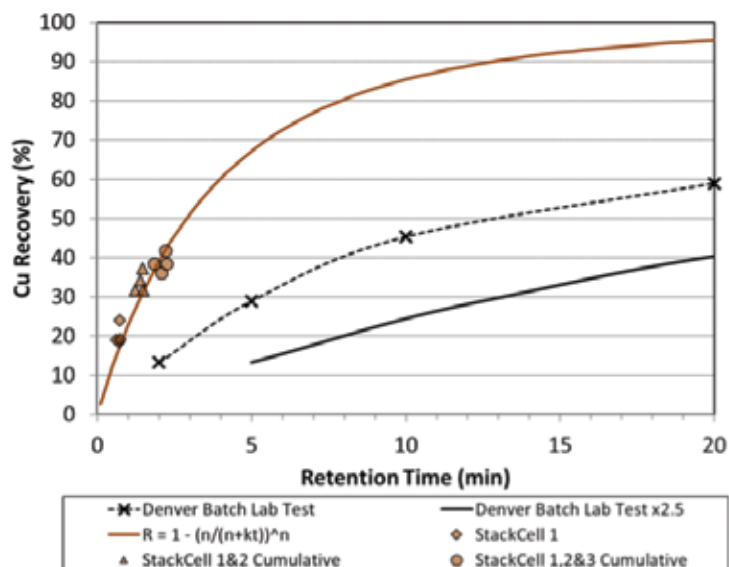


FIGURE 2
Photograph of recent 3 stage StackCell Pilot Plant

FIGURE 3
Recovery kinetics for a three stage StackCell train, benchmarked against the Denver lab cell kinetic response for the same feed.

Results from this campaign are shown below (Figure 3) as residence time versus cumulative recovery for both the StackCell and the lab Denver tests. An estimate of the curve showing expected performance for a full-scale conventional circuit is also shown. The commercial units are sized using the industry-accepted practice of multiplying the required retention time by 2-2.5 times to account for performance losses in scale-up. By drawing horizontal tie-lines at any target recovery, we can see the advantages of the StackCell technology, compared with the incumbent technology. For example, 40% recovery can be achieved in 2.5 minutes with a train of three StackCells, or about 9 minutes in the batch Denver test. Using the standard scale-up rules, this would indicate a requirement of 18-24 minutes in conventional cells. Of course, the scale-up to larger sized StackCells may also require a residence time multiplier like conventional cells, but similar results have been observed for other sulfides in StackCell units up to 1.2 meters in diameter. In addition to the increased kinetics, the StackCell also produces a higher grade in general because of the ability to wash the froth, which is only efficient because of the quiescent environment of the froth recovery stage. Similar results were also observed for the molybdenum contained in this stream.

As the amount of time to recover the material is dramatically reduced, this has a major impact on the working volume of the cells, capital cost, plant space, and energy consumption. The major improvement in energy consumption is achieved by concentrating the energy required for bubble-particle attachment in a small volume and then not adding excessive energy to maintain particles in suspension in the tank, which can be disadvantageous to the froth recovery zone. The StackCell is now being actively tested in a number of metal ore systems with traditionally slow-floating minerals.



Combined with the HydroFloat for coarse flotation, the StackCell for slow-floating mid-size range particles has the ability to revolutionize mineral processing by reducing energy consumption, as well as capital costs. These are two examples of how Eriez is changing the mineral processing business to be less energy and capital intensive for the future. For more exciting new technology, go to www.eriezflotation.com.

REFERENCES

1. Christodoulou, L., "Alternative Approach to Base and Precious Metals Flow Sheet Design", Colorado MPD, 2016.
2. Mehrfert, P., "Investigating the potential of HydroFloat™ coarse particle flotation", Canadian Mineral Processors National Conference, Ottawa, 2017.



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