Issue 21 – August 08

Outotec Australia's quarterly e-newsletter

Output

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Float to the Top – Energise your Flotation Performance

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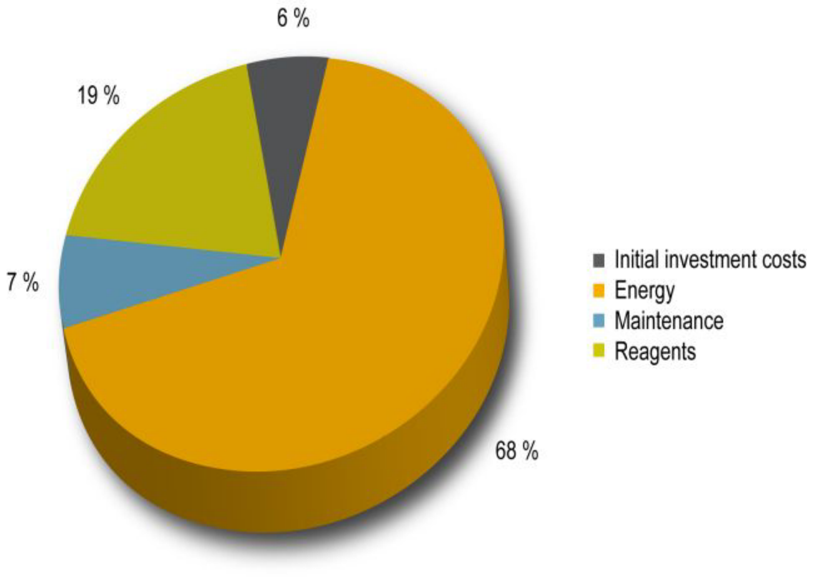
Increasingly, larger sites, greater throughputs, shortage of experienced personnel and a greater focus on water and energy consumption have placed high demands on minerals processing suppliers. Against this arena, many mine owners are now recognizing the importance of looking at the total life cycle cost, not just the initial outlay in technology and equipment.

They realize how critical it is to examine the lifetime operation and maintenance of, say, a flotation machine, as this is what will really affect the bottom line. There is little point in saving thousands of dollars on initial outlay if that equipment ends up costing a site millions in lower recovery rates, increased operational costs, higher maintenance and a greater need for personnel involvement.

Total life cycle cost analysis simply considers not only the initial investment but also the lifetime operation and maintenance costs. It may actually be feasible to pay higher initial cost if one saves in operational expenditures.

In flotation, for example, research shows that roughly 60-80% of the total life cycle costs are spent on energy, while the initial investment comprises less than 10%. As a result, if a small saving in investment is achieved by compromising energy efficiency, it can quickly turn into big losses in operational costs.

The relevant cost factors for a flotation plant are investment, energy, reagent consumption, and maintenance. The chart below shows the breakdown of these factors, based on typical ownership costs of a large mechanical flotation machine (100-200 m^3) over a 25 year lifespan. Investment costs have been based on the purchase of flotation technology only since the variation in infrastructure, installation and assembly costs is significant.

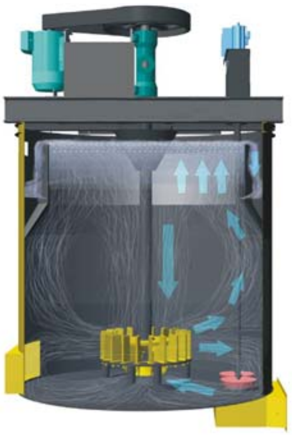


The breakdown strongly suggests that the most significant life cycle cost item in flotation operations is the cost of electricity. Thus the operational expenditures are heavily influenced by the energy price and the energy efficiency of the equipment used for production. Energy prices are obviously based on prevailing market forces and outside of a site's control – however the purchase of energy-efficient flotation technology is not. If we look at the energy efficiency we find that three aspects are critical:

1. Air dispersion
2. Rotational speed of the mechanism
3. Component wear

1. Air dispersion

Optimal air dispersion is one of the basic requirements for good metallurgical performance. Plants operating with forced air cells have often noticed that the best results are achieved using individual and varying air feed rate in each cell. In traditional flotation mechanisms, the air feed is limited by the reduction of power draw and mixing, or by reduced dispersion of air, making the froth surface unstable and causing the froth to collapse. Outotec's new rotor and stator design, FloatForce™, further extends the maximum air feed limit compared to other existing designs. As a result, the cell surface is steady in all situations and the pumping rate of the mechanism is only slightly affected by air. Because of the flat power curve, less power is needed when the mechanism is operated with little or no air. This allows smaller motors and benefits both in investment and operating costs because of the more efficient operation of the motor.



FloatForce® has also been designed with independent slurry and air slots, therefore pumping is independent of air addition, ensuring air dispersion at all pumping rates. Site test results have also shown further advantages such as increased bubble/particle interaction, increased bubble/surface area flux and optimal bubble size distribution. One benefit is that FloatForce® technology can also be retrofitted onto existing equipment, as well as being available on new cells.

2. Rotational speed

In addition to the power transfer ratio of the drive mechanism, the rotational speed of the rotor is an important factor in electrical energy consumption.

Studies on variable-speed drive (VSD) mechanisms have been conducted indicating that a reduction in the rotor speed may be possible without reducing the metallurgical performance of the flotation cell.

The rotational speed has a significant effect on the power draw of the mixing mechanism. The relationship can be simply expressed as:

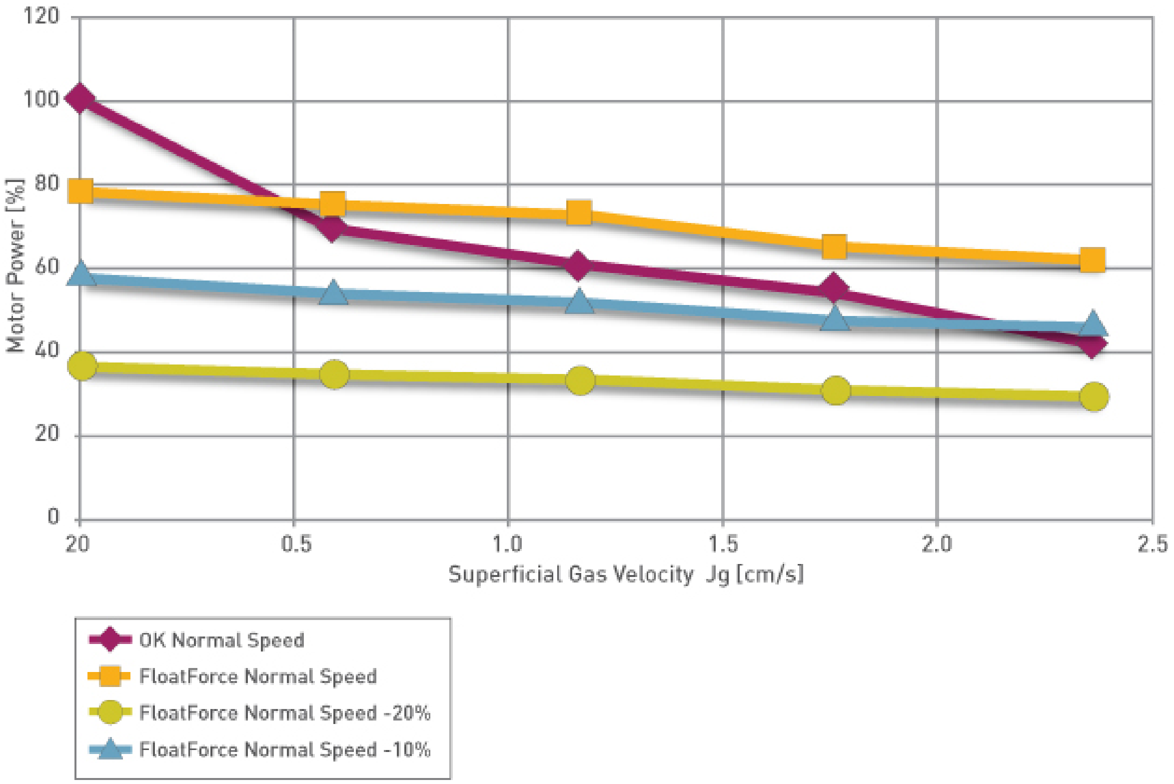
$$P = \frac{1}{\eta} \cdot p \cdot Q$$

Where P is the power draw, η is the hydraulic efficiency of the mechanism, p is the pressure difference generated by the mixing mechanism, and Q is the volume flow rate through the mixing mechanism.

The pressure difference over the mixing mechanism is proportional to the rotation speed squared and the volume flow rate is directly proportional to it. Thus the power draw of the mixing mechanism is proportional to the third power of the rotation speed. Consequently, a minor reduction in rotation speed may have no effect on process performance but a significant effect on the energy consumption. For example, 10% reduction in rotation speed roughly equals to 27% reduction in power draw.

A drive mechanism that enables the adjustment of the rotation speed may produce significant savings in electricity consumption. Outotec's research centre have conducted studies which have shown that a variable speed drive may have payback time of a only few months, if the process allows optimization of rotation speed.

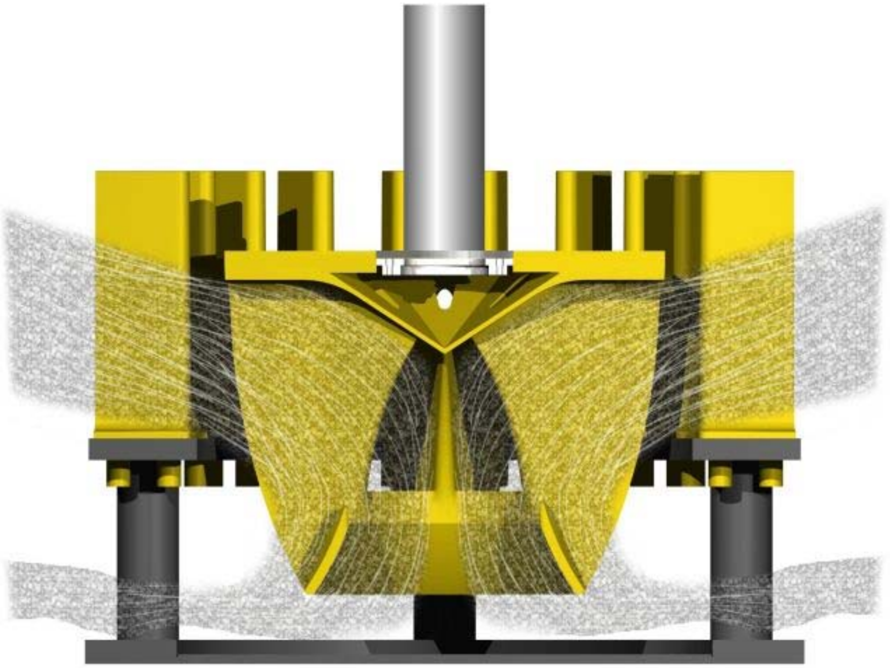
The potential of the recent improvements can be illustrated in a simple chart. Typical power draw curves of a flotation cell equipped with VSD and FloatForce® mechanism and a cell with conventional fixed speed drive with the old OK-mechanism are presented in Figure 6. The main benefit of the new arrangement is the possibility to adjust the cell during normal operation. Float cells typically operate with Jg values in the range of 0.5 to 1.5cm/s where we see the ability to reduce the speed can provide significant power savings.



3. Component wear

The key mechanical aspect for flotation process efficiency is the proper condition of critical wear components. Missing or inferior rotor or stator parts make the cell surface wavy and cause the froth to collapse. Air dispersion is reduced and decreased pumping causes sanding. Experience has shown that non-standard or copied spare parts often have a shorter wear life and in some cases decrease the metallurgical efficiency.

One of the benefits of the FloatForce® is the modular design of the stator. This ensures merely the parts requiring maintenance or replacement can be quickly and easily changed, as opposed to replacing the complete stator.



CFD-generated diagram of slurry flow. Advanced design methods ensure longer wear life

Using CFD and focusing on issues such as the critical flow area, the new stator was designed to resist traditional wear patterns, the wear being just on a small, well defined area. This minimised friction losses and impact angles, thereby ensuring less wear and longer life.

Modular design – safer, faster, more economical

As each blade can also be separately maintained, this allows safer and easier handling (less hauling in confined spaces), faster installation and less equipment downtime. The replacement of the blades for one stator, for example, can take 30-40 minutes.