With over 100 years of development, advances in flotation technology and controls have been substantial. New technology can be used to replace or improve existing equipment, leading to greater levels of efficiency, usability, reliability, stability, and flexibility. There are also many tools (simple and complex) nowadays to understand flotation equipment inefficiencies.

In this two-part article, we will firstly focus on one initial simple step - laboratory testing.

**Flotation profitability factors**
Before you begin laboratory testing you need to consider factors that affect your flotation profitability. Flotation can be a complicated separation process. There are various factors affecting the plant flotation performance, for example:

1. Water quality – residue reagents in process water
2. Ore type – especially changes in ore body
3. Grinding performance – without the correct mineral liberation and PSD it will be difficult to achieve your recovery targets
4. Reagents – selected for the ore type and dosed adequately to achieve target recovery
5. Process equipment – responsible for creating the ideal flotation conditions, with bubble particle attachment and froth transport being crucial
6. People/operators – this, in many cases, is the most important, experienced operators and maintenance crews are critical

**Laboratory testing - a simple assessment tool**
When there is concern over metal recovery, you should begin with laboratory testing. The final flotation tails can be sampled directly from the plant and tested. This approach removes the effect of water quality, ore type, grinding and reagents from the analysis.

When sampling, it is important to take a representative sample of the stream, with no bias in the particle size distribution. Once the sample is transported to the laboratory, a ‘hot’ float test can be conducted immediately (hot means no additional reagents and floated at a similar feed density to the plant). Once the tests and data analysis is complete, the results benchmark the main process equipment.
It is common knowledge that laboratory testing produces better recoveries than the plant. However, the following ‘rule of thumb’ can be applied. If the lab result indicate ≥30% floatable material is in the final plant tails, then further investigation and possible equipment upgrades may be required. If the lab results indicate <30%, then a mineralogy evaluation should be conducted to understand the maximum theoretical recovery for the targeted grind size.

If the curve shows that the target recovery is possible, then an investigation into other reagents types or review of the water quality should be conducted.

In the following two examples, data has been generated from site investigation due to client concerns on plant recovery.

Example 1 - bulk sulphide operation

<table>
<thead>
<tr>
<th>Current plant performance</th>
<th>Lab performance</th>
<th>Expected plant performance</th>
<th>Improvement target</th>
</tr>
</thead>
<tbody>
<tr>
<td>% S</td>
<td>% S</td>
<td>% S</td>
<td></td>
</tr>
<tr>
<td>Rougher circuit feed</td>
<td>9.23</td>
<td>3.11</td>
<td>9.23</td>
</tr>
<tr>
<td>Rougher circuit conc</td>
<td>16.55</td>
<td>26.00</td>
<td>16.55</td>
</tr>
<tr>
<td>Rougher circuit tails</td>
<td>3.11</td>
<td>2.84</td>
<td>1.85</td>
</tr>
<tr>
<td>Sulphur recovery</td>
<td>82%</td>
<td>91%</td>
<td>90%</td>
</tr>
</tbody>
</table>

This example is a bulk sulphide operation where the sulphur recovery was 82% and the tails grade was 3.1% sulphur. The client’s targeted recovery was 85% or above. A sample of the final tails was floated in the laboratory for 4 mins. It was found that 80% of the sulphur in the tails was recoverable by flotation. Our challenge was then deciding what proportion of this 80% should be recovered in the main plant. The approach adopted was to review the kinetic rate data. The graph indicates after 1 min of flotation time, 50% sulphur recovery was achieved. Thus, the material appears to be relatively fast floating. We hypothesised that the main flotation plant should be able to recover this fast floating material. If we achieved the following, the plant sulphur would increase to 90%, resulting in an improvement of 8%. We classified this example as a major opportunity for the client to increase revenue and as a result we recommended an investigation into the process equipment.

Example 2 - Copper operation

This example illustrates a different scenario and is from a copper operation. The reported client recovery was 92% and the client’s target was 93% or higher. A sample of the plant tails was floated again in the laboratory. The result indicated that 37% of copper in the tails was recoverable by flotation. In this particular case we did not have kinetic rate data but instead recovery by size data. We know that coarser and finer sized particles are typically more difficult to recover in flotation circuits so we reduced the expected recovery in these size fractions. You can see in the table the initial improvement target was 2.9%. However after the recovery by size results were reviewed, this was downgraded to 1.3%. For this particular example, the 1.3% increase would be classified as a minor opportunity for the client to increase revenue through equipment upgrade. However it should be noted that revenue is dependent on the feed tonnage. In some large copper operations, (say 240ktpd) even a half percent improvement recovery equates to 14.5 million USD per annum increase in revenue. Depending on the upgrades, the return on investment can still be attractive.

These examples have given some ideas on how to evaluate the process equipment and set recovery targets. In general, when undertaking equipment upgrade projects, the recovery target should be conservative to ensure the success of the project.

What next?

Testwork can be an easy and relatively inexpensive tool and is a key first step to increasing your revenue. When you have completed your testwork and the process equipment is the main contributing factor to inefficiencies, what will be your next steps? Determining what has caused these inefficiencies is next on your list. The five common areas to investigate would include residence time, slurry mixing, froth mobility/velocity, air dispersion and process control. These topics will be covered in more detail in the next issue of our e-newsletter.

If however, you already want to hear more on these five areas, please listen to our free webinar “Boosting flotation profitability with modern technology”.

To listen to full webinar visit www.outotec.com/webinars
WEBINARS

Our free webinars continues! A few of the latest include:

BOOSTING FLOTATION PROFITABILITY WITH MODERN TECHNOLOGY
The focus is on 'flotation modernizations and upgrades,' and their vital importance in improving plants and processes operating under the current pressure of the mineral processing industry. Outotec will explore the latest developments in flotation, introducing some simple tools to make preliminary assessments.

SIMULATION OF MINERALS PROCESSING CIRCUITS
Here we discuss simulation history and terminology. We introduce the use of simulation in personnel training, ramp-up optimization, process control and what simulation can do for our futures.

IMPROVING GOLD PROCESSING WITH HYDROMETALLURGICAL SOLUTIONS
Typical challenges in gold processing are increased processing of refractory raw materials, remote locations, tightened safety and environmental regulations as well as high operating costs.

Here we will cover the following areas:
- What are typical challenges in gold processing?
- How can these challenges be addressed?
- Real cases how hydrometallurgical technologies have improved gold processing

FLOTATION SAMPLING SERIES
This three-part series focuses on sampling in minerals processing, covering both theory and practical approach, including best practices and process insight.

Three seminars include:
1. Introduction to minerals processing sampling.
2. From sampling to simulation of flotation process.

Link to webinars http://new.outotec.com/company/about-outotec/webinars/