Maintaining recovery and ensuring availability and sustainability while keeping costs under control is challenging. Our tailor-made flotation solutions maximize your return on investment by enabling gains in throughput, grade, and recovery, with minimized environmental impact. Our automation solutions keep your equipment running reliably, reduce variations in end-product quality, and reduce additive and chemical consumption.

**OUTOTEC FLOTATION TECHNOLOGIES**

**BENEFITS**

- Proven metallurgical superiority
- Minimized capital expenditure through optimum cell size and minimal footprint
- Reduced operational cost through efficient hydro-dynamics, robust design, and advanced materials
- High availability through ability to handle fluctuating feeds and oversized materials
- Safe, easy operation and maintenance
HARNESS THE POWER OF OUR EXPERIENCE

With expertise based on over 100 years in flotation technology, and over 10,000 flotation cells installed around the world, Outotec has the experience you need to maximize your operations’ productivity and efficiency.
Outotec provides tailor-made flotation packages with support services, modular process sections, and even whole concentrators.

MAXIMUM EFFICIENCY

Our wide range of cell sizes enables plants to be more compact, economical, and efficient. Fewer units in a flotation plant lead to substantial savings in capital expenditure, while our reliable equipment delivers high availability and contributes to a rapid return on investment.

A LIFETIME OF SUPPORT

We offer solutions for the whole life cycle of your flotation plant, from installation and commissioning services to modernizations and upgrades.

TAILORED SERVICE

Each and every flotation operation is unique and when you choose Outotec as your services partner, you are partnering with an organization that is committed to understanding the precise needs of your business.
OPTIMIZED PERFORMANCE AND PRODUCTIVITY

Our expertise at your service
Achieving and maintaining optimal recovery of valuable minerals is not something that happens by chance. Designing a new flotation process, or choosing the right equipment for an existing process, requires experience and a deep understanding of minerals processing and metallurgy. Our solutions are designed in our R&D centers by experts specialized in minerals processing, metals production, and technology development. Using state-of-the-art laboratories and pilot plants for the most demanding test work, our specialists help you evaluate the best options for your process and make informed decisions for the entire life cycle of your plant.

Designed for your productivity
The productivity of your process has a direct effect on the profitability of your operations. Our decades of experience working with metals and minerals processors around the world has enabled us to develop some of the most innovative and productive flotation technologies on the market. For example, by improving flotation hydrodynamics and pumping performance at high air dispersion rates, our FloatForce technology enhances particle recovery in the flotation cell, while also reducing power consumption and the risk of sanding.
Modernization to unlock your plant’s full potential

If you are operating aging equipment, improving your process efficiency – and profitability – means a difficult choice between investing significant capital in new equipment, or modernizing your existing equipment. Our comprehensive range of tailored flotation modernization packages brings measurable value in three key areas:

- **Product recovery** – flotation upgrades that produce higher froth recoveries
- **Plant availability** – design improvements that employ more durable materials and which make maintenance easier and more cost-efficient
- **Operational costs** – technology improvements that improve the energy efficiency of your process

Life-cycle support and beyond

Our extensive service portfolio and customized solutions cover all phases of your flotation plant’s life cycle. We handle engineering and procurement (EP), engineering, procurement, and supervision (EPS) or engineering, procurement, and construction (EPC) projects for flotation plants. Our service scope is always tailored to meet your unique business challenges and to have maximum impact on your performance and productivity. We can help you with everything from increasing productivity, product quality, energy efficiency, and recovery rates to improving water conservation, asset availability, and environmental compliance.
TANKCELL FLOTATION CELLS – PROVEN, HIGH-PERFORMANCE TECHNOLOGY
Outotec TankCell® offers superior flotation performance, optimized fines, and coarse particle flotation with cell sizes up to 630 m³. The cells are easy to operate, low on power and air consumption, and allow for a modular layout.

TankCell flotation units are built to last, with components and electrical equipment selected for maximum operating life. For instance, Outotec rotors and stators have proven to be the most wear-resistant available. The wide range of cell sizes enables a compact, economical, and efficient plant design without the risk of short circuiting, even in today’s high-tonnage operations. Fewer units mean substantial savings in construction costs, piping, cables, instrumentation, and auxiliary equipment.

Outotec FloatForce®
Mixing mechanism performance has a direct impact on the three key areas of flotation: metallurgical performance, energy consumption, and operating costs. The Outotec FloatForce mixing mechanism delivers measurable value in all of these areas. By improving flotation hydrodynamics and pumping performance at high air-dispersion rates, FloatForce enhances particle recovery in the flotation cell while also reducing power consumption and the risk of sanding.

Froth management solution
Using a launder with the correct design and orientation for your specific application helps to ensure optimal metallurgical performance. We can design a froth management solution that maximizes your flotation cell performance and gives you greater metallurgical control with the optimal lip length, froth area, and transportation distance for the specific cell duty, plus robustness for feed grade and capacity changes.

**BENEFITS**
- Lower energy consumption
- Reduced plant footprint
- Less auxiliary equipment
- Proven superior metallurgical performance for all flotation applications
- Easy operation and maintenance

**CASE**
**Project**
CSA mine, Australia, 2010

**Application**
Copper

**Challenge**
Engineering, design, installation, and commissioning of three Outotec TankCell 30s within tight schedule.

**Solution**
TankCell technology, and a strong partnership between CSA and Outotec Services projects teams.

**Benefits**
- Optimized technology, leading to higher recoveries
- Improved control system (accommodating fluctuations in feed grade and throughput)
- Low maintenance and no flotation cell downtime since installation
- Major energy savings (40%)

The FloatForce mechanism maximizes bubble and particle contact in the shear zone between the rotor and stator.
COLUMNCELLS – SUPERIOR METALLURGICAL PERFORMANCE FOR FINE ORES
Get the best flotation performance for your fine ores with the Outotec® ColumnCell, across all duties in flotation circuits. ColumnCell units are available in a wide range of sizes, allowing high capacity and the most appropriate heights for different duties. The absence of moving parts and the options for different types of lining minimizes maintenance and enables high availability.

Flotation of fines requires special features: higher energy collection with smaller bubbles to guarantee a good recovery; a less turbulent regime / good slurry distribution to avoid bypass; and a fluid, deeper and more selective froth to generate a better product quality. Outotec ColumnCell is designed to provide all these features, tailored to the ore type, and the requirements and specifications of each project.

High concentrate and froth quality
The structure of the columns, with higher height, allows the development of deeper froths. With the column’s wash water system, water is distributed over the froth in a soft, homogeneously dispersed manner. This flow of water washes the froth and displaces most of the entrained hydrophilic material back to the pulp.

Outotec ColumnCells use a perforated tray to distribute the water. The number and size of holes are calculated to promote the appropriate distribution of water over the froth. With the use of wash water, a more fluid froth develops, with a higher grade of hydrophobic material, which means a better concentrate in direct flotation or a higher recovery in reverse flotation. The internal launders design promotes the optimal lip length, froth area, and transportation distance for collection of froth, increasing froth recovery.

Easy and safe operation
Outotec ColumnCell is easy to operate, the main controls are the level and air flow rate. Accurate instrumentation is used for air control. Level control can be performed by standard sensors or with the LevelSense, an advanced control system developed by Outotec that provides the most precise measurement of slurry and froth levels.

Outotec SonicSparger™ systems for enhanced recovery
Outotec offers two types of SonicSparger systems; SonicSparger Jet and SonicSparger Vent. The number and position of the spargers are calculated to provide a homogeneous air distribution across the column, resulting in the best bubble surface area to enhance recovery.

BENEFITS
- Superior metallurgical flotation performance for fine ores
- High concentrate and froth quality
- High availability and high capacity
- Easy and safe operation
- Reduced energy consumption and small plant footprint

SonicSparger Jet is based on ultrasonic injection of air or air plus water.

SonicSparger Vent is based on the Venturi principle.
SKIMAIR FLASH FLOTATION – IMPROVED OVERALL RECOVERY
Reduce overgrinding, improve overall recovery, and reduce the impact of feed grade fluctuations with our solution for flash flotation.

Outotec SkimAir® is a flotation cell designed to be installed in a flash flotation role in the grinding circuit. The cell is typically installed in the hydrocyclone underflow stream to capture any sufficiently liberated, fast floating particles that may have reported there. Due to the higher specific gravity of sulfide and precious metal containing minerals, there is a strong likelihood that they will report to the hydrocyclone underflow stream despite being in a suitable size range for flotation. Recovering these particles from the circulating load prevents them from reporting back to the mill and being overground.

Excess grinding of these particles can result in slimes that are difficult to recover in downstream flotation circuits. Recovering these particles from the circulating load can boost overall plant recovery, improve mill capacity, and also lead to improved concentrate dewatering characteristics. Employing flash flotation in the circulating load has also been shown to stabilize the flotation feed grade to the main circuit.

Tough flotation duty handled by smart technology
Since Outotec first implemented SkimAir technology in the 1980s, continuous technological improvement has made it the world’s leading flash flotation technology. Not only has the SkimAir cell improved in wear technology to meet the demands for a flotation cell operating in the grinding circuit, but a number of design concepts have made it flexible enough to suit differing ore types and plants. The top-outlet design allows SkimAir technology to be employed with minimum impact on the water balance in the grinding circuit. Configuration options such as flash roughing have allowed it to be used in circuits where recovery from the cell is paramount, while not compromising on concentrate grade.

BENEFITS
- Reduced overgrinding
- Improved overall recovery
- Smooths out feed grade fluctuations
- Increased mill throughput
- Improved dewatering

CASE
Project
Didipio, Philippines, 2012

Application
Copper and gold

Challenge
To improve copper and gold recovery

Solution
SkimAir 500 cell

Benefits
- 8.8% increase in gold recovery
- 12.6% improvement in copper recovery
OUTOTEC FLOTATION CPLANT – REDUCED CAPITAL INVESTMENT

A cost-effective, flexible solution for tackling challenges with project budget or schedule overruns, constantly changing capacity needs, or operations in remote locations.

The Outotec cPlant is a low-capacity flotation plant equipped with Outotec FloatForce® mixing mechanism and Outotec TankCell® technologies. The plant has been developed for projects handling up to two million tons of ore per year, with cell capacities of 1.5, 3.6, or 11 m³. Its prefabricated modules are easy and cost-effective to transport and install, and can be quickly connected to your process – keeping investment costs low.

The Outotec cPlant is the ideal solution in any of the following situations:
• You are facing challenges with an investment project running over time and budget
• Your capacity needs are constantly changing
• You are processing ore from a smaller deposit in a remote location
• You need to replace old, poorly performing flotation cells
• You require temporary production capacity during a brownfield modernization project in order to minimize production losses
Outotec cPlant can also enable economically feasible processing of old tailings containing significant amounts of valuable metals. Once the ore body has reached the end of its economic life, the plant can be transported to a new location.

The plant is delivered pre-installed in a steel frame that is the size of a standard shipping container, and includes piping, electrical cables, and trays. As the plant is delivered with most of the supporting structures integrated into the prefabricated unit, it requires only basic foundations. Outotec cPlant can be tailored according to the needs of your specific application, with the option to add new modules and reconfigure standard ones as required.

**BENEFITS**

- Reduced EPC project costs compared to a conventional flotation plant
- Up to 20% lower capital investment
- Requires 30% less labor resources
- 95% of pre-commissioning and installation done prior to delivery
- Minimal civil engineering work required
AUTOMATION SOLUTIONS TO STABILIZE AND IMPROVE PROCESS PERFORMANCE

Whatever level of automation you require, Outotec has the optimal solution for your plant. Automation facilitates easy scalability, starting from a basic non-automated process to advanced process controls that work independently to improve and maintain peak performance.

<table>
<thead>
<tr>
<th>Without automation</th>
<th>With basic process controls</th>
<th>With advanced process controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unstable process</td>
<td>• Stable process</td>
<td>• A significant improvement in process performance</td>
</tr>
<tr>
<td>• Fluctuations in end-product quality and process performance</td>
<td>• Early detection of process disturbances enables timely response</td>
<td>• Process performance optimized 24/7</td>
</tr>
<tr>
<td>• Inconsistent operating practices between shifts</td>
<td>• Up-to-date process performance data available 24/7</td>
<td>• No performance variation between shifts</td>
</tr>
<tr>
<td>• Inability to react quickly to process disturbances</td>
<td>• Process data history systematically stored</td>
<td>• Ability to react quickly to ore and other input changes</td>
</tr>
<tr>
<td>• Labor-intensive monitoring and reporting</td>
<td>• Operators have more time to focus on core tasks</td>
<td>• Automatic reporting</td>
</tr>
<tr>
<td></td>
<td>• Reduced risk of human error</td>
<td>• Remote troubleshooting and support from Outotec specialists</td>
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</tbody>
</table>
In order to maintain profitability in the face of challenging commodity prices, it is imperative to improve the efficiency of your existing assets. This means ensuring smooth plant operation, developing a flexible process that can cope with ore changes, maintaining equipment reliability, and minimizing start-up losses. Furthermore, high personnel turnover can make it challenging to retain core skills and competencies. You may also face challenges with the high cost of consumables and the increasing demand for more comprehensive production reports.

**THE OUTOTEC AUTOMATION PORTFOLIO**

**Outotec LevelSense™**
Accurate and robust online slurry level measurement for a stable flotation process, early reaction to, or prevention of, froth collapses, and minimized operational costs.

**Outotec FrothSense™**
Measures several essential properties of froth appearance to provide consistent information 24 hours a day for process control and optimization.

**Outotec Courier® on-line elemental analyzers**
Quick, accurate assaying enables immediate reaction to changes in the metallurgical behavior of the flotation circuit.

**Outotec PSI® Particle Size Analyzers**
Real-time particle size information improves average grinding circuit capacity and availability.

**Outotec sampling solutions**
With over 50 years of experience in sampling, Outotec has an extensive range of slurry samplers for practically all applications.

**Advanced Control Tools (Outotec ACT)**
Outotec ACT advanced process control provides a platform for building customized control applications. For the flotation process, these include ACT froth speed control, EXACT level control, and grade-recovery control solutions.

**Outotec Proscon® Automation System**
Our advanced process control tool helps you to better control the overall process and monitor and adapt to changes.

**Outotec Chena® Chemistry Navigator**
Patented technology visualizes process measurements and chemistry to improve the efficiency of production processes.

Effective, automated, and integrated control can help you solve all of these challenges, while also minimizing the risk of production disturbances and downtime, and supporting compliance with strict health, safety, and environmental standards.

Our proven automation solutions cover virtually every type of flotation and will improve both the efficiency and profitability of your plant. They will ensure that your equipment performs reliably, help reduce variations in end-product quality, and reduce the consumption of additive agents and chemicals.

**CASE**
**Project**
Kevitsa mine, Finland, 2013

**Application**
Multi metal

**Challenge**
A large-scale flotation plant (including 14 300 m³ cells) with a highly variable feed in terms of ore grade, hardness, and content.

**Solution**
Outotec advanced process control with Courier, PSI, FrothSense, as well as ACT froth speed control, EXACT level control, and grade-recovery control, customized to the site’s needs.

**Benefits**
- 1.3% Cu recovery improvement with higher grade when APC was utilized during test work
- Increased process stability
SERVICES AND SOLUTIONS THAT BOOST YOUR PERFORMANCE AND PRODUCTIVITY

Maintaining the efficiency of your operations and protecting your profitability with the right technology is critical to staying ahead of the competition. As your service partner, Outotec ensures that every solution has the maximum impact on performance and productivity throughout your flotation plant’s entire life cycle.

We are committed to understanding the unique business needs of your flotation operation. We collaborate with you to develop a safe, sustainable, and reliable service solution based on our deep process knowledge, leading technologies, and operational and maintenance expertise.

**Full service portfolio**
Our extensive service portfolio and customized solutions cover all phases of your flotation plant’s life cycle – from maintenance inspections and spare parts to modernization and upgrades. Your tailored performance solution will be delivered with mutually agreed targets and shared responsibilities to meet your long-term goals. We can build solutions for individual projects or ones based on broader service agreements.

**Outotec services**
- Maintenance Services
- Spare and Wear Parts
- Upgrades
- Advisory Services
- Operations Services
- Remote Services
- Training Services

**BENEFITS**
- Improved health and safety
- Improved environmental efficiency
- Improved equipment and process efficiency
- Decreased operating cost
- Improved capital efficiency
SERVICE HIGHLIGHTS FOR OUTOTEC FLOTATION PROCESSES

Advisory services
Prioritize the most cost-efficient ways to improve safety, reliability, availability, and productivity based on in-depth information from equipment inspections, studies, audits, and assessments conducted by Outotec experts.

For example, an Outotec Maintenance Inspection provides detailed information of flotation cells’ current condition and helps to identify possible issues early, minimizing unwanted downtime. The Inspection report summarizes the status of the equipment as well as upcoming service needs and gives recommendations for their maintenance and operation.

Spare and wear parts
Enjoy peace of mind with our high-quality spares that ensure the safety and functionality of your equipment. High-quality spare and wear parts are available for all our flotation technologies.

To optimize availability and response times, we have developed an electronic spare parts catalog. Our eCatalogue offers one-stop access to customized spare parts data and helps to identify equipment spare parts or solutions, with illustrations for assemblies and related parts.

With customized solutions, we can facilitate your maintenance planning and budgeting, help you improve equipment reliability and availability, and optimize spare and wear parts consumption and costs.

Upgrades
Restore and enhance your operational performance with our comprehensive portfolio of equipment upgrades and technology modernizations. These can include:

- FloatForce upgrade
- Flotation cell replacement
- Flotation cell retrofit
- Air control upgrade
- Level control upgrade
- Froth management upgrade
- Drive unit upgrade
- Service platform upgrade

Maintenance services
Keep your plant in perfect working order and plan for the future with confidence with our comprehensive range of maintenance services. Our services range from basic equipment upkeep to full maintenance management and shutdown services.

CASE
Project
Yamana Gold, Brazil, 2016

Application
Gold and copper

Challenge
The flotation circuit had poor availability due to heavy sanding, and poor performance in terms of copper and gold recovery. Substantial maintenance was needed due to heavy corrosion but limited shutdown time was available.

Solution
- In-depth metallurgical assessment identified large improvement potential in the flotation plant
- Retrofit of 2 lines of 5 160 m³ flotation cells with 2 lines of 5 TankCell 160s
- A full turn-key delivery: shutdown planning, scheduling and management, and manufacturing of steel works in Outotec Brazil’s own service center
- Advanced operator training with Outotec’s Virtual Experience

Benefits
- Greater stability and control of flotation cells for increased process optimization
- Decreased energy consumption with Outotec cells (40%)
- Minimized production losses during installation and commissioning
- Minimized sanding increases flotation circuit availability, leading to increase in production
- Improved flotation performance, in terms of copper and gold recovery
Outotec provides leading technologies and services for the sustainable use of Earth’s natural resources. As the global leader in minerals and metals processing technology, we have developed many breakthrough technologies over the decades for our customers in the metals and mining industry. We also provide innovative solutions for industrial water treatment, the utilization of alternative energy sources and the chemical industry. Outotec shares are listed on NASDAQ OMX Helsinki. www.outotec.com