PRIMETALS TECHNOLOGIES

HYBRID FLOTATION
FOR BENEFICIATION

primetals.com

STATE-OF-THE-ART BENEFICIATION
FACING THE CHALLENGES OF FINER GRINDING AND LOWER-GRADE ORES

YOUR CHALLENGE

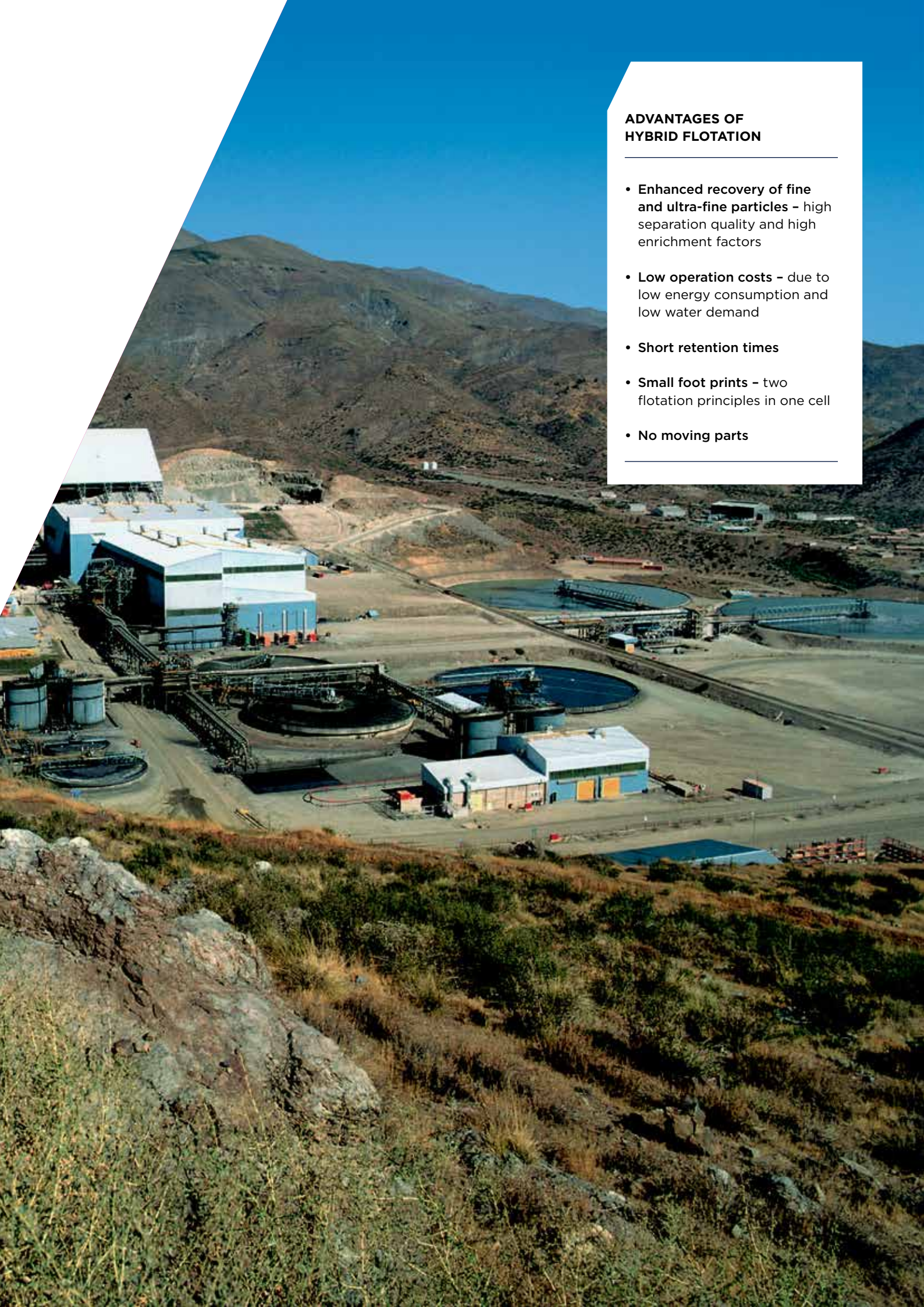
How can your mine meet the continuing demand for raw materials such as coal, copper and other precious metals? How can it operate more economically and at the same time offset rising energy prices? How can you meet customer requirements with regard to the highest grades and best quality? The challenges are clear. It will be necessary to boost production, cut costs and save energy while ensuring maximum safety to the personnel and guaranteeing stability in the machinery, materials and mine. The conservation of natural resources such as water and air is also of great importance.

OUR SOLUTION:

Hybrid Flotation technology. This technology faces the challenges of finer grinding and lower-grade ores. It combines a pneumatic spray-in principle with a column method. The pneumatic component creates very small gas bubbles and inserts high kinetic energy. Feed pulp and gas are mixed inside the mixing chambers of the ejector system before being sprayed into the cell. This results in the increased recovery of fine particles.

One of the principal differences between Hybrid Flotation and conventional cells is the mixing of feed pulp (slurry) and gas (air or nitrogen) in mixing chambers of the ejector system before it is sprayed into the cell. This considerably enhances the frequency of contact between the gas bubbles and very fine particles as well as the ability of the particles to stick to these bubbles.

Furthermore, Hybrid Flotation does not have an impeller system. This means no wear and friction in the rotor/stator system. Another consequence is the ability to create finer gas bubble sizes and the advantage of not having to provide power to an impeller drive. Additionally, the cell technology is characterized by significantly lower gas consumption.



ADVANTAGES OF HYBRID FLOTATION

- **Enhanced recovery of fine and ultra-fine particles –** high separation quality and high enrichment factors
- **Low operation costs –** due to low energy consumption and low water demand
- **Short retention times**
- **Small foot prints –** two flotation principles in one cell
- **No moving parts**

WHY HYBRID FLOTATION?

Challenge

IMPROVE YIELD

- Increase overall recovery and selectivity
- Maximize concentrate product grade

PROCESS LOW-GRADE ORES

- Increasing demand expected from market
- Decreasing head grades and finer dissemination
- Reduce foot print, but increase throughput capacity

ENVIRONMENTAL COMPATIBLY

- Reduce energy consumption and CO_2 emmission
- Water availability and consumption in dry / remote regions

Impact on flotation

IMPACT ON FLOTATION

Flotation as the most important separation technique for the processing of sulfide minerals.

In beneficiation of iron ores, flotation is gaining more and more importance since non-desired minerals such as silicates, sulfurous and phosphorus minerals can only be removed to a satisfactory extent by applying flotation technology on finest particle size fractions.

Flotation required to recover especially small particle fractions as well as to reduce high re-circulation loads.

Target is to continuously reduce power consumption, having effect on both OPEX and CO_2 emmission.

As water is “only” a carrier medium for solids and conditioning chemicals, flotation is required to work with highest possible solid content in the pulp.

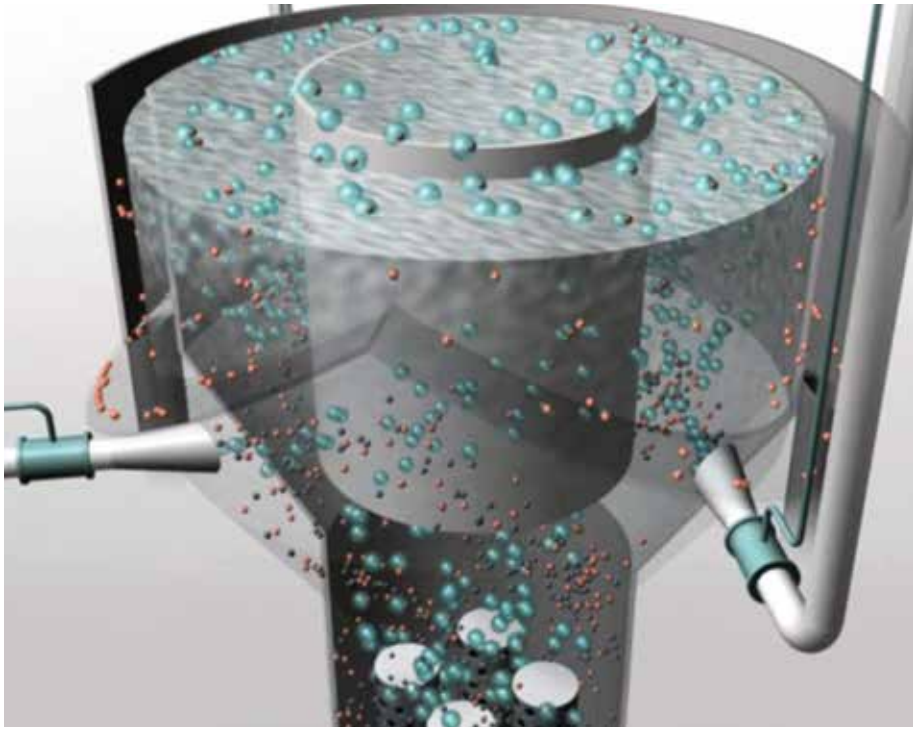
The optimum device

THE OPTIMUM DEVICE

Flotation systems must meet the following requirements:

- Provide the right gas amount and disperse it
- Form optimized bubble size distributions (diameters, total bubble surface area, bubble surface area flux, lifting speed and force) and ensure best possible sterical distribution of the gas bubbles
- Provide the kinetic energy required to enable a best possible attachment rate between particles and bubbles
- Enable a quick and secure discharge of valuable particles in the froth product

HYBRID FLOTATION CELL
COMBINING TWO PRINCIPLES IN ONE MACHINE

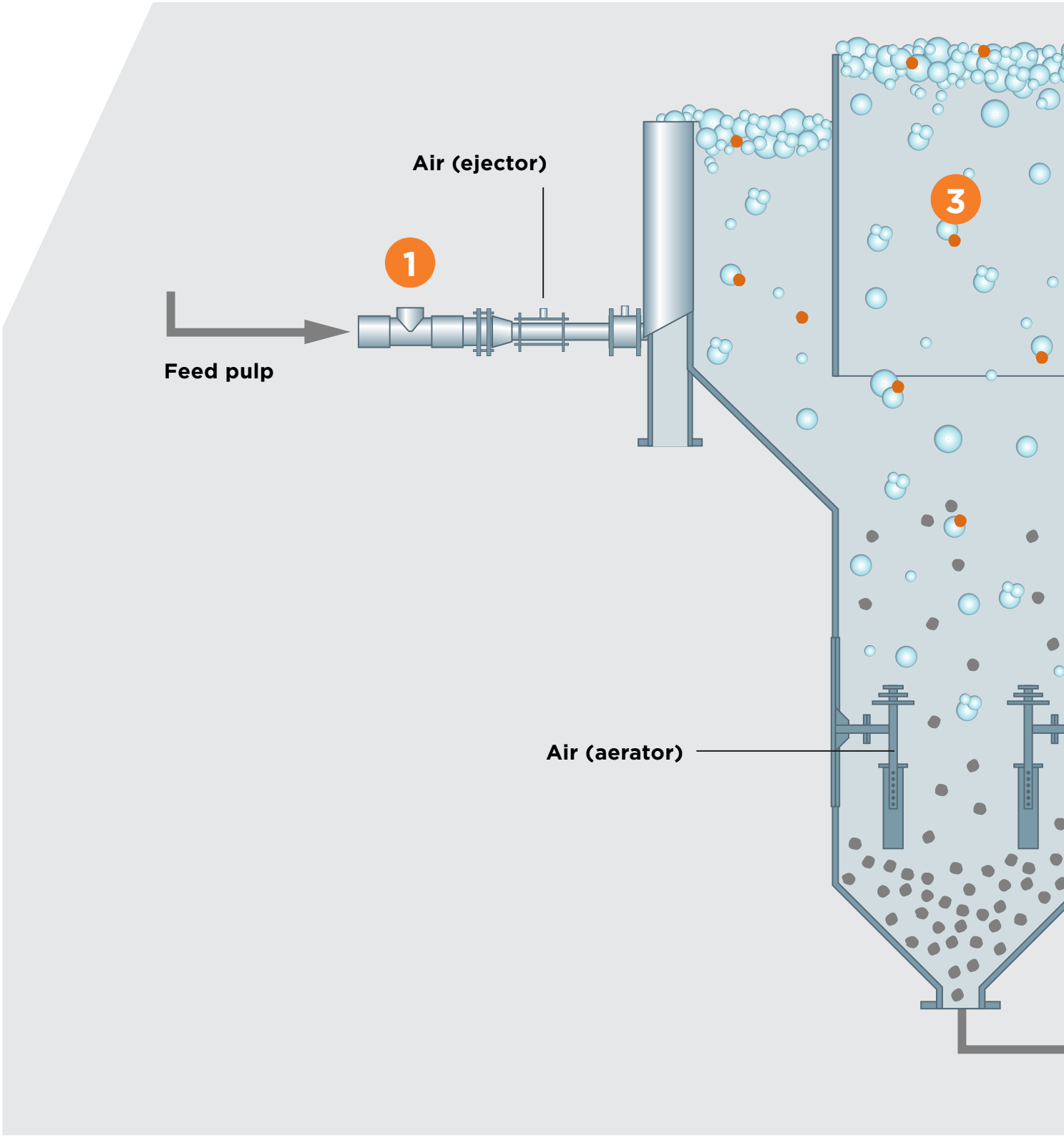


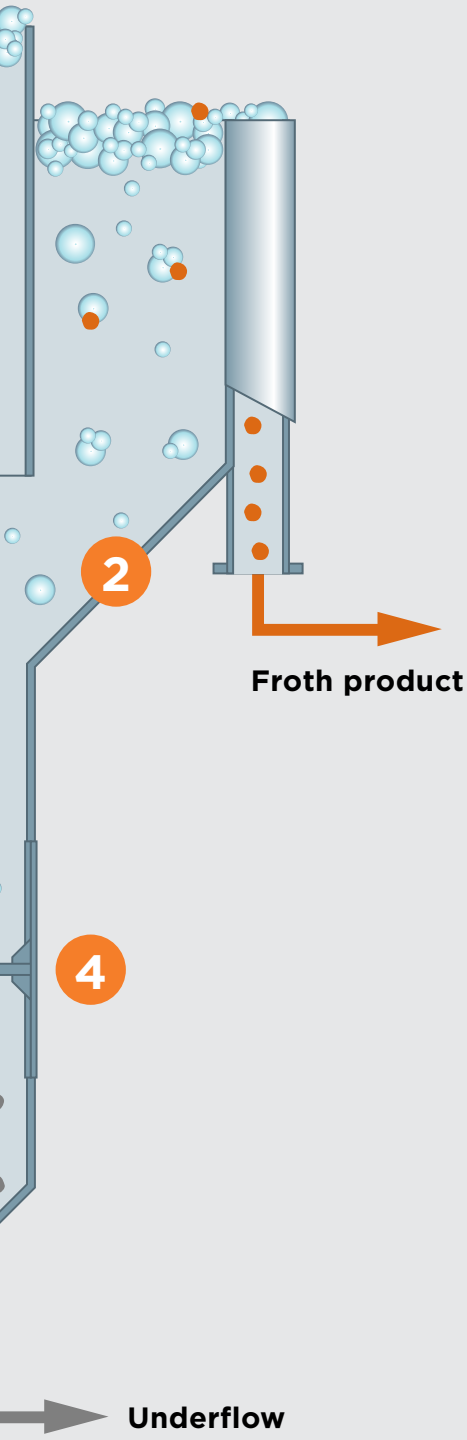
HYBRID FLOTATION

The combination of two priciples allows the the usage of cells in rougher and cleaner circuits. The lack of a stirring device minimizes energy consumption. The foot print is significantly reduced as compared to conventional equipment.

Pneumatic flotation	+	Column flotation	=	Hybrid flotation
Turbulent flows and high kinetic energy are the most important physical principles to provide best fine and ultrafine particle flotation.		The integrated column flotation provides high selective separation, especially for coarser particle sizes. The column principle is free from wear parts and features the lowest operational costs.		A combination of both principles adresses the total range of particle sizes. Short retention times lead to a quick discharge of the froth product.

HYBRID FLOTATION PROCESS



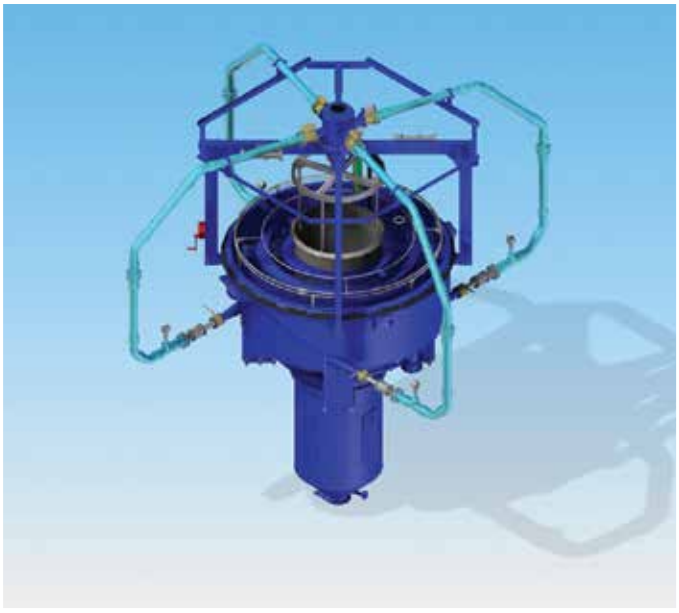


HYBRID FLOTATION

1. **First stage (Pneumatic Section):** Pneumatic principle with three-phase ejectors; especially capable of recovering fines and achieving high enrichment factors
2. **The circular movement** in the Pneumatic Section together with the conical intersec- tion between the upper and lower section leads to a centrifugal effect
3. **Second stage (Column Section):** Column principle with bigger gas bubbles catches coarse particles not attached in first stage at lower enrichment factors and significant- ly increases total recovery
4. **Adjustability of the lower aerators** ensures best possible positioning for optimization of bubble-particle contact

HIGHER CONCENTRATION OF VALUABLE MINERALS

Hybrid Flotation cell installation



3D layout of Hybrid Flotation cell

PROCESS

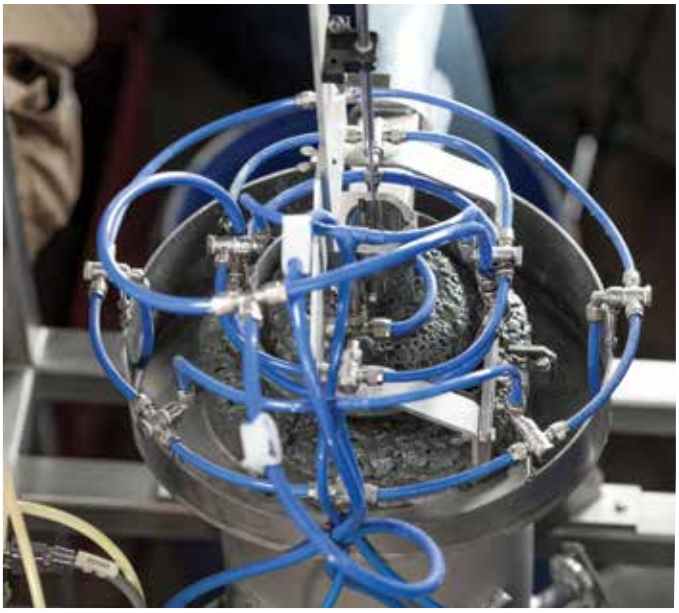
This process results in a higher concentration of valuable minerals in the generated froth product. In reverse flotation applications such as cleaning of fine iron ores, the high fines flotation capability of non-desired minerals such as silica, phosphorus or sulphurous minerals lead to highly purified iron-ore concentrates in the underflow.

The Hybrid Flotation technology is adaptable to base metals such as copper, molybdenum, nickel and zinc as well as precious metals such as platinum, gold, silver and even industrial minerals. The Hybrid Flotation cell operates with a significantly reduced power requirement when compared with conventional systems. Gas and water demands are also significantly reduced.

DESIGN FOR ENVIRONMENT

Ecological design is an integral part of our product planning and development process. Among other things, it calls for use of separate and distinct material fractions, ease of disassembly, a reduction in the number of components per product, durability, low energy requirements during manufacture and day-to-day use, and the avoidance of hazardous substances.

Our system of environmental management enable us to take a holistic and all-encompassing approach to environmental protection spanning the entire product life cycle from product planning to end-of-life recycling and disposal.



Laboratory Hybrid Flotation cell in operation

Laboratory Hybrid Flotation cell

MAIN BENEFITS

- Enhanced recovery of fine and ultra-fine particles • High enrichment factors
- Short retention times in the cell
- Low operation costs
- No moving parts
- Small foot prints
- High separation quality
- Two flotation principles in one cell
- Low energy consumption
- Low water demand

FLOTATION BEHAVIOR TEST

Due to the natural variability of ores, it is often necessary to test flotation behavior to elaborate the decisive parameters for flotation circuit design and optimization. That is why Primetals Technologies developed the 30 l Hybrid Flotation cell to perform quick and versatile evaluation of hybrid flotation technology for various ores and flotation chemical recipes. Flotation behavior test

EXPERTISE FROM EXPERIENCE
SUCCESS STORIES WITH HYBRID FLOTATION

Pre-rougher in coppermolybdenum circuit

CUSTOMER
Antofogasta Minerals, Minera Los Pelambres, Moly Plant

TYPE OF SYSTEM
Hybrid Flotation

OUR SOLUTION
Installation of two 16m² units as pre-roughers at the start of the selective process and upgrade of the produced concentrate in only one cleaner step to final concentrate quality without recirculation into the existing multi-stage cleaner process.

THE RESULT
Higher Moly recovery by floating fines and ultra-fines directly out from the plant feed.

Piloting at the customer plant

CUSTOMER
Compañia Minera Doña Ines de Collahuasi, Moly Plant

TYPE OF SYSTEM
Hybrid Flotation

OUR SOLUTION
A semi mobile version of the Hybrid Flotation cell provides the possibility for industrial-scale tests in operations. The cell comes with all peripheral equipment needed for operation.

THE RESULT
Successful tests at Collahuasi's Punta Patache operations as a pre-rougher showed best performance in fine particle recovery together with improved enrichment.

Rougher-cleaner combination

CUSTOMER
Codelco Division Andina, Moly Plant

TYPE OF SYSTEM
Hybrid Flotation

OUR SOLUTION
An efficient combination: While the 16m³ hybrid flotation cell works as a rougher in the Codelco Andinas Molybdenum plant, the 2m³ hybrid flotation cell works as cleaner and produces final Moly concentrate.

THE RESULT
Primetals Technologies flotation technology optimizes the existing plant to allow for changes in minerals grades.

Primetals Technologies Austria GmbH
A joint venture of Mitsubishi Heavy Industries and partners

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