Metso:Outotec

# Copper SX-EW technology

**Benefits**

- High process performance
- State-of-the-art process technologies
- Project and plant optimization
- High availability and working ergonomics
- Maximum safety and environmental hazard control

## Our solution for leaching, solvent extraction and electrowinning

Metso Outotec offers optimised solutions and complete plants for the production of high-quality copper cathodes through innovative leaching, solvent extraction and electrowinning technologies.

Our technology package for leaching-SX—EW plants may contain basic and/or detailed engineering as well as proprietary and key equipment supply.

# A complete technology solution from a single partner

**Metso Outotec offers**

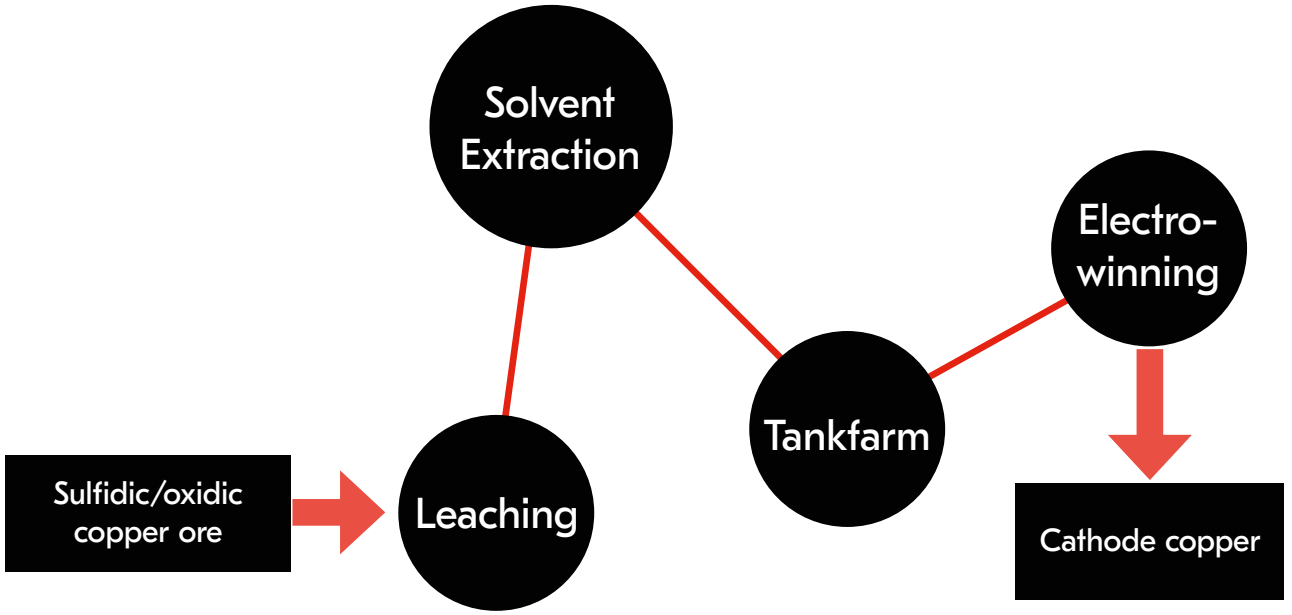
- Innovative technologies for leaching-SX—EW plants
- Feasibility studies
- Basic and detailed engineering
- Proprietary and key equipment supply
- Commissioning and start-up services
- Spare parts and maintenance services
- Plant audits, retrofits and machine upgrades
- Tailor-made process solutions

Metso Outotec's early involvement in a project makes it possible to find the most profitable metallurgical solution from mine to metal production. We provide world leading technologies, technology selection expertise, feasibility studies, basic and detailed engineering, equipment supply, training, erection supervision and start-up assistance, as well as follow-up and technical support services. This comprehensive involvement enables Metso Outotec to guarantee process performance for the whole production line.

Metso Outotec is in the unique position of being able to provide solutions for the whole copper production chain. From cost effective, environmentally friendly leaching, through state-of-the-art solvent extraction to highly reliable automated electrowinning, Metso Outotec has the entire mine to metal process covered.

**Extensive research and development**

Metso Outotec's long history in the operation and development of hydrometallurgical solutions for leaching, solvent extraction and electrowinning processes has made us a world leader in these fields. All processes have been developed with a view to improve production efficiency and to maximize profitability. We also pay special attention to health and safety issues and the minimization of environmental impact of our technologies. With extensive research facilities and resources, we ensure that the latest advances in technology are available when needed — and when they benefit you most.




Outotec is the only company to offer a complete solution for the whole copper production chain, from mine to metal.

**Considerable savings in operating costs**

When a single technology partner provides a combined leaching-SX–EW plant, the unit processes can be integrated and optimized to provide a reliable and economical process.

The design of the plant is compact and the layout is efficient, leading to lower construction and operating costs and a shorter start-up time. We provide guarantees for the plant's capacity, the quality of the produced copper and operational parameters for the process equipment. Our long-term commitment to customer service minimizes operating risks throughout the lifetime of the plant.

**Leaching: the start of the process**

A number of leaching process options are available for the hydrometallurgical treatment of ores and concentrates.

Our solution may include mineral processing, innovative reactor and process technology for atmospheric leaching either in sulphate or chloride media and pressure leaching, depending on the raw materials. This may be followed by Metso Outotec's SX and EW technology.

A total process design byOutotec facilitates economical copper production, especially from low-grade deposits that would not otherwise be viable using traditional metallurgical processes.

## Metso Outotec packages include:

**Leaching:**

- Leaching process with proprietary equipment
- VSF™ solvent extration:
- Dispersion Overflow Pumps (DOP®)
- SPIROK® mixers
- Metso Outotec settlers with DDG® fences and launders
- Loaded organic tank, rich electrolyte after settler as coalescer units
- Organic treatment units

**Tankfarm with proprietary equipment:**

- Electrolyte circulation and composition control system
- Tankhouse:
- Cathode stripping machines
- Permanent cathodes
- Lead anodes
- Tankhouse cranes and bales
- Polymer concrete cells
- Busbar systems
- Acid mist capture systems
- CellSenseTM systems
- Process automation

# Optimized solvent extraction

**In the solvent extraction phase of the process, incoming pregnant leach solution (PLS) is concentrated and purified, and a pure electrolyte is then used in electrowinning to produce chemically and physically high quality copper cathodes.**

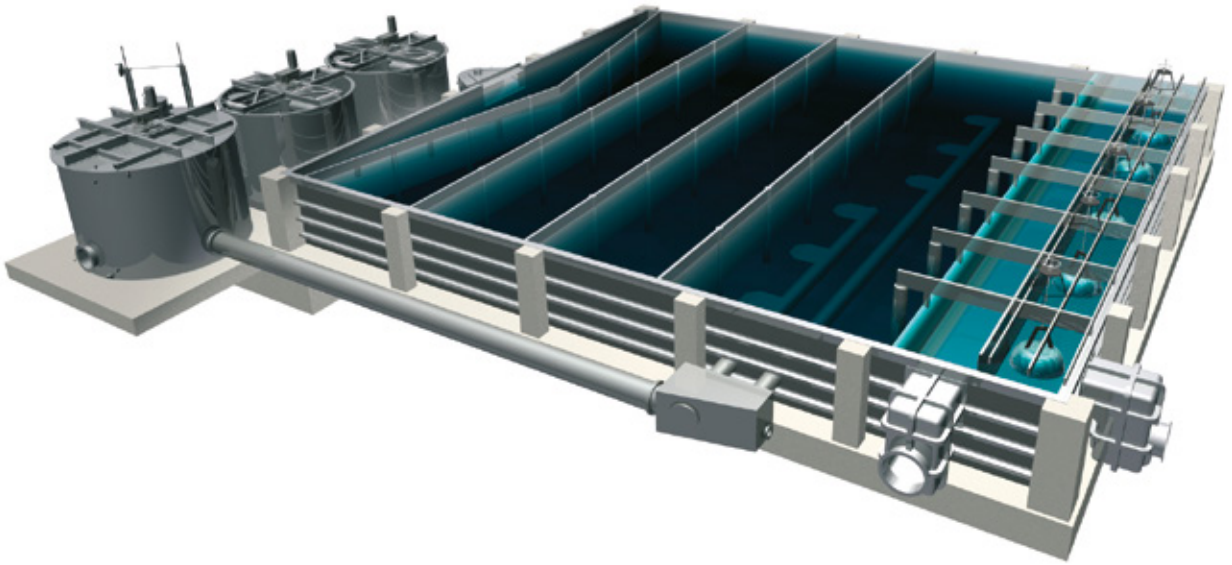
### A history of dedicated research and development

For nearly 30 years, Metso Outotec has been developing its wide range of solvent extraction technologies, delivering both equipment and processes to its customers in the metals processing industries. This long history of dedicated research and development began in response to increasing demands for lower operation and investment costs, together with more reliable and stable production where health & safety issues are given high priority in plant design. The results have been impressive, and today the plants that use our groundbreaking Vertical Smooth Flow (VSFTM) mixer-settler technology are among the most profitable in the world.
Since launching the VSFTM technology for copper applications more than a decade ago, Metso Outotec has gained a leading market share of new copper solvent extraction capacity.

### The VSFTM Solvent Extraction technology

VSFTM technology is the result of the continuous development of mixer-settler technology. It has been designed to run at minimum operating costs, ensuring high profitability even during times of copper price fluctuations. The scalability of this technology makes it exceptionally well suited for both larger and smaller plants, as it enables low entrainment values and very stable performance even with fluctuating flow rates.

SX pilot unit.



VSF™ stands for Vertical Smooth Flow, which describes the operation of a SPIROK® helical tube agitator in a mixing tank. An extremely high agitator/tank volume ratio requires less energy and ensures a smooth flow pattern with uniform mixing conditions.

**The main benefit of the VSFTM technology is that minimal entrainment levels can be achieved without compromising reaction and settling rates.**

**This brings value in terms of**

- Low investment costs, due to smaller settler sizes and less organic inventory
- Low operating costs, due to low copper and reagent losses
- Flexibility, enabling constant cash flow during varying leaching conditions

A further benefit of the scalable nature of VSFTM solvent extraction technology is that it leads to a more compact plant layout and a reduced need for organic first fill inventory, as often only one VSFTM train is required. This leads to significant savings in investment and operating costs.

In the VSFTM technology, pumping and mixing are carried out as separate processes. The VSFTM technology has three key elements: a Dispersion Overflow Pump (DOP®), a set of two SPIROK® mixers, and a proprietary settler design including DDG® fences.

The basic idea behind the VSFTM technology is to have smooth agitation throughout the SX plant to avoid oxidation of organic and development of overly small droplet size in dispersion. These principles give Metso Outotec's SX plant the flexibility to run in widely varying conditions and to have high trough output with very little organic losses and crud formation.

### Maximum pumping efficiency

Metso Outotec's dispersion overflow pump (DOP®) is the heart of the extraction unit. It is specially designed to pump high flow rates of aqueous and organic solutions with relatively low head and generate the dispersion with optimized and controlled droplet size. The impact of the DOP® unit on stage efficiency is considerable, with performance figures typically approaching 100% found in any VSFTM design.

### High-stability mixing

Mixing has been a crucial element in VSFTM technology's development. The SPIROK® mixing technology enables mixers to operate with minimal mixing energy and pumping function, ensuring gentle, uniform mixing and minimal crud formation. The VSFTM mixing unit typically consists of two cylindrical mixer tanks, baffled and equipped with double helical SPIROK® stirrers.

### Flexible and efficient settling

Metso Outotec's deep-dense-dispersion (3D) settlers are typically equipped with DDG® fences, as well as a guiding fence at the feed end of the settler. The 3D settler technology enables high feed flows, low organic inventory and extremely low entrainments.

The VSFTM technology has proved its value from laboratory scale to large high capacity heap leach SX–EW operations.

SPIROK® maintains smooth mixing with optimal reaction surface.

Dispersion Overflow Pump generates optimal droplet distribution.

# Compact design allows maximum production with low operational costs

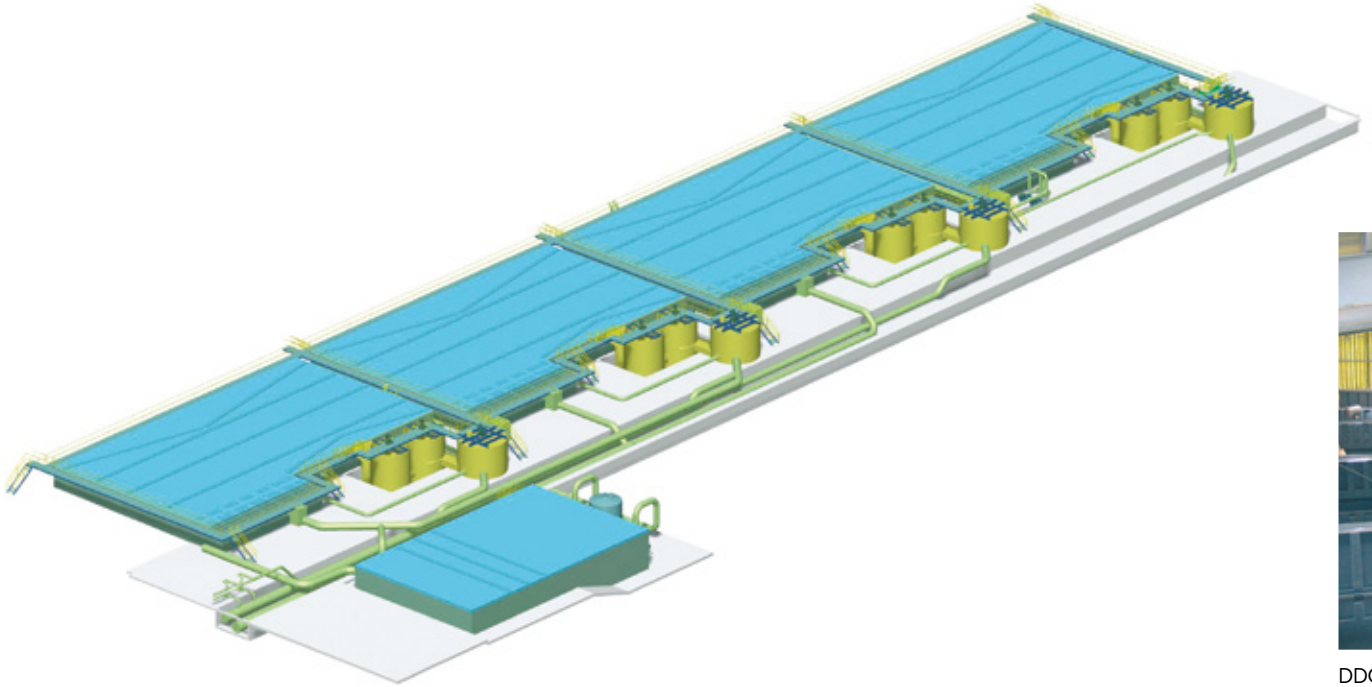
In order to minimize the footprint and to simplify the flow sheet of an SX—EW plant, we use the OutoCompact layout in our process design. In the OutoCompact layout, a loaded organic buffer is held in a loaded organic (LO) tank that is an active piece of process equipment in an SX-track. The wash water circulation and coalescence gates of the LO tank prevent contaminated aqueous residues being carried through the stripping circuit to the electrowinning circuit.

The OutoTrack configuration option enables flexible PLS flow rates to even double by changing from a series to a parallel feed pipeline connection. This is an option when the pregnant leach solution tenor varies/drops.

In certain cases further investment savings can be realised using our latest settler design, the OutoReverse, with in and out flow connections located on one side of the settler.

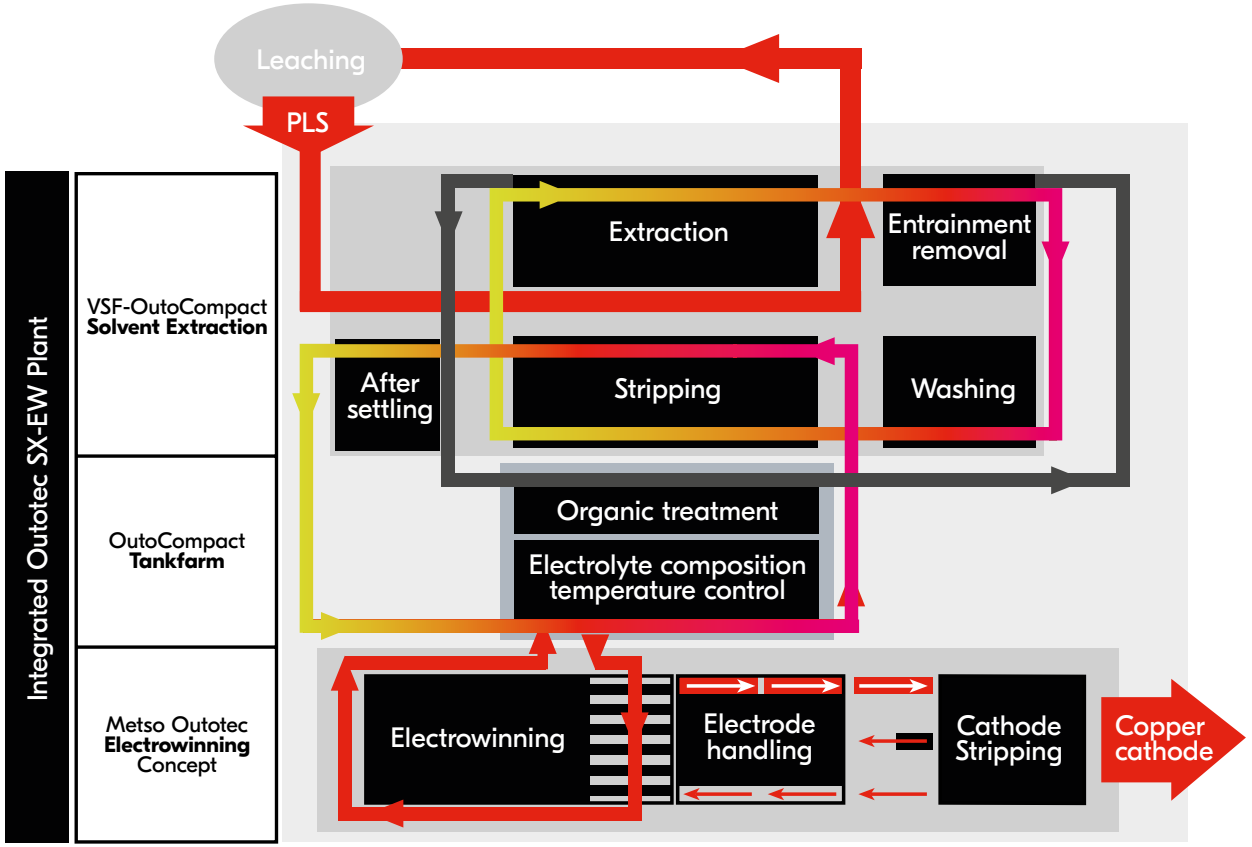
**VSFTM with an OutoCompact settler and layout design enhances your productivity with**

- Lower investment costs
- Lower organic inventory and make-up costs
- Increased health & safety
- Reduced settler area
- Reduced plant area with reduced excavation costs
- Reduced piping costs
- More flexible configuration to tolerate process disturbances
- More stable cash flow over a longer life time



DDG® technology is replacing picket fences.

# Integrated OutoCompact Tankfarm concept




The OutoCompact Tankfarm concept makes a number of conventional tankfarm operations unnecessary, so you no longer need:

- raffinate purification units; due to the low entrainments of VSFTM technology
- loaded organic purification units; because VSFTM technology and the LO-tank in each track ensure the purity of organics recycled to the stripping circuit
- rich electrolyte coalescer units; as VSFTM technology, combined with rich electrolyte after the settler, result in extremely low organic entrainments in the electrowinning circuit.

Our concept gives you significant savings in tankfarm investment costs.

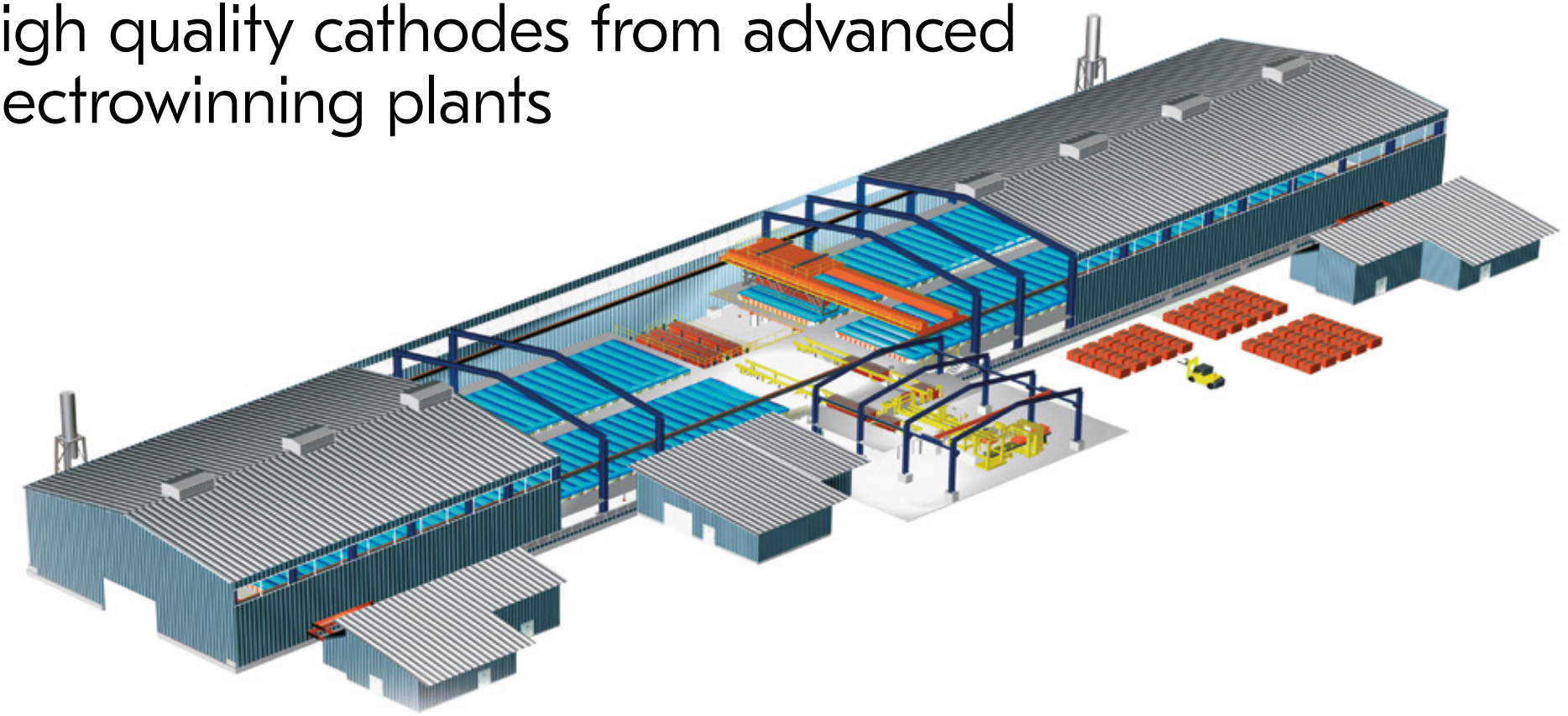
In the OutoCompact track layout, a centralized organic treatment unit is located next to the SX tracks to minimize operations involving organics in the tankfarm. This improves the occupational safety of the tankfarm and reduces fire protection investments.

**An integrated OutoCompact Tankfarm brings savings in investment costs and guarantees secure and economical operations. The benefits further include:**

- Fewer process units
- Less piping
- Fewer excavations
- Smaller fire protected area

The OutoCompact Tankfarm is a link in an integrated plant. The optimal functioning of each link together allows outstanding quality and production guarantees for the entire SX–EW plant.

# High quality cathodes from advanced electrowinning plants



**The value of the Metso Outotec's Tankhouse concept lies in:**

- The high quality of produced copper cathodes
- Reliable process operations and equipment functions
- Savings in investment costs
- Savings in operation and maintenance costs

For decades, Metso Outotec has been the world's leading developer and supplier of tankhouse machines and as a result, our machines can be found in almost all of the world's major copper tankhouses. Our continuous research and development work on tankhouse equipment and processes, as well as our own production experience, has led to a range of impressive new technology developments, specially designed for high performance and cost efficient copper production. Environmental protection and occupational health and safety have been made important aspects for our development work.

The core of electrowinning operations is the material handling technology. Metso Outotec's advanced and proven material handling system bridges mechanical equipment, automation and engineering experience with experienced process metallurgy. Our material handling systems consist of fully integrated material handling cranes, cathode stripping machines, electrolytic cells, busbars and electrodes.

The degree of the machine and the process automation is optimized to the customer's requirements. In addition to reliable production of the highest quality copper, significant savings in electricity, edge strips, cathodes, maintenance, personnel and investment costs are realized.

Metso Outotec's compact tankhouse layout minimizes space requirements and maximizes production efficiency. Our tankhouse machines are compatible with other tankhouse technologies and are suitable for upgrade and modernization projects.

We can offer a complete electrowinning plant to provide reliable and trouble-free operation for the entire life cycle of the plant.

Proven process performance.

Off-gas scrubber captures tankhouse acid mists.

**World-class tankhouse machines**

Our tailor-made tankhouse machines, cathode stripping machines and tankhouse crane systems, can be used with most existing tankhouse technologies, though they are particularly suited to the Metso Outotec's process with state-of-the-art permanent cathodes.

The latest and patented cathode stripping technology maximizes the lifetime of permanent cathodes, especially their edge strips. Only side edge strips are required on cathodes, giving a significantly reduced replacement costs and better trouble-free operation of the plant.

Tankhouse machines can be equipped with numerous automated options. Manual options are also available for smaller capacity plants.

**Advanced electrowinning cell concept**

The design of Metso Outotec's electrowinning tankhouse is based on proven 84-cathode long cell technology. This results in a smaller tankhouse area, which in turn leads to lower construction costs and shorter construction times.

**DoubleContact™ busbar system**

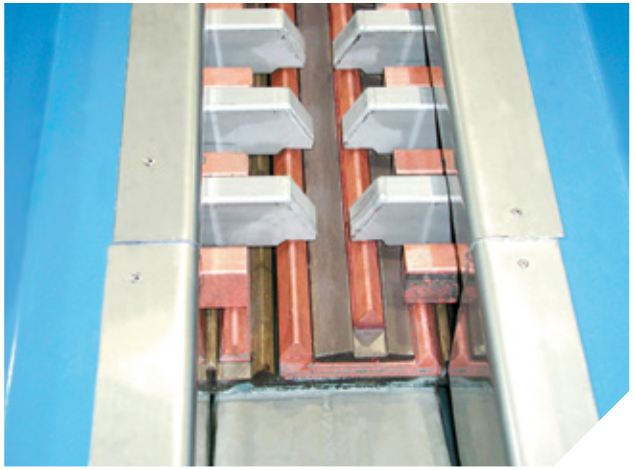
With the innovative DoubleContact™ busbar system, both anodes and cathodes have an electrical contact on both sides. The principal benefit of this technology is a more even current distribution, which in turn leads to reduced energy consumption, a more even cathode weight distribution, and fewer short circuits. Fewer short circuits mean higher current efficiency and better cathode quality, as well as much longer insoluble lead anode life as less damage occurs to the anode's surface. This also extends cell maintenance cycle times.

**Better for the environment, better for people**

The electrowinning plants designed by Metso Outotec have a unique and effective acid mist capture system using cell hoods.

Our acid mist capture system includes an off-gas scrubber, which ensures an excellent atmosphere in the tankhouse, and the lowest possible acid emissions to the environment. As a result, it gives lower operation costs through acid recycling, savings in corrosion-related maintenance as well as improved occupational health and safety. A healthier and safer operating atmos-phere significantly improves employees' work satisfaction.

In cool climates, hoods and scrubbers reduce considerably the amount of general ventilation gas flows, and therefore investment and operation costs. When using hoods the surface of the electrolyte in cells is completely free from floating beads or balls, which can stick on to copper deposit surface. For easy operation of the system, electrode-handling cranes can be equipped with fully automated, semi-automated or manual hood-handling devices. Our expertise brings you long-term safety, work satisfaction, and confidence to operate the plant.



Patented DoubleContact™ busbar system ensures more even cathode weigth distribution.

Advanced automation user interfaces.


State-of-the-art permanent cathodes in laser welding.

**Accurate and modern tankhouse cranes**

Accurate and efficient transportation of electrodes is an essential task in every tankhouse. Metso Outotec ensures that the crane performance, capacity rating and level of automation are tailored to suit the plant flexibility requirements and the customer's needs.

In addition to handling capacity, the high positioning accuracy of the electrodes in the electrolytic cells ensures high efficiency and optimal production to meet today's highest standards.

We work in close cooperation with our partners to develop the performance of their operating plants. This gives us a unique ability to help our customers to select the most suitable technology, taking into account requirements such as:

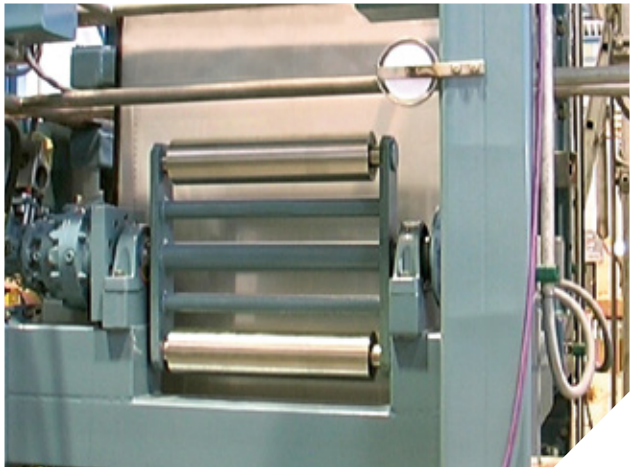
- reliable operation in challenging working environments (acid mist, humidity)
- electric insulation and other safety issues
- suitable levels of automation up to fully unmanned applications
- features of the Pulling Program, including reporting on production figures.

Tankhouse cranes can be equipped with cathode and busbar washing systems, which helps maintain copper quality, fast electrode handling and minimal manual involvement.

The tankhouse cranes handle heavy loads with an accuracy of a few millimeters. At the same time, the cycle time of each motion is minimized in order to prevent the cranes becoming bottlenecks in the production process.

Improved profitability with advanced automation Metso Outotec's Advanced Material Management System helps create reports required for plant operation and copper production.

Our CellSense™ system continuously monitors your copper production in electrolytic cells and enables detection of short circuits at an early stage. As a result the produced copper has better quality, together with reduced lead anode corrosion and electrical energy costs.



New patented detachment unit separates copper deposits reliably, and reduces wear of the edge strips and plate.

Cathode stripping machine in operation.

**Main features of cathode stripping machines:**

- Machine capacities of up to 600 blanks per hour
- Only one machine operator needed
- Compact machine layout
- Simple to maintain
- High reliability and low maintenance costs
- Machine diagnostic monitoring
- Easily synchronized with the tankhouse cranes and with the plant control system

Cathode blanks are marked with ID codes. The performance of each cathode blank can be tracked and optimized based on weighing and/or measuring the surface quality of individual cathodes with machine vision cameras.

**Long-life permanent cathodes**

Our permanent cathodes provide superior strength and performance and are designed to maximize productivity and minimize maintenance. The suspension bar, with a copper core, has a full-length stainless steel jacket, which provides high mechanical strength and excellent corrosion resistance. In addition, the stainless steel jacket means that copper is only exposed at the busbar contact areas. This design allows the possibility to replace a damaged plate and reuse the bar.

The large copper cross section in the suspension bar ensures the lowest electrical losses throughout the lifetime of the cathode. The strong edge strips are designed for a waxless process to reduce maintenance requirements and problems in stripping. They are attached to the vertical sides of the plate with a patented extrusion-weld method.

Our permanent cathode technology ensures reliable and efficient performance for your electrorefining or electrowinning production either in new or existing tankhouse operations.

**Compact cathode stripping machines — a profitable investment**

Cathode stripping machines are an essential and integrated part of the material handling process in the electrowinning tankhouse. Our cathode stripping machines reliably separate deposited copper from cathode blanks with minimal flexing to maximize the lifetime of them and the edge strips.

Machine capacities and degree of automation can be selected according to the customer's requirements. Occupational health and safety aspects have been given high priority in the design phase and our cathode stripping machines fulfill all required safety norms.

**Benefits of permanent cathodes:**

- High mechanical strength
- High dimensional accuracy
- Only stainless steel to stainless steel welds
- High protection against corrosion
- High current efficiency
- Low electrical resistance

Metso Outotec is a frontrunner in sustainable technologies, end-to-end solutions and services for the aggregates, minerals processing and metals refining industries globally. By improving our customers' energy and water efficiency, increasing their productivity, and reducing environmental risks with our product and process expertise, we are the **partner for positive change.**

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Partner for positive change