

Metso:Outotec

Hydrometallurgical nickel and cobalt plants and processes

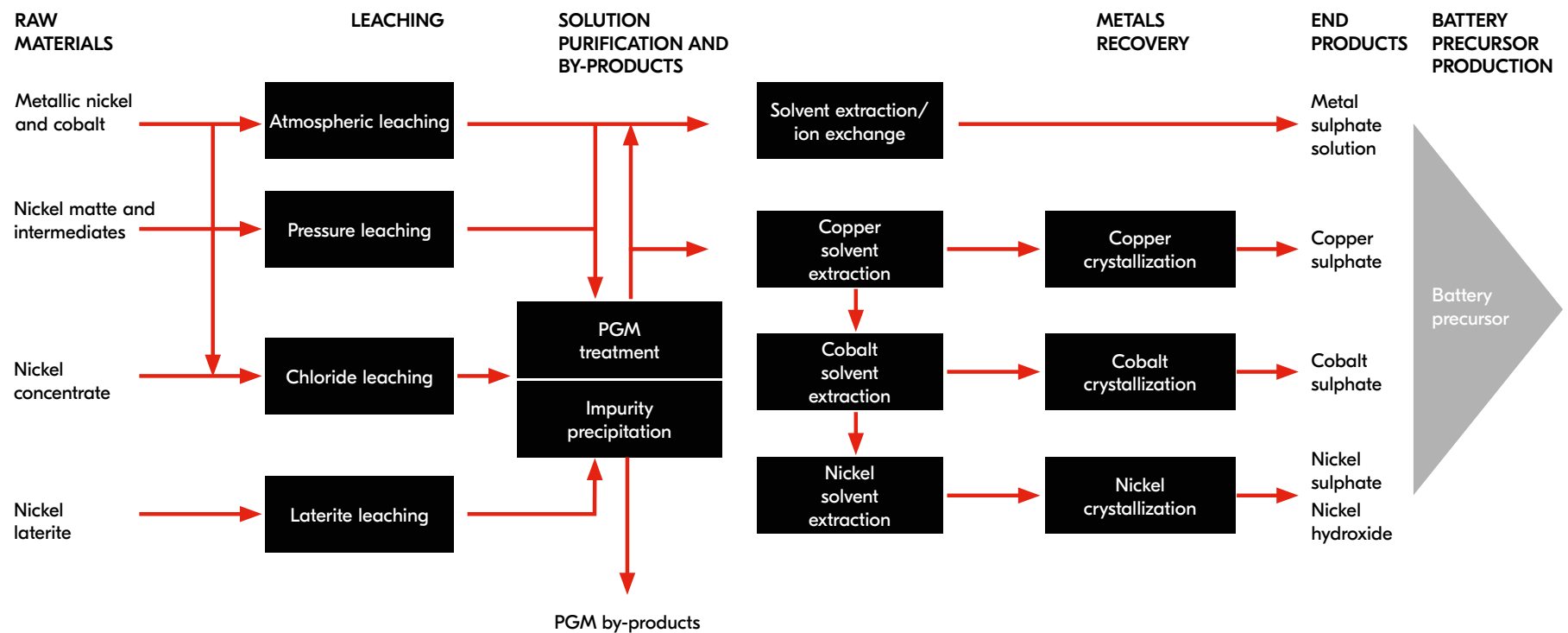
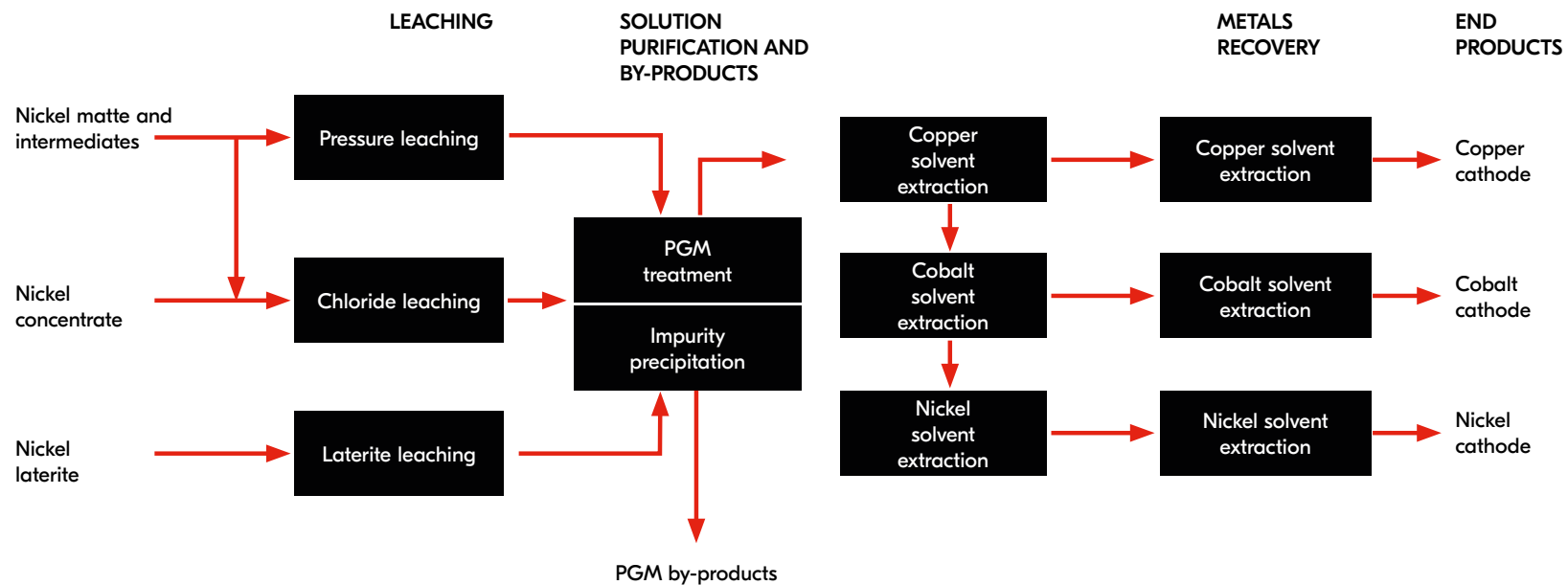
Benefits

- Optimized technology solutions for nickel and cobalt products tailored to raw material and end-user needs
- Unique laboratory facilities and expertise
- Process guarantees
- Technological solutions that minimize the environmental footprint
- One-stop shop: from conceptual design and testing to turnkey deliveries.
- Extensive proven experience in the global nickel and cobalt processing industry



Drawing on our expertise and experience we have developed a wide range of optimized solutions and complete plants that produce high-quality nickel and cobalt products using a wide range of raw materials. We offer innovative and proven leaching, precipitation, solution purification, solvent extraction, and electrowinning technologies, as well as concentrator, sulfuric acid, and pyrometallurgical plants and processes, such as flash smelting, direct flash smelting and converting (DON), Ausmelt nickel smelting and converting, and slag cleaning furnaces.

Our unique technology solutions include laboratory testing, engineering and delivering plants, processes, equipment, and automation, as well as unbeatable service and support. We are committed to co-operating and continuously developing our products and processes with our customers. We always place customer needs and the unique characteristics of their raw materials at the heart of our process design. Particular attention is always paid to safety in both process and equipment design.



Metso Outotec nickel and cobalt technologies:

Beneficiation:

- Physical separation
- Grinding
- Flotation

Leaching:

- Nickel matte sulfate leaching
- Nickel matte chloride leaching
- Nickel concentrate sulfate leaching
- Nickel concentrate chloride leaching
- High copper content nickel matte chloride leaching
- Nickel laterite leaching
- Metallic Ni and Co leaching
- Ni and Co intermediates (hydroxides, sulfides)

Solution purification:

- Iron precipitation and iron residue treatments
- Recovery of precious metals, such as gold, silver and PGM
- Solvent extraction
- Sulfide precipitation
- Hydroxide precipitation
- Gypsum or sulfate removal
- Impurity precipitation for Iron and manganese
- Carbonate precipitation

Nickel and cobalt products

- Cathodes via electrowinning
- Briquettes and powder via hydrogen reduction
- Precipitates via sulfide, carbonate and hydroxide precipitation
- Battery grade crystals via crystallization and sulfate solutions
- Battery precursors

Pyrometallurgical nickel technologies:

- Nickel flash smelting
- Nickel direct flash smelting and converting (DON)
- Ausmelt smelting and converting
- Nickel slag cleaning furnaces
- Ferronickel plant

Sulfuric acid plant

Effluent treatment

Services

Metso Outotec Process Equipment

Metso Outotec Process Automation and Analyzers

- Metso Outotec Procon process control system
- Metso Outotec Courier online analysers

Metso Outotec Hydrometallurgical Equipment:

- Metso Outotec OKTOP Reactors for atmospheric and pressure leaching
- Metso Outotec Thickeners
- Metso Outotec Larox Filters
- Metso Outotec Scrubbers
- Metso Outotec Cooling Towers
- Metso Outotec VSF Solvent Extraction
- Metso Outotec Tankhouse Equipment
- Metso Outotec Courier and OTI Analyzers
- Metso Outotec Procon Process Control System
- Process instrumentation and electrification



From raw material to end product

Metso Outotec is the only technology provider who can offer technology and equipment for the entire nickel and cobalt production chain from mine to metal, with a project scope ranging from equipment packages to turnkey plant delivery. We have several processing alternatives for nickel and cobalt raw materials, ranging from pyrometallurgical to hydrometallurgical approaches.

Not only do our nickel and cobalt processing solutions help you achieve primary end products such as briquettes, cathodes, or battery-grade sulfates, but we can also find ways to recover valuable by-products such as copper and sulfuric acid.



Effective leaching methods

Nickel sulfate leaching

Pyrometallurgically produced nickel matte is leached in atmospheric and pressure Metso Outotec OKTOP reactors with the help of oxygen and sulfuric acid. The leaching circuit typically includes pulping, pre-leaching, pressure leaching in autoclaves, solid-liquid separation, and scrubbing stages. Similar leaching circuits are used for leaching metallic and intermediate nickel and cobalt products.

The leaching process results in an aqueous nickel and/or cobalt sulfate solution. This solution is further treated through iron, manganese, and other impurity-removal and solvent-extraction stages. The solid residue from the leaching is a cake containing potentially precious metals, which can be further treated as a precious metal product.

Nickel chloride leaching

Chloride leaching is an alternative way to treat nickel raw materials. Matte or concentrate is leached in multiple steps at a high acid concentration with hydrochloric acid and oxygen in atmospheric Metso Outotec OKTOP reactors. The solids are removed from the solution with a thickener. The thickener overflow is the pregnant leach solution, which then moves forward into iron and other impurity precipitation.

Nickel laterite leaching

Metso Outotec can perform laterite leaching in HPAL and atmospheric conditions. Depending on your mineralogical requirements, nickel laterite high-pressure acid leaching (HPAL) solutions are available, using Metso Outotec OKTOP autoclaves and other pressure equipment. Nickel laterites can also be leached in several co-current stages in atmospheric reactors, depending on the ore mineralogy.

A viable option for concentrating and washing the leaching solution is an Metso Outotec counter-current decantation circuit. Optimal tailings treatment and effluent processes are critical in this process, which is designed and engineered for maximum safety and minimum environmental impact.

Extensive portfolio of advanced solution-purification and metals-recovery solutions

We offer an extensive selection of processes for solution purification and by-product recovery for nickel and cobalt production. During leaching, other metallic components, such as iron, manganese, zinc, and copper are dissolved and must be removed before nickel and cobalt recovery. The quality of the solution purification process is key to producing both chemically and physically superior end products with high yield.

The Metso Outotec VSF solvent extraction process has impressive references in metals production and is now also available in modular form as Metso Outotec VSFX. Metso Outotec VSF-X has multiple operating references in the processing of Cu, Ni, Co, Zn, and Ni solutions.

For nickel, cobalt, and by-product recovery, our portfolio includes electrowinning, precipitation, hydrogen reduction, and crystallization technology options, enabling nickel and cobalt to be recovered at the purity level needed, for example in battery manufacturing.

Iron and manganese removal

Iron can be removed either in atmospheric or pressure conditions. The selected method is typically linked to the chosen leaching method, with the most typical iron products being jarosite, hematite, or goethite. With the help of our expertise in iron precipitation, nickel and cobalt producers benefit from environmentally acceptable iron residue storage or further use. Manganese, an impurity often associated with these raw materials, can be precipitated as manganese oxide either together with iron or separately.

From iron and manganese removal, the pregnant leach solution can be fed to solvent extraction or other solution purification stages such as ion exchange for further purification and concentration.

Solvent extraction

In solvent extraction the pregnant leach solution is concentrated and purified, and pure aqueous nickel and/or cobalt sulfate solutions are produced for the next processing steps. A number of impurity metals such as iron, aluminum, zinc, cadmium, copper, calcium, manganese, and magnesium may also be treated and removed in the same solvent extraction plant as nickel and cobalt. All metals for which an extraction reagent is available can be extracted using advanced Metso Outotec VSF solvent extraction technology. After solvent extraction other valuable metals like copper can typically be recovered, for example as cathodes or sulfide precipitates. Other impurities can be sustainably recovered in the desired form or safely discharged to landfill.

Modular VSFX solvent extraction plant



Other precipitation processes

Leach solution purification as well as nickel, cobalt, and by-product recovery can also be achieved via various precipitation, oxidative precipitation, neutralization, cementation, and reduction technologies using Metso Outotec OKTOP reactors. Our technologies are a fully integrated part of the plant and provide environmentally sustainable precipitation with minimal consumption of reagents. Metso Outotec OKTOP equipment can be fitted with internal heating or cooling baffles for heat exchange. The mixing solution is optimized to control maintenance costs and provide smooth operation, taking in consideration process requirements such as scaling control.

Precious metals recovery

Nickel sulfide ores or matte may contain valuable amounts of precious metals. Metso Outotec offers process solutions to recover these metals, for example from the anode slime produced in an electrolyrefining plant. This type of precious metals recovery consists of leaching and alternate Metso Outotec Kaldo Furnace and Metso Outotec TROF Converter stages, as well as stages to recover silver, gold, and platinum-group metals (PGM).

Nickel metal recovery via electrolysis

Metso Outotec is a trusted partner for delivering efficient, productive, and safe electrowinning plants with optimized cathode and cell sizes, current densities, busbars, and an automatic material flow of cathodes. Metso Outotec CellSense electrolytic cell performance monitoring system and Coated Titanium Anode (CTA) technology offer significant benefits for tankhouse operations. Metallic nickel powder can also be produced in autoclaves by using hydrogen reduction technology. The new Metso Outotec anode-in-a-bag technology for nickel electrowinning offers an environmentally friendly electrowinning process by significantly reducing nickel emissions and notably improving working conditions for operators. This technology also reduces operating costs and enables fully automated process and oxygen recovery from the electrowinning process.

Nickel and cobalt sulfate production for battery precursor manufacturing

High-purity crystallized nickel and cobalt sulfates (and chlorides) are typically used in the battery industry as a starting point for cathode active material preparation. These nickel and cobalt sulfate crystals are dissolved to form a purified metal sulfate solution from which the cathode precursor manufacturing starts.

The metal sulfate crystallization process includes evaporation and crystallization stages, potentially with stages for additional impurity control. Depending on the raw materials and the required leaching, solution concentration, and purification stages, the produced nickel and cobalt sulfate solutions may also be used directly for precursor manufacturing without the crystallization step in between.

Metso Outotec has references for battery-grade metal sulfate production and together with selected partners can supply all related technology from technology packages to turnkey deliveries. Metso Outotec can also provide technology to develop your precursor manufacturing production chain, from optimized raw materials selection and processing to precipitated metal hydroxide precursor materials.



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