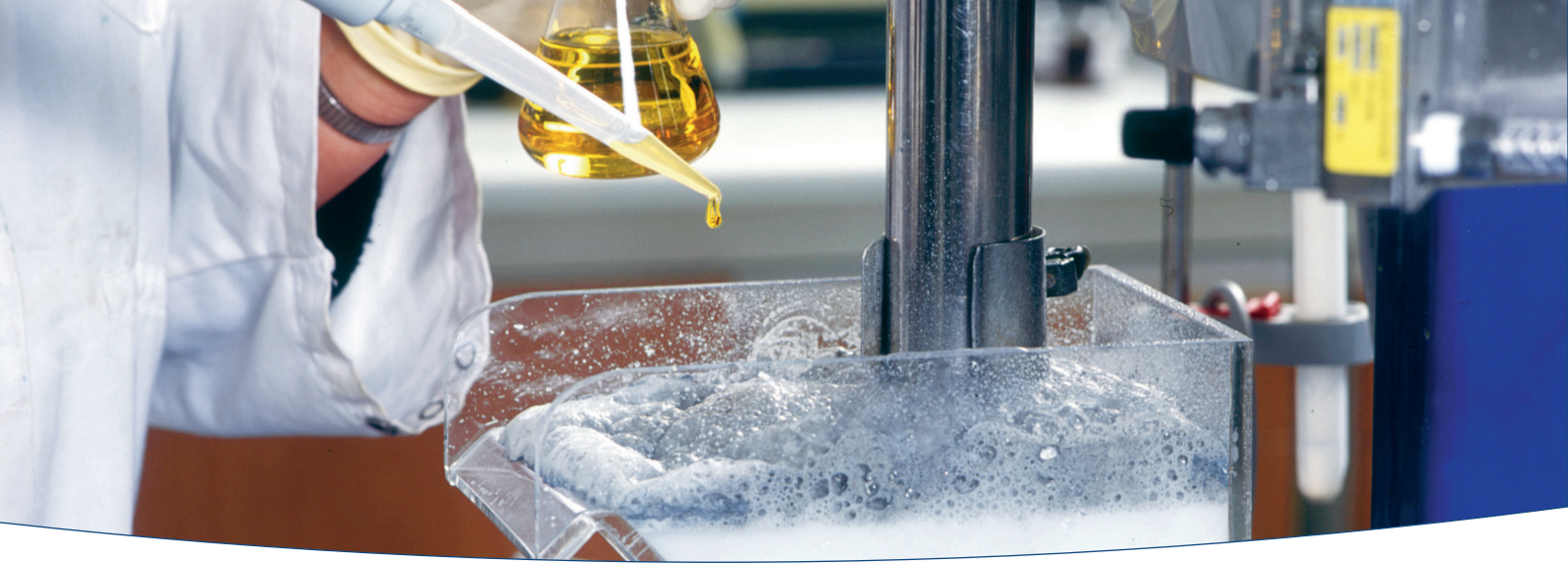
Mining solutions

Maximizing your performance across the mining value chain

Nouryon



Maximize your performance with our essential, sustainable mining solutions

Mined minerals are fundamental to create products we use every day-agricultural fertilizers and soil improvers, computers and cell phones, electrical wiring, buildings and infrastructure, solar panels, wind turbines, and much more. That's why we help maximize your performance, from our labs to your operations, in a sustainable manner.

For more than 80 years, we have served the worldwide mining industry–building our expertise, establishing a global network of R&D labs and service centers, and collaborating with customers.

We deliver the most effective solutions, whether standard or customized, for each stage of the mining cycle we are involved in by working with you. Combining our innovative chemistry with your knowledge of the mining operation, we work to achieve your performance and sustainability objectives.

- Low-density microspheres for emulsion sensitizing
- Organic peroxides for chemical anchor/mine bolt curing and elastomer/rubber crosslinking
- Sulfidizing agents, depressants, and flotation collectors for mineral separation
- Oxidizing agents for extraction, detoxification, and water cleaning processes

Committed to sustainability

We believe good chemistry is key to a sustainable future. Sustainability requires constant innovation, so we continually evolve our portfolio to provide bio-based, biodegradable, and essential solutions that deliver value today and tomorrow.

From the lab to your operations, we help you best utilize natural resources while minimizing your environmental impact, from reducing consumption to providing safe handling practices. A world-class team of toxicologists and scientists evaluate and analyze the development of our chemistry solutions focused on reducing waste, emissions, water usage, and exposure.

Our goal is to not only deliver desired functionality but improved sustainability performance as well.

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website | nouryon.com/markets/mining
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Emulsion sensitizers

low-density thermoplastic microspheres

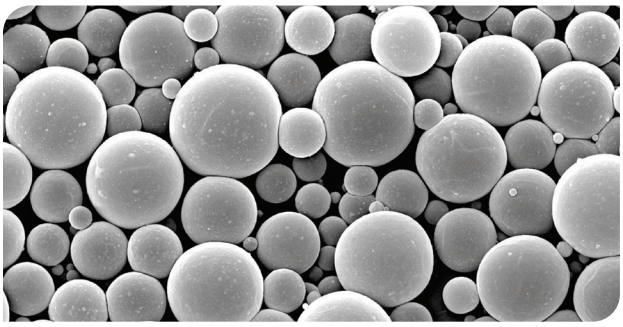
Extensively used as a lightweight filler in emulsion explosives for coal, metal, and quarry mining operations, Expancel® microspheres also offer additional benefits in light ANFO prills and cartridges.

These small spherical particles consist of a polymer shell encapsulating a gas that, when heated, produce a dramatic increase in volume without an increase in weight, while retaining the gas inside. The resilience of these microspheres prevents them from breaking during the processing of or filling of cartridges.

Expancel® microspheres create consistent, uniform voids within the matrix of the explosive, delivering balanced control of density and blasting properties including sensitivity to detonation, strength, brisance, and overall stability. Adding **Expancel®** microspheres typically increases the weight of an explosive by only 0.1%-0.6%, depending on the desired density and sensitivity of the finished product and the type of microspheres used.

Expanded and unexpanded microspheres

As the low density, sustainable option for emulsion sensitizing, **Expancel®** microspheres are delivered either unexpanded or expanded. Expanded **Expancel®** DET microspheres are versatile with strong chemical resistance and are compatible with ammonium nitrate-based emulsions. Widely used as a sensitizer in bulk emulsions and cartridges for coal and metal mining, the microspheres are available with different average particle sizes and a density as low as 15 kg/m^3. Unexpanded **Expancel®** WU microspheres act as a sensitizer in the production of ammonium nitrate (AN) prills for metal mining.



On-site expansion units

We also offer a unique production equipment for our customer's in-house expansion of microspheres. This can generate significant economic gain, increased quality values, and reduced CO_2 emissions from the transportation of material.

Organic peroxides

curing agent and crosslinking

We are the world's leading producer of organic peroxides used to initiate polymerization reactions for the hardening of thermoset composites and to improve the properties of elastomers.

Curing systems for chemical anchors and mine bolts

We offer a full portfolio of high-quality organic peroxides and auxiliaries, including phthalate-free formulations for thermoset applications.

Perkadox® organic peroxides are low concentration dibenzoyl peroxides (BPO) that function as curing agents for chemical anchors and mine bolts. These formulations act as a catalyst for putties based on unsaturated polyester resins and the rapid curing shortens the time needed before sanding and polishing the material surface.

Crosslinking peroxides for elastomers

Crosslinking polymers with peroxide systems can improve the properties of elastomer and rubber cure systems by resisting permanent deformation especially under high temperatures.

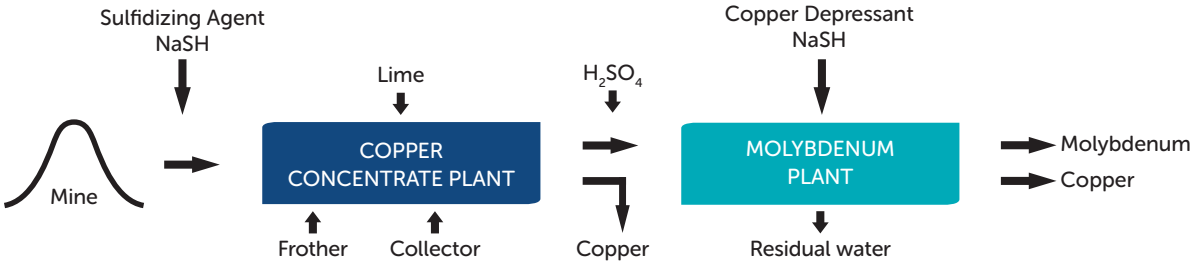
Our **Perkadox®** and **Trigonox®** organic peroxides are used to crosslink peroxides to strengthen the form stability in natural and synthetic rubber for conveyor belts, high-pressure hoses, and rubber cables essential to mining applications.

Organic peroxide can also be applied as a metal adhesion promotor because it quickly incorporates into the rubber matrix resulting in excellent dispersion and homogeneous distribution in the final compound. **Perkabond®** adhesion promotors are ideal for conveyor belts and steel cord reinforced rubber articles, such as specific tires and technical hoses. The unique composition helps achieve optimal bonding between (zinc coated) steel cords and rubber-based materials reducing over dosage, avoiding reversion of the adhesion by oxidative degradation, and improving the durability of the final material.

Sodium hydrosulfide (NaSH)

sulfidizing agent and copper depressant

Our sulfur products are used as basic building blocks and processing aids for mining operations, where sodium hydrosulfide (NaSH) acts as a sulfidizing agent for oxide ores as well as a copper depressant.



Sulfidizing agent

In a flotation process to concentrate sulfide ores where a suitable content of oxides is also present, NaSH can be used to make sulfides from the oxide ores. This increases the ore extraction yield up to 3% or greater. For copper mining processing, NaSH can be added at two process points: the entrance to the pre-rougher and in the cleaning steps.

Copper depressant

NaSH is used to separate copper from the concentrate stream of an ore by depressing it, taking advantage of its strong potential to generate hydrogen sulfide (H_2S) in acidic media. This helps when molybdenum is present in a copper collective concentrate–at the plant, these minerals are separated in flotation cells where molybdenum flotation and copper depression take place simultaneously. As well, NaSH is an effective reagent to separate copper traces from nickel concentrates.

Flotation collectors and depressants

Our strength comes from our specialty chemistry know-how and our ability to design customized and standardized solutions based on the ore type. Working with you, we identify the best process to achieve your objectives.

Flotation collectors

Whether a tailor-made or standard collector is needed, our dedicated specialists approach each assignment individually, assuming the role of a partner rather than a traditional supplier. From lab scale to full operation, we combine our expertise in molecular and surface chemistry with customer input to maximize recovery and grade of the valuable mineral.

We are equally dedicated to providing highly efficient flotation reagents and a sustainable future. Our experienced analytical department and team of toxicologists and scientists assess the behavior and impact of our collector chemistries in each mining environment, performing risk assessments and aligning with local regulations.

Recovery and grade maximization

All components within the flotation process must interact optimally to deliver high performance. We design our collectors to be strong enough to improve recovery while weak enough to enhance selectivity, delivering a high rate of flotation and good froth characteristics. They are non-sensitive to variations in the ore composition and fluctuations in water quality, cost effective, and meet environmental requirements.

Our **Armeen®, Armoflote™, Atrac®, Lilaflot®, Phospholan®,** and **Tecflote®** collectors improve your enrichment rates through direct or reverse flotation for the removal of gangue minerals for a variety of ore types, such as potash, iron ore, phosphate/apatite, sulfide, calcite, and others.

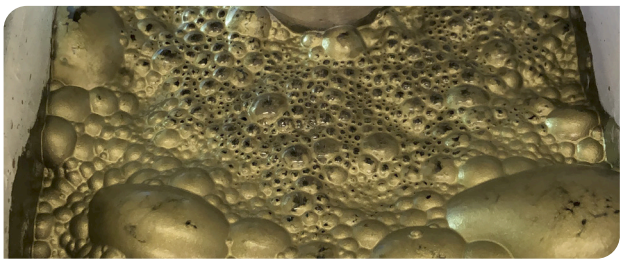
CMC depressants

Our **Finnfix®** and **Celect®** carboxymethyl cellulose (CMC) solutions are designed to enhance the depressant function, improving the recovery and grade of valuable minerals while reducing costs and reagent consumption.

Consumption and cost reduction

We collaborate with you to understand the conditions of each flotation process, combining our expertise in metallurgical testing with a robust product portfolio to improve flotation efficiency..

Laboratory tests applying our **Finnfix®** and **Celect®** CMC showed a decrease in depressant consumption by more than 50%, a reduction in reagent cost by up to 20%, and an increase in valuable metal recovery by at least 10%. Our CMC reagents have also proven to significantly lower the amount of depressant consumed in full-scale plant operations when compared to alternatives.



Continuous innovation

We have built an extensive understanding of the fundamental chemistry and adsorption mechanisms involved in selective flotation by collecting data from both our metallurgical testing laboratory and your operations. Our commitment to continually innovating allows us to identify the best-fit solution for your application, delivering on your performance and sustainability objectives.

Oxidizing agents

extraction and water cleaning

Our versatile sodium chlorate and hydrogen peroxide chemicals are utilized for uranium extraction, cyanide detoxification, and various water and off-gas cleaning processes. Maximizing our use of raw materials, energy, and water, minimizes negative environmental impacts and contributes to the circular economy.

Hydrometallurgical processes

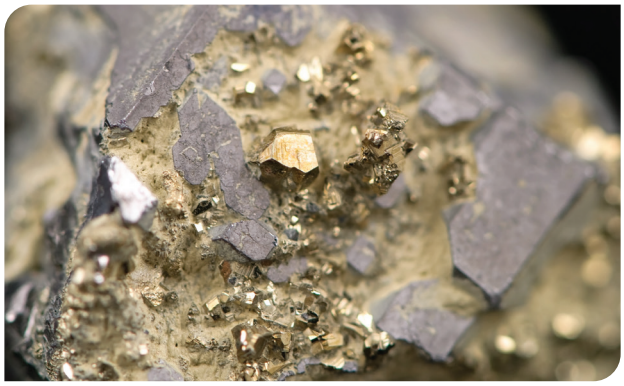
Hydrogen peroxide (H_2O_2) is a powerful oxidizing agent on its own. Available in several different concentrations, **Eka®** HP hydrogen peroxide can be mixed with water in any proportion. The decomposition of hydrogen peroxide only forms two by-products, oxygen and water, which minimizes handling risks.

Eka® HP hydrogen peroxide can be used in several stages within the hydrometallurgical process, such as leaching, separation and refining (purification).

We produce our hydrogen peroxide through a simplified hydrogenation filtration process that reduces effluent production and increases the efficient use of both raw materials and energy, delivering a cost-effective solution.

Sulfide leaching and oxidants

Eka® SC sodium chlorate ($NaClO_3$) is used as an oxidant during the extraction process for a variety of metals and as a key ingredient in the breathing apparatus for mine rescue crews. It has been successfully applied in the leaching of sulfide minerals in acidic media as well as used to chemically extract uranium from the mined ore, producing a partially refined yellow-cake product. Eka® SC sodium chlorate can be delivered in either crystal or liquid form.



Sodium chlorate is produced by the electrolysis of brine–an energy-intensive, multistage process. Conversely, our **Eka®** SC sodium chlorate production is run in closed loop plants designed to minimize electrical power consumption while maintaining high product quality. Whenever possible, we locate our manufacturing facilities where renewable energy sources are available. We place our Chemical Island manufacturing facilities close to our customer and chlorine dioxide production locations, where we can take advantage of available bio-based energy to produce chlorate.

Wastewater micropollutant removal

Complex organic micropollutants generated during the mining process can be removed through an Advanced Oxidation Process (AOP) in which our **MicrOx™** hydrogen peroxide is transformed into powerful hydroxyl radicals by an ultraviolet light reactor (Advanox™ reactor from Van Remmen UV Technology). These hydroxyl radicals oxidize complex organic pollutants in an efficient, easy, and safe process–allowing clean water to be reused for the mining process or be returned to the environment.

Contact us directly for detailed product information and sample requests
website | nouryon.com/markets/mining
email | mining@nouryon.com

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Nouryon is a global, specialty chemicals leader. Markets and consumers worldwide rely on our essential solutions to manufacture everyday products, such as personal care, cleaning goods, paints and coatings, agriculture and food, pharmaceuticals, and building products. Furthermore, the dedication of more than 7,900 employees with a shared commitment to our customers, business growth, safety, sustainability and innovation has resulted in a consistently strong financial performance. We operate in over 80 countries around the world with a portfolio of industry-leading brands. Visit our website and follow us @Nouryon and on LinkedIn.

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