Flotation collectors for optimized performance

Mining chemicals

Nouryon
Together we succeed

We believe that by combining your expertise relating to your particular flotation process and ore with our expertise of chemicals and their function, we can maximize recovery and grade of your concentrates.

With over 50 years of surface chemistry experience and partnering with the industry, we are committed to finding the best solution for your specific ore.

Whether you need a tailor-made or standard collector, we approach each assignment individually, assuming the role of a partner rather than a traditional supplier. Our dedicated flotation specialists are ready to work with you to optimize your particular process.

Towards a sustainable future
Our focus is not only to support you in making the best use of natural resources, but also on ensuring that the flotation collectors are handled in a safe way.

We have extensive knowledge and experience of assessing the impact of our collector chemistry on the environment. To optimize the support we offer, we have developed unique methods of analysis for detecting very low levels of our products in water and air. We have an experienced team of toxicologists, a world-class analytical department and – last but not least – an accomplished mining team.

Regulatory Support – case description
A customer requested our support to ensure that the use of our product at their site would be safe for the environment. Since the plant had not been built yet, discharge water measurements could not be carried out.

Solution
Our ecotoxicologist and flotation technical team worked in close collaboration with our customer to understand the different flows of the mine to set up a risk assessment plan for this unique operation. A lab flotation program was put in place to simulate a full-scale process, and water samples were collected. The analytical department developed a water-analysis method for detecting the level of substances down to parts per billion, which was used on the samples. In the end, having compared the predicted exposure with the toxicity, the use of our product was deemed safe. After the plant was commissioned, additional water samples were taken, and these verified the risk assessment.
Surface Chemistry, a business unit of Nouryon, is a major producer of specialty chemicals. Based in Chicago, USA, our business unit operates in 50 countries, with regional marketing centers, manufacturing and R&D centers worldwide. We are a leading supplier of specialty surfactants, synthetic and bio-polymer additives.
Serving a wide range of applications

How do you achieve successful flotation? By ensuring optimal interaction of all components of the process, where the flotation collector’s performance plays a key role.

Ideally, collectors should be:
- strong enough to enhance recovery but weak enough to enhance selectivity
- able to provide a high rate of flotation and good froth characteristics
- non-sensitive to variations in the composition of the ore and the quality of the water
- designed to meet environmental requirements
- easy to ship, store and handle
- cost-effective

Our products are marketed under the following brands:

Armac®  Armacflote®  Armeen®
Armoflote®  Atrac®  Berol®
Ethomeen®  Lilaflot®  Tecflote™

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Mineral Task
Flotation of potash

Potash is the most important source of potassium in fertilizers. Flotation is one of the major methods used to upgrade the potash.

We are the world-leading supplier of collectors to the potash industry which we have been serving for over 70 years. For the direct flotation of potash, we can deliver either standard amine produced from different types of fatty acids, or special formulations. In some cases, where clay minerals are present in the ore, a slime flotation step using flotation collectors is undertaken prior to potash flotation. We also offer collectors for reverse flotation where halite is floated to beneficiate carnallite.

Case description
A potash customer using direct flotation of sylvite contacted us with issues of flotation recovery, especially involving coarse sylvite. When brine temperatures went above 30 °C, the recovery started to drop and it was not possible to compensate completely by increasing dosage.

Solution
To support the customer, we designed an experiment to evaluate the effect of temperature on recovery and to look at how different amine blends could stabilize the system. As a result, a new formulation was developed that improved the recovery by 4 – 5 percent at temperatures around 35 °C.

For flotation of potash:
Armeen®
Armac®
Ethomeen®
Armoflote®
Flotation of phosphate

Phosphate ore is the most important source of phosphorus in fertilizers. To supply the phosphoric acid plant with phosphate, a high grade of phosphorus is essential, as well as reduced levels of impurities such as magnesium, iron and aluminum oxides.

Flotation is one of the key beneficiation methods. As ores become more complex, the need for tailor-made solutions increases. With over 30 years of experience in phosphate flotation, we have developed boosters as well as customized collectors where the traditional fatty acids are not working optimally for direct flotation. We have also developed direct flotation collectors that successfully float magmatic phosphate from gangue minerals such as silicates and carbonates. In cases where direct flotation is not feasible, we provide carbonate and silica collectors for reverse flotation. In our laboratory, in close collaboration with you, we can fine-tune our products to the particular requirements of your ore.

Case description
We were contacted by a phosphate company that wanted to improve its direct phosphate flotation process with the main impurities being silicates. There were extreme fluctuations in the flotation performance depending on the amount and complexity of the silicates in the feed, as well as a significant drop in performance as process water temperatures went below +15 °C in winter time. At the time, the only available solution for improving performance at lower temperatures was heating the process water to more than 15 °C, resulting in high energy costs. In order to deal with changes in ore quality, the fatty acid dosage needed constant adjustment over a wide range.

Solution
To improve the robustness of the flotation process and be able to perform flotation successfully at temperatures below 15 °C, an anionic booster was proposed to be added to the fatty acid used. On evaluation of the plant, it was recognized that the addition of the booster removed the need for heating and also reduced the total collector dosage by 25 percent and improved the recovery by one percent. By using the booster year round, the collector blend dosage rate was kept stable and a slightly higher recovery was experienced.

For flotation of phosphate/apatite:
Atrac<sup>®</sup>
Berol<sup>®</sup>
Flotation of iron ore

The main objective of iron ore flotation is to upgrade the concentrate by removing silicates and/or phosphorus-containing minerals.

The use of silica flotation has increased in recent decades. The trend will continue as more complex ores have to be mined and higher-grade iron ore concentrates with fewer impurities are requested by the steel industry.

For more than 25 years, we have been developing flotation collectors in close collaboration with the industry both for magnetite and hematite systems. In recent years, we have developed new methodologies to study froth characteristics that complement the traditional float tests. This has improved our ability to successfully progress from the lab to full-scale plant conditions.

Case description
An iron ore company was looking for an alternative product for silica flotation. They requested a product that would achieve the same metallurgical results as the one they were using, but with improved froth characteristics.

Solution
Several different products were screened at the customer lab. A product was identified that fulfilled the requirements of the metallurgical results (it even surpassed them slightly) and at the same time offered improved froth characteristics. Another benefit of the product was that it caused less odor in the flotation plant, which has improved the working environment.

For flotation of iron ore:
Atrac®
Lilaflot®
Flotation of calcite

Our customized collectors remove silicates and graphite from calcite to improve its brightness and reduce its abrasiveness.

Natural calcite deposits contain various types of silicates and graphite. For applications like paper fillers, calcite characterized by a high level of brightness and low level of abrasive silicates is required.

Drawing on more than 40 years of experience from the field, we have developed several formulations to improve the performance of flotation collectors for calcite systems. The formulations are tailored to aspects such as ore complexity and particle size. In cases where discoloring minerals are present, we offer collectors that can be used independently or in combination with silica flotation collectors.

**Case description**
One of our customers approached us requesting an improved silica flotation collector for reverse flotation of calcite as their ore and needs were changing. The reason for the request was that the quality of the ore feeding the flotation plant had been reduced – resulting in lower recoveries – and that the current collector generated excessive froth in the flotation circuit as well as downstream from the flotation plant.

**Solution**
A large development program was initiated in close collaboration with the customer to develop a new silica collector. As a result, a new product was developed that – at the same collector dosage as the previous product – improved the froth characteristics in the flotation plant and resolved the froth issues downstream. The metallurgical results were also improved, resulting in a two percent better recovery at the same grade. An additional benefit was the liquidity of the new product, which reduced production downtime in winter.

For flotation of calcite:
- Lilaflot®
- Armoflote®
- Armeen®
- Ethomeen®
Flotation of sulfide ores has been done with Xanthates, dithiocarbamates and dithiophosphates since the early 20th century. Tecflote™, developed and launched by Nouryon, is a novel proprietary range of nitrile based sulfide ore collectors.

**Novel chemistry**
Tecflote is designed for flotation of sulfide ores and has a number of unique features versus traditional collectors. The collector works with a completely different particle/bubble attachment mechanism compared to conventional sulphide collectors.

**Performance**
Lab tests as well as plant trials have shown significantly improved performance (especially grade) for Cu, Zn, Pb, and Ni. Tecflote works in most circuits and if you are having a selectivity issue Tecflote is ideal for rejecting pyrite gangue.

**Optimization**
For optimal performance Tecflote should be applied in combination with other traditional collectors where the synergies of the components of the blend results in enhanced productivity. With more than 50 years’ experience in developing and implementing flotation collectors with clients all over the world Nouryon offers support and a close cooperation to design the optimal collector formulation to float your sulfides.
Delivering optimized performance

We conduct business all around the world. At Nouryon, we are proud to have dedicated teams that can support your needs.

Our global supply chain guarantees on-time delivery of products with consistent quality to meet your demand. Our responsive highly experienced mining team is ready to work with you to find the optimal solution for your ore. With our fully-equipped mining labs in Sweden, Brazil and the United States backed up by our highly experienced synthesis and analytical team, we are confident we can support you in maximizing your recovery and yield.

Mineral laboratory capabilities:
- laboratory flotation equipment (Denver, Mechanobr, Agitair, etc.)
- ore characterization capabilities
- crushers
- wet and dry grinding capability
- froth characteristics equipment
- analytical, wet chemistry and chromatography
- microscopy techniques
- synthesis department
- design of experiments, multivariate data analysis
- flotation process optimization
**Nouryon history in mining**

- **1940**
  First commercial flotation sales to the potash industry

- **1947**
  Armoflote, Armac, and Armeen tradenames registered

- **1955**
  Ethomeen and Berol tradenames registered

- **1958**
  First sales for flotation of silica-bearing minerals such as feldspar and mica

- **1964**
  Lilaflot tradename registered

- **1974**
  First sales for calcite beneficiation

- **1979**
  First sales for phosphate/apatite beneficiation

- **1981**
  First sales for iron ore beneficiation

- **1983**
  Atrac tradename registered

**From now on and into the future**

Continuing to expand flotation chemical portfolio and developing customized solutions in close collaboration with our customers. What’s good today is not necessarily good enough tomorrow. We come up with practical answers that help people and companies do things better. It’s a technical process but also a thinking process, a human way of looking at the world – Winning together - delivering optimized performance for your mineral processing needs.
We are a global specialty chemicals leader. Markets worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, food, pharmaceuticals and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability and innovation, we have established a world-class business and built strong partnerships with our customers.

We operate in over 80 countries around the world and our portfolio of industry-leading brands includes Armeen, Berol, Atrac, Lilaflote and Tecflote.

For more information visit surfacechemistry.nouryon.com

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