Phosphates and phosphoric acid in everyday life
PRAYON, a long tradition in the chemical industry

Prayon was founded in 1982, but its roots reach back more than 100 years to the Liège region of Belgium. It is the parent company of the Prayon Group, a world leader in producing phosphate chemicals (fertilisers, detergents, food additives and technical applications) and developing inorganic chemical specialities.

The Group’s expertise in the wet process production of phosphoric acid is acknowledged and utilised worldwide, including by its competitors. Currently, some 50% of phosphoric acid production sites use Prayon technology and 70% use Prayon equipment.

Jointly owned by Office Chérifien des Phosphates (OCP) and Société Régionale d’Investissement de Wallonie (SRIW), the Group consists of over 20 companies located in more than 10 countries. It employs 1,450 people and generates a turnover of €500 million.

Prayon boasts worldwide coverage via its production sites in Europe (Belgium and France), the Americas (USA, Brazil) and Africa (Morocco). The Group markets its products in more than 70 countries on five continents, an international presence that reinforces its position as a global player.

PRAYON AND TECHNICAL PHOSPHATES

Prayon markets the following major groups of phosphate products used in technical applications:

- **PURIFIED PHOSPHORIC ACID**: produced using Prayon’s own solvent extraction process. Available in different grades and concentrations, this acid is used in a wide range of technical and food applications.
  - **Production sites**:
    - Engis and Puurs (Belgium): 250,000 tonnes of P2O5 per year
    - Jorf-Lasfar (Morocco), via Emaphos, a joint venture between Prayon (33%), OCP (33%) and CFB (Chemische Fabrik Budenheim) (33%): 150,000 tonnes of P2O5 per year

- **PHOSPHATE SALTS**: sodium, potassium, calcium, ammonium and aluminium phosphates, and a wide variety of special blends based on these products.
  - Phosphate salts are used in the aforementioned industries as well as in ceramics, flame retardants, porcelain, paper, glass, among other applications.
  - Many of these products are marketed under the Europhos brand name. The Group produces over 300,000 tonnes of phosphate salts each year.
  - **Production sites**:
    - Engis and Puurs (Belgium)
    - Les Roches de Condrieu (Lyon, France)
    - Augusta (Georgia, USA)

- **FLUORINE SALTS**: various grades of sodium fluoride as well as sodium and potassium fluosilicates.
  - **Production site**:
    - Puurs (Belgium)
The Prayon Group today consists of more than 20 industrial and commercial affiliated companies.

Specialised industrial subsidiaries ensure that the entire production chain revolves around the Group’s core businesses.

Its sales network of subsidiaries and agencies is structured in such a way that it can ensure an active presence across all five continents and meet the specific requirements of local markets and application sectors.

Prayon’s research programmes focus on two objectives:

• meeting the market’s needs and expectations;
• improving manufacturing processes in order to maximise product quality, control costs and reduce safety and environmental risks.

Since 1992, Prayon has implemented a quality assurance system at all its production sites and in all its commercial subsidiaries. At present, all Prayon’s industrial sites are ISO 9001:2000-certified for quality. The European sites are also OHSAS 18001-certified for safety and have been certified as environmentally friendly under ISO 14001.

The Group’s analytical control laboratories are equipped with state-of-the-art technology used to determine the physical and chemical parameters for production at all of the Group’s industrial plants.

Other, more specialised laboratories work on individual product applications to meet specific customer requirements.

Prayon and its industrial subsidiaries are guaranteed preferred access – in terms of time, quantity and quality – to the basic raw materials needed to produce its end products. This special status is the result of its close partnership and development programme with its shareholder, Office Chérifien des Phosphates, which controls the world’s largest reserve of phosphate ore.
**Detergents**

Purified phosphoric acid and phosphates are key ingredients in industrial detergents (I&I detergents). In household detergents, phosphate-based formulations also offer certain advantages over «alternative formulas». These «builders» serve as complexing (softening), dispersing, emulsifying and buffering agents; they also synergise with surfactants and provide alkalinity.

**Metal treatment**

Purified phosphoric acid and phosphates are used in the process of phosphating metallic surfaces. Phosphatation reduces the susceptibility of metals to corrosion and improves the adhesion of paint to the treated surface. These products are also used in cleaning metal surfaces and manufacturing electrical sheets. Finally, purified phosphoric acid and fluorine derivatives are used in the aluminium industry.

**Fertilisers**

In horticulture, gardening, viticulture and arboriculture, irrigation and spraying are used to bring the three main nutrients – N, P and K – to plants. The excellent solubility of Prayon products is an asset in these applications.

**Water treatment**

The use of purified phosphoric acid and/or phosphates prevents the formation of scale deposits, controls red and black water phenomena and reduces the risk of corrosion in water mains. Some phosphates and purified phosphoric acid are also used for biological treatment of industrial and wastewater.

Fluorine products (NaF, SSF) are also used to improve the quality of public water in many countries.

**Other applications**

- Ceramics, enamels and refractories
- Porcelain
- Paper
- Flame retardants
- Paints
- Glass fibre
- Glass
- Antifreeze
- Biofuels (biodiesel & bioethanol)
- Yeast and fermentation
- Textiles
- Refining of sugar and vegetable oils
- Other applications (pigments, pharmaceuticals applications, various food applications)
Detergents

• Buffer Agent Able To Regulate The Acidity Of Washing Water

To make a detergent as effective as possible, it is essential that the pH of the bath remains as stable as possible throughout the washing process. However, some impurities are acidic. This can cause the bath pH to fall considerably, especially in I&I cleaning. Due to their buffer (pH-controlling) capacity, phosphates neutralize this variation and maintain an optimum pH in the bath.

• Alkalisising Capacity

Solutions of tripolyphosphates are alkaline with a pH of approximately 10. Alkalinity helps the chemicals attack impurities by strengthening the action of the other constituent ingredients of the detergent (e.g. sodium silicate, sodium carbonate).

• Synergy with surfactants

The presence of phosphates makes surfactants more effective, resulting in a more powerful detergent.

Product range and use

<table>
<thead>
<tr>
<th></th>
<th>Household Detergents</th>
<th>I&amp;I Detergents</th>
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<tbody>
<tr>
<td><strong>STPP</strong></td>
<td>Tablets</td>
<td></td>
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<tr>
<td><strong>Powders</strong></td>
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<tr>
<td><strong>Liquids or gels</strong></td>
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Potassium phosphate solutions are available in various grades and concentrations. Solid potassium phosphates are available in powder or granulated form.

We offer purified phosphoric acid in various grades and concentrations.
Metal treatment

Metal cleaning

Before carrying out any phosphating treatment, the surfaces to be treated must be absolutely clean. This stage is vital because it ensures that there are no imperfections in the films covering the metal surfaces since any such imperfections would make them subject to localised corrosion.

A specific product is selected to remove a specific type of impurity. For example,

- acidic or neutral preparations are more effective in removing scale,
- while alkaline cleaners perform better on grease and oily residues.

Electrical sheets production

The electrical sheet industry also uses a particular grade of phosphate - MALP (monoaluminium phosphate) and/or purified phosphoric acid. These products are used in the manufacture of grain-oriented electrical sheets, which themselves are used in the production of high quality low-energy-loss transformers.

<table>
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<tr>
<th>Acid</th>
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<th>Alkaline</th>
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<tr>
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<td>1</td>
</tr>
<tr>
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<td>8</td>
</tr>
<tr>
<td>TKP</td>
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<tr>
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<td>8</td>
<td>14</td>
</tr>
<tr>
<td>MKP</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

We Produce Products in this Field, and, More Specifically, in the Following Areas:

Metal phosphating

Cars, refrigerators, washing machines, and other painted or enamelled equipment all have a phosphated coating between the metal surface and the paint. Purified phosphoric acid and phosphates are used in the process of phosphating metal surfaces. This operation reduces the risk of metals corroding, insulates them electrically, and encourages paint to adhere to the treated surface.

Due to our manufacturing processes, our products have a high level of chemical purity, which is essential in this type of treatment.

Process:

When a ‘reactive’ metal is plunged into a phosphating solution (purified phosphoric acid and/or phosphates in solution), certain elements - such as iron - are dissolved and remain at the metal-solution interface. The acidity level at the interface is reduced. The metal phosphate salts produced, combined with the cations (Ni$^{2+}$, Zn$^{2+}$, Mn$^{2+}$) already present in the solution, precipitate on the surface of the treated metal. The resulting coating makes it easier to form the pieces of metal when cold by plating between the metal and the tool a surface that can be lubricated more easily. In addition, in the case of alkaline phosphating, solutions of sodium and potassium orthophosphates are often used on account of their buffer capacity.

Moreover, when this process is carried out correctly, the metal surface, which is a natural conductor, is changed into an insulating surface offering greater resistance to corrosion when live.

Treatment and polishing (electropolishing) of aluminium

Purified phosphoric acid and fluorine derivatives are used in the aluminium industry.

Fluorine derivatives are used in aluminium foundries as cast covers for baths.

Purified phosphoric acid, in combination with sulphuric acid, is also used in aluminium polishing (electropolishing).
Water-soluble and liquid fertilisers

**FERTIGATION**

In contrast to broadcast fertilisers that are often granulated and spread directly on the ground, fertigation involves providing the plant with the nutrients it needs dissolved in ‘irrigation’ water in the broad sense of the term. The water can be applied in various ways: using a pipe with holes, a spray or a drip irrigation system.

This technique is increasingly popular among professionals, particularly in horticulture, gardening, viticulture, arboriculture, open ground crops and soilless crops.

Due to their high purity and excellent solubility, products from the Prayon range are ideally suited to supplying plants with the three main nutrients they need: nitrogen, phosphorous and potassium - in soluble form. They are available in both solid ammonium orthophosphate (MAP) and DAP and monopotassium phosphate (MKP), and liquid ammonium polyphosphate and phosphoric acid form.

Prayon products can either be applied ‘as is’ by the professional end user, who then mixes them with other nutritive substances at the time of application, or are premixed by manufacturers of NPK fertilisers who supply soluble solid products or actual ready-to-use solutions.

**OFF-THE-SHELF FERTILISERS**

‘Off-the-shelf’ fertilisers are so called because they are intended for use by the general public in NPK mixes, either solid or soluble. They come ready to use and are sold in small packs in garden centres and DIY stores.

Here too manufacturers appreciate the high quality of Prayon products for their ease of use in industrial mixing operations and for their positive impact on the intrinsic quality of the resulting NPK mixtures.
For a number of years, our R&D Department has been developing various products for use in water treatment.

We are active in the treatment of domestic, industrial and waste water.

Phosphates and purified phosphoric acid help to reduce the risk of pipework corrosion, control the lead content of water from the system, prevent the scale deposit, control the water pH and control red and black waters.

Fluorine derivatives such as NaF and SSF are used in water fluoridation.

**PROPERTIES**

- **LEAD (Pb) PRECIPITATION AGENT**
  
  Some water mains and older buildings still use lead piping. The presence of lead (Pb) in the water can be harmful to human health. In order to avoid dangerously high lead content in water from the system, a small amount of purified phosphoric acid can be added to encourage a ‘coating’ to form on the inner surface of the lead pipes thereby preventing the lead from being released into the water.

  A monosodium phosphate (MSP) solution can also be used for this purpose.

- **CORROSION INHIBITION**
  
  Phosphates are used to reduce corrosion in water mains. This may be either anodic corrosion or cathodic corrosion.

- **CONTROL OF RED AND BLACK WATERS**
  
  When water is exposed to the oxidising action of air and chlorine, colour changes can occur in the water. If there is precipitation of iron compounds, water from the system may turn a reddish colour (red water). Similarly, if manganese precipitates, a blackish colour may be observed (black water). Some phosphates can trap these metals, even in very weak concentrations, and control these phenomena.

- **WATER FLUORIDATION**
  
  Water fluoridation has been commonplace for decades in many countries including the United States, Australia and the United Kingdom.

  It is designed to improve the dental health of the population by reducing the risk of tooth decay. Fluor derivatives (SSF, NaF) are commonly used for this purpose.

- **SOURCE OF NUTRIENTS**
  
  The petrochemicals and agrofood industries, and in general, industries which discharge water with a high BOD (biological oxygen demand), purify the water biologically to reduce the BOD. To be effective and to develop, the bacteria used in these procedures require the nutrient P (phosphorous), but they also need optimum pH conditions.

  If any of these elements is missing, then the following products can be used as a source of phosphorous (either alone or in combination): purified phosphoric acid, monoammonium phosphate (MAP), diammonium phosphate (DAP) and monopotassium phosphate (MKP).

- **SCALE INHIBITION - SOFTENING AGENTS**
  
  Hard water causes the formation of scale deposits resulting in a lower flow rate through pipes. This in turn means increased pumping and cleaning costs.

  Polyphosphates can trap calcium and magnesium, sources of scale formation, and can dissolve the compounds formed, which prevents deposits from building up.

  Depending on the water pH, preference will be given to either SHMP (sodium hexametaphosphate) or STPP (sodium tripolyphosphate).

- **pH CONTROL**
  
  Another vital parameter in water treatment is controlling the water pH. Due to their buffer (pH regulating) capacity, orthophosphates and purified phosphoric acid can regulate the pH level of the water.

- **SEQUESTRATION AND PRECIPITATION OF METAL IONS**
  
  Phosphates, and in particular SHMP (sodium hexametaphosphate) and STPP (sodium tripolyphosphate), can trap and precipitate ions in soluble compounds thus preventing deposits from forming.
Phosphoric acid, phosphates and fluorine derivatives in various applications

CERAMICS, ENAMELS AND REFRACTORIES

When preparing solutions used in the ceramics and glazes industry, it may be necessary to include additives in order to obtain a fluid paste or a well-dispersed solution. So phosphates such as STPP (sodium tripolyphosphate) and SHMP (sodium hexametaphosphate) are used as dispersing agents.

In manufacturing refractories, some phosphates such as TSP (tetrasicum pyrophosphate) also act as dispersing agents, but also facilitate the elimination of iron by simple cleaning. In addition, MALP (monocalcium phosphate), MAP (monomagnesium phosphate), and purifed phosphoric acid may be used as binding agents directly in the cohesion of the end product. Fluorine derivatives (NaF, SSF, PSF) act as fluxing agents, i.e. they lower the fusion temperature of some mixtures which in turn leads to a reduction in energy costs. Some fluorine derivatives (SSF, PSF) are also used as secondary opacifying agents.

Calcium phosphates (DCP and TCP) are used in the manufacture of high-quality porcelain (bone china). They increase the translucent effects of this type of porcelain.

Sodium fluosililicate (SSF) is used as an opacifying agent for some types of porcelain.

Paper

Many products are used in the paper pulp industry but few possess such a diverse range of uses as phosphates.

The dispersing properties of phosphates make them extremely useful for limiting the caking of mineral fillers, pigments, resins (and other powdered solids) when in suspension. Accordingly, they play an important role in the preparation of coating compositions.

Other properties are involved in the production of paper pulp generated by chemical, mechanical or de-inking processes. For virgin stock, made out of woods with a high resin content, a sort of ‘gum’ sometimes appears around the fibres which can cause indentations on the sheet of paper. These are known as pitch spots. Adding selected phosphates can prevent this from occurring. The same applies during de-inking with stickies.

In addition, certain phosphates can be added to paper to slow down its rate of decomposition.

The main phosphates used are sodium tripolyphosphate (STPP), sodium hexametaphosphate (SHMP) and disodium phosphate (DSP).

Polyphosphates and, in particular, sodium hexametaphosphate (SHMP), are dispersing agents and can change the distribution of the ionic charges (positive - negative) in soluble compounds, thereby improving their fluidity. This property is very useful in the paint industry. Due to their sequestering properties, phosphates are also used in corrosion inhibition through the sequestration of iron ions.

Flame retardants

Monoammonium phosphate (MAP) and diammonium phosphate (DAP) are often used as flame retardants to fireproof a variety of materials (particle boards, matches, textiles, etc.) and in the manufacture of fire extinguisher powder. DAP and ammonia polyphosphates are found in products used to fight forest fires.

Paints

Polyphosphates and, in particular, sodium hexametaphosphate (SHMP), are dispersing agents and can change the distribution of the ionic charges (positive - negative) in soluble compounds, thereby improving their fluidity. This property is very useful in the paint industry. Due to their sequestering properties, phosphates are also used in corrosion inhibition through the sequestration of iron ions.
Aluminium metaphosphate (ALMP) is used as an additive in the manufacture of special types of glass and optical fibres. This phosphate can also be used as an opacifier in glass. Sodium tripolyphosphate (STPP) is used as an opacifier in crystal making. Sodium fluosilicate (SSF) is an opacifying agent used in the glass industry.

Dipotassium phosphate (DKP) and purified phosphoric acid are used in the manufacture of antifreeze, acting as an anti-corrosion agent in car radiators and other equipment. DKP helps to keep the pH stable at around 9, thereby reducing the risk of corrosion.

Monoaluminium phosphate (MALP) is used in the production of glass-fibre-based materials. It serves as a binding agent, replacing traditional organic compounds. The advantage of MALP is that it does not form harmful and volatile organic compounds at high temperatures. It is also stable over time and therefore imparts excellent insulating properties, thus facilitating recycling.

The great purity of the Prayon Group’s phosphates (mainly MAP, DAP and MKP) and purified phosphoric acid means that they are used extensively as nutrients in the yeast industry as well as in a whole range of bio-industrial processes based on fermentation (e.g., manufacture of alcohol and pharmaceutical products).

Phosphoric acid, phosphates and fluorine derivatives in various applications

Purified phosphoric acid is the basic raw material in the manufacture of phosphates. It is also used in many other applications including vegetable oils purification, activated carbon purification and TiO₂ and H₂O₂ production.

Phosphates are also used in a number of other applications such as textiles, cement, plaster, photography, the treatment of drilling muds, the manufacture of titanium dioxide (TiO₂) and the stabilisation of H₂O₂ solution among others. Fluorine derivatives (NaF, SSF and PSF) are used as insecticides for wood (in the United States only). NaF is also one of the raw materials in the manufacture of MFP (monofluorophosphate).

Sodium fluosilicate (SSF) is used in producing latex foam for mattresses where it serves as an acidifying agent in gelling latex before it is vulcanised.

Purified phosphoric acid is commonly found in biodiesel manufacturing (transesterification). It is used for vegetable oil pre-treatment and glycerine separation. In bioethanol production, it is used during the fermentation process.
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Prayon’s core business consists of transforming rock phosphate into phosphoric acid which is then purified and either marketed or transformed into phosphate salts through reactions with alkali.

Prayon produces a full range of technical and food phosphates at its plants in Europe and the United States.
PRAYON: MEETING YOUR NEEDS

- full product range
- global presence
- applications laboratory

FOR MORE INFORMATION,
PLEASE VISIT THE GROUP’S WEBSITE
WWW.PRAYON.COM