Introduction

IXPER® products offered by Solvay Chemicals, Inc. include IXPER® 60C and 75C Calcium Peroxide, and IXPER® 35M Magnesium Peroxide. These are inorganic peroxides with very slight solubility in water. In the presence of water at their natural pHs, these products decompose to release oxygen and heat as follows:

$$2\text{CaO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Ca(OH)}_2 + \text{O}_2 \text{ (g)}$$

$$2\text{MgO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Mg(OH)}_2 + \text{O}_2 \text{ (g)}$$

In buffered systems with a pH substantially lower than their natural pHs, IXPER® products exhibit a different behavior. As the pH drops, these products become more soluble, and generate progressively higher ratios of hydrogen peroxide (active oxygen) to gaseous oxygen. Under acidic conditions, the available oxygen can be liberated within minutes.

$$\text{CaO}_2 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} \text{ (aq)} + \text{H}_2\text{O}_2$$

$$\text{MgO}_2 + 2\text{H}^+ \rightarrow \text{Mg}^{2+} \text{ (aq)} + \text{H}_2\text{O}_2$$
Applications of IXPER® Products

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The $\text{H}_2\text{O}_2$ generated from acidified IXPER® slurries can further react in a variety of ways:

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\begin{align*}
\text{H}_2\text{O}_2 + \text{OH}^- & \rightarrow \text{H}_2\text{O} + \text{HOO}^- \\
\text{HOO}^- + \text{substrate} & \rightarrow \text{Oxidized Substrate} + \text{HO}^- \quad \text{(oxidation)} \\
2\text{H}_2\text{O}_2 & \rightarrow 2\text{H}_2\text{O} + \text{O}_2 \quad \text{(decomposition)}
\end{align*}
\]

The applications of IXPER® products are based on their ability to generate a combination of oxygen and hydrogen peroxide under various conditions. The release of calcium and magnesium hydroxide can also be advantageous in some applications. For additional information on the properties of these products, please refer to technical data sheets IXP-04-001, 002, and 003.

Environmental applications

Soil and groundwater remediation

IXPER® products can be used to accelerate the natural attenuation of contaminated soils in a cost-effective manner. The capability of aerobic microbes to biologically degrade contaminants, such as petroleum hydrocarbons, can be limited by inadequate levels of oxygen. IXPER® products offer a passive approach to aerobic bioremediation of target contaminants, ensuring that adequate oxygen is present over an extended period of time. Without this supplemental oxygen source, the degradation of contaminants may either stop or proceed by much slower anaerobic processes.

In addition, the hydrogen peroxide released from IXPER® products may accelerate the decontamination process by direct oxidation of the contaminants. The extent of oxidation depends upon the soil pH, its buffering capacity and the presence of other components to enhance the oxidation process. For additional information, please review the corresponding technical data sheets found in the “Soil Remediation Products” section of this website.

Grease traps

IXPER® products may be used for the treatment of grease traps to help reduce sulfide-based odors, caused by anaerobic conditions. IXPER® products provide hydrogen peroxide and oxygen, thereby oxidizing sulfide compounds, which may be present in the grease trap.

The rate of release of oxygen and hydrogen peroxide depends upon the pH of the water. If the pH is not too acidic, the slow release profile of IXPER® products ensures that adequate oxygen levels are present over an extended period of time.

The concurrent release of the alkaline calcium or magnesium hydroxide helps raise the pH and assist in bringing the water to the pH allowed for release in the sewage system. The alkalinity also helps saponify the grease and reduce its level in the grease trap.
Lakes
IXPER® products can be used in oxygenating the lower parts of artificial or natural lakes, as well as wastewater and effluent. Oxygen concentration near the bottom of lakes can be very low and many methods of increasing dissolved oxygen are unsatisfactory either because they require excessive agitation, which moves nutrients to the surface encouraging algae growth, or because they do not ensure sufficient oxygenation.

By sinking to the bottom and releasing oxygen over a period of time, IXPER® products can provide a more satisfactory method of oxygenating the lower layers.

Oil field applications
In this field, a polysaccharide polymer is often used to either fracture the rock or form a filter cake. After the polymer achieves its purpose, it must be degraded by a “breaker” to lower its viscosity so that it can be easily removed.

IXPER® 75C Calcium Peroxide and IXPER® 35M Magnesium Peroxide have unique advantages in this field. They are very slightly soluble in water and have relatively high stability to decomposition at elevated temperatures. At the desired time, these products can be activated by the addition of an acid or by other means. This results in the generation of hydrogen peroxide which is the actual oxidizing agent.

Please review technical data sheet IXP-04-006 for additional information and a patent review about this application.

Agriculture
Low oxygen in the soil can be generated in waterlogged soils due to heavy rainfall or bad irrigation techniques. For example, when rain guns are used on unstable soils, sand, silt or limestone, soils run together creating a seal that is impervious to oxygen and carbon dioxide.

Typically, soils that are low in organic matter are more difficult to aerate naturally. On the other hand, crops growing at high temperatures or under a lot of sunshine have very high oxygen demand at the roots.

Under these conditions, the lack of enough oxygen reduces root growth resulting in stunted growth, poor yields, lack of seed germination, etc.

IXPER® products can be used for soil amendment in agricultural, horticultural and forestry applications. These products slowly decompose in the moist soil, generating oxygen and the corresponding hydroxide. This can have the following advantages:
- Modify the soil’s biological activity as follows:
  - Increase total soil microbial population.
  - Enhance enzyme diversity.
  - Speed aerobic and biological activities at high moisture conditions.
  - Support healthy roots by enhancing symbiotic fungi growth.
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- Maintain and protect healthy plant roots.
- Improve the hydraulic conductivity of the soil allowing more efficient movement of oxygen and nutrients. This effect is especially useful in heavy soils.
- Give plants the ability to absorb more water and nutrients and use them more efficiently.

The use of IXPER® products as a source of slow release oxygen to the soil can also provide calcium or magnesium to the soil. Some soils are deficient in one of these two components. The selection of the appropriate IXPER® product can also compensate for such deficiency.

These advantages have several applications in agriculture, horticulture and forestation.

- **Seed germination** – Coating seeds with IXPER® Calcium Peroxide or adding it to the soil during planting can improve percent of seeds germinating and can also lead to earlier germination, stronger growth and increased yields. Rice seeds are typically coated with calcium peroxide.

- **Tree transplanting** – By ensuring that the roots get a steady and long lasting supply of oxygen, the impact of transplanting is alleviated. Indeed IXPER® Calcium Peroxide can help the trees acclimatize more quickly by ensuring strong root development and avoiding respiration disorders. This will lead to enhanced growth and may enable the tree to reach mature status earlier. It can also lead to a better survival rate after the transplanting process. This is particularly beneficial in areas of forestation. See technical data sheet IXP-04-006 for details.

- **Ornamental plants** – In nurseries, addition of IXPER® Calcium Peroxide to the soil can reduce the problems associated with over-watering of plants such as azaleas and carnations. Combining spores of symbiotic fungi that support healthy roots and IXPER® Calcium Peroxide further enhances plant growth.

- **Vegetable plants** – Benefits of IXPER® Calcium Peroxide have also been observed in the cases of vegetable crops such as tomatoes, lettuce, radish and others when the soil was waterlogged.

- **Horticulture** – IXPER® products are an excellent way to provide a slow release source of oxygen to crops in horticulture.

**Dough conditioning**

IXPER® 75C Calcium Peroxide is widely used in the baking industry in the US and Canada as a component of dough conditioners. IXPER® 75C Calcium Peroxide acts by oxidation of sulfhydryl groups in gluten, reforming the disulfide bonds that were broken during the mechanical mixing of the dough. This imparts several advantages to the baked products.

A major advantage of IXPER® 75C Calcium Peroxide over other dough conditioners is its ability to dry the surface of the dough, and is particularly suitable as a dough conditioner for sticky dough. For more details on this application, please review technical data sheets IXP-03-001 and 002.
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Personal care applications
The low solubility of IXPER® products facilitates their formulation into stable products, with longer lasting activity than other forms of active oxygen.

Oral care
IXPER® products may be used in toothpaste formulations where they help clean teeth and improve oral hygiene through:
- Release of hydrogen peroxide when in contact with saliva resulting in enhanced removal of superficial staining.
- Generation of oxygen bubbles which helps in the removal of food particles.
- Neutralization of food acids due to the generation of calcium or magnesium hydroxide on decomposition.

Hair care
IXPER® products may be incorporated in hair bleaching formulations together with other oxidizers such as persulfates.

In hair coloring formulations, the color is often developed by oxidation of intermediate products that are first allowed to penetrate the hair shaft. These products can then be oxidized by various products including inorganic peroxides.

Sealants
IXPER® 75C Calcium Peroxide is widely used as a curing agent in one-part polysulfide-based anhydrous sealants. It is activated by atmospheric moisture which initiates the generation of active oxygen from the calcium peroxide leading to the oxidation of polyhydrosulfides.

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\text{HS-R...SH + HS-R...SH + CaO}_2 \rightarrow \text{HS-R...-S-S-R...SH + Ca(OH)_2 + H}_2\text{O}
\]

One-part sealants are normally formulated to include between 5 and 15 parts of IXPER® 75C Calcium Peroxide per 100 parts of polysulfide polymer, together with plasticizers and fillers. A white sealant can be compounded or coloring agents may be added. Exclusion of moisture is essential to prevent premature activation of the curing process and all ingredients should be mixed under low humidity, leading to the production of a sealant with a long shelf life.

Under average conditions of temperature and humidity, the surface of the sealant is cured and ready for painting approximately 24 hours after the application. Complete curing is achieved in two to four weeks.
# Metallurgy

IXPER® 75C Calcium Peroxide is used as a source of oxygen in aluminothermic processes and in other metallurgical applications. The addition of IXPER® 75C Calcium Peroxide to aluminothermic mixtures assists in ignition at lower temperatures and increases the temperature of the melt, making it easier to separate the slag from the metal.

$$3\text{CaO}_2 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 \cdot 3\text{CaO} + 385 \text{ kcal}$$

$$2\text{CaO}_2 + 2\text{Al} \rightarrow \text{Ca} + \text{CaO} \cdot \text{Al}_2\text{O}_3 + 273 \text{ kcal}$$

Exothermic mixtures containing IXPER® 75C Calcium Peroxide can also be used during casting to increase the temperature of the feed metal, preventing defects.