

Hydrogen Peroxide Technical Bulletin



Quality

Reliability

Service

Table of Contents

Introduction 1

Chemistry 2

Hydrogen Peroxide Applications 4

Technical Data 9

Analysis 10

Safety 12

Product Quality & Grades 14

Supply Reliability 16

Technical Services 17

Engineering Services 19

Distribution Services 23

Sales and Customer Services 26

Summary 27

Introduction

Hydrogen peroxide is one of the most versatile, dependable and environmentally desirable chemicals available today. The safety and efficiency of its operations have led to the development of numerous applications. For example, hydrogen peroxide is an oxidizing agent for organic and inorganic chemical processing, a bleach for textiles and pulp, and a treatment for municipal sewage and industrial waste. Because of hydrogen peroxide's favorable properties, numerous applications have been developed.

As the leading supplier of hydrogen peroxide, FMC Corporation has made major contributions to the field of peroxygen technology for over 60 years. FMC continues to pioneer new applications for this widely used chemical at the company's extensive research facilities in Princeton, New Jersey.

As a worldwide producer of hydrogen peroxide, FMC has seven manufacturing facilities around the world and is the only producer with four plants and five operating cycles in North America.

FMC offers the full range of concentrations and grades of hydrogen peroxide. Most industrial applications call for the use of 31%, 35%, 50% or 70% concentrations. All grades are manufactured to the highest standards of quality and are readily available in bulk or drum quantities from inventories stocked at strategic distribution points worldwide.

FMC also provides Technical Service Engineers who are prepared to assist in the application of hydrogen peroxide as well as the safe handling and storage of the chemical.

This brochure explains the properties, capabilities, uses and recommended methods for handling hydrogen peroxide safely under varying conditions. It also describes the comprehensive research, manufacturing, technical service, engineering, distribution and sales support services which are responsible for making FMC hydrogen peroxide the market standard.

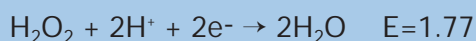
Chemistry

Physical and Chemical Properties

Versatility

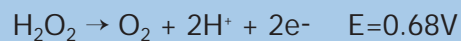
Hydrogen peroxide is a chemical capable of reacting via several mechanisms. Depending on the environment, it can function as an oxidizing or reducing agent, oxygen source, or complexing agent. This versatility enables hydrogen peroxide to be used in a wide variety of manufacturing and industrial applications.

Oxidation

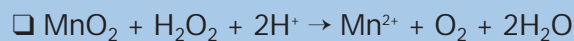
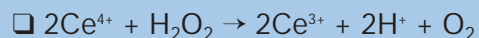


This characteristic of hydrogen peroxide is the basis for its use as a reactant in chemical synthesis, a bleaching agent for pulp and paper, textiles, minerals, clays, etc., and for destroying organic and inorganic contaminants in a variety of environmental applications.

Reduction

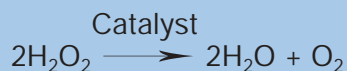


Not often thought of as a reducing agent, hydrogen peroxide is capable of reducing several inorganic species. For example:



This capability finds use in analytical determinations, dechlorination and a number of other areas.

Oxygen Sources



Oxygen can be generated by the addition of decomposition catalysts such as silver, iron and copper to hydrogen peroxide. The oxygen produced can be used in a variety of applications including the forming of materials such as plastics, latex, gypsum products, etc. The oxygen generated by this reaction is often used in environmental dissolved oxygen. This oxygen helps keep the aqueous system from becoming anaerobic.

Complexing Agents

Hydrogen peroxide, has extensive use in byproduct and secondary metal recovery to control the solubility of metals. It can be used to effectively separate metals such as uranium from vanadium or cobalt from nickel through selective oxidation and/or the formation of peroxy-metal complexes.

Peroxygens form complexes with various metals. This changes the relative solubility of the metal being complexed. The effect can either make the metal more soluble, precipitate the metal, or modify extraction coefficients. The relative solubility of peroxy complexes can be used to separate otherwise similar metals, giving increased purification compared to simple separation processes.

Peroxide Derivatives

Molecular addition of hydrogen peroxide to certain compounds results in the formation of perhydrates. When urea is dissolved in a hydrogen peroxide solution and then cooled or evaporated, it forms the crystalline compound urea peroxide. Similar compounds are formed in this way from hydrogen peroxide with tetrasodium pyrophosphate, sodium carbonate, sodium metaborate, and others.

Hydrogen Peroxide Applications

Worldwide Usage

Hydrogen peroxide (H_2O_2) is used in a variety of applications throughout the world. This versatile chemical has widespread applications in pulp and paper, textile, waste treatment, mining, oil, food and chemical processing, cosmetic and pharmaceutical industries. It is also one of the most environmentally desirable chemicals since its primary decomposition by-products are water and oxygen.

Pulp and Paper



Hydrogen peroxide plays a major role in the bleaching of all types of pulps: Mechanical, kraft, and deinked recycle fiber.

MECHANICAL PULPS

H_2O_2 is the preferred bleaching agent for developing high brightness in mechanical and other high yield pulps. The brightness is more stable with hydrogen peroxide than with any other commercial agent. The following are some pulp applications:

❑ *Mechanical Pulps*

- Bleaching pulps in-refiner, in-grinder, single and multi-stage towers
- Treatment to improve physical properties, decrease capital or product costs .
 - Alkaline peroxide treatment prior to refining to develop strength
 - Interstage washing to reduce resins, improve strength and absorbency

CHEMICAL PULPS

Hydrogen peroxide is an environmentally safe oxidizing agent which does not generate chlorine derivatives. Historically, peroxide has been used in chemical pulp bleaching as a cost-effective replacement or supplement for chlorine dioxide, and as a means of achieving higher brightness and improving brightness stability. A major use today is in minimizing or replacing chlorine, chlorine dioxide, and hypochlorite in the bleach sequence. Its use lowers bleaching costs when producing Elementally Chlorine-Free (ECF) grades and increasingly it is the key delignification and brightening agent for today's low-AOX and Totally Chlorine-Free (TCF) grades. Typical applications are:

❑ *Chemical Pulps*

- Enhance delignification to decrease the use of chlorine-based chemicals and improve environmental quality
- Increase brightness and improve brightness stability
- Peroxide can be used in the following stages:
 - Oxygen delignification, (EOP) - or (OP) - stages
 - Reinforced extraction, (EP) - or (EOP) - stages
 - Terminal P and high density storage
 - Hot P-stages (TCF)

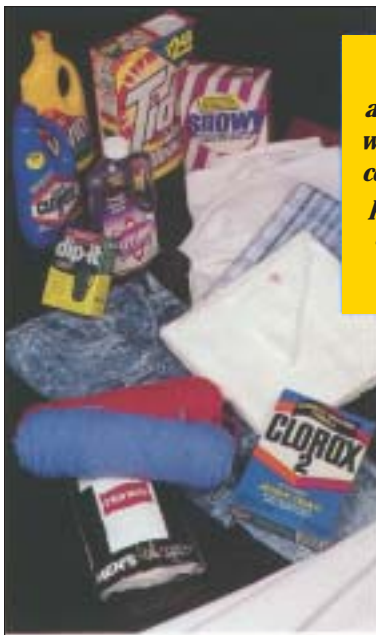
SECONDARY FIBER

Peroxide assists the deinking and bleaching of recycled groundwood fibers to reduce alkali reversion and increase brightness. Peroxide is also used in woodfree secondary fiber bleaching to minimize or replace hypochlorite to improve environmental quality and increase substitution of wood containing grades. Applications include:

❑ *Secondary Fiber*

- Pulper
- Soaking Tower
- Bleaching Tower

Detergents and Textiles



Hydrogen peroxide and its derivatives are widely used as effective color-safe bleaches and processing aids in the textile and detergent industries.

Valued for its versatility, hydrogen peroxide offers textile manufacturers the advantage of ease of application, reduction of processing times, minimization of effluent problems, preservation of textile fiber quality, high and very stable degree of whiteness, and primary decomposition products, water and oxygen.

Hydrogen peroxide can be used to bleach natural cellulose, animal and synthetic fibers. Some examples of textile processing applications as well as hydrogen peroxide based bleaches are as follows:

- *Textile processing*
 - Bleaching of woven and knit fabrics
 - Desizing (CMC, starch, PVA)
 - Denim processing
 - Antichlorination
 - Dye fixation
- *Bleaching agents*
 - Perborates
 - Percarbonates
 - Liquid H_2O_2 bleach
 - Thickened/gelled peroxides
 - Peracids

Environmental Applications



Hydrogen peroxide can be used for the treatment of a variety of inorganic and organic pollutants.

Hydrogen peroxide is used successfully in the detoxification of industrial waste waters. Since its primary decomposition products are water and oxygen, it is not itself a source of pollution. Depending on the pollutant, hydrogen peroxide can be used alone or activated with catalysts such as iron (Fenton's reaction), ultraviolet light, ozone, etc. It is used routinely in many industries such as petroleum refining and chemical operations.

Hydrogen peroxide is effective in treating:

- *Inorganic pollutants*
 - Reduced sulfur compounds (H_2S , SO_x , $S_2O_3^{2-}$)
 - Cyanides (simple and complex)
 - Active chlorine compounds (Cl_2 , $OC1^-$)
 - NO_x
 - Metals removal (Fe, As, Cr)

- ❑ *Organic Pollutants*
 - Phenolics
 - Aromatic hydrocarbons
 - Organosulfur compounds (mercaptans, sulfides)
 - Chlorinated hydrocarbons (vinyl chloride, trichloroethylene, tetrachloroethylene, etc.)
 - Pesticides
 - Aldehydes

As a potential source of oxygen, hydrogen peroxide is used in biological treatment. This oxygenation is especially helpful at times of overload, for the treatment of filamentous bulking sludges, and for the prevention of denitrification in settling tanks. Examples of these applications are:

- ❑ *General*
 - Bioreclamation of aquifers & groundwater
 - BOD/COD control
 - Bulking control/sludge densification
 - Slime removal
 - Process water recycling

Mining Applications

Mining applications take advantage of hydrogen peroxide's properties of oxidation, reduction, complexation and oxygen generation.



Hydrogen peroxide is an attractive reagent in metallurgy since its primary decomposition products are only water and oxygen. Examples of its uses include the extraction of uranium, the separation of cobalt and manganese, and the oxidation of many metal ions.

Common mining applications include:

- ❑ *Gold and silver processing*
 - Heap and agitated cyanide leaching enhancement
 - Cyanide detoxification
- ❑ *Uranium*
 - Yellowcake purification (V, Mo, Na removal)
 - In-situ leaching
 - Oxidant in acid or alkaline leaching
 - Recovery of uranium from wet process phosphoric acid
- ❑ *Copper/molybdenum Flotation Separation*
- ❑ *Copper leaching*
- ❑ *Acid mine drainage (heavy metal removal)*
- ❑ *Phosphate rock purification*

Chemical Manufacturing Applications

Hydrogen peroxide is used to produce a wide range of organic chemicals. This includes epoxides, organic peroxides and organosulfur compounds. Organic peroxides are used as initiators in the production of polystyrene, polyvinylchloride, polyethylene and other polymers, as well as curing agents for polyester resins. Organic synthesis of peracids using hydrogen peroxide is another common application.

Hydrogen peroxide is also used to produce inorganic chemicals of high purity. These include such diverse products as ferric sulphate, hydrazine, sodium chlorite, potassium hydrogen peroxydisulfate and arsenic acid.

Chemical processing applications such as product purification and bleaching are other important uses for hydrogen peroxide.



The selective oxidizing properties of hydrogen peroxide are used in a number of processes for manufacturing chemicals and intermediates.

Examples of typical chemical manufacturing applications include:

- ❑ *Epoxides of:*
 - Oils
 - Intermediates (Steroids)
- ❑ *Organic peroxygens*
 - Peracids, MEK Peroxides
- ❑ *Specialty organics*
 - Lactones
 - Alcohols
 - Polysulfide curing agents
- ❑ *Initiator for polymers*
 - Emulsion Solution polymerization
- ❑ *Oxides of sulfur and nitrogen*
 - Sulfoxides
 - Sulfones
 - Amine oxides

- ❑ *Inorganic peroxygens*
 - CaO₂, ZnO₂, perborates, percarbonates
- ❑ *Arsenic acid*
- ❑ *Chemical processing*
 - H₂SO₄ decolorization
 - Mineral bleaching
 - Starch modification
 - Oil bleaching

Industrial Applications

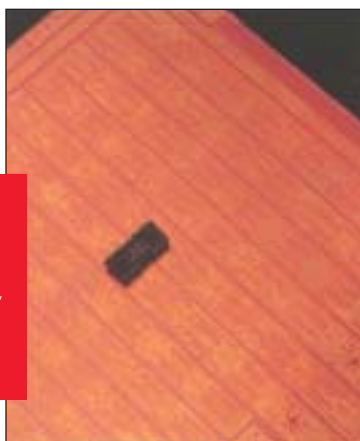
Because of hydrogen peroxide's unique properties, it has found uses in many industries. Some examples include:

- ❑ *Oilfield*
 - Gel/polymer formation and breaking
 - Slime removal in injection wells
 - Emulsion breaking
 - Stimulation and permeability enhancement
 - Natural gas sweetening
 - H₂S removal in brines
- ❑ *Geothermal H₂S abatement*
 - Well drilling
 - Power plants
 - Stacking

Solutions of hydrogen peroxide and sulfuric acid are used in the etching of printed circuit boards. They are also used in other cleaning and etching processes throughout the industry. Some of hydrogen peroxide's common electronics and metal finishing applications include:

- ❑ *Electronics*
 - Silicon wafer cleaning
 - Semiconductor processing
 - Photo resist removal (stripping)
 - Copper etching
 - Cupric chloride regeneration

- ❑ *Metal Finishing*
 - Pickling Al, Fe, Cu
 - Chemical milling



Hydrogen peroxide is an effective environmentally clean reagent in numerous industrial applications.

Hydrogen peroxide is an effective cleaning agent with the advantage of the harmless residues formed when it decomposes. Food processors use H₂O₂ in the following applications:

- ❑ *Food processing*
 - Packaging of milk, fruit juices, etc.
 - Sugar decolorization
 - Food preservative (milk, whey)
 - Bleaching agent
 - Cleaning solutions for equipment and lines

Miscellaneous Applications

One of Hydrogen Peroxide's earliest applications was its use in dilute solutions as an antiseptic. Today, hydrogen peroxide is used in a variety of cosmetic and pharmaceutical applications such as:

- ❑ *Cosmetics*
 - Hair bleaching
 - Perm waves
 - Hair dye setting through oxidation
- ❑ *Pharmaceutical*
 - Contact lens cleaner
 - Denture cleaner
 - Topical antiseptic



Versatile hydrogen peroxide is used in the cosmetics and pharmaceutical industries.

These are just some of the many ways hydrogen peroxide is used effectively and economically throughout the world. With over 60 years of experience, FMC has the technical expertise to assist with all applications and systems technology. A trained applications specialist will provide the technical assistance you need to put hydrogen peroxide to work. (Please see the Technical Service section for more details)

FMC is a leading supplier of hydrogen peroxide. For help with your specific applications needs, contact FMC today at: 215-299-6000

Technical Data

Terminology

FMC hydrogen peroxide (H₂O₂) is sold as an aqueous solution. The amount of H₂O₂ present is expressed as a percent of the solution's weight. Thus, a 35% solution is one which contains 35% hydrogen peroxide and 65% water by weight.

Formerly, the concentration of the chemical was expressed in terms of 'volume' strength. This referred to the volume of oxygen released during decomposition. Thus, 'hydrogen peroxide 130 volume' meant that, under standard conditions 130 volumes of oxygen would be released by one volume of solution.

A list of the concentrations of hydrogen peroxide available from FMC Corporation follows showing weight percentages with equivalent 'volume' strength along with other important properties.

Physical Properties

FMC hydrogen peroxide has a molecular weight of 34.02, is clear, colorless and waterlike in appearance, and has a slightly acidic odor. It is miscible with water in all proportions and is nonflammable. Other physical properties are listed in Table 1.

Stability

FMC hydrogen peroxide is very stable under normal conditions, when properly stored. The rate of active oxygen loss in large containers, such as bulk storage tanks, is less than 1% per year at normal ambient temperatures. In small containers, such as drums, the rate of loss is less than 2% per year. In general, the larger the ratio of the surface area to the volume of the hydrogen peroxide, the greater the rate of oxygen loss.

The decomposition rate of hydrogen peroxide is increased by contamination, alkalinity, increasing temperatures and contact with certain metals.

(H ₂ O ₂) concentrations, weight %	31	35	50	70
'Volume strength' @ 0°C & 1 atm	116	130	197	300
Active oxygen content, weight %	14.6	16.5	23.5	32.9
(H ₂ O ₂) g/l	346	396	600	903
Specific gravity @ 20°C/4°C	1.11	1.13	1.19	1.29
Lbs/gal @ 20°C	9.25	9.42	9.92	10.75
Boiling point, °C	106	108	114	126
Freezing point, °C	-27	-33	-52	-40
Viscosity @ 25°C (centipoise)	0.98	1.0	1.06	1.12
Refractive index @ 25°C	1.353	1.355	1.366	1.381
Dielectric constant @ 20°C	82	83	83	82
Total vapor pressure @ 30°C (mm Hg)	24.0	23.3	18.3	10.1
Partial pressure @ 30°C (mm Hg)	0.24	0.28	0.56	1.17
Heat of dilution, cal/g mole @ 25°C & 1 atm	-66	-84	-178	-381
Surface tension, dynes/cm at 20°C	74.4	74.6	75.6	77.3

Table 1. Chemical and Physical Properties

Technical Data *continued*

- ❑ To provide some protection against accidental contamination during shipment, storage or handling, low levels of special stabilizers are added to FMC hydrogen peroxide. However, since no additive will prevent decomposition if excessive contamination occurs, the best practice is to prevent contamination through proper handling techniques.
 - ❑ Alkaline hydrogen peroxide solutions are much less stable than acidic solutions of comparable purity. For that reason, hydrogen peroxide is shipped and stored at an acidic pH level.
 - ❑ Rising temperatures markedly increase the decomposition rate. The rate increases approximately 2.2 times for each 10 °C rise in temperature in the range from 20 °C to 100 °C. The rate increases 1.5 times for each 10 °F rise from 68 °F to 212 °F.
 - ❑ Hydrogen peroxide remains a liquid until temperatures drop substantially below 0 °C. Crystals begin to appear in 35% and 50% solutions at -33 °C, and -52 °C, respectively. Thus, outside storage is a common practice.
 - ❑ Metals, such as copper and iron, and other contaminants act as catalysts for the decomposition of hydrogen peroxide. Using materials of construction in storage and handling systems that are not compatible with hydrogen peroxide can cause catalytic decomposition of the hydrogen peroxide. To avoid this danger, refer to the Materials of Construction section of this bulletin.
- Information on safe storage and use of hydrogen peroxide is available from your FMC Technical Service Specialist.

Analysis

Qualitative Analysis

A number of color reactions are known which will detect hydrogen peroxide in very small amounts. One of these reactions recommended for practical work is based on the distinct yellow color produced by hydrogen peroxide when a few drops of acid titanium sulfate solution are added to a small amount of the material to be tested. Another very sensitive test is based on the liberation of iodine from an acid solution of potassium iodide containing a few drops of soluble starch solution. Addition of the sample to be tested will produce a distinct blue color if hydrogen peroxide is present.

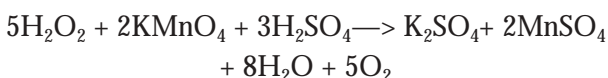


Quantitative Analysis—Potassium Permanganate Method

Principle

Hydrogen peroxide is oxidized by potassium permanganate in the presence of sulfuric acid. Organic or inorganic reducing substances which are capable of reacting with permanganate interfere with the method.

Chemical Reaction



Apparatus

- Analytical balance—accuracy of plus or minus 0.1 mg
- 5 mL beaker or small weighing bottle
- 250 mL Erlenmeyer flask
- 50 mL buret—Class A
- Medicine dropper

Reagents

0.5 N Potassium permanganate titrating solution sulfuric acid — approximately 25% by weight

Safety

Observe standard safety laboratory procedures in the handling of H_2O_2 and H_2SO_4 .

Procedure

To accurately measure the weight percent of hydrogen peroxide in a strong solution, it is important to weigh the sample for analysis. This can be done by using a dropper to transfer the solution to a small tared beaker on the pan of the analytical balance. The sample chosen should contain about 0.35 grams of hydrogen peroxide.

Approximate Sample Size

Percent H_2O_2	Grams Sample
35	1.0
50	0.7
65	0.6
70	0.5

The weighed sample should be transferred quantitatively to a 250 mL Erlenmeyer flask containing 50 to 100 mL of C.P. 25% sulfuric acid. Add, with a vigorous stirring, 0.5N KMnO_4 at the rate of 10 to 30 mL/minute. The end point is reached when a faint pink color lasting for one minute is obtained. If, during the titration, the solution in the beaker turns brown, discard the sample and begin the analysis again. Brown coloration only indicates deficiency of acid, or too rapid addition of KMnO_4 . Titrations should be made on at least two samples to test the accuracy.

Calculation of Results

The concentration of H_2O_2 in the analyzed sample is calculated as follows:

$$\text{weight \% H}_2\text{O}_2 = \frac{\text{mL KMnO}_4 \times \text{Normality of KMnO}_4 \times 1.701}{\text{Sample weight in grams}}$$

Other Methods

You can also obtain an accurate volumetric analysis of hydrogen peroxide by reducing ceric salts to cerous salts; or by liberating iodine from an iodide, followed by titration with a thiosulfate solution.

For more information about analytical methods please consult with FMC's technical specialists.

Safety

General Considerations

A basic understanding of the properties of hydrogen peroxide is the first step in the safe handling of this chemical. Decomposition caused by contamination releases oxygen and heat. In dilute solutions, the heat evolved is normally absorbed by the water present. In more concentrated solutions, the heat raises the temperature of the solution and accelerates the decomposition rate. Therefore, all handling procedures must insure product integrity by *preventing any contamination*.

Hydrogen peroxide should be stored only in original containers or in containers of compatible materials that have been properly designed, thoroughly passivated, and dedicated for this use. To prevent contamination, H₂O₂ should never be returned to its storage container. Dispose of any excess by dilution with purified water.

Hydrogen peroxide is not considered to be an explosive. However, when it is mixed with organic substances, hazardous, impact-sensitive compounds may result. Even small amounts of materials containing catalysts such as silver, lead, copper, chromium, mercury and iron can cause immediate decomposition and explosive rupture of the containing vessel, even if the vessel is properly vented.

Fires caused by hydrogen peroxide are best controlled by using large quantities of water. The chemical itself does not burn, but its decomposition liberates oxygen which supports combustion.

Personnel Safety

Always wear safety goggles, neoprene rubber gloves and shoes, and suitable protective clothing when handling hydrogen peroxide. Concentrated solutions are corrosive to the eye and skin and direct eye contact may cause irreversible tissue damage including blindness. Inhalation of mist or vapor will cause severe irritation

of lungs, throat and nose that usually subsides after exposure ceases. Swallowing may produce corrosion (burning) of the gastrointestinal tract that may be life-threatening. If spilled on the skin, wash off immediately with large amounts of water. If the chemical has come into contact with the eyes follow appropriate first-aid procedures and consult a physician promptly.

Hydrogen peroxide and its primary decomposition products, oxygen and water, are not systemic poisons. However, hydrogen peroxide vapors can cause irritation and inflammation of the respiratory tract. If inhalation has been prolonged, seek fresh air at once and consult a physician immediately.



Although 3% hydrogen peroxide solutions are often used as a gargle or mouthwash, more concentrated solutions should never be allowed to come into contact with the mouth. If hydrogen peroxide is swallowed, ingest lukewarm water freely and call a physician.

If clothing comes into contact with hydrogen peroxide, wash it thoroughly in water. Any H₂O₂ left to dry on the fabric, particularly if it is soiled, may cause fire.

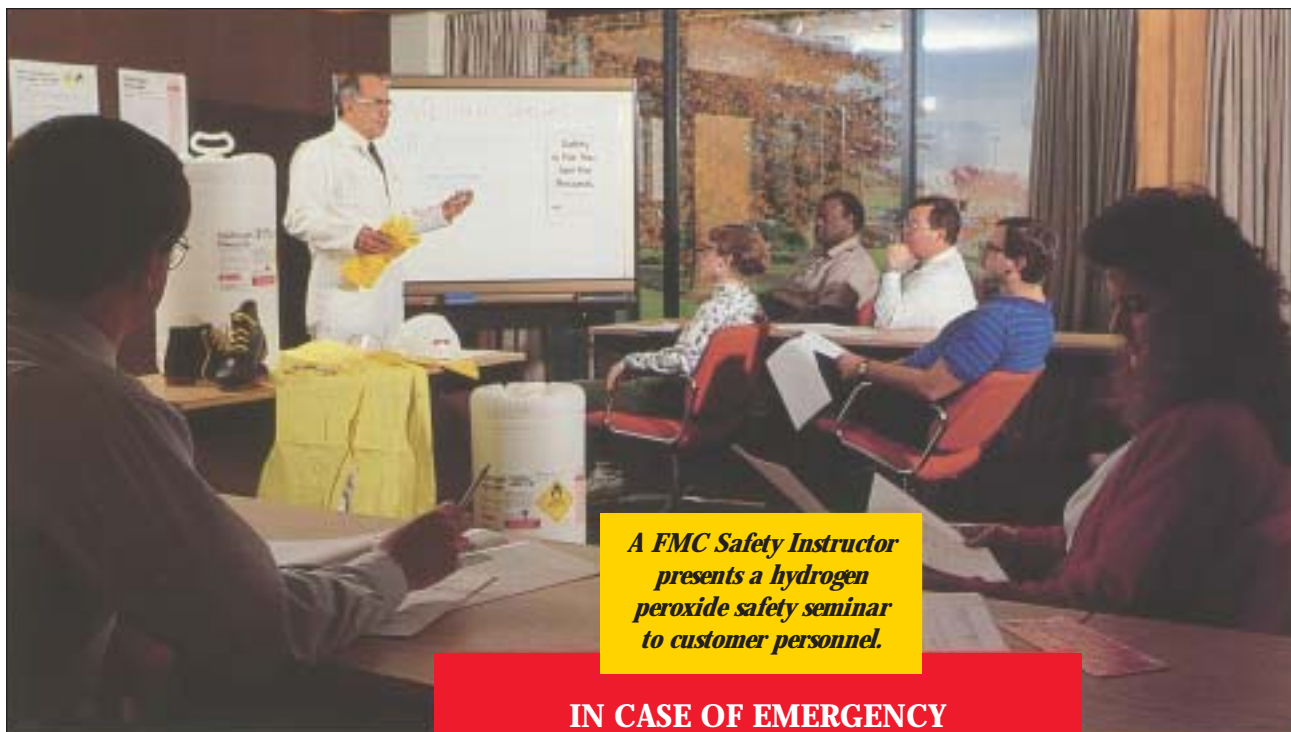
FMC Customer Safety Assistance

To help instruct customer operating personnel, FMC offers a safety wall chart, "Safe Handling of Hydrogen Peroxide," which should be prominently displayed in areas where the chemical is stored, handled and used. This chart is available upon request. FMC also provides:

- ❑ Material Safety Data Sheets maintained through a comprehensive computer system.

- ❑ Safety and Handling Programs available on slides or video cassette for customer training.
- ❑ Product Safety Seminars conducted at customer plant locations.

FMC is committed to the safe delivery, handling and use of our hydrogen peroxide. As an FMC customer, you will receive safety information, materials and training to help you use our product effectively and safely.



A FMC Safety Instructor presents a hydrogen peroxide safety seminar to customer personnel.

IN CASE OF EMERGENCY

For Transportation Emergencies contact:
CHEM TREC at 1-800-424-9300

FMC Emergency Response Center
1-609-924-6677

For Medical Emergencies Contact:
Rocky Mountain Poison Control at 1-303-595-9048

Product Quality and Grades

Consistent product quality is vitally important in many hydrogen peroxide applications. In addition, quality product helps provide safety and reliability to our customers.

FMC Commitment to the Highest Standards

Product quality is of critical importance at FMC. Excellent quality reflects the teamwork and good communications with our customers and throughout the FMC organization.

There are many behind-the-scenes activities and programs carried out by FMC plant and technical staffs which have made our product quality second to none. Here are some highlights of this ongoing commitment to excellence.

Statistical Process Control (SPC)

FMC hydrogen peroxide is consistently within set specifications. Process upsets are spotted early and corrected at once. Data is thoroughly analyzed and quickly communicated to plant operators so that process improvements are recognized and maintained.

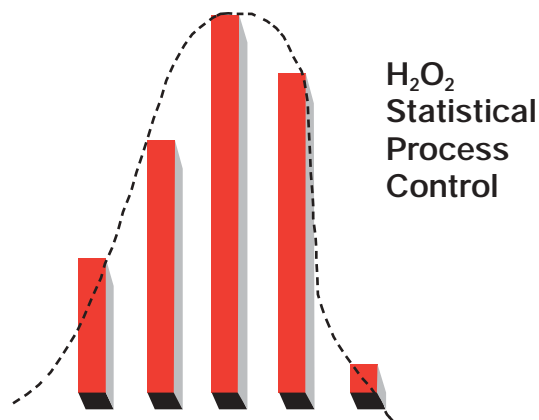
Designed initially to meet the special needs of the semiconductor industry, SPC is now routinely used at all FMC plants to control the manufacture of all product grades. FMC has stringent specifications tailored to each grade of hydrogen peroxide. Our goal is, and will continue to be, to produce hydrogen peroxide that meets those rigid criteria 100% of the time. SPC enables us to minimize the cost of reworking products, improve timeliness on deliveries, and reduce customers' expenses and worries about analytical results. An FMC sales representative can provide you with complete details on our Statistical Process Control Program.

Product Grades

FMC manufactures several grades of hydrogen peroxide tailored to different end-use applications, as shown in Table 2.

Each grade is available in different concentrations to maximize economy and convenience. The grades differ from one another in the types and amounts of stabilizing additives contained. FMC manufactures each grade to best meet our customers' specific needs.

Stabilizer levels for special grades are chosen to ensure that products comply with requirements of the Food Chemical Codex, the U.S. Pharmacopeia and technical organizations such as S.E.M. I. and the American Chemical Society.



<i>Grades (concentration)</i>	<i>Main Applications</i>	<i>Stabilizer/Specs</i>	<i>Dilution Water</i>
Standard (70,50,35)	<ul style="list-style-type: none"> ■ Textile/pulp bleaching ■ Waste treatment ■ General uses 	Tin type and other	Deionized water or continuous monitored tap water of suitable purity. (FMC will assist in analyzing tap water)
Technical (70,50,35)	<ul style="list-style-type: none"> ■ Chemical synthesis 	Organic. Essentially free of metal ions	Deionized only
Chlorate (5o)	<ul style="list-style-type: none"> ■ Hypochlorite destruction during sodium chlorate manufacture 	Tin type and other low phosphate	Deionized only
Super D (65,50,35)	<ul style="list-style-type: none"> ■ Hair bleach ■ Topical antiseptic 	Tin type and other. Meets US Pharmacopeia requirements for 3% topical antiseptic	Deionized only
Durox, Durox LR (50,35)	<ul style="list-style-type: none"> ■ US Food and Drug Administration approved food uses 	Tin type and other. Meets Food Chemical Codex specifications. Residue <60 ppm	Deionized only
<i>Electronic Grades</i>			
Semiconductor (70,31)	<ul style="list-style-type: none"> ■ Contact lens applications ■ Semiconductor processing 	Minimal amount of stabilizer, <20 ppm. Conforms to SEMI and ACS specifications.	Deionized only
SEG/RGS (31)	<ul style="list-style-type: none"> ■ Contact lens applications ■ Semiconductor processing 	Stabilizer free Purity to <1 PPB contaminants	Dilution for storage not recommended

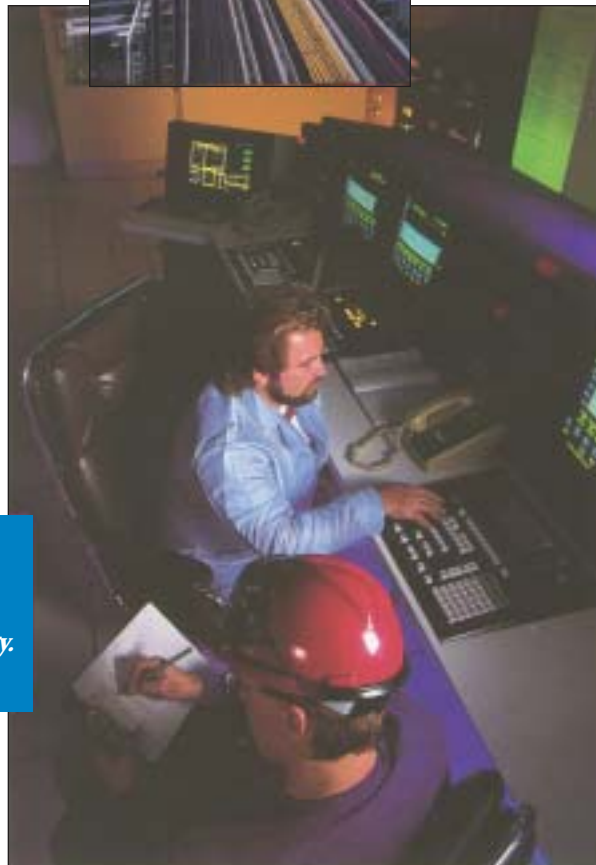
Table 2. H₂O₂ Product Grades

Supply Reliability

Reliability of hydrogen peroxide supply is paramount in all industrial applications. Excessive costs occur without the right product, at the right place, at the right time.

FMC is a leading producer of hydrogen peroxide, with seven worldwide manufacturing plants. Our plants in Mexico, Japan, Thailand and Europe supply the international market. In North America, FMC operates hydrogen peroxide manufacturing plants in Spring Hill, West Virginia and Bayport, Texas. A third plant was recently added to the system in Prince George, British Columbia, which will further enhance our supply reliability. FMC also maintains a strategic network of hydrogen peroxide distribution centers.

FMC's multiple facilities, extensive distribution system, computerized quality control, and industry leadership all add up to one thing: unsurpassed reliability in meeting our customers' hydrogen peroxide needs.



FMC plant personnel use state of the art process control technology.

Technical Services

Technical expertise and assistance in the use of hydrogen peroxide in all applications is a valuable service provided by FMC.

Full Technical Support

When you buy FMC hydrogen peroxide you also receive our full technical support for all your applications needs. FMC Technical Service Specialists are ready to assist you in the following areas:

- Pulp and Paper
- Electronics
- Mining
- Environmental
- Textiles
- Detergent
- New Technology
- Industrial

Personalized Service

FMC personnel understand your needs and will work closely with you to solve any hydrogen peroxide application problems. FMC capabilities range from laboratory evaluation to on-site assistance for plant trials and commercial start-up. Laboratory and field trials can include feasibility studies or statistical optimization studies, depending on your needs. All of these laboratory and onsite services include detailed follow-up reports and personal presentations of data and recommendations. Some of these services are listed below:



Laboratory services provided at FMC's Princeton laboratory help ensure quality results.

Technical Services *continued*

- Training in safety and handling
- Plant audits
- Plant problem solving
- Analytical procedures
- Product and application literature
- Phone consultation
- Laboratory evaluation
- Plant trials
- Commercial start-up assistance
- Feasibility studies
- Statistical optimization studies

FMC is committed to advancing hydrogen peroxide applications technology. We are responsive to the needs of our customers by developing new applications and optimizing existing applications. We are continuously developing new applications at our Princeton research facility, and sponsoring additional studies at leading academic and research centers. FMC is on the front line of hydrogen peroxide application development worldwide through technology transfers with our partners in Europe, Asia and Latin America.

FMC is committed to keeping customers informed of all emerging technology through customer seminars, presentations at industry conferences, and technical publications.

FMC Technical Service Specialist provides on-site applications assistance utilizing a hydrogen peroxide skid delivery unit.



Engineering Services

Expertise in the storage and handling of hydrogen peroxide is an important value for providing safe and efficient systems.

With hydrogen peroxide, proper handling and storage is vital to safe operation. FMC Engineering Services Group has designed and installed approximately three out of every four hydrogen peroxide storage facilities in North America, and has the expertise to assist in all hydrogen peroxide storage needs.



Storage System Design

Hydrogen peroxide solutions should be stored in accordance with National Fire Protection Association Code 43A. This code lists hydrogen peroxide solutions higher than 52% as Class 3 oxidizers and solutions between 27.5% and 52% as Class 2 oxidizers.

Hydrogen peroxide should only be stored in original containers or in tanks built from compatible materials which have been properly designed and thoroughly passivated.

Selection of a drum or bulk storage system depends on the needs of the user and is often a function of economics and safety. The drum storage system requires a minimal capital investment; but the product cost is higher and there are labor costs for drum handling. These costs are avoided in bulk systems.

When designing a storage and handling system for hydrogen peroxide, it is important to *eliminate the danger of catalytic decomposition*. Hydrogen peroxide will decompose into oxygen and water when catalyzed by a variety of materials. Because of this danger,



all systems must be designed with the following basic guidelines:

❑ **Contamination Prevention**

Use only materials compatible with H₂O₂. Design to prevent contaminants from entering the system. Clean and passivate the system prior to first use. Train operating personnel in the proper use and maintenance of the system. *High-purity Aluminum Alloy 5254* is recommended for permanent storage tanks. Care must be taken during fabrication to prevent undesirable substances from becoming embedded in the aluminum surface. Proper welding techniques are absolutely mandatory.

❑ **Decomposition Effect Minimization**

The design should eliminate the consequence of H₂O₂ decomposition by providing proper ventilation in all parts of the system. This will eliminate pressure build-up which could result in system ruptures. Storage tanks must be properly vented and located away from sources of direct heat and combustible materials.

Since the freezing points of hydrogen peroxide solutions are low and the boiling points high (see Technical Data section), storage tanks can usually be located outdoors in both hot and cold climates.

Like any liquid, hydrogen peroxide can be transferred from one point to another by gravity flow or pumping. All equipment used in a transfer must be made of material compatible with hydrogen peroxide and should have adequate pressure relief (venting) systems.

Materials of Construction

Since hydrogen peroxide is a powerful oxidizing agent, *compatible materials* must be used in the construction of any system. The most practical material is *high purity aluminum*. FMC recommends *Aluminum Alloy 5254* for the construction of hydrogen peroxide bulk storage tanks. Aluminum alloys such as 1060 are used in the hydrogen peroxide transfer piping. Type 316 stainless steel is a satisfactory material for H₂O₂ transfer pumps. Materials compatible with hydrogen peroxide are listed

Class 1 materials

These materials can be used for unlimited-time contact with hydrogen peroxide.

- Aluminum alloys, type 5254, 1060 and B-356 (cast) for storage tank, transfer piping, pumps and valves.
- White chemical porcelain
- Some grades of polyethylene may be used under certain carefully selected conditions of temperature, interconnecting materials, physical location, H₂O₂ concentration and hydraulics. Consultation with FMC is advised prior to storing peroxide in polyethylene.
- Pyrex^{®1} laboratory glassware
- Kel-F[®] 81² resin
- Fluorocarbon resin

Class 2 materials

These materials may be used for limited-time contact with hydrogen peroxide.

- Stainless steel type 304, 316 for transfer pumps and tank trucks conveying peroxide on a short residence-time basis only. Consultation with FMC is advised.
- Koroseal^{®3} 700 molded polyvinyl chloride

Table 3. Suggested materials for use with Hydrogen Peroxide

¹Trademark of Corning Glass Works

²Trademark of Minnesota Mining and Manufacturing Company

³Trademark of The B.F. Goodrich Company

in Table 3. Under certain circumstances other materials can be used. (Please contact a FMC specialist for more information)

System Maintenance (Inspection and Passivation)

To ensure maximum, peroxide stability, all equipment

used in handling hydrogen peroxide solutions *must be thoroughly cleaned and passivated* before being placed in service. Aluminum alloys and stainless steels should be passivated by the following procedure:

1. Detergent wash to remove all oil, grease, loose contaminants, etc.

<i>Part</i>	<i>Material</i>	<i>Identification/miscellaneous</i>
Storage tank	5254 aluminum 316 Stainless Steel	Section VIII ASME code for unfired vessels under 14.7 psi (101.4 kPa).
Piping	1060 aluminum alloy, 316 stainless steel; Koroseal® 700 gaskets	Schedule 40 or 80. Butt welded joints. Van Stone flanged connections.
Valves: Manual or electrical operation	B356 aluminum	Model—Ball flanged P515114436T with 110 volt, 60 cycle electric operators. Type EL 20
Check	304/316 stainless steel	
Pumps: Centrifugal Metering	Class 1 or 2 e.g. 356.A 304/316 stainless steel	2" (5.08 cm) 10W self-priming fluorocarbon diaphragm, hydraulically activated
Water meter	Cadmium plated galvanized iron case, bronze working parts	Model DV 1½" (3.81 cm) with batch register and totalizer 50 GPM max. 1¼" (3.18 cm) water meter union connections
Water filter	304/316 stainless steel	Model VCS 1003-EG 16 3-30 micron disposable filter cartridges for water service
Temperature monitoring device	Aluminum or stainless steel	Vapor actuated capillary 6" (15.24 cm) dial type with high alarm contact. For 110 volt, 60 cycle service, audio/visual alarm.
Hoses	304/316 stainless steel	2" (5.08 cm) ID stainless steel flexible metal hose (2.4" [6.1 cm] OD). Male and female stainless steel quick connectors end fittings.
Mechanical seals	316 stainless steel, ceramic and flouorcarbon resin or equivalent	Type 9, code QVICI 316 (for service with hydrogen peroxide transfer pumps).

Table 4. Suggested Specifications for an H₂O₂ System

Engineering Services *continued*

2. Thoroughly rinse with clean, purified water and drain to remove all contaminants and washing solution.
3. Treat all surfaces with a 35% nitric acid solution. Rinse thoroughly and drain several times to remove all acid and water-soluble contaminants.

The size and type of the facility will determine the passivation procedures used. In some cases, tanks, piping and other items may be passivated separately before they are installed in the storage and handling system.

FMC provides customers with detailed instructions for proper passivation procedures. For field passivation, FMC will provide special equipment to customers who wish to perform system passivation after installation. For more information, contact your FMC sales representative. All FMC customers have access to our full range of engineering services.

FMC Technicians complete installation passivation and inspection of a hydrogen peroxide storage system at customer site.



Distribution Services

Moving all grades of hydrogen peroxide through the most extensive peroxide distribution network in North America is a key component of reliability, safety and quality.

Shipping Methods

There are three common types of hydrogen peroxide shipping containers: drums, tank trailers, and tank cars.

Drums

55-gallon polyethylene drum is the most typical drum size. Polyethylene drums are also available in 6-, 15- and 30-gallon (23-, 57- and 114-liter) sizes. Concentrations of up to 50% are available in drums. All are equipped with a venting device in the drum head and should never be palletized or stacked in a way that would damage or block the vent. Hydrogen peroxide drums should be stored on metal or plastic pallets. Since H_2O_2 is a rapid oxidizer, drums should never be stored on wooden pallets. Drums should be handled and emptied using dedicated special drum rockers, bung wrenches and unloading equipment.



Shipping drums used for storage must always be stored head up, preferably on a concrete floor, in a clean, cool, fireproof area away from combustible materials. Wherever hydrogen peroxide is stored, you must have adequate ventilation and ample water for washing away accidental spills.

Tank Trailers

4000-gallon (approximately $15m^3$), 5000-gallon (approximately $19m^3$) and 6000-gallon (approximately $23m^3$) tank trailers deliver into customer-owned bulk storage tanks. These trailers can carry 70% hydrogen peroxide by weight for dilution on delivery. Or they can carry 50%, 35% and 31% concentrations for delivery without dilution. Many tank trailers are equipped with on-board deionization units to improve the local water quality when used for dilutions. They are also equipped with pumps, hoses and fittings for attachment to bulk storage systems. Unloading and dilution are performed by FMC Driver/Technicians. A minimum delivery of 1500 gallons ($5.7m^3$) is generally required.



Distribution Services *continued*

Tank Cars

Special aluminum railroad tank cars—from 4,000 to 20,000-gallon (approximately 15 to 76m³) capacities—normally deliver hydrogen peroxide up to 70% concentration. Customers perform unloading and dilution, with instructions and training from FMC. Before a customer decides to dilute hydrogen peroxide shipments to 35% or 50% from 70%, FMC will assist in the sampling and analysis of the water supply to determine its suitability for use. If the water is not suitable for use either 'as is,' or after deionization, straight 35% or 50% hydrogen peroxide must be specified when ordering.



Distribution Network and Fleet

FMC operates an extensive distribution network throughout North America and worldwide to provide customers with fast, dependable service. 'Becoming our customer's most valued supplier' is not just a slogan, but our day-to-day commitment. Throughout the United States and Canada, our strategically located distribution centers have extensive storage capabilities. Most customers are within hours of an FMC distribution center.

FMC also supplies many chemical distributors throughout North America to further provide a reliable local source of product.

A computer sourcing model is used to analyze all customer shipments of hydrogen peroxide. This ensures minimum delivery times, provides back-up locations, and helps us maintain adequate fleet size and inventory levels to meet our customers' requirements. Special tracking systems are utilized at FMC to provide up to date information on the location of Rail and Truck shipments. Please contact your sales representative for additional information regarding this service.

Rail Shipments and Deliveries

A fleet of 20,000-gallon jumbo rail cars stocks our North American distribution centers with hydrogen peroxide from FMC plants in Spring Hill, West Virginia, Bayport, Texas and Prince George, British Columbia. FMC also provides direct rail shipments to customers. The fleet includes 4,000, 6,000, 8,000 and 10,000 gallon cars for specialized customer needs.

Tank Truck Deliveries with FMC Driver/Technicians

FMC Driver/Technicians deliver hydrogen peroxide in a modern fleet of tank trucks, the largest fleet in North America. FMC tank trailers are totally dedicated to hydrogen peroxide service. This eliminates the possibility of contamination with other products. Many of the tankers are equipped with deionization units to improve water quality. Some tank trailers are lined with polyethylene for use in transporting semiconductor grade peroxide.

Specially trained Driver/Technicians operate FMC's tank truck fleet. These skilled FMC employees have been recognized nationally in *DISTRIBUTION* and *MODERN BULK TRANSPORTER* magazines for providing the highest quality of delivery service.

FMC Driver/Technicians understand hydrogen peroxide and inspect customer storage tanks for possible contamination or leakage. They take samples of the peroxide in the customer storage tanks before and after delivery and test the samples for pH, concentration and stability. They also check water conductivity during dilution deliveries.

Driver/Technicians are carefully trained and routinely deliver 70% hydrogen peroxide and dilute it to lower concentrations required by the customer. This can result in significant freight savings to our customers.

For hydrogen peroxide delivery, dilution and tank inspections, an experienced Driver/Technician is your front line contact.



FMC Driver/Technician performs analysis during delivery to a customer plant.

Sales and Customer Service

Sales Services

Field Sales Representatives

FMC's field sales representatives are your point of contact for all FMC services. Our advanced field communication networks assure ready access to our representatives. These individuals are highly trained professionals with extensive experience serving hydrogen peroxide consuming industries. They can help meet your hydrogen peroxide requirements and assist you with technical, engineering, safety and application services.

Customer Service

Customer Service Representatives

Our customer service representatives are experienced professionals prepared to handle your hydrogen peroxide orders and sample requests, and provide up-to-date information about product availability, delivery status, freight costs, quality and safety. They utilize FMC's customer service system (CSS), which is one of the most advanced computer order entry and transportation management systems in the chemical industry. The CSS network instantaneously transmits information about your order to sales, manufacturing and distribution operations, ensuring that your order is handled quickly and efficiently.

The FMC Commitment



Reliability

FMC strives to become your most valued supplier. Our commitment to uncompromised Reliability, Quality, Service and Safety ensures every customer the most complete value package in the industry.

Reliability

FMC is the only producer of hydrogen peroxide in North America operating four plants on five separate cycles which are backed up by sister plants throughout the world. FMC also provides the most extensive hydrogen peroxide distribution network in the industry. With FMC reliability, you get the right product, at the right place, at the right time.

Service

As a leading supplier of hydrogen peroxide for over 60 years, FMC provides expert technical service for every application of hydrogen peroxide.

Service

Quality

Our advanced engineering service provides safe and efficient storage and handling systems. Finally, our distribution services, with our FMC employed driver/technicians, provides the safe and reliable delivery of a quality product.

Quality

FMC offers all commercial grades of hydrogen peroxide which are specially stabilized for our customer's applications. Implementation of SPC (Statistical Process Control) programs at all our hydrogen peroxide plants enables FMC to supply product of the highest quality with every shipment.

Safety

Overriding our Reliability, Service and Quality programs is our utmost concern- Safety. You can rely on FMC's technicians who are trained to provide expert advice and assistance in the safe handling of all applications.

Safety

Becoming your most valued supplier for every hydrogen peroxide need.



FMC Corporation
Hydrogen Peroxide Division
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Questions on hydrogen peroxide?

Call 215-299-6000

*in Eastern Canada call Eastern region
Sales Offices at 1-800-668-5166*

*in Western Canada call Vancouver
Sales Office collect at 1-800-567-5700*