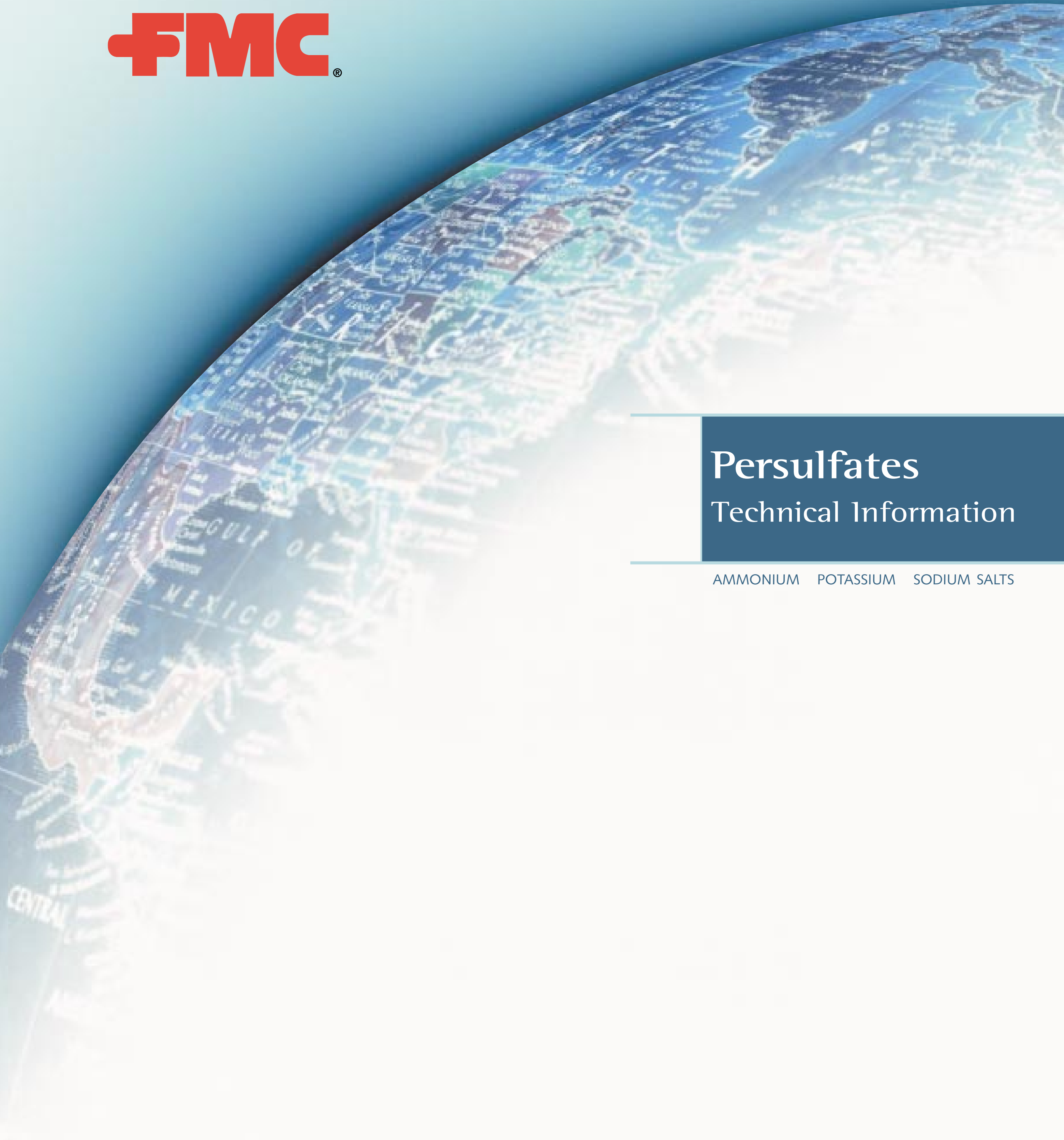


Persulfates

Technical Information

AMMONIUM POTASSIUM SODIUM SALTS

QUALITY PERSULFATES
RELIABLE SUPPLY

Table of Contents

FMC Active Oxidants Sales & Marketing
Pictured from left to right:
Paula Scott, Account Manager
Rosanne Menzel, Senior Product Representative
Robert Mulholland, Account Manager
Richard White, Sales & Marketing Director

Leading the persulfate market with improved products and reliable supply.

Persulfates are the most chemically active of the peroxygens, with great utility in a variety of chemical processes. FMC persulfates, backed by years of experience, are manufactured to strict specifications for thermal stability, making them among the most stable available.

FMC is the leading producer of peroxygen chemicals and a major researcher in active oxidant chemistry. We are the world's largest and North America's only producer of peroxydisulfates, a group of chemicals commonly referred to as persulfates. FMC manufactures ammonium, potassium, and sodium persulfates at a plant in Tonawanda, New York. Our dedicated plant employees contribute to FMC's 70 years of peroxygen production experience.

FMC provides a reliable supply of high-quality, stable persulfates to the global market. The Tonawanda plant is an ISO-9002 certified facility near the Niagara River outside Buffalo, NY. This location provides abundant local resources, including reliable supplies of hydroelectric power and cooling water.

FMC has been the world's leading producer of persulfates for decades, yet we continually find ways to improve our products, especially their safety.

Our research into the characteristics of peroxydisulfates has improved the quality and the stability of all FMC persulfates. An understanding of the crystalline structure of persulfates and the interplay with heat and moisture have changed quality control procedures, manufacturing processes, and storage requirements for these products. We have established new specifications for thermal stability which make persulfates among the most stable available.

Persulfates are strong oxidants, have excellent shelf life when stored properly, and are economical to use. These properties make persulfates suitable for a variety of applications.

FMC is committed to the principles of Product Stewardship and to manufacturing, transporting, storing, and using chemicals in a safe manner. The commitment begins with the manufacturing process and continues throughout the life cycle of our products. Our continuing effort is to ensure that safety, health, and environmental issues are addressed wherever persulfates are handled or used.

Applications and Chemistry

Applications

Persulfates are key components in many industrial processes and commercial products.

The polymer industry uses aqueous solutions of persulfates as initiators in the polymerization of latex and synthetic rubber. The electronics industry considers sodium persulfate an efficient microetchant in the manufacture of printed circuit boards. The following examples further illustrate the chemical versatility of persulfates.

Polymerization

Plastics and rubber — Ammonium, potassium, and sodium persulfates are used as initiators for emulsion polymerization reactions in the preparation of acrylics, polyvinyl chlorides, polystyrenes, and neoprene.

They are used as polymerization initiators in the manufacture of synthetic rubber (styrene butadiene and isoprene) for automobile and truck tires.

Persulfate initiation is used to prepare latex polymers for paints, coatings, and carpet backing.

Structural materials — Persulfates are used as initiators in polymeric concrete formulations.

Inorganic chemicals and minerals — Persulfates are also initiators for the polymeric coating of graphite filaments.

Soil stabilization — Ammonium persulfate is used as a curing agent in chemical grout systems used to stabilize soil near dams, tunnels, and buildings.

Oxidation

Surface preparation — The oxidation power of persulfates is used to clean and microetch a variety of printed circuit board substrates.

Persulfates are important oxidants in plating and coating processes. They are also etchants for nickel, titanium, and zink alloys.

Persulfates are used to clean and mill aluminum, brass, copper, and many other metal surfaces prior to plating or adhesive bonding.

Persulfates are used to clean and activate carbon and charcoal before and after their use as absorbents.

Cosmetics — The cosmetic industry has developed formulations which use persulfates to boost hair bleaching performance.

Organic synthesis — Persulfates are oxidizing agents in the preparation of aldehydes, ketones, carboxylic acids, quinones, and a variety of other compounds.

The pharmaceutical industry uses sodium persulfate as a reagent in the preparation of antibiotics.

Other Applications

Adhesive — Persulfates are used in the preparation of adhesive films and metal bonding adhesives.

Gas and oil production — In enhanced oil recovery, persulfates are used "down hole" for gel forming and breaking.

Inks, pigments, and dispersants — Persulfates are used to graft substrates to polymers (for example, carbon black to sodium acrylate). Persulfates are used in the preparation of dispersants for ink jetting and toner formulations.

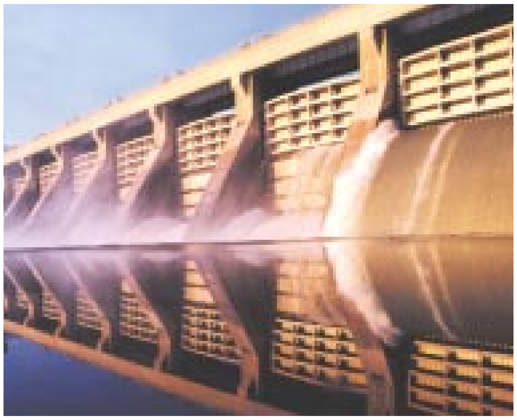
Mining — Persulfates can be used in nickel and cobalt separation processes.

Peroxymonosulfate — FMC developed a process using ammonium and sodium persulfates to prepare peroxymonosulfate solutions. This patented process allows fast, efficient, on-site production of an alternative to Caro's acid and potassium caroate.

Photography — Persulfates are used in many photographic applications, including bleaching solutions, solution regeneration, equipment cleaning, and waste water treatment.

Pulp and paper — Persulfates are used in the sizing of paper, preparation of binders and coatings, and production of special papers.



An activated alkali metal persulfate effectively repulps neutral/alkaline wet-strength broke and decolorizes dyes and optical brightener.[1]

Textiles — Ammonium and sodium persulfates are used in the desizing and bleaching of textiles and the development of dyestuffs.

Swimming pools — Clear Advantage® shock treatment is used to oxidize non-filterable waste in swimming pools and other recreational water. Clear Advantage® shock clarifies water and prevents the formation of combined chlorine.

Environmental — Persulfates are very strong oxidants, have excellent shelf life when stored properly, and are economical to use. These properties make persulfates suitable for a variety of environmental applications, such as soil remediation and wastewater/groundwater cleanup.

Oxidation Chemistry

The persulfate anion is the most powerful oxidant of the peroxygen family of compounds.

The electromotive force data listed below compares three commonly used peroxygens:

$$S_2O_8^{-2} + 2H^+ + 2e^- \longrightarrow 2HSO_4^- \qquad E = 2.12V$$

$$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O \qquad E = 1.77V$$

$$HSO_5^- + 2H^+ + 2e^- \longrightarrow HSO_4^- + H_2O \qquad E = 1.44V$$

Many metals are oxidized by persulfate to form soluble metal sulfates, for example, copper:

$$Cu + S_2O_8^{-2} \longrightarrow CuSO_4 + SO_4^{-2}$$

Under certain circumstances, hydrolysis of the persulfate anion will yield the bisulfate anion and hydrogen peroxide a kinetically faster oxidant than persulfate:

$$S_2O_8^{-2} + 2H_2O \xrightarrow{H^+} 2HSO_4^{-2} + H_2O_2$$

Another reaction of note is the acid-catalyzed hydrolysis of persulfate to form peroxymonosulfate anion.

Fast, high-temperature, acid hydrolysis followed by thermal quenching will yield solutions of peroxymonosulfate:

$$S_2O_8^{-2} + H_2O \xrightarrow{H^+} HSO_4^- + HSO_5^-$$

The resulting solution is a useful replacement for Caro's acid, H_2SO_5 and potassium caroate, $KHSO_5$.

Reactions at different pH:

Neutral (pH 3 to 7)

$$S_2O_8^{-2} + H_2O \longrightarrow 2HSO_4^- + 1/2O_2$$

Dilute acid (pH > 0.3; [H+] < 0.5M)

$$S_2O_8^{-2} + 2H_2O \longrightarrow 2HSO_4^- + H_2O_2$$

Strong acid ([H+] > 0.5M)

$$S_2O_8^{-2} + H_2O \xrightarrow{H^+} HSO_4^- + HSO_5^-$$

Alkaline (pH > 13)

$$S_2O_8^{-2} + OH^- \longrightarrow HSO_4^- + SO_4^{-2} + 1/2O_2$$

Free Radical Chemistry

Persulfates produce free radicals in many diverse reaction situations.

When solutions of the persulfates are heated, free radicals are formed:

$$S_2O_8^{-2} + heat \longrightarrow 2SO_4^{\bullet -}$$

In the presence of suitable monomers, the radical anions act as polymerization initiators to produce polymer molecules:

$$SO_4^{\bullet -} + nCH_2 = \underset{R}{\overset{}{\underset{|}{CH}}} \rightarrow {}^-O_3SO(CH_2(\underset{R}{\underset{|}{CH}}))_{n-1}(CH_2\underset{R}{\underset{|}{C}}{\bullet}H)$$

Free radicals suitable as polymerization initiators are also generated in the presence of reducing agents, for example, the bisulfite anion:

$$S_2O_8^{-2} + HSO_3^- + 1/2O_2 \longrightarrow HSO_4^- + 2SO_4^{\bullet -}$$

Free radicals can also be generated in the presence of transition metals:

$$S_2O_8^{-2} + Fe^{+2} \longrightarrow Fe^{+3} + SO_4^{-2} + SO_4^{\bullet -}$$

and mercaptans:

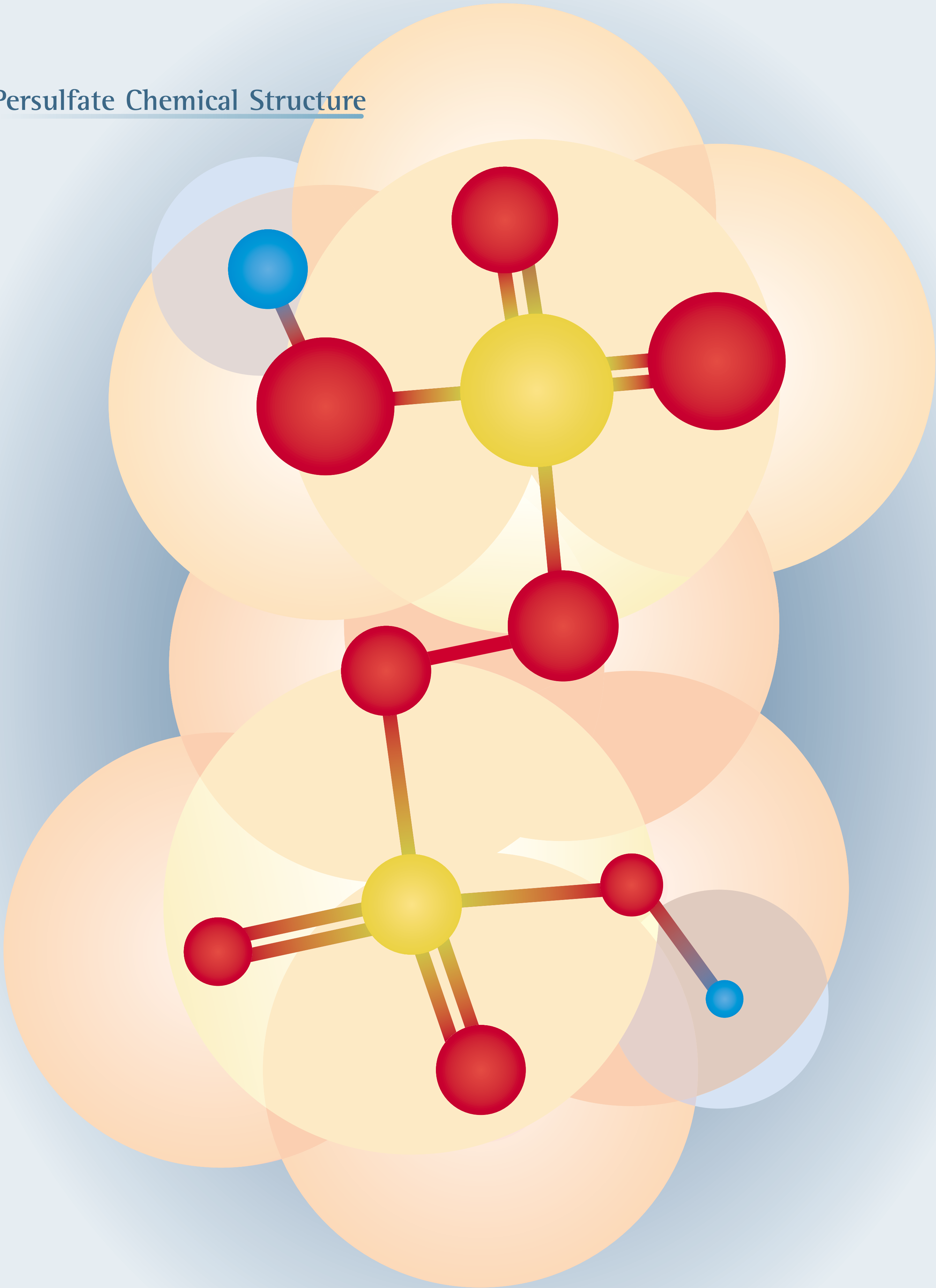
$$S_2O_8^{-2} + 2RSH \longrightarrow 2HSO_4^- + 2RS\bullet$$





[1] Sold under the tradename Kybreak,® a registered trademark of Hercules, Inc.

Persulfate Chemical Structure



Physical and Chemical Data

FMC conducted physical and chemical studies of persulfates to provide the data for this section. You will find the data useful for applying persulfate chemicals to various processes and products.

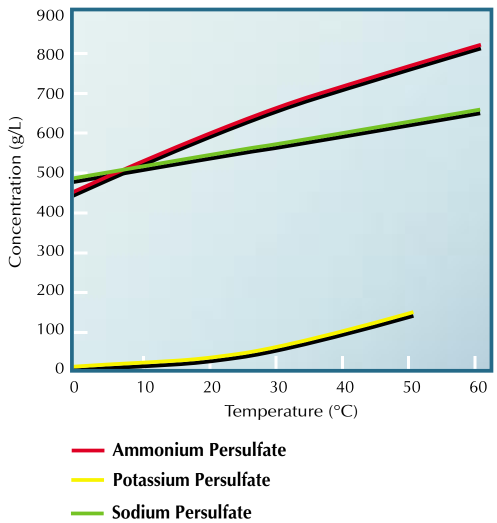
The density, viscosity, electrical conductance, and solution heat capacity data are presented in graphic and equation form. This format enables you to view the general trend of the physical data. Then, with the aid of equations, you can calculate the correct values for your application.

If you have any questions with regard to the information in this section, contact the FMC Research and Development Center in Princeton, NJ. Contact information is listed on the back cover.

Physical and Chemical Properties of Persulfates

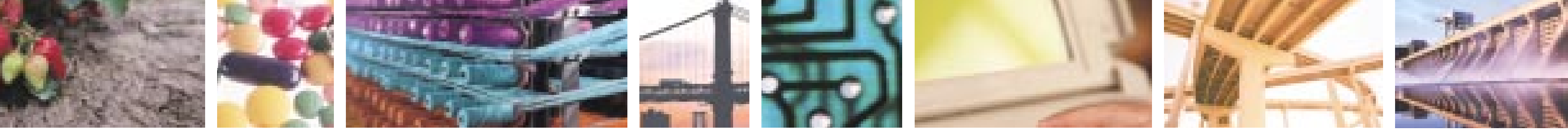
Common name	Ammonium persulfate	Potassium persulfate	Sodium persulfate
Chemical name	Ammonium peroxydisulfate	Potassium peroxydisulfate	Sodium peroxydisulfate
Physical form	Crystalline (monoclinic)	Crystalline (triclinic)	Crystalline (monoclinic)
Formula	$(NH_4)_2S_2O_8$	$K_2S_2O_8$	$Na_2S_2O_8$
Molecular weight	228.2	270.3	238.1
Crystal density (g/cc)	1.98	2.48	2.59
Color	Off-white	White	White
Odor	None	None	None
Loose bulk density (g/cc)	1.05	1.30	1.12

Solubilities of Persulfate Salts

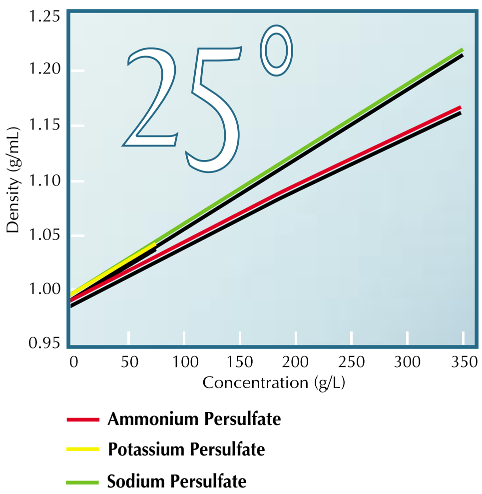


Maximum solubility of persulfate salts in water

Solubility (g/100g of H_2O)	Ammonium Persulfate	Potassium Persulfate	Sodium Persulfate
25˚C	85	6	73
50˚C	116	17	86



Density of Aqueous Solutions



Equation for calculation of density

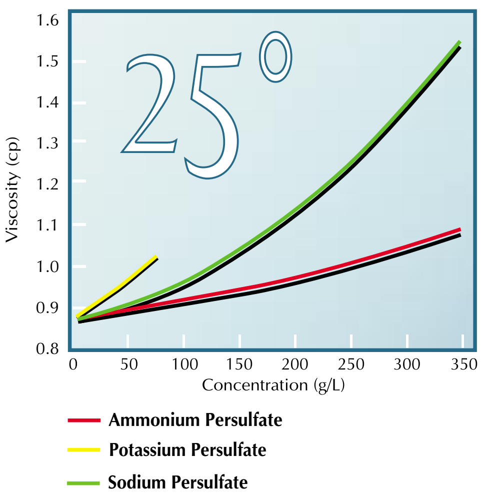
Density (g/mL) = density H_2O + (A/1000)X + (B/1000)$X^{1.5}$,
where X = solution concentration in grams per liter (g/L).

Salt	Constant	25°C	35°C	45°C
Ammonium	A	0.4903	0.4860	0.4789
	B	-2.6730×10^{-4}	-7.6254×10^{-4}	-5.0971×10^{-4}
Potassium	A	0.6368	0.6273	0.6294
	B	-1.4934×10^{-3}	-8.1965×10^{-4}	-1.6472×10^{-3}
Sodium	A	0.6709	0.6727	0.6610
	B	-1.4934×10^{-3}	-1.4909×10^{-3}	-1.0038×10^{-4}

Density of water

	25°C	35°C	45°C
Density H_2O	0.99707	0.99406	0.99025

Viscosity of Aqueous Solutions



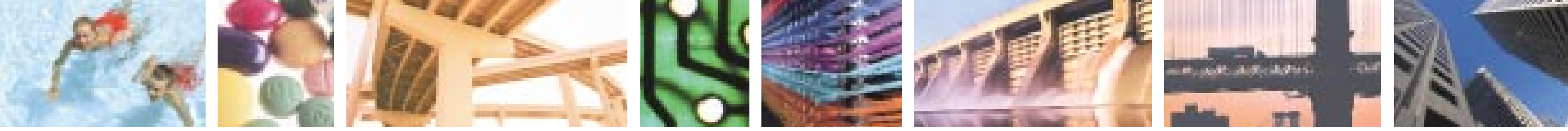
Equation for calculation of viscosity

Viscosity (cp) = viscosity H_2O + $CX^{0.5}$ + DX + $EX^{1.5}$,
where X = solution concentration in grams per liter (g/L).

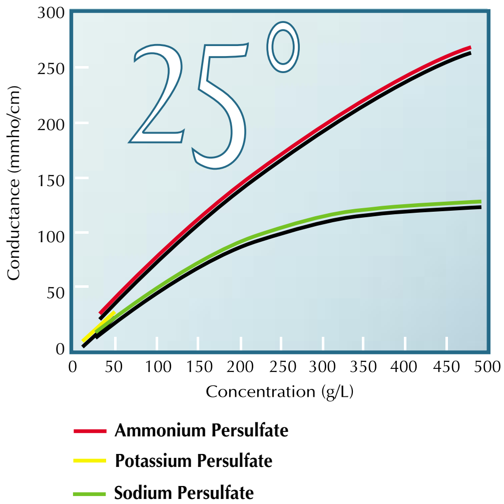
Salt	Constant	25°C	35°C	45°C
Ammonium	C	-1.0686×10^{-3}	6.8050×10^{-3}	5.3134×10^{-3}
	D	1.7140×10^{-4}	-9.4542×10^{-4}	-5.8450×10^{-4}
	E	2.4670×10^{-5}	5.9785×10^{-5}	4.5080×10^{-5}
Potassium	C	0	5.9187×10^{-3}	3.5413×10^{-3}
	D	1.0661×10^{-3}	-1.0551×10^{-3}	-9.5623×10^{-5}
	E	9.8884×10^{-5}	1.0674×10^{-4}	1.2477×10^{-5}
Sodium	C	4.3857×10^{-3}	6.1743×10^{-3}	1.3461×10^{-2}
	D	-1.2218×10^{-3}	-4.6619×10^{-4}	-1.9741×10^{-3}
	E	1.5146×10^{-4}	8.1093×10^{-5}	1.3540×10^{-4}

Viscosity of water

	25°C	35°C	45°C
Viscosity H_2O	0.8904	0.7194	0.5960



Electrical Conductance of Aqueous Solutions

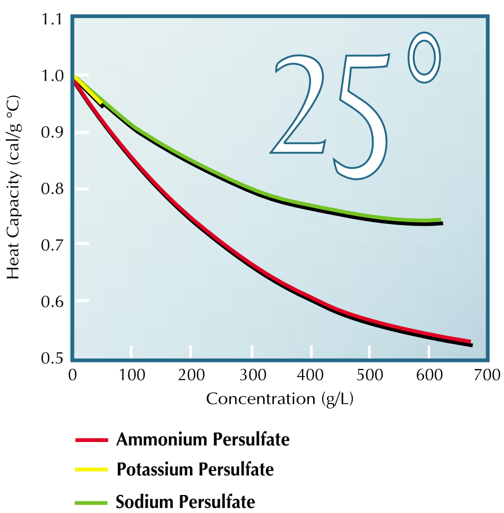


Equation for calculation of electrical conductance

Conductance (mmho/cm) = $F + GX + HX^2$,
where X = solution concentration in grams per liter (g/L).

Salt	Constant	25˚C	35˚C	45˚C
Ammonium	F	3.9016	6.6081	6.2538
	G	0.8568	0.9804	1.1578
	H	-6.2904×10^{-4}	-7.1312×10^{-4}	-8.8912×10^{-4}
Potassium	F	2.9603	3.7314	4.1673
	G	0.6704	0.7972	0.9525
	H	-1.0456×10^{-3}	-1.1982×10^{-3}	-1.9173×10^{-3}
Sodium	F	5.9501	7.1826	8.1825
	G	0.5880	0.6967	0.8123
	H	-6.6193×10^{-4}	-7.5821×10^{-4}	-8.6226×10^{-4}

Heat Capacity of Aqueous Solutions

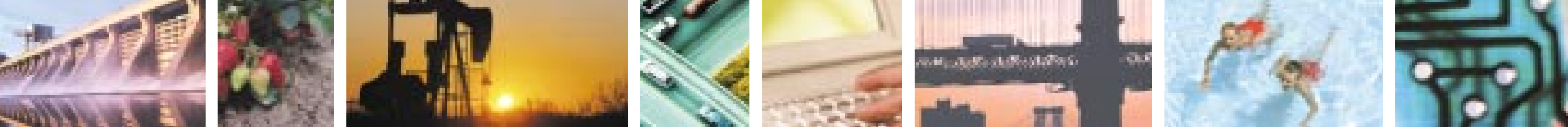


Equation for calculation of heat capacity

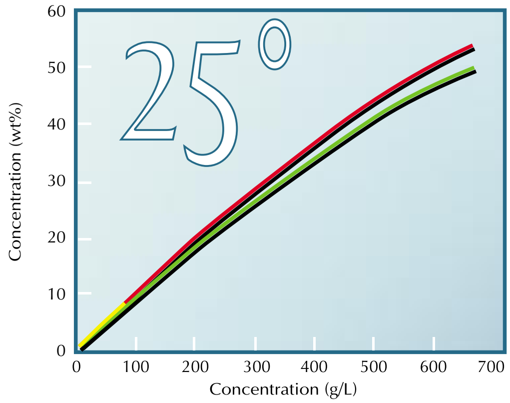
Heat capacity (cal/g ˚C) = $K - LX + MX^{1.5}$,
where X = solution concentration in grams per liter (g/L).

Salt	Constant	25˚C
Ammonium	K	0.994
	L	-1.863×10^{-3}
	M	4.531×10^{-5}
Potassium	K	0.997
	L	1.150×10^{-3}
	M	2.670×10^{-5}
Sodium	K	0.997
	L	1.190×10^{-3}
	M	3.112×10^{-5}

Conversion cal/g ˚C = Btu/lb ˚F = J/g ˚C / 4.184



Conversion: Grams/Liter to Weight %

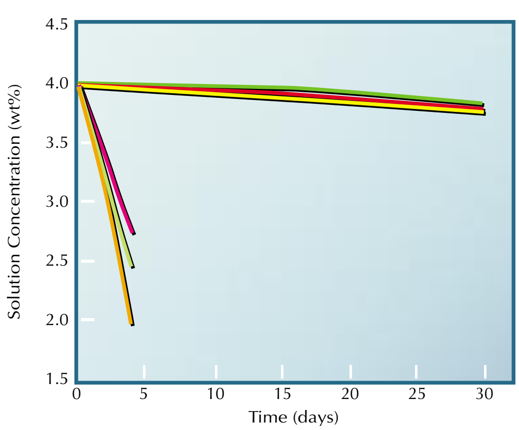


Conversion grams/liter to weight percent

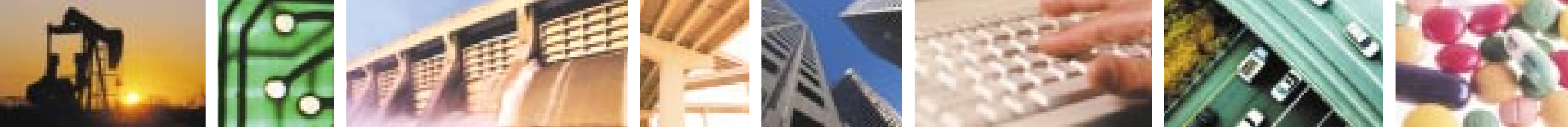
Note: Potassium persulfate is the least soluble of the three FMC persulfate salts.

	Ammonium persulfate (wt%)			Potassium persulfate (wt%)			Sodium persulfate (wt%)		
g/L	**25˚C**	**35˚C**	**45˚C**	**25˚C**	**35˚C**	**45˚C**	**25˚C**	**35˚C**	**45˚C**
0	0	0	0	0	0	0	0	0	0
25	2.477	2.485	2.495	2.468	2.476	2.486	2.466	2.474	2.484
50	4.895	4.911	4.931	4.861	4.877	4.896	4.854	4.868	4.888
75	7.256	7.281	7.311	7.183	7.208	7.237	7.167	7.187	7.219
100	9.562	9.598	9.635	——	9.470	9.510	9.410	9.435	9.479
125	11.815	11.863	11.912	——	11.668	11.719	11.586	11.616	11.672
150	14.017	14.077	14.136	——	——	13.868	13.699	13.733	13.801
175	16.170	16.244	16.311	——	——	15.959	15.751	15.790	15.870
200	18.275	18.364	18.440	——	——	17.994	17.745	17.788	17.880
250	22.349	22.471	22.564	——	——	——	21.572	21.620	21.738
300	26.251	26.411	26.519	——	——	——	25.197	25.250	25.394
350	29.993	30.194	30.316	——	——	——	28.634	28.695	28.864
400	33.583	33.831	33.964	——	——	——	31.910	31.969	32.164
450	37.031	37.329	37.473	——	——	——	35.026	35.087	35.307
500	40.346	40.699	40.850	——	——	——	37.998	38.060	38.305
550	43.536	43.946	44.104	——	——	——	40.836	40.898	41.168
600	46.607	47.079	47.241	——	——	——	43.551	43.613	43.905
650	49.566	50.103	50.268	——	——	——	46.150	46.211	46.527
700	52.420	53.025	53.191	——	——	——	48.642	48.702	49.040

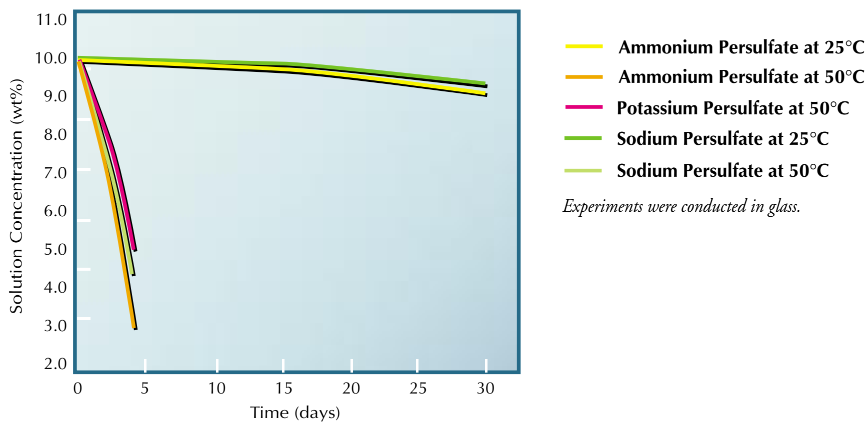
Decomposition Rates of 4% Solutions



Experiments were conducted in glass.



Decomposition Rates of 10% Solutions



Experiments were conducted in glass.

Typical Analysis of Persulfates

Analysis	Ammonium persulfate	Potassium persulfate	Sodium persulfate
Purity %	99.5	99.5	99.4
Active oxygen (%)	6.98	5.90	6.68
Moisture (%)	0.02	0.02	0.01
Ammonium persulfate (%)	——	0.14	0.01
Sodium sulfate (%)	——	——	0.70
pH (1% solution)	5.2	6.4	6.0
Iron (ppm)	1	3	2
Insolubles (ppm)	21	18	29
Copper (ppm)	<0.3	<0.2	<0.2
Chloride (ppm)	<10	<10	<10
Heavy metals, as lead (ppm)	<1	<1	<1
Manganese (ppm)	<0.5	<0.5	<0.5
Chromium (ppm)	<0.5	<0.5	<0.5
Sodium (ppm)	20	——	——
Potassium (ppm)	50	——	——

Screen analysis Mesh size	Ammonium persulfate % passing	Potassium persulfate % passing	Sodium persulfate % passing
8	100	100	100
30	78	97	99
50	24	75	80
70	9	54	48
100	3	40	15
140	1	24	2

Analytical Chemistry

Persulfates or their solutions can be conveniently assayed by the methods described below. In each method, persulfate is determined by titration of a standardized potassium permanganate or ceric ammonium sulfate solution with a standardized ferrous ammonium sulfate solution, a back-titration technique.

Reagents can be purchased prestandardized or prepared from commercially available chemicals. All reagents, chemicals, and apparatus used are common, off-the-shelf items, and can be purchased from commercial supply houses.

Every phase of persulfate manufacturing is monitored and controlled electronically, including the crystallization and drying steps critical to the product's thermal stability.

Assay Procedures

Solids

To a 250 mL Erlenmeyer flask, add about 1 gram of sample weighed to the nearest milligram and about 50 mL of 1N H_2SO_4. Dissolve the sample and add exactly 40 mL of 0.5 N ferrous ammonium sulfate solution. Swirl constantly while adding the ferrous ammonium sulfate solution. Let this stand for one minute and titrate with 0.5 N $KMnO_4$ to permanent pink endpoint or with 0.5 N $Ce(SO_4)_2$ to a Ferroin indicator endpoint. The calculations require a blank titration on exactly 40 mL of ferrous ammonium sulfate solution, as used above, in 50 mL of the 1 N H_2SO_4.

$$\%\ \text{active oxygen} = \frac{(A - B)C \times 0.8}{D}$$

$$\%\ \text{ammonium persulfate} = \frac{(A - B)C \times 11.4}{D}$$

$$\%\ \text{potassium persulfate} = \frac{(A - B)C \times 13.5}{D}$$

$$\%\ \text{sodium persulfate} = \frac{(A - B)C \times 11.9}{D}$$

A = mL $KMnO_4$ or $Ce(SO_4)_2$ solution used for titrating the blank.
B = mL $KMnO_4$ or $Ce(SO_4)_2$ solution used for titrating the sample.
C = Normality of the $KMnO_4$ or $Ce(SO_4)_2$ solution used.
D = Weight of sample in grams.

Solutions

To a 250 mL Erlenmeyer flask, pipette 2-20 mL of persulfate solution (depending on the approximate solution concentration). Add about 50 mL of about 1 N H_2SO_4 solution. Add exactly 40 mL of 0.5 N ferrous ammonium sulfate solution. Swirl constantly while adding the ferrous ammonium sulfate solution. Let stand for one minute and titrate with 0.5 N $KMnO_4$ to a permanent pink endpoint or with 0.5 N $Ce(SO_4)_2$ to a Ferroin indicator endpoint. The calculations require a blank titration on exactly 40 mL of ferrous ammonium sulfate solution, as used above, in 50 mL of the 1 N H_2SO_4.

$$\text{g/L active oxygen} = \frac{(A - B)C \times 8}{D}$$

$$\text{g/L ammonium persulfate} = \frac{(A - B)C \times 114}{D}$$

$$\text{g/L potassium persulfate} = \frac{(A - B)C \times 135}{D}$$

$$\text{g/L sodium persulfate} = \frac{(A - B)C \times 119}{D}$$

A = mL $KMnO_4$ or $Ce(SO_4)_2$ solution used for titrating the blank.
B = mL $KMnO_4$ or $Ce(SO_4)_2$ solution used for titrating the sample.
C = Normality of the $KMnO_4$ or $Ce(SO_4)_2$ solution used.
D = Volume of sample in milliliters.

General Material Information

Persulfate Handling and Safety

Persulfates are oxidizing chemicals that require careful attention to all aspects of handling and use. For more information, you may request a Material Safety Data Sheet (MSDS) which is available from any FMC office.

Personal Protective Equipment

When handling persulfate chemicals, follow the guidelines listed here and in the MSDS.

Protect your eyes — Wear chemical-type goggles or a face mask whenever splashing, spraying, or any eye contact is possible.

Protect your respiratory system — Use dust respirators approved by NIOSH/MSA whenever exposure may exceed the established standard listed in the current MSDS.

Protect your hands — Wear general purpose neoprene gloves.

Protect yourself with proper clothing — Wear ordinary work clothes with long sleeves and full-length pants.

Protect yourself with proper footwear — Wear shoes with neoprene soles.

First Aid

Eye contact — Flush with water for at least 15 minutes. If irritation occurs and persists, obtain medical attention.

Skin contact — Wash with plenty of soap and water. If irritation occurs and persists, obtain medical attention. Wash clothing before reuse.

Inhalation — Get fresh air. If breathing difficulty or discomfort occurs, call a physician.

Ingestion — Drink one to two glasses of water. Do not induce vomiting. Do not give anything by mouth to an unconscious individual. Call a physician immediately.

When properly handled and stored, persulfates and their solutions do not present serious health hazards. The MSDS provides information concerning exposure, emergency, first aid, and disposal of persulfates.

Disposal

Persulfate crystals should never be discarded to trash bins. Contact with moisture, contaminants, and/or reducing agents can initiate a chemical reaction or a persulfate decomposition. Persulfate crystals which become a waste material are classified as hazardous waste because they are oxidizers. Persulfates which are spilled on the floor, or otherwise contaminated, are best dissolved in copious quantities of water.

An acceptable disposal method for spent persulfate solutions is to dilute with large quantities of water and dispose via a treatment system.

Any disposal method must be in full accordance with all local, state, and federal regulations.

Shipping

The U.S. Department of Transportation classifies persulfates as OXIDIZER and regulates them as hazardous materials for transport by air, water, and rail. The "Code of Federal Regulation – Title 49" details specific requirements for packaging, marketing, labeling, and describing these materials for shipment.

Containers and Packaging

FMC packages and ships crystalline persulfate chemicals in three different container types, according to customer requests.

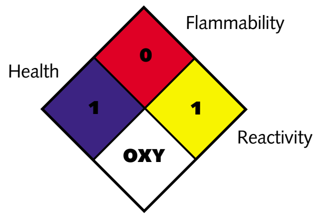
For more information, contact your nearest FMC Sales Office.

Type	Construction	Persulfate wt/container	Containers per pallet	Persulfate wt/pallet
Bag	Polypropylene	55 lbs	42	2,310 lbs
Drum	Fiber drums, polyethylene liner	225 lbs	8	1,800 lbs
IBC*	Polypropylene sack, polyethylene liner	1,000 – 2,200 lbs	1 – 2	1,000 – 2,200 lbs

**IBC = Intermediate Bulk Container, equipped with easy opening bottom spout for discharging into tanks or hoppers.*

Storage

Persulfates should be stored in accordance with the National Fire Protection Association's (NFPA) 430 *Code for the Storage of Solid and Liquid Oxidizers*. FMC personnel can provide additional support in reviewing storage facilities.



General Precautions — Persulfates should be kept in a cool, dry storage area, in a configuration that is appropriate for the sprinkler capacity of the building per NFPA 430.

Personnel should be trained to handle persulfates safely, properly dispose of spilled materials, and prevent contamination.

If material gets wet or spills, it must be isolated and disposed of properly.

Handling — To remove and transport persulfates from the shipping containers, use clean plastic or stainless steel scoops, shovels, pails, etc. Cleanliness is essential.

Solution Storage — Aqueous solutions of ammonium persulfate are more susceptible to decomposition than the solid product. The recommended materials of construction for storage and conveyance equipment (tanks, pipelines, etc.) are 304 and 316 stainless steel. Other acceptable materials include polyvinyl chloride, polyethylene, Plexiglas® plastic (or other suitable generic), Teflon® resin (or other suitable generic), chemical stoneware, and glass. Metals other than 304 and 316 stainless steel cause decomposition of the persulfate solutions or may be corroded by them. This is particularly true of Monel, copper, brass, and iron.

Do not store or process persulfate solutions in sealed or closed containers or vessels. Normal solution decomposition will release oxygen gas which may overpressurize a sealed container and cause rupture.

Storage of persulfate solutions above 25˚C will accelerate the rate of decompostition. See data on pages 10 and 11.

Decomposition Hazard

Overheating or contamination of persulfates can lead to a runaway decomposition. The persulfate salt will begin to effervesce with an acid-like odor. Persulfates decompose to form solid sulfate salts and emit noxious fog or fumes of SO_x and NO_x. This decomposition may form a high temperature melt. The material will flow like magma and may ignite nearby combustible materials such as wood or paper. Oxygen produced by persulfate decomposition can increase the intensity of the fire.

The only way to halt a decomposition event is to apply LARGE quantities of water to the reacting material. Eight pounds of water per pound of decomposing materials is recommended, but no less than two pounds of water should be applied. Insufficient amounts of water will intensify the reaction and increase the acid mist concentration.

Please note that carbon dioxide (CO_2) or other gas-filled extinguishers will have NO effect on decomposing persulfate. The use of water as an extinguishing agent is emphasized. Control of the melt and firefighting efforts are enhanced if persulfates are stored within containment areas.

Persulfate decomposition will require emergency responders wearing full protective rubber clothing, face and head protection, plus self-contained breathing apparatus (SCBA).

Decomposition Prevention

Observe the following precautions to prevent decomposition:

Do not expose persulfates or their containers to moisture. Moisture significantly lowers the decomposition temperature.

Do not store persulfates near incompatible materials such as reducing agents, acids, bases, halide salt solutions, organics, ammoniacal solutions, alkaline cleansers, or other oxidizers. These materials can initiate decomposition.

Do not store near point sources of heat such as steam pipes, electrical appliances, heating vents, gas flames, welding sparks, or radiant heaters. Do not store at ambient temperatures above 113˚F or 45˚C.

Do not return spilled or unused portions of persulfates to the original container. Dirt, metal, moisture, or other contaminants can induce the decomposition of persulfates.

Do not cross-contaminate with scoops, cups, or stirrers that may have been exposed to or used with other chemicals. Use only dedicated clean, dry plastic or stainless steel scoops and utensils for transfer.

Do not grind or dry mix in equipment or machines that develop frictional heat.

Customer Support Services

Quality Assurance

FMC persulfate products are produced under an ISO 9002 certified quality system. Statistical Process Control (SPC) and a distributed control system combine to provide consistent process control. FMC operators monitor key parameters to ensure consistent quality for all products.

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DNV
DNV Certification, Inc.
ISO 9002 REGISTERED FIRM

All materials–raw, intermediate and final–are checked and tested in a new, modern laboratory employing the latest analytical technology. Quality test results are maintained on each batch of product. Certificates of Analysis and other end-product information can be customized to meet your system requirements.

Our production facility uses SPC methods to improve and assure the quality of persulfate chemical products. FMC operators chart key operating parameters to maintain process control; this assures that quality is built in to each customer's order.

The SPC system is designed to meet your specific quality standards. Product is analyzed and identified as it leaves the packaging areas. Product quality is maintained by batch number. The information is then stored in a computer database, enabling FMC to issue Certificates of Analysis that are specific to each batch of materials received by our customers.

FMC is the only persulfate producer that uses cutting-edge technology to ensure that our products are stable for storage or transport and use. We have established new product safety standards for thermal stability to ensure a high-quality, stable persulfate.

Distribution

Domestic — All FMC persulfates are distributed throughout North America. Our persulfate distribution facilities are located in:

Bridgeview, Illinois
Carteret, New Jersey
Tonawanda, New York

Minimum shipment from any domestic FMC distribution center is 24,000 lbs of FMC products. Persulfates may be any portion of the total weight. Contact us for more information.

International — Persulfates are also available from a network of chemical supply distributors that represent FMC persulfate products worldwide.

Technical Services

All FMC customers have access to a staff of technical service representatives at the Research and Development Center in Princeton, NJ and at the plant in Tonawanda, NY. These chemists and engineers are experienced in the production, sale, and distribution of peroxygen chemicals. They are fully capable of answering questions on the safe handling and usage of persulfates. In fact, FMC specialists have helped our customers pioneer many successful applications for persulfate chemicals.

Our engineering services include the design and construction of storage facilities, or the safety inspection of your present warehouse or production facilities. FMC also offers a complete list of technical articles, bulletins, data sheets, and patents. For more information, call or write the nearest FMC sales office.

Consistent process control and monitoring ensure a reliable supply of quality persulfates to a global market.

FMC's Tonawanda warehouse reflects state-of-the-art design, featuring monitors and detectors which close the fire doors in any emergency and sprinklers powerful enough to handle any fire or decomposition. Let FMC help you with your persulfate storage and warehousing.

Domestic and International Offices

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The persulfate applications referred to in this publication are solely for illustrative purposes. It is the responsibility of the user to determine whether a persulfate compound may be suitable for any specific application, in accordance with accepted good practices and applicable regulatory restrictions.

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