

# PQ<sup>®</sup> Magnesium Sulfate

*Crystal and liquid products*



**PQ Corporation**

*Advancing the art of inorganic chemistry<sup>™</sup>*

# PQ<sup>®</sup> Soluble Silicates

SS<sup>®</sup>  
SS-C<sup>™</sup>  
G<sup>®</sup>  
GD<sup>®</sup>

## Sodium Silicates - Solids

*Available in a variety of weight ratios and particle size distributions.*

N<sup>®</sup>  
N-CLEAR<sup>™</sup>  
RU<sup>™</sup>  
O<sup>®</sup>  
D<sup>™</sup>

## Sodium Silicates - Solutions

*Available in a variety of weight ratios and viscosities.*

METSO BEADS<sup>®</sup>  
METSO  
PENTABEAD<sup>®</sup>  
BRITESIL<sup>®</sup>

## Sodium Metasilicates

*METSO<sup>®</sup> products come in both anhydrous and pentahydrate forms. BRITESIL<sup>®</sup> products are hydrous powders.*

KASIL<sup>®</sup>  
KASOLV<sup>®</sup>

## Potassium Silicates

*Available in solids and solutions, as well as flake glass, hydrated, and anhydrous powder forms.*

# Magnesium Sulfate

PQ<sup>®</sup>  
Magnesium  
Sulfate  
MagnaBrite<sup>™</sup>  
MagnaGrow<sup>®</sup>  
Go Soak  
Yourself<sup>®</sup>

## Magnesium Sulfate Heptahydrate

*Available in crystal and liquid solutions and special formulations for different applications.*

# ***Providing for All Your Magnesium Sulfate Needs – Today and Tomorrow***

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PQ Corporation has grown from a family soap and candle business into a leading producer of magnesium sulfate with plants located in the United States and Canada. A driving force in the industry, PQ is North America's largest manufacturer of magnesium sulfate heptahydrate – a versatile compound commonly referred to as epsom salt.

By developing new end uses for magnesium sulfate, we've transformed a workhorse compound into safe, cost-efficient solutions to our customers' processing and performance challenges. PQ has collaborated with its major customers and leading industry research institutions to develop creative solutions for a wide variety of bleaching processes. In addition, ongoing PQ R&D is leading to product innovations that enrich agricultural growth and enhance livestock quality.

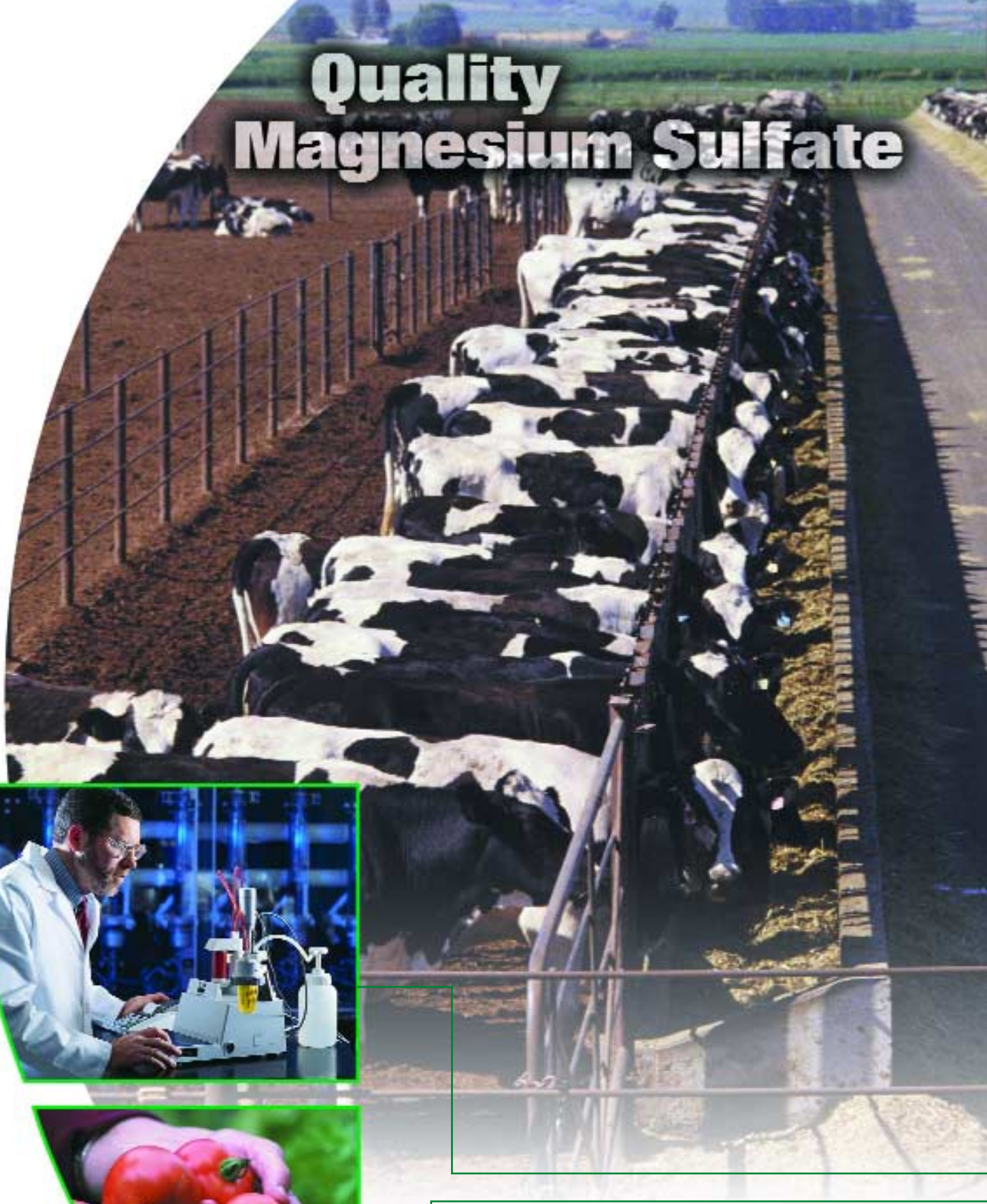
PQ innovation goes beyond products. We are continually developing new ways to help you improve your processes and increase the quality of your products in applications as diverse as analgesic soaks, textiles, plant fertilizers, cattle feed, and paper bleaching. In fact, every time you soak in an epsom salt bath, print a document, or fertilize your garden...you benefit from PQ chemistry.

PQ's Industrial Chemicals Division (ICD) – our largest manufacturing group – has the muscle to support all of your magnesium sulfate needs. We can meet your formulating challenges, offering magnesium sulfate in three, high-quality grades for different applications: USP (parenteral and non-parenteral), Agricultural, and Technical. PQ also offers *Go Soak Yourself*® epsom salt for bath and body, *MagnaGrow*® agricultural-grade magnesium sulfate for plant nutrition, and *MagnaBrite*™ magnesium sulfate solution – a critical player in metals management for the pulp and paper industry.

On the world stage, PQ's presence extends to more than 65 manufacturing facilities in 19 countries on five continents. Strategic international partnerships allow us to serve you even in the most remote areas. Regional customer service centers support you from the lab to the plant. So no matter where you are, PQ is there – prepared to be your global magnesium sulfate supplier.



# Quality Magnesium Sulfate



## ***PQ® Magnesium Sulfate... Hard at Work Everywhere You Are***

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PQ® magnesium sulfate is widely recognized for its exceptional purity and high solubility. Diaphanous filtration processes are used to ensure delivery of magnesium sulfate products with no perceptible impurities. Our customers have reported that PQ magnesium sulfate is easy to work with because it dissolves quickly and is less dusty than competitors' products. Even Hollywood prefers to work with our product to make synthetic snow as seen in several recent blockbusters.

As a source of magnesium and sulfur, PQ magnesium sulfate is ideal for use in a variety of different applications.

**Industrial and Agricultural.** PQ magnesium sulfate usage has grown significantly: industrial and agricultural companies now turn to magnesium sulfate as an environmentally safe alternative for other, more expensive and relatively harsh products; for example, there are now several possible applications for magnesium sulfate in Kraft pulp bleaching processes.



***Magnesium sulfate is recognized for its therapeutic properties in important pharmaceutical and clinical applications. Two of the biggest breakthrough uses include prenatal care and asthma treatment.***

With its unique properties, PQ magnesium sulfate is also a nourishing additive in cattle feed, fertilizers, and other agricultural applications.

**Horticultural.** *MagnaGrow®* – a unique PQ epsom salt brand – is most commonly used in households as a plant fertilizer. *MagnaGrow* agricultural-grade magnesium sulfate also enriches your lawn by increasing its chlorophyll content and improving its ability to synthesize food. And, *MagnaGrow* speeds the ripening process of certain fruits and vegetables.

**Medicinal.** Because it naturally draws toxins from the skin's pores, PQ magnesium sulfate heptahydrate, known commonly as epsom salt, is a safe way to remove splinters and treat infections, insect bites, scrapes, and poison ivy. Dissolved in bath water, PQ's unique *Go Soak Yourself®* product acts as an analgesic to help relieve soreness and stiff joints caused by mild arthritis and strained muscles.



# Innovative Applications



*Plant Micronutrient*  
*Bath and Beauty/Analgesic Soak*  
*Paper Manufacturing*  
*Manufacture of High-Fructose*  
*Products*  
*Textile Manufacturing/Finishing*  
*Soaps and Detergents*  
*Livestock Feed*  
*Leather Tanning*



# Physical Characteristics and Product Properties

PQ USP-grade magnesium sulfate (epsom salt) comes in the form of small translucent crystals – virtually colorless – that are very soluble in water. It meets all USP standards and Food Chemicals Codex III specifications for magnesium sulfate.

PQ technical- and agricultural-grade magnesium sulfate both come in the form of small, uniform, opaque crystals. However, they do not meet the requirements of USP or Food Chemicals Codex III, and are not intended for human consumption in solution or as direct food additives. Their use in certain indirect additive applications is allowed by government regulations.

Table 2

STORAGE TEMP. OF SOLUTION CONCENTRATIONS		
Wt% MgSO <sub>4</sub> in solution	Minimum Temp. °F	Rec. Temp. °F
18%	32	≥ 40
20%	40	≥ 45
25%	70	≥ 75
26%	75	≥ 80
27%	80	≥ 85

Table 3

CRYSTAL STABILITY (IN DRY AIR)	
Temperature	Moisture Loss
@ Ambient Temperature (25°C)	Loses 1 H <sub>2</sub> O (7%)
@ 70° – 80°C	Loses 4 H <sub>2</sub> O (29%)
@ 100°C	Loses 5 H <sub>2</sub> O (36.5%)
@ 120°C	Loses 6 H <sub>2</sub> O (43.8%)
@ 250°C	Loses 7 H <sub>2</sub> O (51%)

NOTE: Water is rapidly reabsorbed when the product is exposed to moist air. This can result in some caking.

Table 4

CRYSTAL SOLUBILITY (IN 100 ML WATER)	
@ 20°C	71g
@ 40°C	91g

It is very soluble in water; soluble in glycerol; and slightly soluble in alcohol.

Table 5

SPECIFIC GRAVITY OF MAGNESIUM SULFATE SOLUTIONS VS. TEMPERATURE			
Wt % MgSO <sub>4</sub>	Specific Gravity		
	@ 32°F (0°C)	@ 105°F (40°C)	@ 175°F (80°C)
10	1.11	1.10	1.08
15	1.17	1.16	1.14
20	1.23	1.22	1.20
25	—	1.28	1.26
30	—	1.34	1.31

Table 7

VISCOSITY OF MAGNESIUM SULFATE SOLUTIONS VS. TEMPERATURE			
Wt % MgSO <sub>4</sub>	Viscosity (cps)		
	@ 77°F (25°C)	@ 100°F (38°C)	@ 140°F (60°C)
15	2.8	2.0	1.1
20	3.8	3.0	1.9
25	6.0	4.8	2.7

Table 1

TYPICAL CRYSTAL CHARACTERISTICS	
Formula:	MgSO <sub>4</sub> • 7H <sub>2</sub> O
Molecular weight:	246.50
Appearance:	Colorless or white
Form:	Rhombic or monoclinic crystals
Index of refraction:	1.455
Hardness (Mohs scale):	2 – 2.5
Bulk density (lb/ft <sup>3</sup> ):	58 – 62
Particle size distribution (Tyler Screen):	83% -10 to +48 mesh
pH (1% solution):	5 – 9.2
TYPICAL ANALYSIS:	BY WT.
Magnesium Sulfate (anhydrous basis)	99% min
Magnesium oxide	16.4%
Water content (by wt. loss @ 450°C)	51.0%
Principal elements (as derived from magnesium sulfate heptahydrate)	
Magnesium	9.8%
Sulfur	12.9%
Trace ingredients	within current USP limits

Table 5

BOILING POINTS OF MAGNESIUM SULFATE SOLUTIONS @ 1 ATM	
Wt. % MgSO <sub>4</sub> in solution	Boiling Temperature (°F)
0	212
10	213
20	215
28	217
32	220
38	223
40	224

# ***PQ<sup>®</sup> Magnesium Sulfate:***

## ***Industrial Applications***

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The number of industrial applications of PQ magnesium sulfate has greatly increased over recent years. One reason for this increase is industry's concern with the environment. The mild nature of PQ magnesium sulfate makes it a safer, more environmentally friendly alternative to other products.

### **Paper Manufacturing**

PQ magnesium sulfate provides magnesium to impart strength in the paper and is generally recognized as safe (GRAS) by the U.S. Food and Drug Administration when used as an ingredient in the manufacture of paper and paperboard that contacts food.

### **Amino Acid Production**

The sulfur content of PQ magnesium sulfate aids in the synthesis of sulfur-containing amino acids, which are essential ions – especially for the lysine processes.

### **Chemical Manufacturing**

PQ magnesium sulfate is used in the production of magnesium stearate and other magnesium compounds.

### **Fermentation**

PQ magnesium sulfate can be used as a nutrient source in the production of yeast and antibiotics. It can also be used as a yeast nutrient in brewing beer.

### **Flame Retardant**

PQ magnesium sulfate is a safer, often more effective alternative to boric acid.

### **Fuel Oil Treatment**

For the reduction of sulfur and vanadium corrosion, PQ magnesium sulfate is effective in the fuel oil treatment process.

### **Leather Tanning**

PQ magnesium sulfate can be used as a weighting agent and filler in the production of sole leather for shoes.

### **Manufacture of High-Fructose Products**

PQ magnesium sulfate can be used in the manufacture of high-fructose corn syrup for soft drinks and juices by acting as a glucose isomerase enzyme activator to promote optimal enzyme high lifes. PQ magnesium sulfate can also be used safely as a flavor enhancer, nutrient supplement, and processing aid in the production of certain foods and beverages.

### **Ore Processing**

PQ magnesium sulfate helps remove phosphate from molybdenum.

### **Refractory and Ceramic Compositions**

PQ magnesium sulfate enhances the manufacture of refractory brick and tile, and can be used to bind magnesium refractories.

### **Soaps and Detergents**

PQ magnesium sulfate is used in soap and detergent formulations to provide proper sudsing and water conditioning.

### **Textile Manufacturing/Finishing**

Use PQ magnesium sulfate as a bleach stabilizer for cloth; conditioning agent for cotton and wool; fixing agent or mordant in the dyeing of wool; antifeltting agent for wool; spinning-bath additive for rayon to produce a softer, more silky fabric with less luster; and to give fabrics weight and body.

### **Titanium Dioxide Production**

PQ magnesium sulfate serves as a deflocculating agent in titanium dioxide production.

### **Other Applications**

Additional industrial uses for PQ magnesium sulfate include:

- Zinc processing
- Metal plating
- Latex and rubber processing
- ABS resin manufacturing
- Manufacture of explosives



# ***MagnaBrite™ Liquid Magnesium Sulfate:*** ***For Use in Pulp & Paper***

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## **The Role of MagnaBrite™ in Alkaline Peroxide Brightening of Mechanical Pulp**

- 1. Peroxide stabilizer**
- 2. Scale control**

It has been well established that soluble magnesium sulfate can be used to trap and deactivate transition metals under alkaline conditions, through the formation of hydrous magnesium hydroxide gels and precipitates.

Most commonly, magnesium sulfate is used in combination with sodium silicate to enhance the transition metal deactivation characteristics of both chemicals. Metal silicates that are rich in magnesium do not adhere to equipment surfaces. The magnesium sulfate therefore helps minimize the risk of silicate-related scaling.

## **The Role of MagnaBrite™ in Oxygen Delignification**

- 1. Cellulose Protection**
- 2. Enhanced Delignification**

### **Reaction Mechanisms**

Although the reaction mechanisms that explain the role of  $MgSO_4$  in protecting pulp viscosity during bleaching with oxygen-containing compounds are not yet fully determined, there are two widely accepted hypotheses:

Magnesium sulfate reacts with alkali (sodium hydroxide) in situ and produces magnesium hydroxide ( $Mg(OH)_2$ ), which inactivates transition metal ions present in the pulp by physically encapsulating them. These metal ions (the most damaging are Fe, Mn, and Cu) catalyze the production of free radicals-species known to attack the cellulose chain-and consequently reduce pulp viscosity.

Magnesium ions also prevent cellulose chain cleavage in the alkaline oxidative environment by forming stable metallic magnesium-carbohydrate complexes with the partially degraded cellulose compounds (cellulose chains containing weak carbonyl bond functional groups). Further fiber damage is thereby avoided.

## **The Role of MagnaBrite™ in Kraft EOP and EP Bleaching**

- 1. Peroxide Stabilization**
- 2. Cellulose Protection**
- 3. Enhanced Delignification**

PQ has demonstrated the effectiveness of using liquid magnesium sulfate to reduce costs in EOP bleaching. Bleach Chemical cost savings of \$0.25 to \$1.00 per ton and even more have been realized as a result of reduced chlorine dioxide usage and/or reduced peroxide application addition rates. The precise savings are very mill-specific and can be determined only by mill trials. ISO brightness gains resulting from addition of magnesium sulfate have ranged from 3-10 points. From the technology description that follows, improved delignification and pulp viscosity benefits may also be obtained. Please contact PQ if you would like to discuss your application and develop a customized trial.

### **Technology Description**

In oxygen/peroxide-enriched alkaline extraction, several reactions take place:

- 1. Solubilization of chlorinated lignin fragments.**
- 2. Pulp delignification.**
- 3. Pulp brightening.**
- 4. Cellulose degradation.**
- 5. Peroxide decomposition.**

To maintain pulp viscosity at acceptable levels and to obtain maximum efficiency from the peroxide in this stage, the first three reactions need to be maximized and the latter two minimized. The addition of fresh  $MgSO_4$  to the EOP stage protects pulp viscosity and prevents peroxide decomposition. These functions result in improved pulp strength, increased delignification, and increased pulp brightening. The reaction mechanisms through which  $MgSO_4$  acts are best understood by the following hypotheses:

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# **MagnaBrite™ Liquid Magnesium Sulfate:**

## **For Use in Pulp & Paper**

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Magnesium sulfate reacts with alkali (sodium hydroxide) in situ to produce magnesium hydroxide  $Mg(OH)_2$ , which traps and inactivates transition metal ions that would otherwise catalyze rapid generation of free radicals. Since free radicals degrade cellulose, controlling their rate of generation can improve the selectivity of the process. The direct consequences of improved selectivity are increased pulp viscosity, increased delignification, and increased pulp brightness. This method of transition metals control is believed to be superior to other chemistries based on chelation agents because the metal ions are completely encapsulated and are physically incapable of coming into contact with organic peroxides.

Besides removal of transition metals, magnesium may also function to stabilize alkali degradation of cellulose. It has been shown that the introduction of carbonyl groups to the cellulose chain is responsible for degradation in an alkaline oxidizing medium. Magnesium has been shown to form stable metallic-carbohydrate complexes with these weak carbonyl bonds and thereby prevent polymer cleavage.

Pulps that have been bleached with chlorine-containing chemicals, in acidic conditions, usually have low levels of metals. While this situation is desirable with regard to transition metals, however, it is not desirable with regard to magnesium ions. To maximize the selectivity of the process, a certain level of magnesium should be maintained, even if the concentration of transition metals is low. These factors explain (1) why, in most cases, acid washing and chelation of the pulp before oxygen or peroxide bleaching do not completely solve the problem of viscosity loss, and (2) why soluble magnesium compounds must be added in these bleaching stages.

### **Scale Management**

N<sup>o</sup> sodium silicate and MagnaBrite™ magnesium sulfate solutions are crucial elements in today's metals management programs. PQ's expertise with these two versatile chemicals, combined with our mill experience, will help you get the best, most economical performance and at the same time avoid scale formation problems without extensive process modification in conventional and closed-effluent systems.

Scale Formation can be managed effectively in two ways: first by avoiding pH shock and second by increasing the ratio of magnesium sulfate to sodium silicate.

The addition of MagnaBrite™ magnesium sulfate solution can also modify the physical properties of soluble silicate so that any scale formation will consist of a soft, nonadherent talc-like material that has low affinity for metal surfaces and is easily removed.

Knowledge of the reactions among bleaching and deinking chemicals leads to a better understanding of their useful interactions and vital role in today's pulp and paper industry.

MagnaBrite™ magnesium sulfate solution has the following specifications:

MgSO <sub>4</sub> .....	.26.0
Chlorides (as Cl), max.% .....	.0.5

### **PQ Technology Group Capabilities**

PQ Corporation, through its Canadian subsidiary, National Silicates, operates a modern, fully equipped technical center in Toronto for pulp and paper applications. To ensure efficient use of PQ's soluble silicate and magnesium sulfate products, our team of trained technical professionals stands ready to assist customers around the world with information, analytical services, and processing studies.

# ***PQ<sup>®</sup> Magnesium Sulfate:***

## ***Agricultural & Livestock Applications***

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### **Essential Nutrient**

PQ magnesium sulfate can be used as a plant macronutrient, either added to fertilizers or used as a foliar spray. It has been proven to positively affect the harvest growth, crop yield and overall plant health of a wide variety of agricultural crops, including apples, berries, citrus fruits, corn, pineapples, potatoes, tomatoes and rice.

### **Enhance Chlorophyll Production and Disease Resistance**

PQ magnesium sulfate is important for plants requiring magnesium to produce chlorophyll, a magnesium containing compound essential to photosynthesis. Increased photosynthesis results in higher nutritional value of the treated crops. Without sufficient magnesium, chlorosis can occur, causing plant leaves to turn yellow due to chlorophyll deficiency and can result in poor growth and yield. Lower levels of chlorophyll reduce the plants' ability to capture energy.

As a source of magnesium, PQ magnesium sulfate helps plants absorb phosphorus, which contributes to plant growth, flowering and disease resistance. It increases a plants' ability to synthesize food by helping plants absorb and use phosphorus, nitrogen and other important elements.

PQ magnesium sulfate is also an excellent source of sulfur, which is important in metabolic reactions. In this readily absorbed form, sulfur increases a plants' resistance to disease, drought and insect damage. Sulfur also acts to scavenge toxic heavy metals and free radicals.

### **Fertilizer Supplement and Foliar Feeding**

PQ magnesium sulfate can be formulated into granular fertilizing mixtures as well as plant nutrient solutions. Rapidly dissolving PQ magnesium sulfate is the best magnesium source available for foliar feeding as it significantly increases magnesium absorption as compared to feeding by soil application. Foliar feeding is also advantageous where high levels of potassium in the soil would restrict absorption of magnesium in the roots.

### **Livestock Dietary Supplement**

PQ magnesium sulfate is a convenient and efficient source of magnesium and sulfur for livestock. It can be used as a dry or liquid supplement.

The magnesium in PQ magnesium sulfate is an essential component of bones and teeth and is a necessary activator of various enzymes for proper nerve and muscle functions. Magnesium is also important in maintaining the appetite of cattle, sheep and other ruminants.

Magnesium provides a balanced environment for ionic exchange across cell membranes. In addition, magnesium is a biological carrier of phosphorus and proteins and is important in cellulose digestion. It also plays a major role in regulating heart rate and muscle relaxation.

### **Prevent Hypomagnesemia**

PQ magnesium sulfate helps to prevent hypomagnesemia, also known as grass tetany, grass staggers, lactation tetany, or wheat pasture poisoning — from harming lactating and pregnant dairy cows. PQ magnesium sulfate should be used in early spring when pasture grasses may be magnesium deficient. It may also be mixed in a dry protein supplement to supply additional magnesium during fall and winter feeding.

### **Synthesize Sulfur Containing Amino Acids**

PQ magnesium sulfate is also a convenient source of sulfur, which is used by rumen microbes to synthesize sulfur containing amino acids. It is common to add one part sulfur per 15 parts nitrogen to rations containing urea.



# Go Soak Yourself® Epsom Salt and Go Soak Your Plants™ Epsom Salt: Applications

## Analgesic Baths

A hypertonic solution of *Go Soak Yourself* epsom salt crystals acts osmotically to draw fluid out of tissues, causing coagulation of proteins in the skin cells. The underlying tissues are then protected and cell volume is decreased.

Soaking in *Go Soak Yourself* epsom salt helps to reduce body stiffness, relieve minor aches and pains, and reduce swelling associated with minor sprains and bruises. *Go Soak Yourself* epsom salt is also recommended by massage therapists to pamper feet, soften skin, and absorb odors because it helps soften and exfoliate patches of rough, dry skin. Use up to two cups in bath water to provide relief.

## Insect Bite/Poison Ivy Relief

To take the sting and itch out of insect bites, add two teaspoons of epsom salt to one 1/2-cup of boiling water. Chill, and then apply to the affected area with a gauze pad or cotton ball. To relieve the itch and inflammation of poison ivy, soak in a bath of cool water containing two cups of epsom salt.

Table 1

USING EPSOM SALT CRYSTALS FOR PLANTS & GARDENS
<p><b>TOMATOES</b> Apply one tablespoon per foot of height for each plant every two weeks.</p>
<p><b>ROSES</b> Apply one teaspoon per foot of height for each plant every two weeks.</p>
<p><b>EVERGREENS, AZALEAS, RHODODENDRONS</b> Apply one tablespoon per nine sq. ft. (3' x 3') over the root zone every two to four weeks.</p>
<p><b>LAWNS</b> Apply three lbs. per 1250 sq. ft. (25' x 50') Apply six lbs. per 2500 sq. ft. (50' x 50') Apply twelve lbs. per 5000 sq. ft. (50' x 100')</p>
<p><b>TREES</b> Apply two tablespoons per nine sq. ft. (3' x 3') over root zone once every four months.</p>
<p><b>GARDEN STARTUP</b> Sprinkle approximately one cup per 100 sq. ft. (10' x 10') and mix into soil prior to planting.</p>
<p><b>HOUSEPLANTS</b> Mix one teaspoon per gallon of water and feed to the plants every two to four weeks.</p>

## Laxative

According to the U.S. Food and Drug Administration, epsom salt is recognized as a safe and effective over-the-counter laxative when properly used as advised on the package's instructions.

However, precautions must be observed. Epsom salt should not be taken when abdominal pain, nausea, or vomiting are present unless directed by a doctor. If a sudden change in bowel habits is noted that persists over a period of two weeks, consult a doctor before using epsom salt. It should not be taken for a period longer than one week unless directed by a doctor.

Rectal bleeding or failure to have a bowel movement after use of epsom salt may indicate a serious condition. Should this situation occur, discontinue use of epsom salt and consult a physician.

## Plant Food/Fertilizer

*Go Soak Your Plants™* epsom salt is a convenient source of magnesium, which is critical in the formation of chlorophyll and in aiding the absorption of phosphorus. As a plant food, *Go Soak Your Plants* epsom salt provides a greener appearance in acid-loving plants, such as tomato plants, outdoor lawns, rhododendrons, camellias, roses, and azaleas.

Table 2

THE FOLIAR APPLICATION OF EPSOM SALT TO VARIOUS CROPS			
CROP	TIMING	CONCENTRATION	TOTAL APPLICATION
Alfalfa	At closing and after each cutting	6%	30 lbs. per acre
Citrus	At fruit formation (not flowering)	3%	30 lbs. per acre
Corn	4 leaf stage onwards	6%	30 lbs. per acre
Cotton	Bud formation onwards	6%	20 lbs. per acre
Grapes	Leaf emerge and after flowering	3%	30 lbs. per acre
Leaf Vegetables	At 10-15 day intervals	3%	40 lbs. per acre
Melons	After flowering at 15 day intervals	3%	30 lbs. per acre
Peas	Ground cover to pre-flowering	6%	20 lbs. per acre
Potatoes	Inter-row leaf covering onwards	3-6%	30 lbs. per acre
Soybeans	Ground cover to pre-flowering	6%	20 lbs. per acre
Strawberries	Ground cover to pre-flowering	3%	40 lbs. per acre
Sugarbeets	Inter-row leaf covering onwards	6%	20 lbs. per acre
Vegetables	At 15 day intervals to pre-harvest	3%	40 lbs. per acre
Wheat	First node to early milky ripe	6%	20 lbs. per acre
MISCELLANEOUS	TIMING	CONCENTRATION	TOTAL APPLICATION
Ferns	At 15 day intervals	3%	5-10 lbs/1,000 sq. ft.
Lawns/Turf	At 15-30 day intervals	6%	20 lbs. per acre
Soilless Fertigation	Continuously	According to system	10-15 lbs/1,000 sq. ft.

**FOLIAR APPLICATION:** Epsom Salt is generally applied several times per cropping season in a concentration range of 3-6%. It is recommended not to apply it at high temperatures and when humidity is very low. Epsom Salt should be applied either in the early morning or late afternoon.

Table 3

DESIRED CONCENTRATION	EPSOM SALT SOLUTION MAKEUP		
	5 GALLONS	10 GALLONS	20 GALLONS
3%	1.25 lbs.	2.5 lbs.	5 lbs.
6%	2.50 lbs.	5 lbs.	10 lbs.

# ***PQ<sup>®</sup> Magnesium Sulfate:***

## ***Medical Applications***

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Pharmaceutical usage of PQ magnesium sulfate solution is increasing substantially due to technological breakthroughs in the medical industry. New equipment can now accurately monitor the effects of magnesium sulfate in certain cases. Research has found that PQ magnesium sulfate works on cells and organs in the body and manipulates enzymatic reactions. It affects blood vessels and the transmission of impulses between nerve cells throughout the system.

The following are just two of the many medical applications of PQ magnesium sulfate.

### **Prenatal Care**

The American Pregnancy Association suggests magnesium sulfate as one of the drugs used to prevent premature labor. And, The Institute for Clinical Systems Improvement “Tocolytic Therapy for Preterm Labor” considers magnesium sulfate as the first line of therapy to prevent premature labor.

The Magpie Trial Collaborative Group, conducted a worldwide study that adds to the mounting evidence that magnesium sulfate is the drug of choice for both eclampsia and pre-eclampsia (source: 1) Laurie LaRusso, MS, EL. Printed by Care New England Wellness Center, 2) The Magpie Trial Collaborative Group, “Do women with pre-eclampsia, and their babies, benefit from magnesium sulfate?”).

**WARNING: Large doses of magnesium sulfate supplements can cause complications, such as respiratory distress in the mother and nervous system problems in the baby. Expectant mothers must consult with their doctors before taking any supplements.**

# ***PQ<sup>®</sup> Magnesium Sulfate:***

## ***Shipping, Handling, Storage, and Safety***

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### **Shipping and Handling**

Truckload package shipments can be supplied in 2,000-pound semi-bulk bags, as well as 50-pound and 55-pound multi-wall paper or plastic bags.

### **Sparger Hopper Trucks**

Magnesium sulfate can be shipped in sparger-equipped trucks or trailers permitting unloading of the product in solution form.

The sparger system in each hopper consists of: 1) a 2 1/2" sparger inlet pipe for the introduction of water; 2) a 4" solution outlet pipe extending from the top of the hopper to a "T" at the bottom then to exits at either side; and 3) a 4" bottom outlet pipe. All the outlets have stainless steel, female, easy-disconnect fittings for attaching hoses.

The use of stainless steel or plastic pipe fittings and valves is recommended for unloading magnesium sulfate. Rubber hoses with compatible connections should be able to tolerate temperatures over 150°F, which is the water temperature required to dissolve the magnesium sulfate in the sparger hopper truck.

The amount of water needed to dissolve magnesium sulfate – i.e., to produce a saturated (24.5% by weight) solution – can be determined by the following calculation:

**Wt. (pounds) magnesium sulfate x 0.12 = gallons of water (150°F/60°C) required.**

To unload, water is pumped into the truck via the sparger inlet and removed through the solution outlet pipe to a storage tank. Complete off-loading requires continuous recirculation of the calculated amount of water to the hopper truck to achieve complete dissolution of the magnesium sulfate in the hopper.

For proper and efficient unloading, consult with the hopper truck operator. Also, employees involved should be properly trained and supervised, and established safe unloading procedures should be followed.

### **Semi-Bulk Bags**

PQ offers magnesium sulfate in semi-bulk bags, containing 2,000 pounds of material. These bags consist of a strong and durable polycoated woven fabric on the outside with replaceable inner poly liners to protect against contamination and moisture.

The heavy duty construction of these bags allows for rugged handling and protection against wear.

The use of semi-bulk bags provides cost savings over smaller, paper bags due to the elimination of paper bag disposal, reduced labor costs in handling, and elimination of dusting during unloading. The standard size semi-bulk container (35" x 35" x 50" high) holds approximately 40 cubic feet of material.

To move or discharge semi-bulk bags, reinforced handling slings are attached at the upper four corners of the bag. These slings enable the bags to be easily picked up by a forklift. For actual discharge of material, the bags can be suspended from a custom-designed steel frame and the contents allowed to flow to a surge hopper or volumetric feeder.

### **Storage**

#### **Liquid Solutions**

Tanks made of vinyl resin – reinforced with fiberglass – are recommended for storing magnesium sulfate solutions. The tanks must provide suitable corrosion resistance and have sufficient insulation to maintain a solution temperature of 65°F–75°F. Mechanical agitation is not necessary for storage.

#### **Dry Storage**

Because magnesium sulfate is very soluble in water, it may absorb water from the air causing it to cake over time. Therefore, magnesium sulfate should always be stored between 68°F and 110°F, and 54% and 87% relative humidity. Storage under a controlled environment minimizes caking but the longer magnesium sulfate is kept, the more likely caking will occur.

### **Environmental/Safety**

The industrial handling and use of magnesium sulfate involves relatively small hazards to human health or the environment. However, care should be exercised to avoid excessive inhalation of dusts or mists of this product, or prolonged contact with the eyes or skin. Face masks and safety glasses should be worn. If the product comes in contact with the eyes, they should be flushed with plenty of water for five minutes.



## ***The PQ Commitment***

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***Doing all that it takes to support  
your global magnesium sulfate needs.***

PQ specializes in developing better ways to use our products in your existing applications, and in developing new end uses that add value to your products. With unparalleled expertise in magnesium sulfate chemistry and extensive experience in the industries PQ serves, our Technical Service Department is a valuable resource to address all of your product, process, and application questions.

PQ operates manufacturing plants in every major industrial region in the U.S., so we can deliver products to you quickly and efficiently. A team of PQ Customer Service Representatives is available at every plant, providing you with responsive, hands-on support.

PQ also provides emergency information 24 hours a day through our Emergency Response Answering Service. In the event of an emergency involving a PQ magnesium sulfate product or any other PQ product, please call **610-651-4200**.

When you need technical assistance, information, or product samples...talk to PQ Corporation – the world's source for magnesium sulfate, silicate, and silica-based derivative products.

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***Industrial Chemicals Division***

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**[www.pqcorp.com](http://www.pqcorp.com)**



PQ Corporation, recently acquired by JPMorgan Partners, is a leading producer of silicate, zeolite, and other performance materials serving the detergent, pulp and paper, chemical, petroleum, catalyst, water treatment, construction, and beverage markets. It is a global enterprise, operating in 19 countries on five continents, and along with its chemical businesses, includes Potters Industries, a wholly owned subsidiary, which is a leading producer of engineered glass materials serving the highway safety, polymer additive, metal finishing, and conductive particle markets.

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