TECHNOLOGY FOR A CHANGING ENVIRONMENT

DuPont™ Glycolic Acid

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DuPont™ Glycolic Acid...
A versatile and effective solution for a broad range of cleaning and industrial applications

Glycolic Acid (hydroxyacetic acid) is the first member of the series of alpha-hydroxy carboxylic acids, which means it is one of the smallest organic molecules with both acid and alcohol functionality. Although Glycolic Acid occurs naturally as a trace component in sugarcane, beets, grapes and fruits, DuPont synthesizes the product through a sustainable manufacturing process in Belle, West Virginia.

DuPont has been the leading supplier of Glycolic Acid to customers and distributors worldwide for more than 50 years.

A unique combination of properties makes DuPont™ Glycolic Acid ideal for a variety of end uses including:

Cleaning applications

- Hard Surfaces (consumer and institutional)
- Masonry Surfaces
- Concrete Cleaners and Removers
- Metal Surfaces
- Industrial Water Systems
- Boiler Systems
- Water Wells
- Dairy and Food Equipment

Industrial applications

- Textile Dyeing and Finishing
- Printed Circuit Board Fluxes
- Laundry Sours
- Leather Dyeing and Tanning
- Oil Field Applications
- Petroleum Refining
- Industrial Chemical Manufacturing
- Electropolishing

Why customers use DuPont™ Glycolic Acid

Ideal choice for you, your customers and the environment

- Readily biodegradable (90% in 7 days)
- Low corrosivity

Household Cleaners				
Metal	% Weight Loss using 5 wt% of acid at 23°C*			
	Glycolic	Citric	Sulfamic	urea HCl
1018 Carbon Steel	0.16	0.13	0.30	0.37
1100 Aluminum	0.010	0.005	0.086	10.20
304 Stainless Steel	0.007	0.009	0.011	0.064
CDA360 Brass	0.017	0.021	0.008	0.015

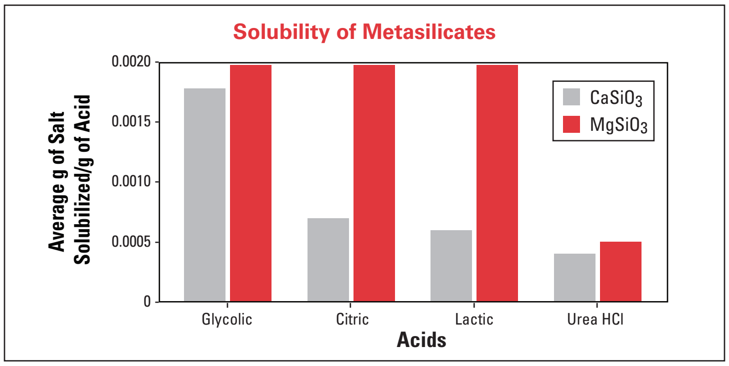
Industrial Cleaners				
Metal	% Weight Loss using 10 wt% of acid at 70°C*			
	Glycolic	Phosphoric	Sulfamic	HCl
1018 Carbon Steel	10.53	15.70	20.26	53.22
110 Copper	0.040	0.087	0.090	0.52
316 Stainless Steel	0.002	0.001	0.055	6.58

*Based on 48-hour contact time, with no agitation

- VOC-exempt in California
- Negligible odor
- Low toxicity

A very effective cleaning and complexing agent

- Broad metal sequestering properties
- Excellent solubility of hard water salts (calcium, magnesium, metasilicates)



- Excellent rinsability; minimal residue
- Excellent formulation compatibility
- Effective pH adjuster

Easy to handle and use

- Easy handling liquid
- Readily dilutable at all concentrations
- Non-flammable

DuPont™ Glycolic Acid

TECHNICAL PRODUCT ATTRIBUTES

Chemical and Physical Stability

Glycolic Acid 70% technical solution and DuPont™ Glypure® 70% solution are chemically stable when stored at normal temperatures. The solution products are physically stable if they are stored at temperatures above 10°C (50°F). At colder temperatures, Glycolic Acid crystals can form. The crystals can be put back into solution by warming the container with stirring. This does not affect chemical quality. DuPont personnel can provide detailed procedures for reconstituting precipitated Glycolic Acid.

The Glypure® 99% crystalline grade of Glycolic Acid is chemically stable to 50°C (122°F). Above this temperature, polymerization begins to occur. DuPont guarantees the specification chemical quality of its Glycolic Acid products for two years, provided the container has not been opened. DuPont will help customers determine if the quality of their Glycolic Acid is still viable.

Properties of Equilibrium

Glycolic Acid 70% Technical Solution		
Concentration of Glycolic Acid Solution, %	**% Free Acid at 25°C (77°F)**	**Precipitation Point, °C (°F)**
0.0	0.0	0 (32)
10.0	10.0	–2 (28)
20.0	19.9	–5 (23)
30.0	29.6	–9 (16)
40.0	39.0	–14 (7)
50.0	47.7	–19 (–2)
60.0	56.2	–5 (23)
70.0	63.6	9.5 (49)
80.0	69.0	22 (72)
90.0	71.8	32 (90)
100.0	68.0	37 (99)

Physical Properties

Glycolic Acid 70% Technical Solution	
Weight, lb/gal at 15.6°C/60°F kg/L at 15.6°C/60°F	10.6 1.27
Density, g/mL at 15.6°C (60°F)	1.27
Coefficient of Thermal Expansion at 15.6–60°C at 60–140°F	0.00047 0.00026
Viscosity, MPa/s at 15.6°C (60°F) at 43.3°C (110°F)	11.28 3.49
Heat Capacity, Btu/lb·ft at 25°C (77°F)	0.579
Heat of Solution, kJ/mol	–11.55
Enthalpy, Btu/lb·ft at 25°C (77°F)	–464.4
Heat of Combustion, kcal/mol	166.6
Boiling Point, °C (°F)	112 (234)
Precipitation Point, °C (°F)	10 (50)
pH at 25°C (77°F)	0.1
Dissociation Constant at 25°C (77°F)	1.5×10^{-4}
Heat of Neutralization, kcal/mol	–52.02
Biological Oxygen Demand (BOD) at 5 days (standard diluted sewage)	0.175
7-day Biodegradability, %	89.6
Volatile Organic Compound (VOC), at 101°C (213°F), 45 min	99.6 (water)

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Materials of Construction and Corrosion Information

General Corrosion Information

Stainless steels are resistant to corrosion over a wide range of temperatures and Glycolic Acid concentrations. Monel and Inconel are suitable materials of construction. DuPont™ Glycolic Acid is mildly corrosive to iron, mild steel, tin, and aluminum at ambient temperatures. Copper and bronze are resistant in the absence of air.

A wide variety of polymeric materials, like polypropylene, PVC, epoxy, vinyl ester, and polyethylene, are stable to Glycolic Acid, depending on acid concentration and temperature.

Specific corrosion data is available upon request.

Storage Equipment

Tanks constructed of 304 stainless steel are recommended for storage at temperatures up to 50°C (122°F). 316 stainless steel is recommended for temperatures up to 70°C (158°F). Mild steel lined with Heresite or Plasite can be used at ambient temperatures. Limited experience shows that fiber reinforced plastic tanks are suitable for concentrations below 30% or for use in a heated storage building.

Process Equipment

Piping of 304 or 316 stainless steel is suggested. Chlorinated polyvinyl chloride (CPVC) can be used at temperatures up to 50°C (122°F). Elevated temperatures (above 70°C [158°F]), particularly in the presence of mineral acids and water, require materials of construction like silver lining.

Plug or ball valves made of 316 stainless steel, with Teflon® gaskets, are recommended.

Fiber-filled gaskets are preferred because they are less susceptible to failure. Kalrez®, Viton®, and Nordel™ are accepted materials of construction for O-rings. Kalrez® O-rings offer the highest level of performance.

Suitable materials of construction for pumps depend on the process conditions. In mild service, stainless steel is acceptable. In harsh service, Hastelloy®, Alloy 20 ALX6XN, or titanium should be evaluated.

For further information visit our website at www.glycolicacid.dupont.com
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DuPont: Your Source for Quality Glycolic Acid

Our Products:

- Extremely low salt content, which provides greater application flexibility.
- NSF/ANSI Standard 60 Certified for use in potable water systems.
- USDA approved for use as an acid cleaner in all departments of official establishments operating under the Federal meat, poultry, shell egg grading and egg products inspection program. Providing these food contact surfaces are rinsed with potable water after cleaning.
- DuPont™ Glyclean® AM, containing 68% Glycolic Acid, is EPA registered as a manufacturing use product and is approved for use as an active ingredient in liquid disinfecting formulations on hard, non-porous surfaces.
- A purified form of Glycolic Acid, marketed as Glypure® and Glypure® L, is widely used in cosmetic applications. Industrial grade Glycolic Acid is not acceptable for this category of product.
- Other solid and liquid Glycolic Acid grades available for specialty applications.

Our People:

- Knowledgeable and committed laboratory and plant staff to address your technical needs.
- Dedicated sales force available to support you, our customer.

Our Plant:

- World's largest purpose-built facility with ISO 9001:2000 certification to ensure that we will meet your global supply needs.
- Continuous operation ensures consistency and quality of product.

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DuPont™ Glycolic Acid as a Hard Surface Cleaner

A hard surface is defined in the household and institutional cleaning fields as a surface or object that cannot be removed to a basin, sink or mechanical device in order to be washed. It must be done in situ, in place, and usually by hand. Hard surfaces include ceramic tile, grout, porcelain tubs, sinks, counter tops, toilet bowls, shower doors and stalls.

Glycolic Acid has many excellent characteristics, which enable it to be utilized (individually or as a blend with other acids) in cleaning formulations.

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Characteristics as a Hard Surface Cleaner

- Glycolic Acid's low pKa, low molecular weight, and organic nature, makes it the ideal choice for performance on mineral scales and oily soils. The most common example of a soil with both characteristics is soap scum, which is easily removed by formulations containing Glycolic Acid. When cleaning with acid based cleaners, Glycolic Acid is the premier builder for cleaning both kitchens and bathrooms.
- Glycolic Acid effectively complexes hard water salts. This characteristic makes it an effective bathroom scale remover. The resulting salts are water soluble and easily rinsed.
- Glycolic Acid is more effective in solubilizing inorganic silicates than other organic acids and some mineral acids.
- Glycolic Acid's low corrosivity to household surfaces makes it an excellent choice for household applications.
- Formulating with Glycolic Acid is easier since it is more compatible than mineral acids with a wider range of ingredients such as surfactants, biocidal agents, corrosion inhibitors, fragrances and dyes.
- When blended with other organic and inorganic acids like citric acid and sulfamic acid, Glycolic Acid improves their cleaning and penetrating effectiveness. For example when blended with these and similar acids it enhances iron stain removal.
- Glycolic Acid is readily biodegradable; therefore, waste disposal is not a problem.
- Glycolic Acid is VOC exempt.
- Glycolic Acid has a very mild odor, which reduces the need for masking agents.

Bathroom "soap scum" soils are complex mixtures of hard water minerals (iron, calcium, and magnesium carbonates and metasilicates) and organic/oily components from soap residues and soils. These soils are hard to remove, and can be a breeding ground for molds, mildew and bacteria. Regular cleaning is necessary to keep bathrooms pleasant and healthy areas in the home or in institutions.

Customer Values for Bathroom Cleaners

Consumer Values

- Cleaning Efficacy: Removes soils easily and thoroughly.
- Aesthetics: Has a pleasant fragrance and color.
- Handling Ease and Safety: Ease of application and does not require rubber gloves.
- Low toxicity.
- Safer for the Environment: Does not harm wildlife and is not bio-accumulative.
- Cost effective.

Formulator Values

- Matches up with consumer values.
- Ease of Formulation:
  Ingredients should be easy to handle: non-flammable, low toxicity, low corrosivity, good chemical stability and good water solubility. Ingredients should be easily formulated and compatible with other cleaner components like solvents, fragrances, surfactants and colorants.
- Formulations must have good shelf life.
- Supplier Support.

Attributes of Glycolic Acid from DuPont

- Excellent cleaning capability as described above.
- While synthetically produced, it is a naturally occurring compound that is found in sugar cane, the mammalian metabolic system (Krebs Cycle), etc. The synthetic form of Glycolic Acid has the same structure as the natural form.
- Low toxicity:
  The LD 50 is 4240 mg/kg in rats.
- It has favorable environmental properties:
  – Low volatility: <0.1 mm Hg pressure at 25°C.
  (= VOC exempt) (per EPA and SCAQMD)
  – Readily Biodegradable: 89% degraded in 7 days
  – Low fat solubility: Octanol/water solubility = 8%/92%
  (KOW = –1.11)
- Low color: very pale amber.
- Low odor: very mild, burnt sugar odor.
- Non-flammable.
- High water solubility: –19°C for 50%; 10°C for 70% (the commercial product).
- Low corrosivity to most common metals and synthetic materials. (Formulations should be tested, particularly on marble or natural stone surfaces, before use.)
- Chemical stability under most conditions (except to active metals or strong oxidizers like peroxide, hypochlorite, etc.).
- Dedicated sales and technical support.
  Formulators value good support from their ingredient suppliers. Many formulators have highly sophisticated testing techniques and very extensive formulation experience. Nevertheless, they appreciate technical information that assures them that their development efforts have a good probability of success.

Glycolic Acid is the organic acid of choice for cleaning applications when all aspects are considered. In a customer prepared formulation, its performance exceeded citric acid. It is less toxic, less corrosive and, as a liquid, easier to handle than mineral acids, oxalic or sulfamic.

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DuPont™ Glycolic Acid for Concrete Remover Formulations

Clean and maintain your tools, equipment, and vehicles with Glycolic Acid based concrete remover formulations.

Key Attributes

- Efficient at penetrating and loosening concrete.
- Highly effective calcium complexing agent.
- Low to no corrosion on most metals and coatings. Significantly lower corrosion than hydrochloric acid based removers.
- Active ingredient is readily biodegradable.
- Glycolic Acid is found in natural products, such as fruits and vegetables.

Functionality

As the smallest hydroxycarboxylic acid available, Glycolic Acid combines the key cleaning attributes, acidity and metal complexing capability, in an efficient and cost effective manner. Glycolic Acid is significantly less corrosive than mineral acids such as HCl. The results are that Glycolic Acid is preferable to use on many metals and surfaces including stainless steel, aluminum, painted surfaces, and most plastics.

Application

Glycolic Acid's high water solubility and small molecular size allow it to penetrate deep inside concrete residues and react from within. Because of its less corrosive nature Glycolic Acid can be used on most surfaces and equipment without concerns for etching and damage. In addition, readily biodegradable Glycolic Acid is easier to dispose of than other cleaning agents such as phosphoric acid or HCl.

Corrosivity

Solutions at 10% (100% basis) concentrations of Glycolic Acid, phosphoric acid and HCl were tested for corrosion on 1018 carbon steel, 1100 aluminum, 304, and 316 stainless steel. The tests were performed, in triplicate, at 23°C (73°F) for 48 hours with no agitation. The results are the average of the percent weight loss.

		% Wt. Loss	
Test Metal	**Glycolic**	**Phosphoric**	**HCl**
1018 carbon steel	0.17	0.64	2.03
1100 aluminum	0.009	1.39	55.51
304 stainless steel	0.008	0.011	0.53
316 stainless	0.002	0.002	0.94

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Starting Point Formulations

Standard Concentrate	Wt%
Glycolic Acid, 70% Tech Grade (DuPont)	80.0
Tergitol 15-S-9 (Dow)	4.0
Dowanol DPM (Dow)	16.0

Standard Ready-To-Use	Wt%
Glycolic Acid, 70% Tech Grade (DuPont)	20.0
Tergitol 15-S-9 (Dow)	1.0
Dowanol DPM (Dow)	4.0
Water	75.0

Low/No Corrosion Concentrate	Wt%
Glycolic Acid, 70% Tech Grade (DuPont)	76.0
Tergitol 15-S-9 (Dow)	4.0
Dowanol DPM (Dow)	12.0
Rodine 103	8.0

Low/No Corrosion Ready-To-Use	Wt%
Glycolic Acid, 70% Tech Grade (DuPont)	20.0
Tergitol 15-S-9 (Dow)	1.0
Dowanol DPM (Dow)	4.0
Rodine 103	2.0
Water	73.0

Instructions

Concentrate

- Dilute 1:4 with tap water for use.
- Spray onto surface needing concrete removal.
- Wait at least 30 minutes (allowing to react overnight or between shifts is acceptable).
- Powerwash equipment and parts to remove residual concrete
- Extremely heavy residuals may require 2 treatments.
- Wear appropriate personal protection equipment.
- As with all acids it should not be sprayed on hot surfaces.

Ready-To-Use

- Spray onto surface needing concrete removal.
- Wait at least 30 minutes (allowing to react overnight or between shifts is acceptable).
- Powerwash equipment and parts to remove residual concrete.
- Extremely heavy residuals may require 2 treatments.
- Wear appropriate personal protection equipment.
- As with all acids it should not be sprayed on hot surfaces.

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DuPont™ Glycolic Acid General Metal Finishing and Cleaning

Glycolic Acid is an excellent choice for your copper and aluminum metal finishing processes. It is a good raw material for new or reformulated surface cleaner applications when looking for less toxic materials. Glycolic Acid is 100% biodegradable, reducing the impact your finishing application leaves on the environment. It is a great choice for metal cleaning because it has dual functionality. The molecule contains both a carboxylic acid functional group as well as a hydroxyl group and can act as an acid or an alcohol or both. As a fairly strong acid it is a good source of protons for acid to neutral cleaner.

Glycolic Acid Advantages

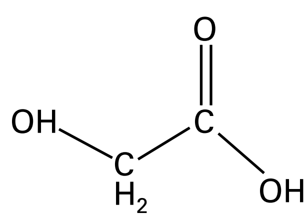
- Low Corrosiveness
- Low Toxicity
- Readily Biodegradable
- Low Odor
- Negligable VOC
- Freely Water Soluble

Applications

- Aluminum and copper cleaner and finishing
- Electroless plating premix
- Electropolishing electrolytes
- Anodizing and sealer formulations
- Pickling and mill scale
- Acid cleaning and degreasing
- Wheel cleaner
- Buffing compound cleaner

Physical and Chemical Description

Technical grade Glycolic Acid is sold as a clear to light amber solution in a 70% concentration. Glycolic Acid is the first and simplest member of the family of hydroxycarboxylic acids. GA has an acid dissociation constant of 1.47×10^{-4}, or a pK_a of 3.87. Glycolic Acid has a 7 day biodegradability value of 89.6 percent.



70% Technical Grade

Molecular Weight	76.04
Total Acid, %	70.0–72.0
Sulfates, ppm	800, max.
Color, Gardner	< 3
Formic Acid, %	< 1, max.
Turbidity, NTU	6, max.

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Glycolic Acid as a Metal Cleaner

Glycolic Acid is useful in a wide variety of metal cleaning applications, including equipment, stainless steel boilers, heat exchangers and many other industrial metal surfaces.

The properties listed here contribute to its effectiveness and versatility:

- A relatively strong organic acid. The pH of a 4% solution of Glycolic Acid in water is below 2.0.
- Low volatility. This means little corrosive fumes evolve on heating. Low acid yield loss is experienced, even when hot solutions are used. Non VOC due to low vapor pressure.
- Very mild odor versus the strong objectionable odor created by other acids like acetic. Does not fume as some mineral acids do.
- Dissolves carbonate, oxide, and most casein scales readily. The resulting salts are water soluble. This gives good rinsing properties.
- As supplied, is already in complete solution. Easy to handle as a liquid. There are no "incomplete dissolving" problems, and the 70% concentrate can be quickly diluted to any desired strength with water.
- Relatively low corrosion rate on metals. Specific corrosion data are available upon request from DuPont. These low rates of corrosion can be further reduced by addition of a corrosion inhibitor.
- Contains essentially no chlorides. It can be used for cleaning stainless steels without the possible chloride cracking or embrittlement sometimes experienced in acid chloride systems.
- In formulation, is compatible with many cleaning additives. These can include surfactants, biocidal agents, corrosion inhibitors, scents, colors, other acids, and of course, water.
- Possesses complexing properties. This characteristic may preclude the need to add a special chelating or complexing agent. Enhances the rinsibility property of the cleaner.
- A relatively safe acid to store and handle. Always be sure to follow material safety data sheet guidelines for chemical handling.
- Readily biodegradable, but does not support the growth of bacteria in use.

Starting point formulations for metal cleaning are given in the Glycolic Acid Cleaner Formulary.

For further information visit our website at www.glycolicacid.dupont.com
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DuPont™ Glycolic Acid in Industrial Water and Boiler Systems

Glycolic Acid has a unique combination of attributes which makes it attractive in a wide variety of water treatment applications. Glycolic Acid can work in these systems to remove hard water scale deposits (calcium, iron, magnesium, manganese salts) by forming water soluble complexes (chelates) which are easily rinsed away.

Attributes

- Good acidification properties to decompose carbonates.
- Ready biodegradability which helps waste treatment and prevents accumulation in the environment.
- Low corrosion to most metals and synthetic materials.
- Low toxicity, low odor, and negligible volatility (low VOC).
- Ease of handling and storage: very water soluble, non-flammable liquid.
- Contains no phosphates.
- Compatibility with other acids and additives.

Applications

- Cooling Towers—hard water scale deposits reduce cooling tower heat exchange efficiency
- Ground Water Remediation Systems—designed to remove organic impurities in ground water often use vapor flashing and/or activated carbon systems. Iron and other mineral deposits can cause fouling of feeds, flash equipment, and carbon bed equipment.
- The recommended mixture containing Glycolic Acid is fast and effective for cleaning high pressure stainless steel steam generators. The mixture has been tested extensively to establish its safety and to confirm its effectiveness. Residue from the process decomposes to volatile, non-corrosive products. Wastewater from this process is easy to treat.
- Water Well Rehabilitation—due to scale buildup, the flow from industrial and potable water wells diminishes with time. Please see Water Treatment and Water Well Stimulation insert #K-16086.

(continued on back page)

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The recommended mixture containing Glycolic Acid offers the following advantages:

- Rapid, effective removal of mill scale (including iron oxides, calcium salts, magnesium salts, silica, silt, nickel oxides and copper oxides)
- Freedom from organic iron precipitation
- No chlorides — it can be used for cleaning stainless steel without the possible chloride cracking or embrittlement sometimes experienced in acid chloride systems
- Low corrosion rate on most metals. Formulations should be tested on specific metal types prior to use.
- Volatile, non-corrosive decomposition products
- Easy waste treatment (Glycolic Acid is readily biodegradable; heavy metals can readily be removed from wastewater)
- The Glycolic Acid mixture performs optimally in high pressure boilers due to increased circulation

Versus other chemistries, Glycolic Acid offers these advantages:

- EDTA is generally higher cost than Glycolic Acid. Scale is removed more slowly. In addition, there are environmental concerns about the use of EDTA regarding carryover of heavy metals.
- Citric acid removes scale more slowly than Glycolic Acid. Also, iron and calcium salts of citric acid are less soluble than those of Glycolic Acid, so they may precipitate onto the surfaces of the boiler, diminishing cleaning effectiveness.
- Hydrochloric acid, while generally much less expensive than Glycolic Acid, has been found to cause stress cracking in austentic stainless steel. It is also much more corrosive and difficult to handle (fumes, odor) than Glycolic Acid.

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DuPont™ Glycolic Acid in Water Treatment and Water Well Stimulation

Glycolic Acid is used extensively to rehabilitate the flow efficiency of water wells. Glycolic Acid accomplishes this by removing hard water scale (calcium, magnesium, manganese salts), various iron deposits and polysaccharide deposits.

The efficiency of industrial and potable water wells decreases with time. This can be the result of:

- Gradual damage to the water producing formation.
- Mechanical deterioration to the down-hole well screen/ gravel pack filter system.
- Accumulation of deposits on the screen and gravel pack filter system.
- Iron bacteria.

The deposits result from hard water scale (calcium, magnesium and iron salts) accumulation or deposits of iron oxide and bioslime. The deposits can also result from build up of clay.

It should be noted that reduced water production can result from many factors in addition to scale build up. Each water well should be viewed as a distinct case. The specific cause for the reduced production should be defined by water analysis, underground surveys, well history, etc. The typical useful life of a well is 35 years. Only after reviewing this information can the appropriate remedial action be selected. Consultation with a professional water well rehabilitation company is recommended.

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Glycolic Acid has the following advantages which makes it very useful for this application:

- National Sanitation Foundation (NSF) certification for use in cleaning potable water wells. (Internet reference: http://www.nsf.org)
- Formation of water-soluble compounds (chelates) with the hard water metal salts. The compounds are easily rinsed away.
- Low corrosion to the metal parts of the well.
- Easily handled organic wastes since Glycolic Acid biodegrades rapidly.
- Low toxicity, low odor, non-flammable, and negligible fumes.
- Easy handled liquid.
- Compatible with other acids to improve cost and effectiveness.
- Displacement of polysaccharide deposits.

The following information describes the routine maintenance procedure to increase the productivity of a water well using Glycolic Acid. This procedure is typically used every 2 to 3 years depending on well performance.

Well Pretreatment

Determine the current well flow in comparison with historical flows. Flow will deteriorate with time as formation damage occurs. This will help set a goal flow for the well cleaning.

When iron metabolizing bacteria are present, the well is treated with chlorine bleach to loosen the bioslime organic deposits.

Scale is loosened by applying high frequency shock via detonating blasting caps in the well bore.

Purge the well. Large amounts of rock and gravel can indicate serious problems with the screen and gravel pack. These should be corrected before proceeding.

Determine the pH of the well water.

Glycolic Acid Application Procedure

The recommended procedure for the use of DuPont™ Glycolic Acid 70% Solution for the treatment of water wells can be summarized as follows:

1. *Amount of Glycolic Acid*
   Add 70% Glycolic Acid at a rate of 1/2 gallon per cubic foot standing in the well bore. This provides approximately a 5% concentration of acid in water. Refer to **Table 1** to calculate total acid requirement for wells 2 inches to 30 inches bore diameter. The Glycolic Acid can also be pre-mixed with water in a preparation tank.

Table 1
Glycolic Acid Quantity Guide for Cleaning Water Wells

Diameter of Well in Inches	Gallons of Glycolic Acid, 70%, to add per foot of water to give a 5% (wt) solution
2	0.010
4	0.040
6	0.090
8	0.160
10	0.241
12	0.361
14	0.491
16	0.641
18	0.811
20	1.000
22	1.210
24	1.440
26	1.690
28	1.960
30	2.250

Example: A 10″ diameter well 126′ deep with a static water level 30 below the surface would require: (126′–30′) x 0.241 = 23.1 gallons of Glycolic Acid 70% solution.

2. *Cleaning Procedure*

After adding the acid, surging the well should be considered to facilitate mixing and to achieve penetration into the well formation. By starting and stopping the pump, surge the column of water to the top of the well every 3 to 4 hours or more often to help dislodge scale. An alternative is to surge the well by dropping and retrieving a large plug into the well bore.

Allowing the acid to remain in the well for at least 24 hours or more is recommended.

3. *Removal of Cleaning Solution*

Pump the water to a location (ground or biological treatment facility) in conformance with local environmental regulations.

To facilitate suspension of solid matter, the following procedure might be used:

a) Purge slowly at first and then at about 25% of full flow.

b) At 15 to 30 minute intervals, stop the pump long enough to allow the well to drop to its static level.

4. *Before Use of Well Water*

Continue pumping until the pH of water is within 0.5 pH units of the original value before treatment. This affords a concentration of approximately 25 ppm or less. This could occur in 1 to 3 hours after starting the flushing operation. **Table 2** shows the relationship of free Glycolic Acid concentration and pH.

5. *Repeat the above steps as necessary to achieve the optimum rate of flow.*

Note: The ideal pH for cleaning is about 1.0. Periodically check the pH of the well bore contents. Consider adding more Glycolic Acid if the pH rises above 3. As an alternative, consider repeating Steps 1–4.

Table 2
pH as a Function of Free Gycolic Acid
(Deionized Water)

% Concentration	pH
70	0.1
60	0.3
50	0.6
40	0.9
30	1.1
20	1.3
10	1.6
8	1.7
6	1.7
4	1.9
2	2.1
1	2.3
0.1	2.8
0.01	3.3
0.001	4.0
0.0001	4.5

Example

A water well in Pittman, Ohio, 149 feet deep, and 16 inches in diameter that contained 685 gallons of water at its static level, was treated with 47 gallons of 70% Glycolic Acid (concentration about 6 wt%). Full flow rate increased from about 200 gallons/minute prior to treatment to 400 gallons/minute following the treatment. The table below shows the change in pH and the decrease in Glycolic Acid with time after flushing of the well was started.

Change in pH After Well Flushing

Time After Flushing Began (Minutes)	pH
Before Treatment	7.6
20	6.6
40	6.9
80	7.0
180	7.1
1440	7.8

Post Treatment

The well is treated with hypochlorite bleach to eliminate any bacteria that might have been returned to the well. This helps to reduce the future build up of iron scale resulting from iron metabolizing bacteria (gallionella ferruginea).

Carbonate Scale

If a persistent carbonate scale exists in the well to be cleaned, a blend of Glycolic Acid and mineral acids may be the preferential cleaning solution. A 50:50 mixture of Glycolic Acid and hydrochloric (muriatic) or sulfamic will dissolve carbonate scales more quickly. A water analysis showing a pH of 7.5 or greater and total carbonates in the 300–700 ppm range indicates heavy carbonate scales. Carbonates in the 50–300 ppm range indicate moderate to heavy scales. The blend of Glycolic Acid and a mineral acid will remove scale very effectively.

Reduced Treatment Cost

Reduced cost of treatment may be facilitated by using a blend of Glycolic Acid and sulfamic acid. The blend should be 1:1 by weight. The amount of Glycolic Acid established in **Table 1** can be reduced by ½ and for every gallon of Glycolic Acid used also use 7.3 pounds of sulfamic acid. In the example shown below **Table 1** you would use 11.6 gallons of 70% Glycolic Acid and 83.8 pounds of sulfamic acid.

Clay Removal

The use of Glycolic Acid to clean water wells does not replace the need to use dispersants if clay removal is a specific problem. If clay build up or pluggage is the cause of the decrease in well production, a clay dispersing agent may be required.

Intensive Remediation

Water wells can have serious formation damage, which could lead to drilling a new well. An intensive remediation procedure should be considered prior to drilling a new well. An example is the use of liquid carbon dioxide treatment. This expands the formation by freezing the water. The carbon dioxide evaporates to form dilute acid (carbonic acid) which frees scale. The evolution of carbon dioxide gas loosens scale. Glycolic Acid treatment can then be considered for subsequent treatment. A professional well rehabilitation company should be consulted.

For further information visit our website at www.glycolicacid.dupont.com
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302-892-7536, International Customers

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DuPont™ Glycolic Acid as a Laundry Sour

Industrial and institutional laundries use a multi-step laundry process which includes the use of alkaline detergents. This detergent must be neutralized by a "sour". In the past, silicafluorides or hydrofluosilicic acid have been used to neutralize the laundry. Today's modern laundry equipment, including automatic dispensers, requires a flexible yet dependable liquid sour. Glycolic Acid provides the dependability and flexibility demanded in a modern laundry system.

Advantages of using a Glycolic Acid-based Sour

- Since it is a liquid, Glycolic Acid is easier to measure and add when using automatic dispensing equipment. The poor solubility of some of the silicafluorides limits solution concentrations and creates possibilities for the equipment to become blocked.
- The lower toxicity of Glycolic Acid over the fluorosilicates causes fewer handling problems and concerns.
- Glycolic Acid offers better storage stability. As a liquid, Glycolic Acid won't cake in storage.
- Glycolic Acid does not damage the fabric, especially when the fabric is ironed wet. Due to their rather poor solubility, the undissolved fluorosilicates can occasionally bind to the cellulosic fiber and cause grating action which tears the fabric apart.
- Silicafluorides impart a buffering action with the pH at around 6 or 5.5. Because of this action, excess amounts of the acid salts are often added. Glycolic Acid, however, does not buffer and addition of excess can be prevented by simple pH control.
- Glycolic Acid reacts to reach a final pH of 5–6 in alkaline wash conditions much more quickly, especially at lower wash temperatures, than silicafluorides.
- Glycolic Acid is very soluble in water and presents no problem with salting out. The fluorosilicates are poorly soluble. Undissolved solids will result in a salt carryover which, when ironed, causes a whitish deposit on the laundry.
- Glycolic Acid complexes calcium and iron to prevent scale deposition and rust decoloration of fabric.

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DuPont™ Glycolic Acid as a Dairy Cleaner

Glycolic Acid has been used for many years as a dairy cleaner. It is particularly effective at dissolving casein, a milk protein found in milkstone, as well as hard water deposits.

Advantages of using Glycolic Acid as a dairy cleaner are:

- Glycolic Acid is a good environmental choice. It is readily biodegradable, non-volatile, and phosphate free.
- Glycolic Acid is easy to handle. It is non-toxic and non-fuming.
- Glycolic Acid dissolves calcium carbonate and iron oxide scales faster than phosphoric acid therefore, may decrease process downtime for cleaning.
- Glycolic Acid has a higher capacity for calcium carbonate than phosphoric acid. One pound of 70% Glycolic Acid will dissolve as much calcium carbonate as 1.2 pounds of 75% phosphoric acid. The resulting calcium or iron glycolate salts are highly water soluble vs. insoluble phosphates.
- Glycolic Acid is essentially chloride free. It will not cause the chloride stress cracking in stainless steel normally associated with hydrochloric acid, so Glycolic Acid use can prolong equipment life.

Background

The modern dairy processing industry is undergoing consolidation from many small dairy processing plants to fewer large ones. In modern dairy processing plants, most equipment is cleaned in place (CIP). As much cleaning as possible is done automatically, with minimal human intervention. Dairies prefer to save time by cleaning with food-grade cleaners and then just draining and refilling their equipment with dairy product. These cleaning trends save the dairies in labor costs and allow them to maximize throughput to meet demand.

(continued on back page)

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Since milk products are some of the most perishable major foods, cleaning and sanitization in that industry generally require the highest standards. Dairy process cleaning technology is frequently adaptable to the other food industries because the soils produced by other food processing are usually similar to dairy soils but easier to remove. Cleaning advice, equipment, and services are often provided by companies focused on servicing the cleaning needs of the dairy and food industries. In these cases, acid formulations are developed and recommended by the service company. The dairy or food processor would be the direct customer of the service company and would not purchase many unformulated chemical cleaners. Dairy equipment is generally cleaned by a series of solutions and drained in between steps. A typical cleaning process is: water rinse; alkaline cleaner (removes fats and proteins); optional water rinse; acid cleaner (or combination acid cleaner and sanitizer); optional water rinse; sanitizer (if acid sanitizer is not used); optional water rinse. Glycolic Acid is classified as an "A3" acid cleaner by the USDA. This classification requires that: "before using these compounds, food products and packaging material must be removed from the room or carefully protected. After using these compounds, all surfaces in the area must be thoroughly rinsed with potable water."[1] Visits to dairy processing plants indicate that increased product shelf life as well as consistent product quality are very desirable. One way dairy processors achieve this goal is by cleaning more often and sanitizing more effectively than in the past. Recent popularity of foods and beverages containing little or no preservatives places additional demands on food and dairy cleaning processes. Fast, efficient, effective cleaning methods and chemicals in the plant are critical for food and dairy processors to meet the needs of their downstream customers.

[1] United States Department of Agriculture; Food Safety and Inspection Service, Misc. Publication Number 14149; "List of Proprietary Substances and Nonfood Compounds."

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