FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TO: SHARON TROCHER, EPA April 8, 2003

FROM: CHARLES MALANIAK

CC: HEIDI ROLDAN

SUBJECT: CALCIUM CARBONATE TREATMENT STUDY

Aguilar Environmental Services (Aguilar) performed a treatment study for the Vestal Well 1-1A water treatment facility. The facility has been experiencing operational problems due to carbonate deposition. Specifically, calcium carbonated depositions are evident in the clearwell, high service pump, pump control valve, bypass hydraulic valve and float assembly and in discharge piping. The calcium carbonate deposition causes additional wear and decreased post-treatment system efficiency.

Aguilar's treatment study investigated four treatment options - softening, acid sequestering, polyphosphate sequestering, and non-treatment. The treatment study concluded polyphosphate sequestering and non-treatment were two potential options for the Vestal Well 1-1A treatment facility. Due to the high capital cost, requirements for additional land and buildings, and safety considerations, the treatment study did not consider softening and acid sequestering acceptable treatment options a this time.

Based on a cost comparison of the two potential treatment options, the Aguilar study recommended polyphosphate sequestering for the Vestal Well 1-1A treatment facility.

Foster Wheeler Environmental has examined Aguilar's treatment study and provides the following conclusions and recommendations:

- Temperature, hardness, calcium and pH all affect carbonate deposition rates. Therefore, summer temperatures may aggravate the carbonate deposition problem.

- Polyphosphate sequestering and "non-treatment" are both viable potential options for the Vestal Well 1-1A treatment facility under current conditions.

- In the cost estimate for the "non-treatment" option, Aguilar included annual replacement of the stripper media. However, the Vestal Well 1-1A treatment system has been operational since 1996 and has not yet required stripper medial replacement. After annual replacement of the air stripper media is removed from the cost estimate, the "non-treatment" option becomes the least expensive potential treatment option.

- If the "non-treatment" option is selected and the Town of Vestal determines at a later date that the treated water is required as a source of potable water, the carbonate solids deposition must be addressed. Softening may become a more desirable treatment option at that time, as it addresses iron, as well as carbonate deposition.

- Acid sequestering has shown to be economical in addressing carbonate deposition in other treatment facilities. In Aguilar's study, acid sequestering is discounted primarily due to safety considerations. However, assuming acid sequestering and polyphosphate sequestering require similar capital costs (as suggested in Aguilar's study), it is believed that acid sequestering will still be more expensive than the "non-treatment".

- A slight alteration in the current plant configuration may reduce operational problems resulting from carbonate deposition. In the current treatment system configuration, the treated water accumulates in a sump and is pumped to the Susquehanna River. In the event of pump failure, the treated water overflows the sump and discharges into a trench, which in turn discharges to the river. The sump and pump could potentially be placed with a baffle and flume to direct all treated water to the trench for discharge to the river via gravity. This in effect would eliminate carbonate deposition in the pump and discharge piping, as well as reduce electrical costs associated with pump operation.

Foster Wheeler Environmental recommends that, under the current circumstances surrounding the Vestal Well 1-1A treatment facility (i.e. the water is not required for human consumption), the "non-treatment" option addresses the operational problems due to carbonate deposition without significantly affecting the system performance, environment, or budget.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

26 February 2003
RAC II-2003-041

Ms. Sharon Trocher
Work Assignment Manager
U.S. Environmental Protection Agency
290 Broadway, 20th Floor
New York, NY 10007-1866

SUBJECT: USEPA RAC II CONTRACT NUMBER: 68-W-98-214
WORK ASSIGNMENT NUMBER: 009-RALR-0238
VESTAL WELL 1-1 SITE, OPERABLE UNIT 1
CALCIUM TREATABILITY STUDY

Dear Ms. Trocher:

Enclosed please find the calcium treatability study for your review. Please feel free to contact me at (973) 630-8318 if you should have any questions.

Sincerely,

Charles Malaniak
Project Manager

1000 The American Road, Morris Plains, NJ 07950
TEL: 973-630-8000 FAX: 973-630-8025

Vestal Well 1-1

Treatment Study

Prepared by

Acorn-Conklin Associates, Inc
Andrew R. Huray P.E.

And

Aguilar Environmental

Andrew R Huray

HISTORY

Vestal Well 1-1 is a municipal well developed in 1954 to supplement a small area serviced by the Village of Endicott as purchase district. The Hamlet of Vestal and the Twin Orchards area were the original Town Water District. As the water system grew, this service area was known as Vestal Water District #1. The identification of the well as 1-1 meant that it was water district #1, well #1. The well originally operated via a gasoline engine and right angle gear drive. In the late 1950's and early 1960's, the population of Vestal was growing rapidly. The Town of Vestal developed additional water districts that purchased from Water District #1 and also developed additional source districts. To meet the needs of Water District #1, the Town developed additional wells and electrified well 1-1.

In 1980, there was a large chemical spill (1,1,1-trichlorethane) at an industry in Endicott, New York. Endicott is located due north of Vestal and the boundary between the two communities is the Susquehanna River. In evaluating the extent of groundwater contamination in the area, the New York State Department of Environmental Conservation (NYSDEC) began drilling monitoring wells in Endicott and decided to test the Vestal municipal wells for any contamination associated with the spill. The NYSDEC found high levels of 1,1,1-trichlorethane and other synthetic organics in the Vestal Wells. It was later determined that the spill in Endicott did not contribute to the levels of volatile organic contaminants (VOC's) and metals in the groundwater around Vestal Well 1-1.

Groundwater investigations commenced in the Vestal Water District #1 area as well as in the industrial areas near the well field. It was determined that the contaminated plume was traveling from the east to the District #1 well field and that the contamination was only present in Well 1-1. It was decided that a short-term remedy would be to discontinue using Well 1-1 as a potable supply and to use it as an interceptor of the contamination, thus preventing the plume to migrate to the other wells. The Town applied for and received discharge permits from the New York State Department of Environmental Conservation (NYSDEC) to discharge the contaminated water into the Susquehanna River.

The long-term remedy was outlined in the Remedial Action Plan (RAMP) and Remedial Investigation/Feasibility Study (RI/FS). The plan overview was: identify the extent and the contributors of the contamination, litigate for current and future cost associated with clean-up and lastly, remediate the groundwater and provide on-site treatment at Well 1-1 to restore the facility as a source of potable water.

In 1988, construction began for the treatment facility. It was determined that an air stripper would provide adequate treatment of the VOC's and allow the Town of Vestal to operate the facility as a source of potable water. The treatment facility would also continue to serve as an interceptor of the plume and prevent any addition migration towards the other wells in the well field. Construction, start-up and take-over of the system took place in late1990.

After the Town of Vestal began operating the facility, the well began to pump large quantities of sand. Re-development of the well was attempted, but unsuccessful. The well could no longer pump 1 million gallons per day (MGD) and the sand would cause excessive wear to all the pumping equipment. Due to the large amount of money spent to date on the project, the need to contain the plume, and lack of a formal acceptance of the facility, it was decided to locate and drill a new well in close proximity to the old well. This work was completed in 1992.

The Town of Vestal again attempted to operate the system but continued to experience problems. This time, directly after start up, dirty water, iron staining and taste and odor complaints plagued the Town of Vestal. The Town of Vestal again declined formal acceptance of the facility. As previously mentioned, the large amount of money spent to date on the project and the need to contain the plume, necessitated the USEPA to again determine what was the best approach for the site.

It was determined that the USEPA would oversee and operate the site through their sub-contractors. Foster Wheeler Environmental was chosen to supervise the site and assure compliance with USEPA's remediation plan. Foster Wheeler Environmental then sub-contracted the day-to-day operation of the facility. Terra Systems of Delaware received the first operation and maintenance contract and operated the facility until 1998. During that time, system operators began experiencing problems with calcium carbonate scale build-up on valves, pumps, floats, etc. Notes placed in the Operator's daily log sheets can

document this. Aguilar Environmental began operating the system as Foster Wheeler's sub-contractor in 1999 and continues to operate the system under a new contract awarded in 2002. It is important to note that the increased notations in Aguilar's field notes pertaining to the calcium carbonate scale problem stem from increased visitation to the site and the desire to operate the facility with all equipment functioning as designed. Before Aguilar Environmental's operation of the system, the facility was inspected weekly. Now the facility is inspected 3-7 times per week. Inspections that are more frequent expose operating problems and the need for corrective measures.

Aguilar Environmental requested that this treatment feasibility study be conducted.

PROBLEM

The water treated at well 1-1 has average hardness and alkalinity for ground water found in the Southern Tier of New York. Hardness values range from 120 mg/L (as CaCO3) to 500 mg/L. The hardness value found in the raw (influent) at Vestal Well 1-1 is 342mg/L. This value is considered to be in the moderate to very hard and normally does not create operational problems for packed tower aeration systems. The hardness typically stays in solution and continues through the stripper and treatment train with minimal calcium carbonate deposition occurring.

What has been found in many packed tower air stripper installations is that carbon dioxide is present in the raw water and is removed by aeration, which in turn minimally increases the pH of the water. Though the increase is generally .1 to .5 pH units, and typically considered insignificant, the increase causes a change in the calcium carbonate solubility. As the pH increases, the form of alkalinity can change from bicarbonate to carbonate and from carbonate to hydroxide. If the water contains an appreciable amount of calcium and magnesium, calcium will precipitate in the carbonate form and magnesium will precipitate in the hydroxide form.

Water analysis from Vestal Well 1-1 indicates that the pH is increasing from 7.23 to 7.69 and total harness (as Caco3) is reducing from 342 mg/l to 336 mg/l. This reduction seems insignificant, only 6 mg/l drop. However, when you look at it based on 1 MGD for 365 days per year, the number then begins to be relevant to the problems experienced at Well 1-1. Using the formula for pounds per day:

#'s = Mg/l x 8.34 x flow (in MGD)

#'s = 6 x 8.34 x 1.0

#'s = 50.04

At just 6 mg/l of CaCO3 precipitation, 50.04 pounds per day of Calcium carbonate precipitation is produced. This extends out to over 18,000 pounds (9 tons) per year.

The CaCO3 precipitate is coating the entire treatment train:

The Air Stripper - media, vents, demisters, distribution trays. As the media becomes fouled with CaCO3, the airflow decreases and the removal efficiency is reduced. Preliminary test performed by Layne Christensen indicate that the air volume has decreased.

The clearwell – currently has a buildup varying from 1/8 to 3/8 of an inch on the walls and other surface areas. The screen (.5" x .5" mesh) for the overflow was completely clogged and prevented the system from functioning properly.

The high service pump – the internal working parts were found to be completely covered with CaCO3 when disassembled by Layne Christensen (NY) and had to be acid treated prior to repair. Premature wear of pump and motor can be directly attributed to this.

The pump control valve – has to be disassembled 2-3 times per year and rebuilt due to CaCO3 buildup internally.

The bypass hydraulic valve and float assembly - – has to be disassembled 2-3 times per year and rebuilt due to CaCO3 buildup internally.

Discharge piping – Though never examined, the inside diameter of the pipe has to be reducing in size and will increase power consumption and reduce system hydraulics.

TREATMENT OPTIONS

There are four options available for calcium carbonate deposition problems associated with the air stripping process:

Softening - Softening the influent water to reduce the amount of hardness is generally accomplished by either lime softening or ion exchange.

- Lime softening requires the addition of lime to increase the pH above 9.6 at which the hardness will precipitate as CaCO3. Lime softening has been practiced for many years and is generally the most accepted treatment of excessive hardness. Drawbacks to the lime softening process are: high capital cost to build tanks and purchase equipment; sludge storage and disposal; and the requirement for additional property which is not available at the current site.

- Ion Exchange softening uses a pressure vessel filled with a resin that exchanges a sodium ion for a calcium ion. The sodium ion is provided by regeneration of the resin with sodium chloride (salt) at regular intervals.

Drawbacks to the use of ion exchange at the Vestal site include: high capital cost for ion exchange vessel(s), the need for a heated building to accommodate the vessel(s), and a means to handle regeneration (backwash) water – discharge permit, holding tank and disposal, or connection to the Town of Vestal sanitary sewer system.

Acid Sequestering – This process utilizes the injection of acid to the stripper influent to reduce the pH and increase the solubility of calcium carbonate. Equipment required for acid sequestering would include an inline static mixer, two chemical metering pumps and injectors (1 spare). Pumping of acid would be direct from 30-55 gal drums that the product shipped in from supplier. Initial capital cost would be relatively inexpensive. No major capital expenditures or handling of sludge would be required. Drawbacks to acid sequestering are: transportation, storage and handling of a hazardous material, probable need for additional ventilation equipment, and the incompatibility of the air stripper materials with long term exposure to an acid.

Polyphosphate Sequestering – Polyphosphates chemically tie up calcium, iron, and manganese preventing oxidation/precipitation from taking place. Advantages to polyphosphate sequestering are similar to acid sequestering. Low capital cost, minimal equipment (two feed pumps and an inline static mixer) and the ability to pump from shipping containers. No additional space or sludge treatment would be required. Polyphosphates are also non-toxic and require little special equipment for handling.

Drawbacks to polyphosphate sequestering include residual phosphorous (PO_4 as P) which is restricted in discharge permits for receiving streams and that the phosphates can promote slime growth on the media.

No treatment – this option is currently in place at the facility. Advantages are no capital cost and no handling of any chemicals. Drawbacks include frequent down time for maintenance and the know fact that in excess of nine tons per year of calcium carbonate precipitation occurs.

RECOMMENDATION

Of the four options detailed above, only the last two options appear to be acceptable for consideration. Those options are polyphosphate sequestering and no treatment. The other options have either high capital cost, require additional land and buildings, or are considered operations unfriendly.

The no treatment option has no initial "up-front" cost, but can be very expensive down the road. If this option is chosen, replacement of key parts such as pump control valve, by-pass valve, float assembly must be anticipated. Consideration must also be given to having the air stripper media cleaned annually. An estimated annual cost associated with the no treatment option is as follows:

Clean media and disposal of chemicals	$42,000.00
Replacement parts for pump control valve (2 x /yr)	$ 776.00
Replacement parts for by-pass valve (2 x /yr)	$ 265.00
Float assembly replacement (1 x /yr)	$ 340.00
Labor to perform repairs/replacements (estimated 20 hr. X $25.00/hr X 2 events/yr)	$ 1,000.00
Labor for routine cleaning with acid (estimated 8 hr./month X 12 months X $25.00/hr)	$ 2,400.00
Miscellaneous cost (muriatic acid, tools, etc.)	$ 1,000.00
TOTAL ANNUAL COST	**$47,781.00**

It must be stressed that in addition to the cost estimate for the no treatment option given above, there is no cost assigned to the wear on the clearwell pump and motor and all other piping and appurtenances that are being subjected to over 18,000 pounds (9 Tons) of calcium carbonate precipitation. It is impossible to assign such cost. An example of possible problems that could be encountered would be excessive build-up of $CaCO_3$ on the pump moving parts. This could cause excessive wear of the pump, premature bearing failure of the motor, etc. A failure such as described above could easily cost in excess of $25,000.

Polyphosphate sequestering is the preferred choice of treatment. This option would eliminate the calcium carbonate deposition and prolong the equipment life throughout the entire treatment train.

Based on the vendor's (Aquamag) recommended dosage of 8.75 gallons of product per million gallons, a cost of $9.00 per gallon (plus freight) and an estimated flow of 1MGD, the cost of polyphosphate treatment would be:

8.75 gal. X $9.00/gal. X 1.0 MGD = $78.75 per day

$78.75/day X 365 days/year = $28743.75 per year = $28,750.00

Equipment purchases required to implement treatment would be:

2 – Chemical Metering Pumps @ $359.59 ea =		$ 720.00
1 – In-line Static Mixer		$ 2,514.00
1 – Injector Corporation Stop		$ 286.00
Labor to Install Pumps and Mixer		$ 650.00
Miscellaneous Small Parts		$ 100.00
	TOTAL	$ 4,270.00
Chemical Cost (annual)		$28,750.00
	Total annual cost	**$33020.00**

CONCLUSSION

Treatment with polyphosphates is the best long-range solution to the CaCO3 precipitation problem being experienced at Vestal Well 1-1. Treatment with polyphosphates would increase the total PO4 (as P) in the effluent being discharged into the Susquehanna River. The NYSDEC has been contacted and the discharge of PO4 into the receiving body of water has been discussed. No formal response to this situation has been received from NYSDEC.

Due to the report completion deadline of February 1, 2003 imposed by Foster-Wheeler, a final conclusion cannot be determined. When the response from the NYSDEC is received, an addendum with a final conclusion will be provided.

ENVIRONMENTAL
390 N. Pennsylvania Ave.
S. Waverly, PA 18840-2826
Phone (570) 888-0169
FAX (570) 888-0717

ELS Ltd
Eastern Laboratory Services Ltd
quality ■ accuracy ■ reliability

Certificate of Analysis

Shimer, Dennis	Project: Vestal Well 1-1	
2316 Acorn Drive	Project No: [none]	**Reported:**
Vestal NY, 13850	Project Manager: Dennis Shimer	11/20/02 16:50

Raw
2K15071-01 (Ground Water)

Date Sampled: 11/15/02 12:40
Date Received: 11/15/02 16:17

Analyte	Result	MCL	Units	Prepared	Analyzed	Method	Analyst	Notes
Field Analyses								
Carbon dioxide, free	30	0	mg/l	11/15/02 12:40	11/15/02 12:40	CO2 field	fld	
Conventional Chemistry Parameters by APHA/EPA Methods								
Alkalinity as CaCO3	248	0	mg/l	11/15/02 00:00	11/15/02 00:00	SM18-2320B	EF	
Calcium	130	0	mg/l	11/18/02 00:00	11/18/02 00:00	EPA 215.2	CEH	
Corrosivity	-0.19	0	SI	11/20/02 16:43	11/20/02 16:43	Calculation	BH	Corr.
pH	7.23	0	pH Uni	11/15/02 17:04	11/15/02 17:04	EPA 150.1	EF	
Total Dissolved Solids	502	0	mg/l	11/18/02 00:00	11/18/02 00:00	EPA 160.1	EF	
Total Hardness as CaCO3	342	0	mg/l	11/20/02 00:00	11/20/02 00:00	EPA 130.2	RN	

Corr. = For corrosivity a slight positive number usually indicates a non-corrosive condition, while a negative number tends toward corrosion.

Finished
2K15071-02 (Ground Water)

Date Sampled: 11/15/02 12:30
Date Received: 11/15/02 16:17

Analyte	Result	MCL	Units	Prepared	Analyzed	Method	Analyst	Notes
Field Analyses								
Carbon dioxide, free	10	0	mg/l	11/15/02 12:30	11/15/02 12:30	CO2 field	fld	
Conventional Chemistry Parameters by APHA/EPA Methods								
Alkalinity as CaCO3	237	0	mg/l	11/15/02 00:00	11/15/02 00:00	SM18-2320B	EF	
Calcium	95	0	mg/l	11/18/02 00:00	11/18/02 00:00	EPA 215.2	CEH	
Corrosivity	0.12	0	SI	11/20/02 16:43	11/20/02 16:43	Calculation	BH	Corr.
pH	7.69	0	pH Uni	11/15/02 17:05	11/15/02 17:05	EPA 150.1	EF	
Total Dissolved Solids	500	0	mg/l	11/18/02 00:00	11/18/02 00:00	EPA 160.1	EF	
Total Hardness as CaCO3	336	0	mg/l	11/20/02 00:00	11/20/02 00:00	EPA 130.2	RN	

Corr. = For corrosivity a slight positive number usually indicates a non-corrosive condition, while a negative number tends toward corrosion.

Eastern Laboratory Services, Ltd.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Barbara Hohman

Reviewed by Barbara Hohman, QA Manager

PA 08380 NY 11216

CHAIN OF CUSTODY

Eastern Laboratory Services, Ltd.
390 N. Pennsylvania Avenue • S. Waverly, PA 18840
Phone: (570) 888-0169

PAGE _____ OF _____

REPORT TO: Dennis Shimer

CONTACT

PH. #

FAX #

BILL TO:

PO#

PROJECT DESCRIPTION

SAMPLER SIGNATURE / AFFILIATION

REFRIGERATE SAMPLES AFTER COLLECTION.

TRANSPORT TO LABORATORY IN COOLER WITH ICE

DW DRINKING WATER · GW GROUND WATER · SW SURFCE WATER · WW WASTE WATER · SL SLUDGE · SO SOIL · HZ HAZARDOUS · OTHER

RESULTS ARE BEING USED FOR: NYDOH NYDEC PADEP LANDFILL _____ PERSONAL OTHER _____

ARE SPECIAL DETECTION LIMITS NEEDED: YES NO
IF YES PLEASE ATTACH
IS A QC PACKAGE NEEDED? YES NO
IF YES PLEASE ATTACH REQUIREMENTS

P PLASTIC · G CLEAR GLASS · AG AMBER GLASS

H HYDROCHLORIC ACID · S SULFURIC ACID · N NITRIC ACID · SO_3 SODUIM SULFITE · Thio SODIUM THIOSULFATE · OH SODIUM HYDROXIDE · AS ASCORBIC ACID · AC ACETIC ACID · NH_4 AMMONIUM CHLORIDE · ZN ZINC ACETATE · Hg MERCURIC CHLORIDE

Please fill out all applicable areas completely

#	CONTAINER / SAMPLING POINT	DATE SAMPLED	TIME OF SAMPLING	SAMPLE MATRIX	SAMPLE TYPE - GRAB / COMPOSITE	SAMPLER (INITIALS)	CONTAINER TYPE	CONTAINER SIZE	PRESERVATIVE	ANALYSIS TO BE PERFORMED (PER CONTAINER)	PRESERVATIVE ADDED ON RECEIPT
1	vestal well 1-1 Raw	11/15	1240	GW	G	KTE				pH, TDS, Ca, Corrosivity	
2	↓	↓	↓	↓	↓	↓				Alkalinity	
3	↓	↓	↓	↓	↓	↓				Hardness CO_2 = 30 mg/l	
4	vestal well 1-1 Finished		1230							pH, TDS, Ca, Corrosivity	
5	↓	↓	↓	↓	↓	↓				Alkalinity	
6	↓	↓	↓	↓	↓	↓				Hardness CO_2 = 10 mg/l	
7											
8											
9											
10										Due 12/3/02	

ELS USE ONLY: DELIVERED BY: KTE · 1. SAMPLES WERE: SHIPPED / HAND DELIVERED · 4. PROPERLY PRESERVED (Y) N · 7. TRIP BLANKS Y N
TEMPERATURE UPON RECEIPT: 3°C · 2. CONTAINERS INTACT (Y) N · 5. WITHIN HOLDING TIMES (Y) N
3. COC COMPLETE (Y) N · 6. LABELS MATCH COC (Y) N

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
[signature]	11/15/02	1535		/ /	
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:

WATER SOLUTIONS

Water Quality Consultants

January 24, 2003

Aguilar Environmental
c/o Mr. Dennis Shimer
2316 Acorn Drive
Vestal, NY 13850

Dear Dennis,

Thanks again for your consideration of our services.

As discussed, I have taken the water quality you provided along with the expected flow rate of the site to be treated for keeping iron and manganese in solution.

Enclosed are my recommendations.

If you have questions or require additional information, please call me.

Sincerely,

WATER SOLUTIONS CO.

William T. Cornish
President

WTC/jl

Enclosures

P.O. Box 208
Mattapoisett, MA 02739
508 758-6126
FAX: 508 758-6128

Northeast distributor of Aqua Mag

AQUA-MAG TREATMENT PROPOSAL FOR VESTAL WELL 1-1 VESTAL, NEW YORK

AQUA-MAG DOSAGE:	1.9mg/L
AQUA-MAG USAGE:	8.75 gallons Aqua-Mag per million gallons of water pumped
AQUA-MAG PRICING:	5 or more 55-gallon drums $9.00 per gallon* Bulk of 500-gallons or more $8.10 per gallon

*All orders F.O.B. Peru, IL

WTC/jl

WATER SOLUTIONS

Water Quality Consultants

PARTIAL LIST OF AQUA-MAG USERS FOR PRETREATMENT OF AIR STRIPPING TOWERS

CDM Federal Programs Corp.
120 Marcus Boulevard
Deer Park, NY 11729
Contact: Kenn Roberts
Tel. No.: (631) 254-2040

Clean Harbors Environmental Services
1501 Washington St., P.O. Box 859048
Braintree, MA 02185
Contact: Jack Maserejian
Tel. No.: (781) 849-1800 x-8144

Geologic Services Corporation
360 West Main Street
Evans City, PA 16033
Contact: Barbara Jordan
Tel. No.: (412) 538-8798

Gowanda Electronics Corp.
One Magnetics Parkway
Gowanda, NY 14070
Contact: Mel J. LeBar
Tel. No.: (716) 532-2234

Hydro Group
97 Chimney Roack Road
Bridgewater, NJ 08807
Tel. No.: (201) 563-1400

Northeast Environmental Products
17 Technology Drive
West Lebanon, NH 03784
Tel. No.: (603) 298-7061

Tuscan Dairy Farms, Inc.
750 Union Avenue
Union, NJ 07083
Contact: Bob Epler
Tel. No.: 908-851-5372

Washington Gas (E. Station Site)
1240 12th Street, S.E.
Washington, D.C. 20003
Contact: Kris Murthy
Tel. No.: (202) 624-9063

P.O. Box 208
Mattapoisett, MA 02739
508 758-6126
FAX: 508 758-6128
Northeast distributor of Aqua Mag

WATER SOLUTIONS

Water Quality Consultants

P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

Aqua Mag

Aqua Mag is a water treatment additive designed to control corrosion of metallic piping in water distribution systems and sequester trace levels of dissolved minerals in water supplies. Manufactured as a liquid concentrate of inorganic phosphates through a process technology of thermal reactions, Aqua Mag is a product of superior purity, stability, and performance. It is fully certified by the ANSI/NSF Standard #60, the USDA, the USEPA, and is produced in a food grade FDA inspected facility using statistical process control (SPC) to guarantee the highest level of product quality and purity. To protect our nation's most valuable asset of public drinking water, Aqua Mag provides the following features:

- Lead and Copper corrosion control and compliance
- Biofilm penetration for enhanced disinfection
- Improved chlorine residuals through mineral sequestration
- Gradual removal of scale and tuberculation
- Calcium scale control and protective film formation
- Stain and color control by sequestering iron and manganese
- Cost savings in operational and maintenance expense

Applications

Aqua Mag dosage rates are determined by water quality advisors based on current water analysis, field observations, and computer modeling reports. Aqua Mag is easily dispensed directly from the shipping container and injected into the water flow with a standard chemical metering pump. No mixing or transfer is necessary, saving additional time and labor expense. For additional details call Water Solutions at (508) 758-6126.

Shipping•Handling•Storage

Aqua Mag is available nationwide in all container sizes from the manufacturing facility, convenient warehousing, or bulk terminals. Water Solutions is the authorized chemical distributor for the Northeast region. Refer to the Material Safety Data Sheet (MSDS) for safety and handling requirements. Store the product in a clean, dry area protected from freezing and extreme heat.

Properties

- ANSI/NSF #60 Compliance
- Extended shelf life
- Totally soluble in any dilution
- Freeze/thaw stable
- 11.4 pounds per gallon
- pH (1% solution) - 6.5
- Contains no zinc
- 100% Made in U.S.A.

Northeast Distributor of Aqua Mag

WATER SOLUTIONS

Water Quality Consultants

P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

Aqua Mag

BLENDED ORTHO/POLYPHOSPHATE

Aqua Mag is not a cyclic chain phosphate such as tripolyphosphate and hexametaphosphate, but an extremely stable linear chain concentrate. It is a clear liquid with a density of 11.4 pounds/gallon, a pH of 6.5 in a 1% solution, and requires no mixing. This uniqueness makes it cost competitive to any powders or liquids available.

Aqua Mag is a major breakthrough in the water treatment industry. It is specifically designed to sequester (tie up) soluble iron, manganese, calcium, magnesium and silica even under high temperature operations. It also has the ability to dissolve existing scale and iron deposits, eliminating food for bacterial growth and dropping culture counts to nil.

Aqua Mag completely inhibits corrosion caused by electrolysis and dissolved oxygen by forming a microscopic film on the surface of all metals.

Aqua Mag has been on the market for over 20 years and has the federal and state approvals for potable water up to 10 ppm. Although in use, only 1/2 to 1 ppm is required.

Aqua Mag has a shelf life of at least twelve years and, unlike other phosphate treatments, will not revert or decompose. It may be mixed with water or fed directly for either surface or ground water.

Aqua Mag is a formulated product intended for treating municipal, industrial and private water systems where the requirements of potability must be met.

Aqua Mag provides four distinct actions: First, control of red waters; second, cleaning action to remove rust and scale deposits from pipes and distribution systems; third, protection against corrosion and pitting; and fourth, inhibition of scale formation.

Aqua Mag contains only linear chain phosphates. The use of such linear chain phosphate is the first major advance in the treatment technique for potable water systems offering benefits never before satisfactorily realized with glassy phosphate types normally used for this purpose.

Aqua Mag dosage and usage rates are determined based on current water quality data and water production rates. Please contact Water Solutions at the number above and one of our water quality advisors will assist in providing further information on Aqua Mag and/or discuss recommendations and pricing for a specific application.

Northeast Distributor of Aqua Mag

WATER SOLUTIONS

Water Quality Consultants

GUIDELINES FOR DETERMINING THE EFFECTIVENESS OF A PHOSPHATE TREATMENT PROGRAM

The following guidelines are of extreme importance and consideration when determining the degree of effectiveness of a phosphate treatment:

1. Observe closely the product's ability to meet the objectives set forth, along with any additional benefits seen as the result of its use. A successful phosphate program will deliver results.

2. Monitor the program to assure consistent PO4 residuals throughout the distribution system (a clear indicator of the product's stability). A stable phosphate assures that what you feed at the source(s) is being carried throughout the distribution system, all the way to the customer's tap. Beware of increased PO4 residuals throughout the distribution system, since this is a clear sign of a failed phosphate program (signals breakdown of the phosphate in the distribution system).

3. Monitor chlorine residuals. An unstable phosphate breaks down in the distribution system and results in increased chlorine demands since the precipitated phosphate acts as nutrient for bacteria.

4. Observe the product's physical characteristics. Assure that the phosphate is not breaking down in its container (i.e. check the bottom of the container to make sure that no sludge accumulation is present). A phosphate of premium quality, purity and stability will not precipitate out of solution. A phosphate that does break down in the container illustrates its unstable nature and requires a higher use or higher percentage of active phosphate to do the job.

5. Track the use cost. Less expensive products normally require a much higher usage to be able to do the same job that a more expensive product can do by using much less. Price per gallon or pound is relative to how many gallons or pounds are required to achieve the proposed goals. Assure yourself that you are ultimately not using much more phosphate than originally proposed. Often a more concentrated (active) phosphate is more costly in terms of price per gallon or pound, but requires a much lower usage to meet your objectives, and thus costs less in the long run.

6. Require a Certificate of Analysis with all deliveries to insure quality and consistency of your product.

7. Require your supplier to make ongoing recommendations based on their monitoring of your source(s) and distribution system, as phosphate treatment requires adjustment even with the slightest water quality changes.

P.O. Box 208
Mattapoisett, MA 02739
508 758-6126
FAX: 508 758-6128

Northeast distributor of Aqua Mag

WATER SOLUTIONS
Water Quality Consultants
P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

Aqua Mag
PHYSICAL CHARACTERISTICS

Appearance/Color	Clear and homogeneous liquid
Shelf Life (Neat)	> 2 years (12 years established)
Solubility/Stability	Totally soluble and freeze/thaw stable
pH (1% Solution)	6.5
pH (Neat)	5.2 +/- 0.5
Weight	11.4 pounds per gallon
Viscosity	1.008 centipoise at 70° F
Boiling Point	> 212° F
Freezing Point	<37° F
Specific Gravity	1.367 +/- 0.01
% Total Phosphate	34.5 +/- 1.0 as PO_4
% Ortho/% Polyphosphate Ratio	30/70

Northeast Distributor of Aqua Mag

WATER SOLUTIONS

Water Quality Consultants

P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

Aqua Mag

10 WAYS TO BETTER WATER QUALITY

1. *CORROSION CONTROL:* Aqua Mag inhibits corrosion of steel distribution system water lines, iron and galvanized piping, domestic lead and copper plumbing, and brass faucet fixtures by complexing to form a microscopic film on the inside of these metallic surfaces.

2. *IRON & MANGANESE CONTROL:* Aqua Mag sequesters minerals and light metals to reduce discoloration, staining and mineral buildup throughout the water system.

3. *CALCIUM SCALE CONTROL:* Aqua Mag inhibits excessive calcium and magnesium carbonate scale from hard water supplies while promoting a protective film type scale in corrosive low hardness water qualities. Excess calcium scale deposits are typically seen in hot water lines and heaters.

4. *BIOFILM REDUCTION:* Aqua Mag enhances disinfectant penetration into biofilm contamination, tuberculation, and scale formation inside water pipes.

5. *CHLORINE SAVINGS:* Aqua Mag sequesters chlorine consuming minerals and slows the deposition of scale by-products to improve available chlorine residuals and system disinfection.

6. *PRETREATMENT AID:* Aqua Mag's unique molecular structure performs as a secondary coagulant aid to improve sedimentation rates and particle formation prior to filtration. The residual effect after coagulation will aid filtration capacity and backwash efficiency.

7. *CATALYZE H_2S REMOVAL:* Aqua Mag expedites the oxidation process to remove annoying odors and the rotten-egg smell from hydrogen sulfide present in many ground water supplies. Aqua Mag's residual effect controls the potential sulfide odor from redeveloping in residential hot water heaters.

8. *SAVE MONEY:* Aqua Mag provides the highest rate of return on investment (ROI) for money spent on any operational and maintenance chemical in the water plant. Savings from reduced corrosion and scale, less chlorine demand, fewer failures and leaks, less hydrant flushing and fewer consumer complaints will average $10 savings for every $1 spent on Aqua Mag.

9. *FOOD GRADE PRODUCT:* Aqua Mag is fully certified by the ANSI/NSF Standard #60, the USDA, and the USEPA. It is produced in a food grade FDA inspected facility using statistical process control (SPC) to guarantee the highest level of product quality and purity. Aqua Mag is 100% made in the U.S.A.

10. *TECHNICAL SERVICE:* Aqua Mag dosage rates, water analysis, on-site inspection, and professional consultation are available from Water Solutions, the Northeast region distributor of Aqua Mag.

Northeast Distributor of Aqua Mag

AQUA MAG?

MATERIAL SAFETY DATA SHEET

Information: 815-223-1500 **Emergency: 800-435-6856** **CHEMTREC: 800-424-9300**

I. IDENTIFICATION

PRODUCT NAME:	Aqua Mag ?	**REVISION DATE:** 05/30/01			
CHEMICAL NAME:	Sodium Ortho/Polyphosphate	**FORMULA:** Proprietary			
SYNONYMS:	Blended Phosphates	**PACKING GROUP:** NA			
D.O.T. HAZARD CLASS:	Non-Hazardous	**UN NO.**	NA	**CAS NO.**	NA
D.O.T. SHIPPING NAME:	Not Regulated			**CAS NAME**	NA

II. PHYSICAL DATA

PHYSICAL STATE: Clear liquid	**SPECIFIC GRAVITY:** 1.37	**pH:** 5.2
BOILING POINT, °C: > 100?C (212? F)	**SOLUBILITY IN WATER:** Soluble in all proportions.	
FREEZING POINT, ?C: < 3?C (38? F)	**VOLATILES VOLUME %:** NA	
VAPOR PRESSURE AT 20°c. Mm Hg: NA	**EVAPORATION RATE:** NA	

III. HAZARDOUS COMPONENTS GREATER THAN 1%

MATERIAL	PEL	TLV	CAS.NO.	%
Monosodium Phosphate	No Data	No Data	7758-80-7	> 1%
Sodium Acid Pyrophosphate	No Data	No Data	7758-16-9	> 1%
Non Hazardous Components	*****	*****	*****	Balance
This product contains no toxic chemicals subject to the reporting requirements of Section 313 – Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.				
CARCINOGENICITY: Not listed by NTP, IARC, or OSHA				

IV. FIRE AND EXPLOSIVE HAZARD DATA

FLAMMABILITY:	Non-flammable
NORMAL EXTINGUISHING AGENT:	Suitable for surrounding materials.
SPECIAL FIRE FIGHTING PROCEDURES:	Not Applicable
USUAL FIRE AND EXPLOSION HAZARDS:	None known

V. REACTIVITY DATA

STABILITY:	Stable	**CONDITIONS TO AVOID:**	Heat
INCOMPATIBILITY (materials to avoid):	Chlorine and mineral acids		
HAZARDOUS COMBUSTION / DECOMPOSITION PRODUCTS:	May liberate oxides of sodium or phosphorus if involved in fire.		

Responsible Care®
Good Chemistry at Work

CARUS CHEMICAL MUNICIPAL

DIVISION OF CARUS CORPORATION

VI. HEALTH HAZARD DATA

ACUTE EFFECTS OF EXPOSURE	
INGESTION:	May cause irritation to mouth and throat, or nausea and vomiting.
SKIN CONTACT:	May cause skin irritation.
INHALATION:	May cause irritation to the respiratory tract.
EYE CONTACT:	May cause eye injury.
CHRONIC EFFECTS OF EXPOSURE:	No specific information.
OTHER HEALTH DATA:	No specific information. Maximum use level per NSF Standard 60: 23mg/L

EMERGENCY AND FIRST AID PROCEDURES	
INGESTION:	Burning of mouth area may be reduced or eliminated through continued rinsing with water. Do not induce vomiting. Drink large quantities of water. Consult a physician.
SKIN :	Flush exposed area with water. Rinse thoroughly. Consult a physician.
INHALATION:	Remove to fresh air. Consult a physician.
EYES:	Flush eyes with copious amounts of water for at least 15 minutes. Consult a physician.

VII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:	Contain all spills and dispose of properly. Flush area with large amounts of water.
WASTE DISPOSAL METHOD:	Disposal of all materials shall be in full and strict compliance with all federal, state, and local regulations pertaining to phosphates.

VIII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:	Approved NIOSH/MSHA mist respirator.		
PROTECTIVE GLOVES:	Chemical resistant	**EYE PROTECTION:**	Chemical safety goggles
VENTILATION	Well ventilated area	**SPECIAL EQUIPMENT:**	Impervious apron, eyewash fountain, safety shower

IX. SPECIAL PRECAUTIONS

HANDLING AND STORAGE:	Store in cool, dry place. Protect container from physical damage and freezing.
OTHER:	None known

CARUS

Division of Carus Corporation
315 Fifth Street
PO Box 599
Peru, IL 61354
Tel (815) 223-1500
Fax (815) 224-6697

CALCIQUEST®

Specialist in
Water Treatment

181 Woodlawn Ave.
Belmont, NC
28012

704-822-1441
Fax: 704-822-0922

Monday, January 13, 2003

Eastern Laboratories
Attn: Mr. Dennis Shimer
1017 Conklin Road
Conklin, NY 13748

Dear Mr. Shimer:

CalciQuest, Inc. would like to offer our two products delivered to you at the following pricing:

12 ppm	CalciQuest Liquid Plus -	$8.00 per gallon (30 gallon drums) $10.00 per gallon (5 gallon pails)
8 ppm (Phosphonate)	CalciQuest Tan -	$12.00 per gallon (30 gallon drums) $15.00 per gallon (5 gallon pails)

Please see the attached information on both products. Please call me if you have any additional questions at 800-929-6789.

Thank you,

C. P.

Craig Principi
National Sales Manager

PRODUCT DATA SHEET

PRODUCT: **CalciQuest-Liquid Plus**

BENEFIT Organic and inorganic polyphosphate content sequesters high levels or calcium, iron and manganese over a broad temperature and ph range. Orthophosphate content forms a film on metals to reduce corrosion.

PHYSICAL DESCRIPTION: Slight amber liquid with no foreign odor.

MAXIMUM USE LEVEL: 27.7 mg/l

TYPICAL VALUES: Based on materials tested in our laboratories.

Specific Gravity @ 25 degrees C/15.5 degrees C	1.38
Active Content	42%
Polyphosphate Content (as PO4)	24.3%
Organic Phosphate	10%
Orthophosphate Content (as P04)	8.1%
Lbs. per gallon	11.8

PACKAGING: 5, 15, 30 and 55 gallon drums and 4000 gallon tanker truck loads.

CERTIFICATIONS: Certified by the National Sanitation Foundation to conform to ANSI/NSF Standard 60.

State approvals available upon request.

181 Woodlawn Ave. - Belmont, NC - 28208 Tel: 704-822-1441 Fax:704-822-0922
www.calciquest.com

MATERIAL SAFETY DATA SHEET

GENERAL INFORMATION

TRADE NAME:	**CalciQuest Liquid Plus**
CAS NUMBER:	N/A - Blend
CHEMICAL NAME:	Stabilized Blend of Long Chain Phosphates
FORMULA:	Proprietary
ADDRESS:	181 Woodlawn Avenue Belmont, NC 28012
CONTACT:	John C. Walsh
PHONE:	1-800-929-6789
ISSUED DATE:	12/3/86
REVISED DATE:	5/1/99

FIRST AID MEASURES

Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposure and removal of the material from eyes, skin and clothing.

HAZARDS INFORMATION

Health

Inhalation:	No known risk of overexposure.
Ingestion:	Ingestion of CalciQuest Liquid Plus Liquid Plus may cause nausea. Ingestion of CalciQuest Liquid Plus as recommended in potable water presents no known risk of overexposure.
Skin:	Possible irritation of exposed tissue due to individual sensitivity.
Eyes:	Possible irritation to eyes if exposed to CalciQuest Liquid Plus due to individual sensitivity.

Fire and explosion

Flash Point:	None
Auto Ignition Temperature:	None
Flammable limits:	N/A
Unusual fire and explosion hazards:	NONE

PRECAUTIONS & PROCEDURES

Fire extinguishing agents recommended: This product is an aqueous solution. Even after the water boils off, the byproducts present minimal hazards.

Fire extinguishing agents to avoid: N/A

Special fire fighting precautions: None.

Ventilation: Standard general ventilation is sufficient.

Normal handling: To avoid individual sensitivity to material, wear gloves and protective clothing when handling.

Storage: Store in a cool, dry place. Keep container tightly closed during transport and storage.

Spill or Leak: CalciQuest Liquid Plus is not a hazardous waste. Mop up spill and pour waste solution down the drain.

Special Precautions/Procedures/Label Instructions: None

PERSONAL PROTECTIVE EQUIPMENT

Wear gloves and protective clothing to protect against individual sensitivities to CalciQuest Liquid Plus.

PHYSICAL DATA

Material is: (At normal conditions):	Liquid
Appearance & Odor:	Clear to slight haze - no odor.
Specific Gravity:	1.355
Boiling Point:	220 degrees Fahrenheit
Vapor Density:	N/A
Solubility in water:	100%
pH:	6.0 +/- 0.3

REACTIVITY DATA

Stability:	Stable
Conditions to avoid:	None
Incompatibility (materials to avoid):	None
Hazardous decomposition products:	None
Hazardous polymerization:	Will not occur
Conditions to avoid:	Not established

HAZARDOUS INGREDIENTS (MIXTURES ONLY)

None

ENVIRONMENTAL

No phosphate component of CalciQuest Liquid Plus has tested worse than:

96-hour LC 50 Bluegill: 6500 ppm practically non-toxic

96-hour LC50 Trout: 3200 ppm practically non-toxic

EPA hazardous? *No*

Waste Disposal methods: *Sanitary Sewer*

RCRA status: *Not Hazardous*

REFERENCES

Registry of Toxic Effects of Chemical Substances, National Institute of Occupational Safety and Health

Merck Index, Tenth Edition

ADDITIONAL INFORMATION

None

Albright & Wilson Americas

BRIQUEST® Phosphonates For Potable Water Application

Benefits of Phosphonates as Drinking Water Additives for Scale/Corrosion Control

- ✓ Hydrolytically stable - no reversion to orthophosphate, i.e. at low pH
- ✓ Suitable for chlorinated systems
- ✓ Provides scale control at very low dosage (<<10 ppm)
- ✓ Provides excellent metal ion control - Fe, Mn, … to > 1.0 prevent red/black water
- ✓ Highly efficient sequestrant - superior to long chain or blended phosphate chemistry
- ✓ Compatible with other additives, i.e. polyphosphate
- ✓ Synergistic corrosion inhibition achieved with other materials (i.e. Zn-HEDP based products well known for corrosion control in cooling water)

ALBRIGHT & WILSON Americas PRODUCT DATA SHEET	BRIQUEST® ADPA-60AW (HEDP)

DESCRIPTION	An aqueous solution of acetodiphosphonic acid (ADPA), a multifunctional phosphonate also known as 1-hydroxyethylidene-1, 1-diphosphonic acid (HEDP). Widely used in the water treatment industry for scale and corrosion inhibition, detergent action and metal ion control.
PACKAGES	Plastic Drum, 650 lbs.; Bulk.
SHIPPING	Corrosive Liquid, NOS U.N. 1760, Class 8, Packing Group III
SAFETY STORAGE & HANDLING	Store in a cool, dry location away from strong oxidizers and strong alkalies. Keep container tightly closed. When handling, wear goggles, acid-proof coveralls, and impervious gloves and boots. **NOTE:** The Material Safety Data Sheet for this product must be reviewed by all personnel who handle or come into contact with it. This information may be obtained by calling Albright & Wilson Americas (804) 550-4300.
GENERAL PROPERTIES & APPLICATIONS	Threshold Scale Inhibition: Less than stoichiometric quantities are required to prevent precipitation of a variety of inorganic salts. Crystal Growth Modification: Retards or halts crystal growth rates by blocking active growth sites. Incorporation of the ADPA molecule into the crystal results in a radically-altered crystal morphology, and therefore, a lower degree of scaling. Sequestration: Both phosphonic acid groups are "bis" functional. Under typical conditions, proton dissociation will yield tetrahedral anions. Metal cations may become associated with these groups, making ADPA a sequestrant of intermediate strength. Hydrolytic and Chlorine Stability: BRIQUEST® ADPA-60AW, like other phosphonates, is more hydrolytically stable than polyphosphates, which revert to orthophosphate in aqueous solution and may promote calcium phosphate scale formation in water treatment systems. It is also relatively chlorine-stable, unlike nitrogen-containing phosphonates. This allows for the concurrent use of moderate levels of chlorine for biocide activity and ADPA for scale inhibition. Acidity: The four acidic protons of the molecule are released at progressively higher pH. The first two protons easily dissociate to make ADPA equivalent to a strong mineral acid, such as phosphoric acid. The third is not removed until pH 7 and the fourth dissociates at pH 12 or when it is replaced by a cation such as Ca^{2+} or Ba^{2+}. Scale and Corrosion Control: The largest use area is in scale inhibition and corrosion control, primarily in water treatment. Scale formation in water treatment applications can significantly reduce heat transfer efficiencies and can lead to extensive and costly downtime. It is highly effective in inhibiting scale formation, primarily $CaCO_3$, via the threshold effect and crystal growth modification. Corrosion Inhibition: Formulations have been developed using it in combination with both metallic and non-metallic inhibitors. Promotes an improved coating of metal ions on the surface to be protected and retards the breakdown of the protective coating itself when used with metallic inhibitors (i.e., zinc). Other Uses: I&I Compounding — sequestration (i.e., in acid cleaners); Swimming Pool Chemicals — stain removal and control; Photographic Chemicals — metal ion control in developing solutions; Cosmetics — metal ion control in bar soaps; Desalination — multistage flash (MSF) evaporator antiscalant.

ALBRIGHT & WILSON Americas

PRODUCT DATA SHEET

BRIQUEST® 543-45AS

DESCRIPTION	An aqueous solution of a partially neutralized organophosphonate known as diethylenetriaminepenta (methylenephosphonic acid) or DETPMP.
PACKAGES	Plastic Drum, 600 lbs.; Bulk.
SHIPPING	Not restricted.
SAFETY STORAGE & HANDLING	Store in a cool, dry location away from strong oxidizers and strong alkalies. Keep container tightly closed. When handling, wear goggles, acid-proof overalls and impervious gloves and boots. **NOTE:** The Material Safety Data Sheet for this product must be reviewed by all personnel who handle or come into contact with it. This information may be obtained by calling Albright & Wilson Americas (804) 550-4300.
GENERAL PROPERTIES & APPLICATIONS	Threshold Scale Inhibition: Less than stoichiometric quantities are required to prevent precipitation of a variety of inorganic salts. Crystal Growth Modification: Retards or prevents crystal growth through incorporation of its molecules into the crystal, where it radically alters the crystal morphology. Sequestration: Capable of sequestering a variety of common metallic cations. Since each of the five phosphonic groups is "bis" functional, under typical use conditions proton dissociation will create tetrahedral anionic groups which, in turn, associate with metal ions. Hydrolytic Stability: BRIQUEST® 543-45AS, like other phosphonates, is more hydrolytically stable than polyphosphates, which revert to orthophosphate in aqueous solution and may promote calcium phosphate scale formation in water treatment systems. Scale and Corrosion Control: The major use area is in scale inhibition and corrosion control in water treatment systems. While BRIQUEST® ADPA-60AW and BRIQUEST® 301-50A are effective in controlling "soft" scalants, BRIQUEST® 543-45AS is particularly effective in preventing "hard" scale formation. Calcium sulfate, found mainly in water treatment systems high in mineral content, and barium sulfate, a serious problem in the petroleum industry, form very hard and insoluble scale deposits that are difficult and expensive to remove. BRIQUEST® 543-45AS inhibits these species primarily via the threshold effect and crystal modification. It also acts synergistically in corrosion control formulations. It has been proven highly effective with both metallic and organic inhibitors. With zinc or molybdate, it produces an improved protective coating of metal ions, resists coating breakdown and reduces the dosage requirement. Secondary Oil Recovery and Desalination: In addition to superior scale inhibition for "hard" scalants, BRIQUEST® 543-45AS also exhibits two important characteristics desirable in secondary oil recovery and desalination operations. Firstly, it has a very high brine tolerance, so it will not be precipitated out of highly saline solution. Secondly, it displays excellent hydrolytic stability, demonstrating persistence under high temperature use conditions. **Other Uses**: Detergent Formulations — peroxygen bleach stabilization in package and wash cycle, water conditioning and scale inhibition; Pulp & Paper Processing — alkaline peroxide bleach stabilization via heavy metal (i.e., iron) sequestration and scale inhibition; Textile Processing — alkaline peroxide bleach stabilization and scale inhibition.

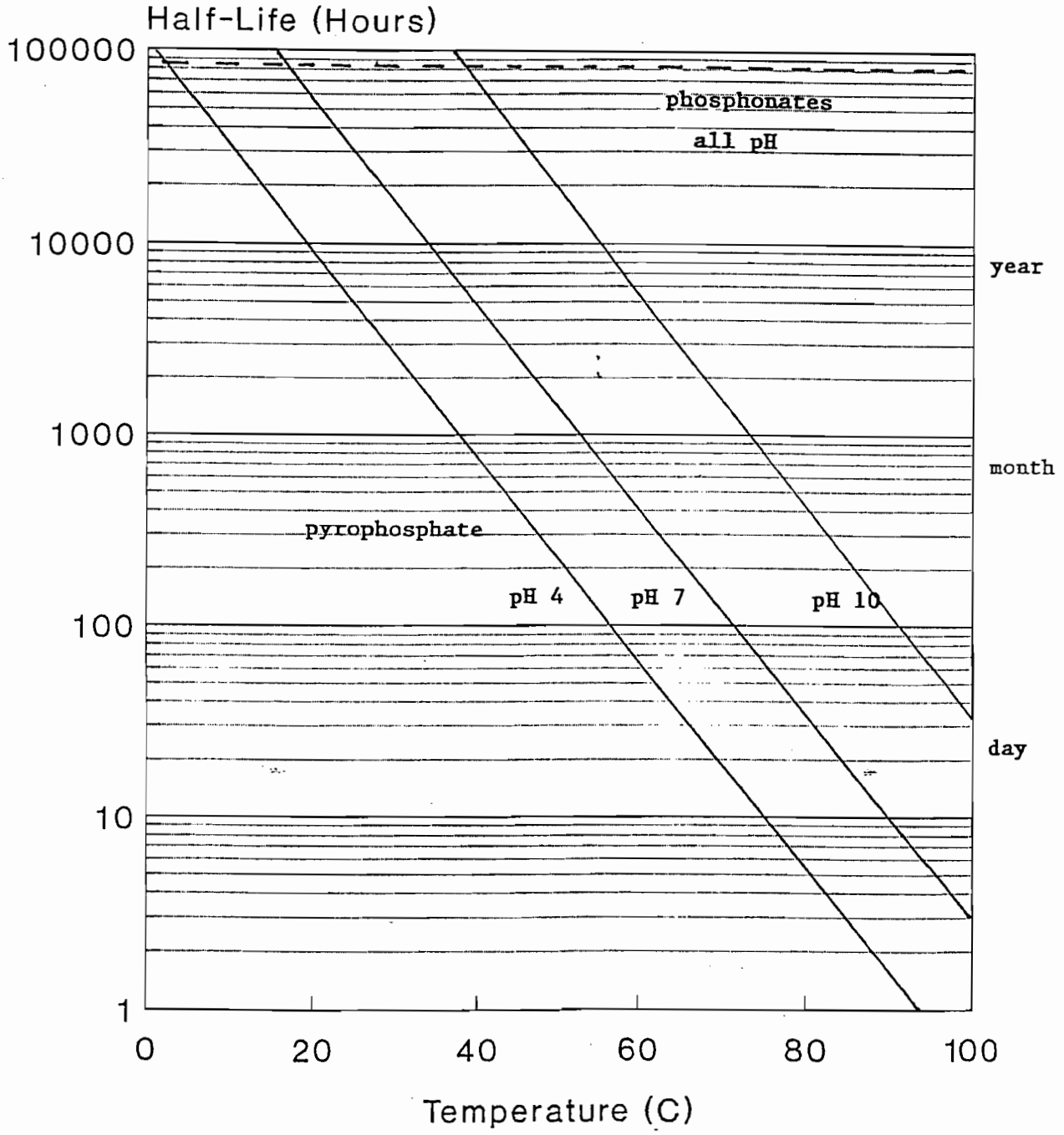
ALBRIGHT & WILSON Americas

BRIQUEST® 301-30SH

PRODUCT DATA SHEET

DESCRIPTION	An aqueous solution of the pentasodium salt of aminotris (methylenephosphonic acid) or ATMP, also known as nitrilotris (methylenephosphonic acid) or NTMP. Extensively used by compounders when it is more convenient to formulate with a neutralized form of ATMP.
PACKAGES	Plastic Drum, 600 lbs.; Bulk.
SHIPPING	Not restricted.
SAFETY STORAGE & HANDLING	When handling, wear goggles and impervious gloves and boots. **NOTE:** The Material Safety Data Sheet for this product must be reviewed by all personnel who handle or come into contact with it. This information may be obtained by calling Albright & Wilson Americas (804) 550-4300.
GENERAL PROPERTIES & APPLICATIONS	Threshold Scale Inhibition: Less than stoichiometric quantities are required to prevent precipitation of a variety of inorganic salts from supersaturated solutions. Crystal Growth Modification: Retards or prevents crystal growth by blocking active growth sites. Incorporation of the ATMP molecule into the crystal results in a radically altered crystal morphology, and, therefore, a lower degree of scaling. Sequestration: Capable of sequestering a variety of common metallic cations. Each of the phosphonic acid groups is "bis" functional and, under typical use conditions, proton dissociation will yield tetrahedral anions which, in turn, associate with metal ions. Hydrolytic Stability: BRIQUEST® 301-30SH, like other phosphonates, is more hydrolytically stable than polyphosphates, which revert to orthophosphate in aqueous solution and may promote calcium phosphate scale formation in water treatment systems. Scale and Corrosion Control: The major use area is in scale inhibition and corrosion control in industrial water systems. Scale formation impedes heat transfer and can lead to extensive and costly downtime. "Soft" calcium carbonate deposits, a result of the thermal instability of bicarbonate waters and the insolubility of this scalant species, is the most frequently encountered problem. Proven to be a highly cost-effective inhibitor for "soft" scales, functioning primarily via the threshold effect and crystal growth modification. Highly effective corrosion control formulations have been developed in conjunction with both metallic and non-metallic inhibitors. When used with metallic inhibitors like zinc, it provides an improved coating of metal ions on the surface to be protected, retards the breakdown of the protective coating itself, and permits lower metal ion levels. Other Uses: Bottlewashing – sequestration during wash stage, reduces spotting during rinse and downstream scale inhibition; Textile Processing – metal ion control during scouring, often in conjunction with TEA; I&I Compounding – water conditioning and scale inhibition in alkaline cleaners; Photographic Chemicals – metal ion control in developing solutions; Concrete Admixtures – set retarding properties.

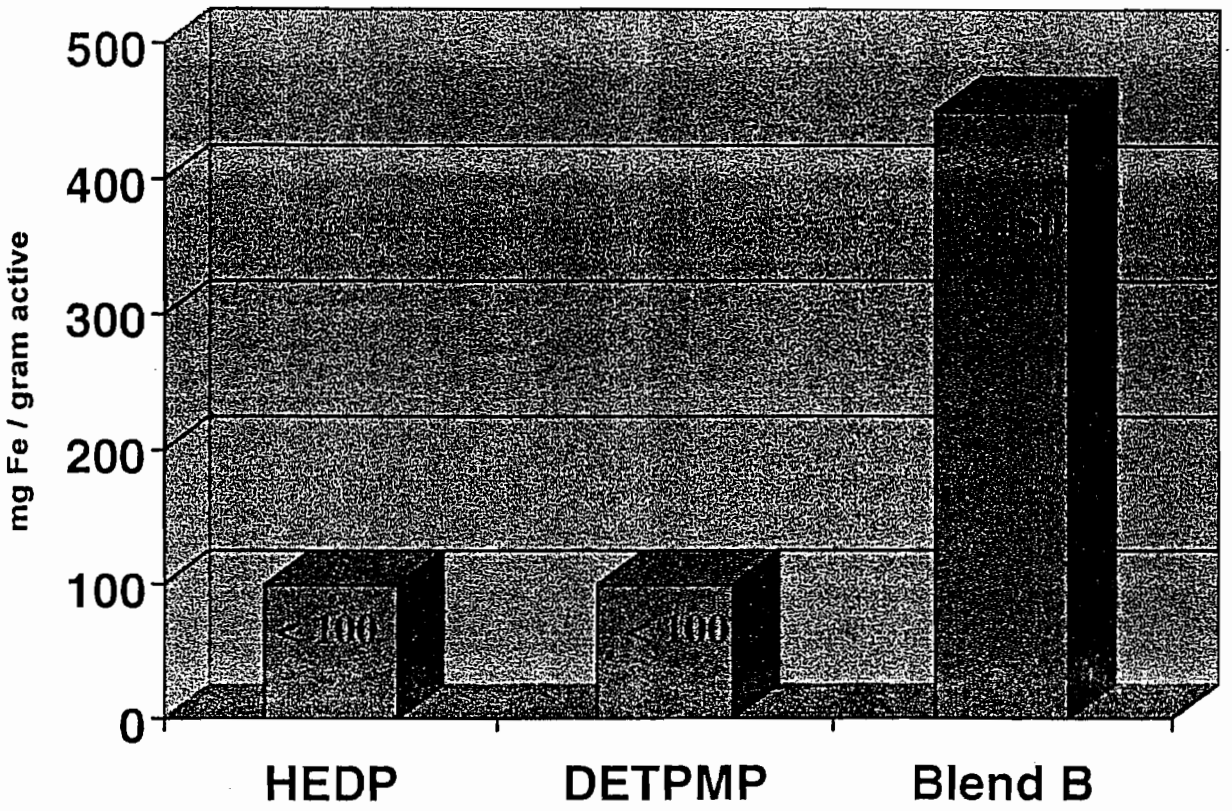
Hydrolytic Stability of Phosphonates
Compared to Pyrophosphate



Sequestrant	Chemical Composition	% Active	pH Sequestering Power[1] 9	10	11	12	pH Sequestering Power[2] 9	10	11	12
BRIQUEST ADPA-60AW	HEDP	60	500	535	550	540	830	880	910	895
BRIQUEST 301-50A	ATMP	50	300	365	415	445	600	730	830	890
BRIQUEST 543-45AS	DTPMP	45	405	450	485	490	900	1000	1075	1090
STP		100	225	250	250	255	225	250	250	255
EDTA		100	370	360	350	355	370	360	350	355
DTPA		100			310				310	
NTA		100			400				400	

1. Milligram $CaCO_3$ per gram of as is product
2. Milligram $CaCO_3$ per gram of product at 100% concentration

Iron Chelation



Determined by boiling inhibitor dosed solutions under reflux with Fe^{iii} added.

Optimizing Metal Ion Control
(i.e. Ca, Fe)

Try: BRIQUEST ADPA-60AW 3.5 mg/l

BRIQUEST 543-45AS 1.5 mg/l

in same formulation

Calcium Sequestration by Briquest Phosphonates

Run	ADPA HEDP	221 EBMP	422 EDTMP	543 DETPMP	684 (Hexa)	5123 BHMTPMP	Blend B	Blend G	PBTC	Bricorr 288
1	625	390	725	575	625	427	775	800	337	450
2	625	396	721	580	629	430	773	793	342	452

Drinking Water System Components,
Additives and Treatment Units

Drinking Water Products

Underwriters Laboratories Inc.®

Directory

www.ul.com/eph

ALBRIGHT & WILSON AMERICAS INC MH18679 (N)
4851 LAKE BROOK DR
GLEN ALLEN VA 23060

Trade Dsg	Category	Max Use
Briquest ADPA 60-AW	Corrosion and Scale Control	4.8 mg/L
Briquest 301-30SH	Corrosion and Scale Control	6.0 mg/L
Briquest 543-45AS ~~XX~~	Corrosion and Scale Control	10 mg/L

Manufacturer's instructions for application must be followed.

AMERICAN DEVELOPMENT CORP MH25259 (N)
1456 STATE CAMP RD
PO BOX 385
VANCEBORO NC 28586

Trade Dsg	Category	Max Use
Aqua Mag	Sequestering, Corrosion and Scale Control	30.2 mg/L
K-5	Sequestering, Corrosion and Scale Control	30.2 mg/L

AMERICAN INTERNATIONAL CHEMICAL INC MH18305 (N)
17 STRATHMORE RD
NATICK MA 01760

Trade Dsg	Category	Max Use
Copper Sulfate*	Algicide, Miscellaneous Treatment Applications	4 mg/L
AQUOX Brand Potassium Permanganate	Disinfection and Oxidation	50 mg/L

*This product is to be used according to the manufacturer's written instructions in drinking water treatment application. Monitoring of the final drinking water product should ensure that the level of copper does not exceed 1.3 mg/L.

AMERICAN WATER CHEMICALS INC MH19603 (N)
5912-F BRECKENRIDGE PKY
TAMPA FL 33610

Trade Dsg	Category	Max Use
A-132	Miscellaneous Water Supply Product	29 mg/L
A-132 Concentrate	Miscellaneous Water Supply Product	4.8 mg/L

How Can You Deal Effectively With Packing Fouling?

Jaeger Products, Inc.
Houston, Texas

Fouling and plugging of packings

Random and structured packings are used in gas/liquid mass transfer operations such as distillation, absorption, and stripping in order to provide available surface for mass transfer. The mechanisms for the generation of active surface are varied, but can be summarized into two: formation of films and rivulets, and formation of drops and drips. In both cases, the geometry of the system is such that the ratio of liquid volume to surface area is very small.

This small ratio maximizes mass transfer efficiency, but also promotes precipitation of insoluble compounds. A very common example is the precipitation of iron oxides onto plastic packing surfaces in air stripping units. These strippers are generally used to remove organic contaminants from source waters to acceptable limits. Oxygen from the air is simultaneously transferred into the water and this promotes the conversion of iron to oxidation states that are insoluble in water. These insoluble iron oxides precipitate out of the water and the crystals attach themselves to any available surface. As soon as a crystal attaches itself, it becomes a "seeding" site for other crystals to adhere and grow. A complicating factor is that the heavily aerated water is also an excellent medium for bacterial growth. Bacteria colonies in the water attach themselves to the packing and provide numerous sites for inorganic deposition and vice-versa. Some forms of bacteria will use the iron oxides as a nutrient.

Paradoxically, the high mass transfer efficiency provided by the packing promotes the deposition of the oxides and bacterial growth. Packings with high surfaces will be more efficient but would tend to promote fouling as well.

There is no magic cure for fouling. The composition of the water, the irrigation and aeration rates, and the operating temperature have much more to do with how rapidly a tower will foul than does the type of packing used. Figure 1 shows a conventional Pall ring that has fouled severely in an air stripping application. Pall rings are not considered among the "high efficiency" packings, but they plug nevertheless. It is interesting to note in Figure 2 how the trough distributor at the top of the same stripper shows severe iron fouling as well. In other words, even the low-surface trough plugged significantly. Presumably this happened because entrained liquid droplets adhered to the surface of the trough, evaporated, and deposited the iron.

Figure 3 shows a similar application where a structured plastic packing, with very high surface area, suffered severe plugging by iron oxide. It seems that the large surface availability was a hindrance more than an advantage in this application.

Figures 4 and 5 show pieces of a supposedly "non-fouling" plastic random packing that are actually severely fouled. These pieces came out of an air stripping unit in an area with high iron water.

All packings foul and one can be sure that the solution to a fouling problem can be found in good maintenance practices, good monitoring of process conditions, and good overall process design. Severely fouled packed beds are inefficient and cause high pressure drop. They can also be very dangerous since support plates are generally not designed to handle the weight of packing heavily laden with inorganic salts.

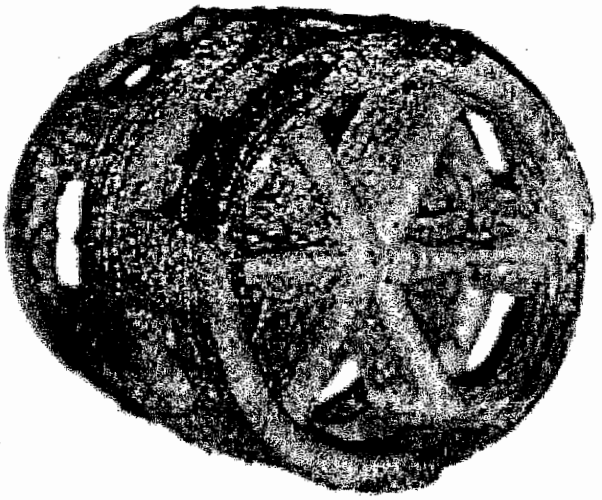


Figure 1. Plastic Pall ring fouled with iron precipitate from a groundwater stripper.

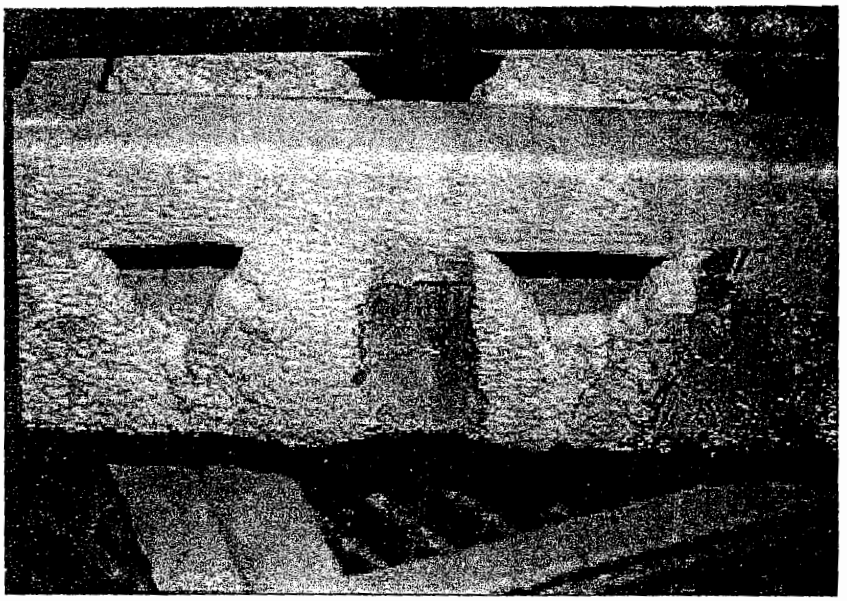


Figure 2. Fouling on trough distributor of an air stripper. Pour points can be severely plugged.

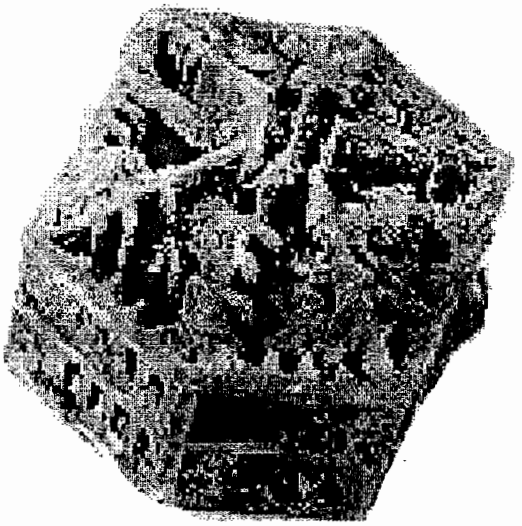


Figure 4. Modern plastic packing severely with iron deposits. This plastic packing is said to be "non-fouling" by the supplier.

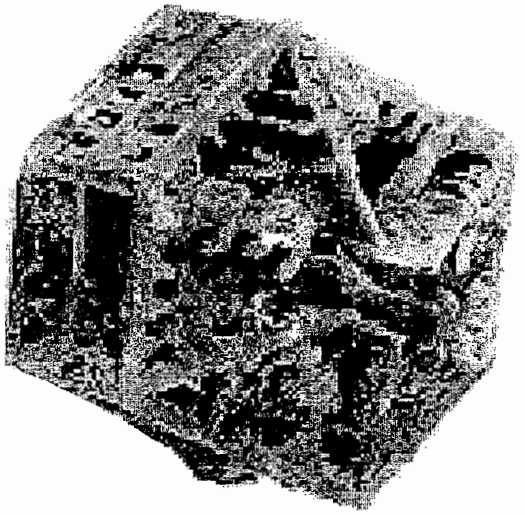


Figure 5. Modern plastic packing severely with iron deposits. This plastic packing is said to be "non-fouling" by the supplier.

In some extremes, the weight of the packed bed can increase by a factor of 10 or more as the packing fouls.

What can be done to minimize the risk of fouling?

Operate at higher water loads to eliminate dead spots in the packing
Manipulate water chemistry by pH adjustment
Optimize liquid distribution in the bed
Pre-treat feed with sequestering agents and biocides
Pre-treat with ozone or other strong oxidants
Clean and maintain packing frequently

There is no such thing as a "perfectly anti-plugging" packing. Jaeger Products, Inc. can provide assistance in analyzing an existing or potential fouling problem and provide a viable solution. Sequestering agents, ozone/detergent and acid cleaning technology in combination with sequestering agent chemicals are available from Jaeger that will work on any packing in water service, even the competition's, as long as the fouling is not excessive.

Keeping Groundwater Air Stripping Units Clean and Unplugged

As mentioned before, if the contaminated ground water contains free iron or other minerals, such as calcium and manganese, the action of the stripping air could cause some of these compounds to precipitate and foul the packing media. The degree of fouling is usually a function of several factors beyond the actual inlet conditions. Among them:

1) If the packings or any of the other internals are exposed to ultra violet light, then algae growth will be accelerated. Algae formation creates an excellent base for mineral deposits, such as iron, manganese, and calcium.

2) A packing that stays completely and continually wet, thereby constantly washing itself of the precipitate, seems to resist fouling and plugging. Thus, fouling and plugging can be accelerated by poor initial liquid distribution.

The reality is that all air strippers will eventually lose some of their efficiency and capacity due to fouling, if the water is not pre-treated before entering the tower. The degree of fouling and the amount of time for the fouling to affect the performance of a stripper are functions of all of the above factors, plus other unique characteristics of a particular site.

The best answer to the problem is a combination of good design and pre-treatment. Jaeger Products, Inc. can assist you in both activities to provide an effective solution to the problem of fouled packing. Our engineers will properly select the right internals for your tower to assure good liquid distribution and will also detail the recommended pre-treatment and maintenance options. Pre-treatment involves the continuous addition of chemicals to the water, to keep the minerals from precipitating and to prevent algae build-up during the stripping process. Jaeger Products has put together a complete treatment/ maintenance package to address plastic packing fouling in water service. Two processes are available: a pH adjustment process, using a mild acid solution, and a process that sequesters ions of insoluble salts and prevents them from precipitating.

Furthermore, ozone or chlorine can be used to attack biological fouling in the contactors as well as in the packing itself. Without biological growth, the possibilities of inorganic fouling are greatly diminished. Ozone is an unstable compound in air and has a very short life reverting quickly back to O_2. Ozone emissions to the

atmosphere or any post-treatment facilities should not represent a problem. Chlorine on the other hand can present complications of THM generation. Consult with Jaeger Products, Inc. when deciding which treatment technique to apply.

An additional option for controlling inorganic salt and oxide deposition is to pre-treat the feed water with a sequestering agent that will maintain the solids in solution. The selection of the type and dosage of the sequestering agent can be done very precisely to ensure that the effluent water meets all drinking water standards and that it can be directed harmlessly to its desired destination. The inorganic polyphosphate agents that are used in this application have been approved by EPA, the US Department of Agriculture, and several state health agencies for use in potable water systems at concentrations well above those needed for treatment. This technique can also be used to clean fouled packings since the sequestering agent will tend to solubilize the deposited salts. The effectiveness of this wash can be substantially enhanced by combining it with the ozone treatment procedure outlined above.

Keeping Wastewater Stripping Units Clean and Unplugged

Organic stripping from waste waters presents additional fouling problems than the ones outlined above. Wastewaters typically have higher concentrations of organics, and in the case of steam strippers, operate at higher temperatures. These high temperatures often result in inorganic salt precipitation that can severely foul packed beds.

The use of sequestering agents in wastewater strippers should be evaluated carefully since the consumption of chemicals can be very high due to the high concentrations and flows. Selection of a preventive process based on sequestering agents can still be relevant where wastewaters have moderate inorganic concentrations, such as the ones from chemical plants and oil refineries. Furthermore, correct design of a steam stripping system will direct the majority of the salt deposition to the feed preheater section of the process. Heat exchangers that can be easily cleaned are then a necessity.

The most significant fouling problem found in wastewater strippers is caused by bacteria and algae growth promoted by high organic loads. This problem is more prevalent in air strippers, but it does present itself in steam strippers as well. Methods to control biological growth in wastewater strippers do not differ much from those outlined above for groundwater strippers. Good design of liquid distribution systems, combined with manipulation of the water chemistry, offer the best possibilities for control. Ozonation of the wastewater is certainly a viable alternative.

How Can a Fouled Stripping Unit be Cleaned?

In many cases, preventive maintenance, such as described above, is not performed. Severely fouled towers need to be cleaned, preferably without having to remove the packing and internals. Implementation of a cleaning procedure is not trivial since one has to consider many issues ranging from the chemistry of the system to the mechanical design of the stripper.

There are two major issues to be addressed in terms of selecting a proper cleaning protocol: liquid distribution and proper chemistry.

First and foremost, it is essential that whatever cleaning solution is used reaches the fouled areas of the packing. In towers where the fouling has been excessive, so that areas of the packing are completely plugged off, it would be impossible to reach the most critical portions of the packing by trickling the liquid down the media.

If the mechanical design of the tower allows for liquid-full operation, then filling the tower with cleaning solution and recycling it is the best alternative. On the other hand, this procedure consumes large amounts of cleaning solutions. The next best choice is to trickle the liquid down the packing at the maximum possible rate and to feed gas (air, nitrogen, etc.) into the bottom of the tower at a rate that propitiates flooding. The volume of liquid required in this approach is significantly less but there is the requirement of gas flow.

A stripper that is cleaned before severe fouling occurs, as described above, will be more readily irrigated properly by the use of the tower distributor. Nevertheless, it is recommendable that the tower be flooded with the cleaning solution as the first step in the cleaning process.

There are some fairly effective "in-situ" cleaning techniques that can be very helpful, as long as the bed is not fouled too severely and it has remained wet. Washing the packed bed with a mild acid solution is an effective technique for removing some inorganic deposits. Ozone injection can clean plastic packings by breaking down the bacterial colony structure and allowing the salts to fall off the surface of the packing. Ozone injection, in combination with detergent rinses, provides a good maintenance solution. The user does need to perform the cleaning with certain regularity to prevent excessive buildup. The use of phosphates as metal sequestering agents can also be very effective in keeping metal salts and oxides in solution during heavy aeration.

Most towers can be completely cleaned in 24 to 72 hours. Cleaning time is, of course, a function of the severity of the fouling problem and the size of the tower. In cases where a tower cannot be out of service for the entire cleaning period, the process can be alternated with normal tower operation. Additionally, the final filtration and neutralization process can be performed in a separate holding tank, thus allowing the tower to be put back in service at the earliest possible time.

Figures 6 and 7 illustrate the effectiveness of the clean-up process. In both cases, the packings were severely fouled with iron deposits and biological growth. The pictures show how different degrees of treatment can achieve remarkable results. All these were packings that fouled while in air stripping service without water pre-treatment. It should be noted that structural damage of the polymeric packing pieces has never been a problem because of the relative short exposure times and the availability of oxidizable material.

Figure 8 shows a complete cleaning and treatment process for a groundwater stripper with heavy biological and inorganic fouling tendencies. The inorganic polyphosphate is used to sequester iron, calcium and manganese ions to prevent their deposition.

The correct selection of the chemicals to be used in the cleanup is also of extreme importance. The nature of the fouling needs to be identified as extensively as possible so that the proper combination of chemicals, and in the proper order, can be used. There are some general guidelines that can be established:

1) Biological fouling (bacteria, algae). The chemical of choice for removal of biological fouling is an oxidant or a free radical generator. Ozone used as described above is very effective and less sensitive to liquid maldistribution effects. Furthermore, ozone is both an oxidant and a free radical generator. Other oxidants that are commonly used include potassium permanganate and hydrogen peroxide. Chlorine can also be used as a radical producer.

2) Inorganic fouling by basic salts and oxides (for example calcium carbonate, iron oxide, calcium hydroxide, etc). These can be removed by weak acid solutions. Mineral acids, such as phosphoric and nitric, are frequently used. Organic acids can also be used effectively. A sequestering agent can work in these applications but it would be significantly slower.

3) Inorganic fouling by neutral or acidic salts and oxides (for example calcium sulfate, iron sulfate, calcium chloride, etc). Acids will not be effective in removing fouling caused by these compounds. The best solution here is a combination of a sequestering agent with colloidal agents that can break crystal-crystal bonds and disperse the pieces. These fouling compounds are the most difficult to remove.

It should be noted that acid cleaning can, in some cases, form new acidic salts that precipitate and aggravate the fouling problem significantly.

Service from Jaeger Products

Jaeger Products, Inc. offers its customers the necessary proprietary hardware and chemicals to perform preventive as well as corrective maintenance. The chemicals can be specially formulated for the particular application and can be supplied to the user on a pre-set schedule. Jaeger also offers the customer several different service options.

1) **Call Out** - We will do a site assessment and provide a quotation for the complete cleanup. Our quotation will include complete mobilization, tower modification (if needed), and all equipment and treatment process.

2) **Contract Call Out Program** - We will do a site assessment, and design and build all the necessary hardware to clean a tower by the end user or a qualified third party contractor. We provide all chemicals as well as supervisory resources on a time and rate basis.

3) **Contract Maintenance Program** - We will do a site assessment, and design and build all the necessary hardware to clean a tower by the end user or a qualified third party contractor. The tower will be put on a regular maintenance program in which we will make regular follow-up visits to clean the tower or to supervise the cleaning of the tower by the owner or a contractor. We will also supply all the necessary chemicals.

4) **Continuous Maintenance Lease Program** - We will do a site assessment, and design and build all the necessary hardware to clean a tower by the end user. Lease includes all chemicals, training of operating personnel, product information updates, and four (4) annual inspections of equipment.

All equipment is packaged on a skid or trailer mounted, pre-wired, and factory tested and ready for operation. In many cases, one system can be designed to service more than one unit.

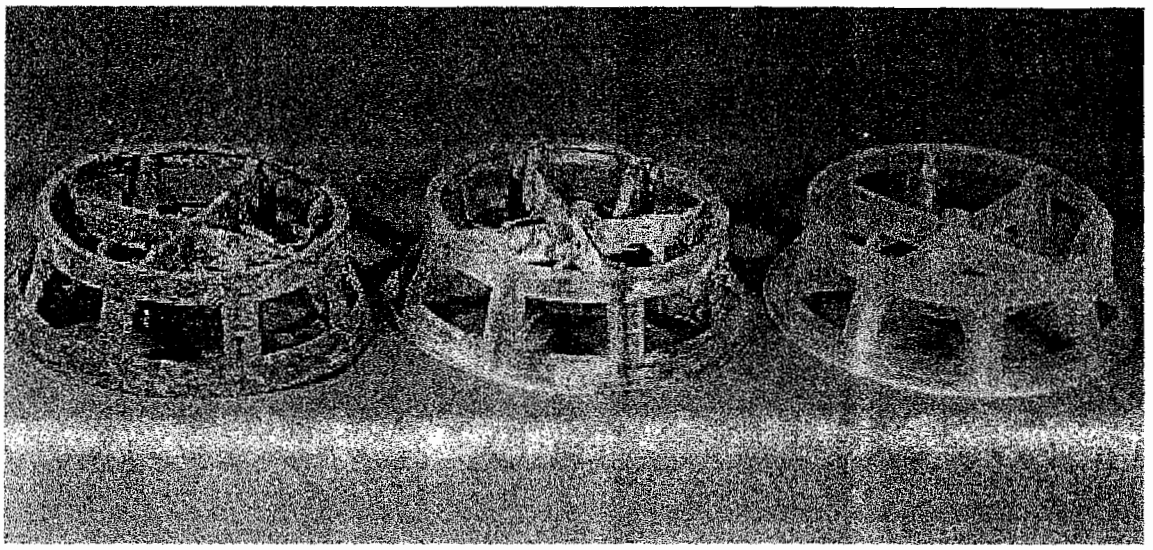
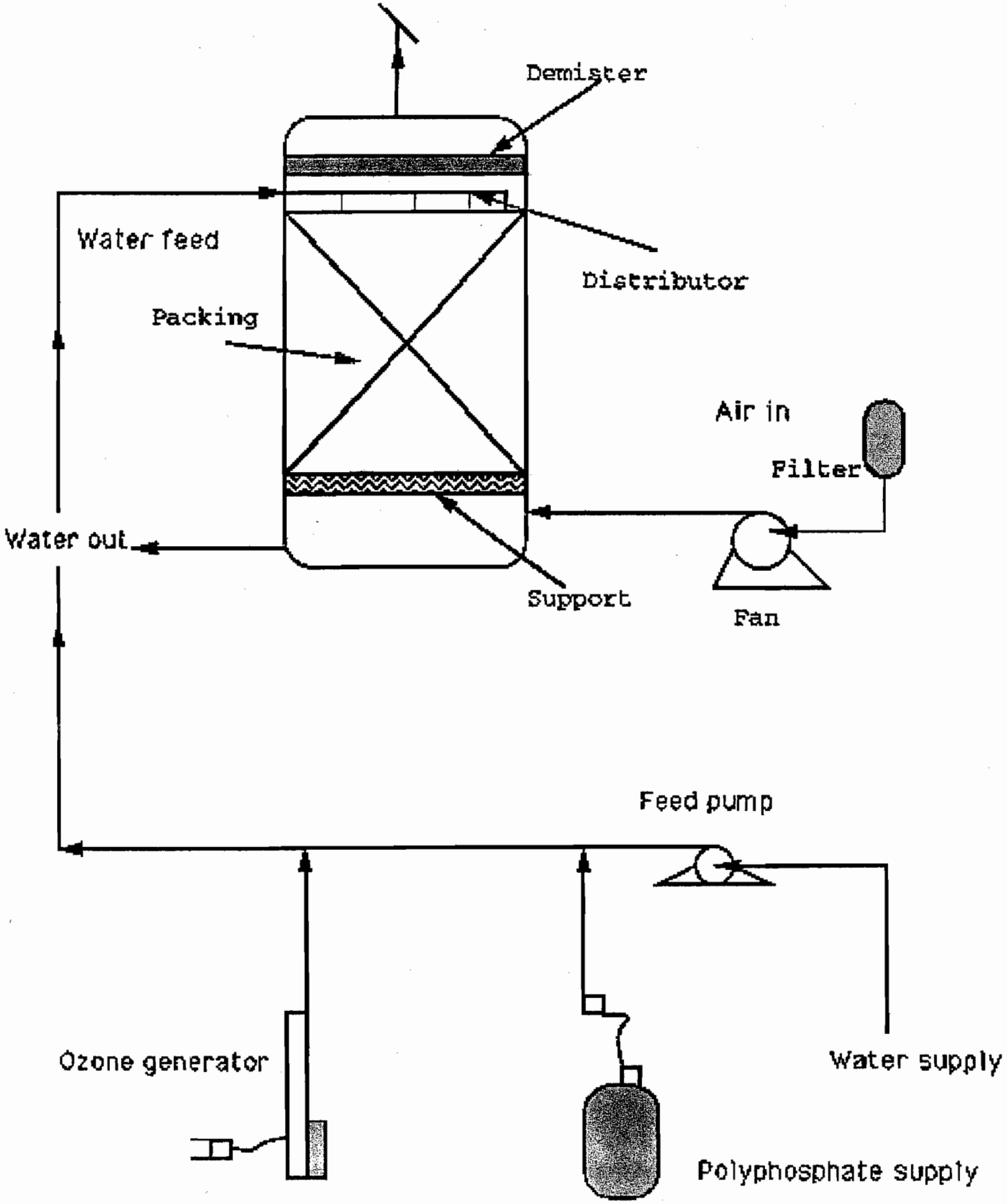


Figure 6. Fouled plastic packing cleaned by the use of ozone. First piece is as found in tower before clean-up. Second piece appears as it was halfway through cleaning process. Third piece is the final product.



Air stripper for VOC removal

Inorganic Polyphosphates

Jaeger Products, Inc. offers water pre-treatment technology using inorganic polyphosphates. These chemicals are recognized as non-hazardous, therefore, permitted for human consumption and use in potable water distribution systems. The chemical is supplied in liquid form. Dosages are calculated for every case after a detailed analysis of the feed water is performed. They can be adjusted as the water composition varies with time.

Polyphosphates maintain iron, calcium, and manganese in solution by complexing with the metal ions and forming large, soluble clusters that prevent crystallization and deposition of the metal salts. In some ways, these polyphosphates act as "molecular detergents" and can even be used to dissolve or disperse crystals by tuberculation.

The temperature of the system, phosphate concentration, pH, and the reversion tendency or time stability of the polyphosphates all play a very important role when assessing pre-treatment possibilities. The conditions in a stripper can be very severe with respect to phosphate chemistry, since the dilutions are large, the pH can vary from 2 to 13, and temperatures can be high (i.e., in steam strippers where conditions can exceed 220 deg. F).

These stringent requirements mandate the use of polyphosphate blends that can operate at high temperatures and low concentrations without significant reversion. The better polyphosphate blends offer synergistic effects that cannot be found in single polyphosphate. The technology exists today to produce high-performance polyphosphate blends that are uniquely suited for use in air and steam strippers. Some packing vendors offer this expertise to the users, as do some specialized water treatment chemicals suppliers.

Summary

If you are going to install a stripping unit, you should make provisions for keeping the packing clean. A few inexpensive modifications now can save time and money in the future. As a starting point, you may want to request our write-up on air stripping volatile organic compounds (VOCs) from groundwater. Request Product Bulletin No. 600AS.

If you are operating a stripping unit in fouling service, you should begin now to pre-treat the feed water. Prevention is still the least expensive option. We have pre-treatment options to suit your specific needs.

If you have a stripping unit that is fouled, we have effective technology for cleaning it without the expense and problem of removing the media from the tower.

For us to recommend a pre-treatment procedure or a procedure for cleaning an existing stripping unit, please fill out the attached form. This form can be copied and faxed directly to our office.

CARBONAIR®

Fact Sheet #3

Inorganic Fouling in Air Strippers: Mechanisms & Prevention

Cause

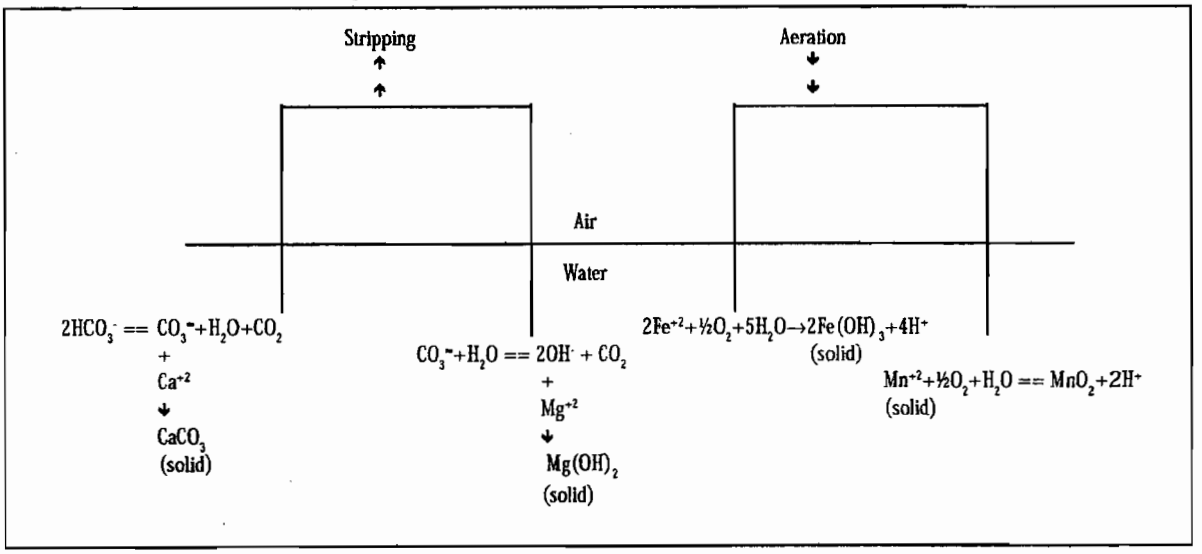
Fouling in air strippers is typically caused by precipitation of inorganic material such as hardness (mainly calcium and magnesium), iron and manganese. The hardness of groundwater varies considerably from place to place. Groundwater is commonly classified in terms of the degree of hardness, as follows: soft (0-75 ppm), moderately hard (75-150 ppm), hard (150-300 ppm) and very hard (greater than 300 ppm). The occurrence of iron in groundwater at concentrations of 1-10 ppm is common; however, higher concentrations of up to 50 ppm have been found in some cases. Manganese is often present with iron in groundwater at concentrations of 0.1-1 ppm. Since the concentration of iron is always much higher than the concentration of manganese, fouling in air strippers is caused more by the precipitation of iron than manganese.

In the air stripping process, carbon dioxide, together with, volatile organic chemicals (VOCs), will be removed from water, causing an increase in pH. As the pH increases, the form of alkalinity will change from bicarbonate to carbonate, and from carbonate to hydroxide. If the water contains an appreciable amount of calcium and magnesium, calcium will precipitate in a carbonate form, and magnesium will precipitate in a hydroxide form. Iron and manganese will precipitate due to the aeration in the forms of iron hydroxide and manganese oxide. Figure No. 1 below illustrates the chemical reactions involved in inorganic fouling during the air stripping process.

Prevention

There are three common approaches for the prevention of inorganic fouling in the air strippers: 1) enhancing the

Figure No. 1
Chemical Reactions Involved in Inorganic Fouling Airstrippers



precipitation before entering an air stripper, 2) sequestering the precipitation by adding an acid to maintain a low pH, and 3) sequestering the precipitation by adding a polyphosphate.

Precipitation and Filtration

Hardness is typically removed from the water by adding lime or caustic soda to adjust the pH, usually above 10.5. It is more difficult to dissolve lime than caustic soda in the water; however, the former will give denser sludge with less volume. The removal of iron and manganese typically involves pH adjustment and oxidation using chlorine, hypochlorite, or permanganate. Permanganate is a more powerful, but more expensive, oxidizing agent than chlorine and hypochlorite. When permanganate is used, it is essential that a media such as greensand (natural ion exchanger,"zeolite") be used to adsorb any excess permanganate after oxidation. Otherwise, excess permangante will bleed through as a pink color. After the chemical oxidation for either hardness or iron and manganese removal, the sludge needs to be removed from the water through a settling tank and media filters.

Acid Sequestering

One of the advantages of using sequestering agents is that no sludge will be produced due to the inorganic precipitation, and the capital cost can be significantly reduced because there is no need for a settling tank and media filters. However, using an acid as a sequestering agent for water with high concentrations of hardness and iron, may require an excessive amount of acid. Also, the use of a strong acid for a sequestering agent requires the transportation, storage, and handling of a hazardous material. Also, air strippers, which are constructed of stainless steel or aluminum, may not be compatible with the long-term exposure to an acid.

Polyphosphate Sequestering

The use of polyphosphates as sequestering agents is more attractive because they are less hazardous, compared to acids. Polyphosphates inhibit the precipitation of hardness by distorting the cube-like shape of calcium carbonate molecules and preventing the molecules from building on each other. Polyphosphates inhibit the iron and manganese precipitation by preventing the close contact between the ions which is necessary for iron and manganese to form their respective oxides. The dosage of polyphosphates can be easily determined by the hardness, iron and manganese contents. Polyphosphates, however, should be used with caution where treated water is stored in open reservoirs, because, algae blooms and slime may result. The treated water containing polyphosphates must be discharged into an acceptable body of water.

Guidelines

The general guidelines for preventing inorganic fouling in air strippers are as follows:

Hardness <100 ppm and/or Dissolved Iron <1 ppm

Air strippers are expected to operate for a long period of time (over a year). No preventative measures are necessary; however, an annual inspection of the interior of the air strippers is recommended. An acid cleaning may be necessary when appreciable inorganic build-up is found.

Hardness 100-300 ppm and/or Dissolved Iron 1-5 ppm

Air strippers are expected to operate for at least half a year. No preventative measures are necessary. Periodic cleanings are more economical than the continuous addition of preventative chemicals. It is recommended that the interior of the air strippers be inspected every six months. An acid cleaning is recommended when appreciable inorganic build-up is found.

Hardness >300 ppm and/or Dissolved Iron >5 ppm

Air strippers are expected to operate for less than half a year and may foul very rapidly. A sequestering agent, preferrably polyphosphate, is recommended. An acid should only be used under the following conditions: 1) the use of polyphosphates is not allowed by regulation, 2) the air stripper is constructed of materials compatible with acid and 3) hardness is below 500 ppm and/or iron is below 10 ppm. When the use of a sequestering agent, either polyphosphate or acid, is not practical, the removal of hardness and iron by chemical precipitation and filtering is recommended prior to air stripping.

JONES WATER SUPPLY, INC. QUOTATION WORK SHEET

QUOTATION DATE 1/16/03 — CUST. QTD. - Dennis Shimer

QUOTE DUE / / — Cell 725-7111

JOB - Vestal well

JOB LOCATION -

ENGINEER - — Fax 786-0918

F.O.B. POINT -

TERMS -

PAGE NO. - OF — PREPARED BY - MB

QUANTITY	ITEM			UNIT PRICE
2	UNI DOSE V011-281 Feed Pump			710.00
1	10" FL PVC Static MIXER			2514.00

Remediation Equipment

Industrial Equipment

Groundwater Sampling

Filtration Media

Rental Systems

Customer Support

Learning Centre

Technical Library

INORGANIC FOULING IN AIR STRIPPERS: MECHANISMS & PREVENTION

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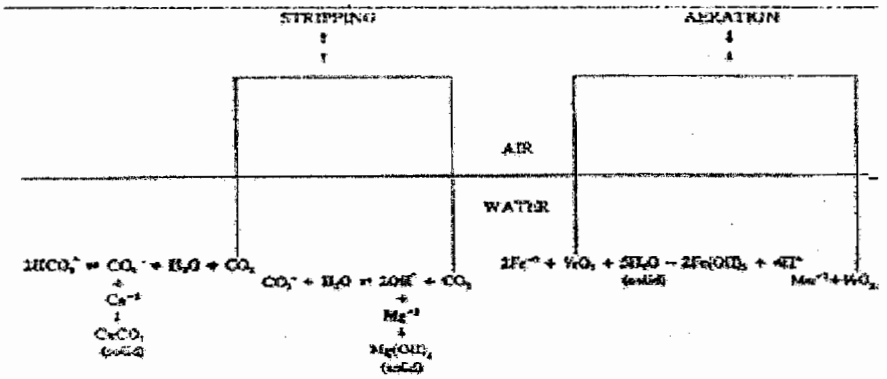
Fouling in air strippers is typically caused by precipitation of inorganic material such as hardness (mainly calcium and magnesium), iron and manganese. The hardness of groundwater varies considerably from place to place. Groundwater is commonly classified in terms of the degree of hardness, as follows: soft (0-75 PPM), moderately hard (75-150 PPM), hard (150-300 PPM) and very hard (greater than 300 PPM). The occurrence of iron in groundwater at concentrations of 1-10 PPM is common; however, higher concentrations of up to 50 PPM have been found in some cases. Manganese is often present with iron in groundwater at concentrations of 0.1-1 PPM Since the concentration of iron is always much higher than the concentration of manganese, fouling in the air strippers is caused more by the precipitation of iron than manganese.

In the air stripping process, carbon dioxide, together with, volatile organic chemicals (VOC's); will be removed from water, causing an increase in pH. As the pH increases, the form of alkalinity will change from bicarbonate to carbonate, and from carbonate to hydroxide. If the water contains an appreciable amount of calcium and magnesium, calcium will precipitate in a carbonate form, and magnesium will precipitate in a hydroxide and magnesium will precipitate in a hydroxide form. Iron and manganese will precipitate due to the aeration in the forms of iron hydroxide and manganese oxide. Figure No. 1 below illustrates the chemical reactions involved in inorganic fouling during the air stripping process.

Figure No. 1 Chemical Reactions Involved in Inorganic Fouling in Air Strippers



preventative measures are necessary; however, an annual inspection of the interior of the air strippers is recommended. An acid cleaning may be necessary when appreciable inorganic build-up is found.

Hardness 100-300 PPM and/or dissolved Iron 1-5 PPM

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Hardness>300 PPM and/or Dissolved Iron >5 PPM

Air strippers are expected to operate for less than half a year and may foul very rapidly. A sequestering agent, preferably polyphosphate, is recommended. An acid should only be used under the following conditions: 1) the use of polyphosphates is not allowed by regulation, 2) the air stripper is constructed of materials compatible with acid and 3) hardness is below 500 PPM and/or iron is below 10 PPM When the use of sequestering agent, either polyphosphate or acid, is not practical, the removal of hardness and iron by chemical precipitation and filtering is recommended prior to air stripping.

Maple Leaf Environmental Equipment Ltd.
Phone: 1-(613)-498-1876 Fax: 1-(613)-345-7633
or call toll-free 1-(800)-420-4056
www.maple-leaf.ca

607-796-0918

Layne Christensen Company *Integrated Groundwater Services*
97 Chimney Rock Road • Bridgewater, NJ 08807 • Phone: (732) 469-8720 • Fax: (732) 469-9402

November 12, 2002

Aguilar Environmental, Inc.
919 Highway 33 Suite #47
Freehold, NJ 07728
Attention: Julius Glickstein

Re: Vestal Well 1-1 Repairs

Dear Mr. Glickstein:

Layne Christensen Co. is pleased to present a schedule and scope of work for repairs on the Vestal Well 1-1 air stripper. The required repairs and maintenance outlined in Layne's Inspection Report dated November 12, 2002 are based on our site visit on October 30, 2002. We propose to re-inspect the blower system once the recommended maintenance work is completed on the blower, and provide a recommendation on replacement of the packing material. We also propose to perform repairs based on the recommendations. Our scope of work is outlined below, with an estimated time-line to complete the tasks. The scope of work is dependant on if the packing requires replacement. Packing replacement is outlined in Option 2.

Task 1
We propose to travel to site and re-test blower performance after replacement of blower motor, belts, and realignment. The determination of blower static pressures will be compared to design and historical measurements, if available. The pressures will be used to determine airflow rates through the stripper, which will be compared to design rates.

We require one day to perform the testing, including travel time, and will supply our recommendations the following day.

Cost estimate for the blower inspection **$1,355.00**

Task 2
Task 2 will be dependant on packing replacement. Option 1 details maintenance and repairs without packing replacement while Option 2 includes replacement of packing with new packing and removal of spent packing.

Option 1
1. Remove top of air stripper tower, remove demister, clean distribution tray.
2. Replace demister with new, re-install demister.
3. Re-install demister.
4. Replace top of air stripper
5. Replace differential pressure switch in blower room, replace tubing and check operation.

Estimated time of completion is two to three days, with two weeks lead time. Cost estimate for Option 1 includes labor, man lift, crane, pressure switch, and demister replacement. Cost estimate for Option 1 is **$21,105.00**

Option 2

1. Remove top of air stripper tower, remove demister, and remove section of distribution tray. May require cutting section of distribution tray depending on whether all section are welded.
2. Remove lower manway window, set up to remove packing from manway. If packing is cemented in place, removal will be from top, access through demister tray.
3. Remove all packing from air stripper
4. Check shell integrity, check for corrosion and leaks
5. Install retaining screen in lower manway, clean and re-install Plexiglas window
6. Repack tower with 1270 cubic feet of 2-inch HiFlow Rings
7. Repair and clean Distribution tray
8. Replace demister with new, re-install demister
9. Re-install demister.
10. Replace top of air stripper
11. Replace differential pressure switch in blower room, replace tubing and check
12. Install Blower safety screen

Estimated time of completion is dependant of condition of packing, and ability to remove packing from lower manway. Under ideal conditions the work may be completed in four to five days, but may require six to seven days if packing is cemented in. We will require two weeks lead-time.

Option 2 will be performed for a on a time and material basis. The cost estimate includes labor and equipment for an estimated four days to completion with a three man crew. Supplied material include packing, demister, safety screen, and lifting equipment. Cost estimate for four days completion for Option 2 is **$70,355.00**

Alternatively, our estimate without supplied packing for Option 2 is **$45,764.00**

Additional days for removal and installation of packing will be billed at **$7,125.00**

If you have any questions or comments, please feel free to call at (732)469 8720.

Very truly yours,
LAYNE CHRISTENSEN COMPANY
Integrated Groundwater Services

Peter Nash
Engineer

Vestal repairs schdule&price.doc