FILTRONICS

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Filtronics has a long and distinguished water treatment history with several hundred systems operating throughout the United States and Canada. We're especially proud of our success in effectively removing arsenic from drinking water and look forward to this opportunity to further demonstrate our capabilities.

Our superior system design, ease of operation, effectiveness dealing with difficult water quality issues, high flow rates, permanent media, low capital and operating costs, small footprint, outstanding quality assurance, and unrivaled customer support are just a few of the qualities that make Filtronics a world-class treatment system manufacturer.

Please don't hesitate to contact us if you have any questions or require additional information. Thank you.

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ABSTRACT

Filtronics, Inc. is a manufacturer of down flow pressure sand filters, to use general terms. It does not, however, employ sand or any silica products in its product line. This unique filtration system incorporates the latest technology for the removal of arsenic, iron, manganese, and hydrogen sulfide. The systems utilize a special permanent, back washable media, chemical feed system, and oxidation system to accomplish arsenic removal to less than 5 ug/l (ppb). Filtronics' ***Electromedia®*** permanent filtering media is a granulated, naturally occurring, sand-like filtering media that can filter particles as small as two microns (***Electromedia®* V**). It is not a resin, plastic, or silica product, but instead a processed mineral that can filter up to 15 gpm per square foot – with the same or better performance than other systems that filter only at 3 to 5 gpm per square foot.

Filtronics has manufactured water and waste water treatment systems for industrial and municipal applications since 1974. Our high quality municipal drinking water systems using innovative technology have provided low capital cost, low operation and maintenance, and simple operation for small towns and large cities. Our automated systems operate unattended providing high quality water at the lowest cost.

Naturally occurring arsenic exists in two different forms: +3 (arsenite) and +5 (arsenate). Oxidation is provided by any convenient oxidant such as chlorine gas, sodium hypochlorite, chlorine dioxide, ozone, mixed oxidants, or hydrogen peroxide. The oxidant transforms arsenic, iron, hydrogen sulfide, and manganese into a processable form to be removed by the filtration unit. If there is not enough native iron in the source water to facilitate arsenic capture following oxidation, an iron coagulant chemical feed is introduced. Pilot testing gives accurate performance and chemical cost data for the full scale installation.

Filtronics full-scale arsenic removal units have been in operation since 1992 and our process has been featured in The American Water Works Association *Opflow* publication, Vol 22 No.2 "Question of the Month" as well as in the March 2001 edition of WaterWorld.

Filtronics ***Electromedia®* I** systems have been shown to reduce arsenic concentrations of 69 to 100 ug/l down to 2.6 ug/l – Well below the new 10 ug/l MCL. Recent pilot test results proved a reduction from 39 ug/l to non-detectable levels. This data has been validated by third-party laboratory testing.

The backwash water is not hazardous and may be disposed directly to sewer or stored for solids precipitation and water recovery. Concentrated solids may go to a standard landfill.

Filtronics systems are designed to be operator friendly and are automated for full, unattended operation. The control panels provide a simple, clear, intuitive display panel for easy operation. The filter, chemical feed systems, well pumps and auxiliary equipment are automatically operated.

All ***Electromedia***® systems have a four-minute backwash duration. Backwash rates are 17 gallons to 20 gallons per minute per square foot, depending upon the media selected. The short duration results in lower wash water requirements and thus provides a better backwash-to-filtration ratio. The high rate and media design provide complete fluidization of the working media. Thorough cleaning of the media is obtained without the requirement of filter cleaning aids such as surface wash and air scour. This feature results in a significant reduction in initial capital investment and reduced operation and maintenance costs by eliminating the air scour equipment, associated plumbing and controls. This is true even in treating traditionally difficult supplies such as arsenic laden waters.

A typical Filtronics ***Electromedia***® system consists of one or more filter vessels, two reaction vessels, automation control panel, pneumatically driven valve nest (electric valves optional), flow control valves & meters, ORP residual analyzer, and chemical feed panels & accessories. The Filtronics automation control panel typically includes a chart recorder for residual monitoring, a panel-view LCD touch screen operator keypad, interposing relays for all contact points, air control valves, and a PLC (programmable logic controller). Each PLC includes RS-232 and SCADA ports. A modem is supplied with each system for remote data access as well as for factory troubleshooting assistance.

Photo 1 – Typical Filtronics filter vessel (behind blue & red piping) and reaction vessels. Note sodium hypochlorite chemical oxidant injection point (foreground right) and backwash reclamation tank (right background).

Plant size varies significantly with application variables such as flow rate, filter & reaction vessel orientation, site piping, etc. A 150 gpm system can be expected to require approximately 22 square feet of space whereas a larger 3,000 gpm dual filter system might require 50 to 60 square feet. Actual plant sizing is verified following piloting and system selection. Filtronics units are energy efficient and require 220 VAC to drive a small compressor provided to supply air to the pneumatic valves. The automation control cabinet requires 110 VAC at 3 amps for the PLC.

TECHNOLOGY DESCRIPTION AND FUNCTION

Filtronics, Inc. ***Electromedia*®** **I** Process Description: ***Electromedia*®** **I** is a granulated, naturally occurring sand-like filtering media which can filter particles as small as 5 to 7 microns. It is not a resin, plastic, or silica product. It is a processed mineral which can filter up to 15 gpm per square foot. All components are NSF 60/61 Certified.

The process oxidizes soluble iron, manganese, sulfides and arsenic into insoluble forms and uses native iron in the raw water as a coagulant and/or adds iron coagulant to attract the arsenic. The filter then removes these metals from the water.

OXIDATION: The prime ingredients for chemical reactions are provided by the ***Electromedia*®** **I** reaction vessels - mixing and time. The two reaction vessels are constructed to provide thorough mixing and a one minute detention time each.

REACTION VESSEL #1: Water is received from the source and treated with chlorine, sodium hypochlorite, or another oxidizing chemical convert the iron, manganese, sulfides and arsenic to treatable forms. ***Electromedia*®** **I** may be used with any number of oxidants or combination of oxidants.

Iron is oxidized to ferric iron. If there is not enough native iron in the source water to facilitate arsenic capture following oxidation, iron is introduced in the form of ferric chloride or other iron-based flocculent chemical feed. The actual amount of iron required to achieve arsenic sequestration is determined during pilot testing.

Manganese is oxidized to the manganic form and sulfides are oxidized to sulfate. Sulfate is common in water supplies and does not contribute objectionable taste or odor. The arsenic is oxidized to +5 form. A sufficient amount of chlorine is added to the water to meet the chemical oxidation demand and thus reach the chlorine breakpoint. A minimum free chlorine residual of 0.5 mg/l is provided to the distribution system. A higher residual may be carried if desired.

The oxidation reduction reactions are:

$$2Fe^{+2} + Cl_2^{0} \rightarrow 2Fe^{+3} + 2Cl^{-}$$

$$Mn^{+2} + Cl_2^{0} \rightarrow Mn^{+4} + 2Cl^{-}$$

$$S^{-2} + 4Cl_2^{0} \rightarrow S^{+6}\ (SO_4^{-2}) + 8Cl^{-}$$

$$As^{+3} + Cl_2^{0} \rightarrow As^{+5} + 2Cl^{-}$$

The Stoichiometric requirements for the above reactions are:

- 0.64 mg/l of chlorine per mg/l of iron
- 1.29 mg/l of chlorine per mg/l of manganese
- 8.33 mg/l of chlorine per mg/l of sulfide
- 1.07 mg/l of chlorine per mg/l of As

REACTION VESSEL #2: The water is received from reaction vessel number one and injected with a small dose of sodium bisulfite or sulfur dioxide (SO_2). The sulfur dioxide injection point is in the cross-over pipe between the reaction vessels. Sulfur compounds are similar to carbon compounds in that they both tend to link with one another. When sulfides are oxidized this tendency is prevalent. If the sulfur does link together, polysulfides are formed. Their presence is identified by the characteristic "musty or rubber tire" taste and odor.

The introduction of 0.25 mg/l to 0.50 mg/l of sodium bisulfite or sulfur dioxide accelerates the oxidation of the sulfides to sulfates and precludes the formation of intermediate objectionable products.

FILTRATION: The filter vessel contains ***Electromedia*® I**, a media specifically designed for iron, manganese and other heavy metal removal. Its adsorptive surface attracts iron and manganese ions and holds them in the bed. The oxidation of iron and manganese is quite rapid. The reaction with water to form hydroxides or precipitates (filterable substances) requires significant times. Iron requires approximately 20 minutes for a complete reaction to a filterable precipitate at pH of 7 to 8. Manganese requires an hour or more to complete the reaction. The adsorptive qualities of ***Electromedia*® I** hold the iron and manganese ions in the filter bed and permits this reaction to occur as the water passes through the filter.

The adsorptive qualities of the media or any media cannot be effectively explained. Some of the theories proposed to explain the effects of adsorption include:

- Van der Walls forces
- Hydrogen bonding
- Coulombic bonding
- Chemical bonding

Chemical bonding is known to play a role in "green sand" because of the regeneration requirement and the oxidation-reduction reactions which occur within the bed.

The ***Electromedia*® I** system does not require regeneration or media replacement. The nature and size of the media and the vigorous backwash characteristic of the system achieve a mechanical cleaning of the media surface. This system is so effective there is no requirement for "air scouring" or "surface wash" as is needed by other systems.

At the end of the filtration cycle the iron, manganese, and arsenic are backwashed from the media and the surfaces are thoroughly scrubbed. The backwash rate is 20 gallons per minute per square foot for a period of 4 minutes. The clean bed is then rinsed to waste (forward flow) for one minute and put back into service. The backwash water is not hazardous and may be disposed directly to sewer or stored for solids precipitation and water recovery. Concentrated solids may go to a standard landfill. The general mineral analysis of the raw water is examined to see if the water will comply with the lead and copper rule. If lead and copper levels will be unacceptable, a variety of chemicals can be used based on the characteristics of the general mineral analysis such as sodium carbonate, calcium carbonate, lime, sodium or potassium hydroxide to correct this condition.

PROCESS ANALYZER: At the discharge of the filter a continuously monitoring analyzer samples the effluent. The process signal is displayed on a color coded chart recorder. The operator must adjust the chlorine dosage to maintain the recording in the green area to affect proper chemical dosage. No calculations or separate analysis is required. This system has a positive response to the oxidant dosage. Five minutes after adjustment the trend is displayed on the recorder and equilibrium is reached within 10 minutes. Therefore, the operator can quickly establish the proper dosage without guessing.

SYSTEM ADVANTAGES: Oxidation may be provided by chlorine, sodium hypochlorite, chlorine dioxide, ozone, mixed oxidants, or hydrogen peroxide. Gas chlorine is the lowest cost material.

1. If gas chemical feed is used, oxidant dosage is dedicated to the source water quality by separate meter panels and rate valves. The valves are operated by solenoid valves. This feature permits setting the dosage for both the flow and the chemical demand for the source.

2. No pink water complaints. Since the system utilizes only chlorine as the oxidant, pink water complaints from excess potassium permanganate are not possible.

3. Positive indication of the proper chemical dosage through the process recorder. This feature provides the operator with a simple and direct method for control of the system.

4. If gas chemical feed is used, there is a continuous stand-by reserve of chemicals. Automatic switchover is provided for both chlorine and sulfur dioxide. This gives maximum assurance of continued uninterrupted service.

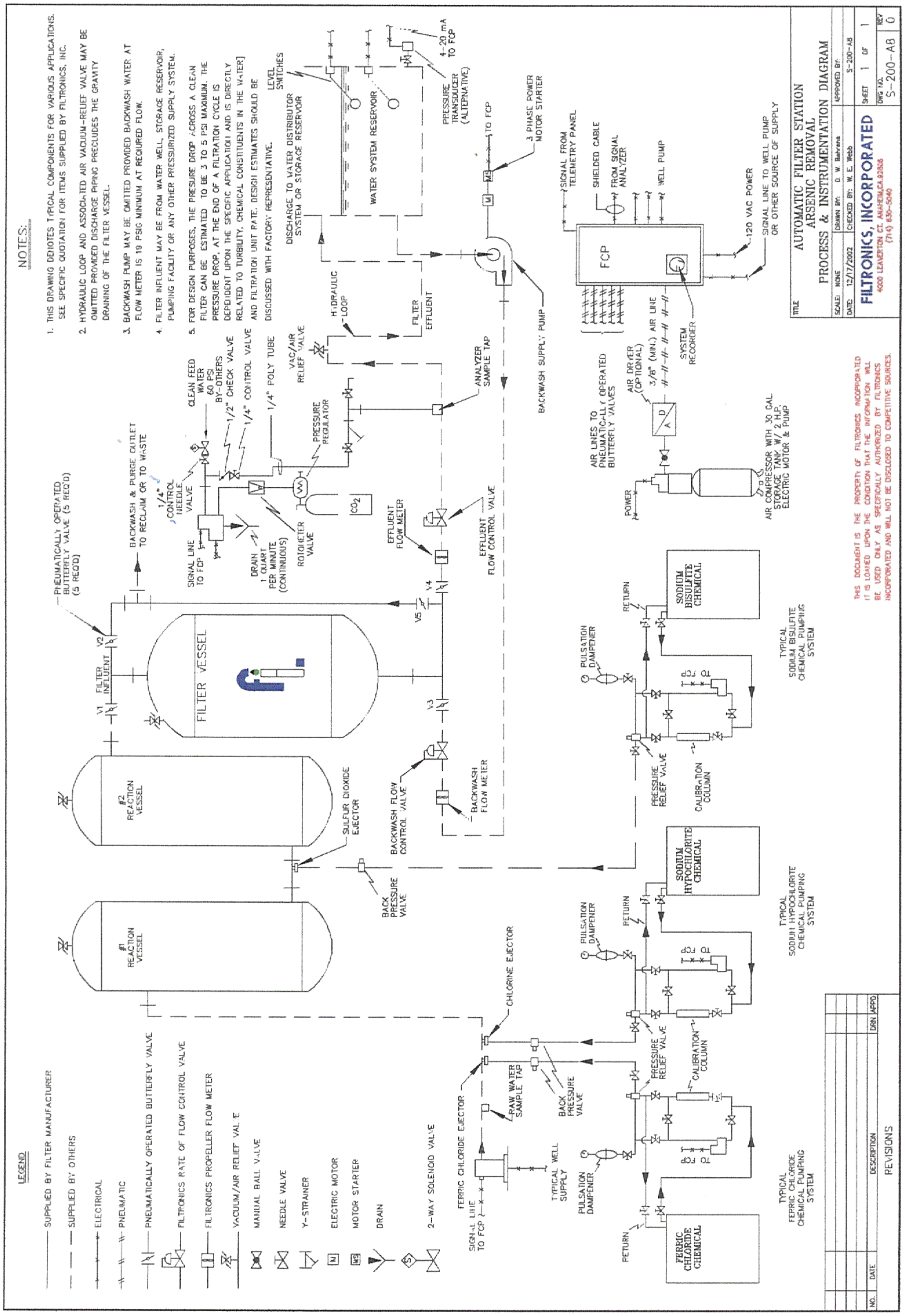
5. Safe. The ***Electromedia*®** **I** system utilizes an all vacuum distribution of chemicals from cylinder mounted regulators to the point of injection when gas feed is used. The only pressure point is at the cylinder. A failure in a vacuum line automatically shuts down the gas supply.

6. Efficient. When gas feed is used, chemical injection is accomplished by gas at the point of application. This utilizes the maximum chemical oxidation-reduction potential possible at a minimum cost. There are no errors in measuring or dilution of chemicals. Approximately 30% less chlorine is required to perform the same oxidation task performed by potassium permanganate. The filter loading is reduced since potassium permanganate is not present to be removed by the filter.

7. Operator friendly. The system is designed for unattended automatic operation. The operator checks chlorine dosage by ensuring that the pen arm on the recorder stays in the green band area. This is done by the operator, if necessary by adjusting the chlorine feed and waiting 10 minutes to insure equilibrium in the "green".

OPERATION AND DESIGN SPECIFICATIONS:

- Filter flux rate: Up to 15 gpm/ft^2
- Backwash duration: 4 minutes regardless of loading
- Backwash initiation: 8 to 12 hours, started by a timer with a differential pressure override at 10 psi
- Purge: 1 minute, after each backwash
- Internal distribution system: Hub and lateral/manifold and lateral
- Valving; Pneumatic/butterfly
- Chlorine feed: Gas feed system injected before the first one minute reaction vessel
- Chlorine feed rate: Shall be that which must stoichiometrically oxide: 0.63 mg/l of chlorine per mg/l of iron, 1.29 mg/l of chlorine per mg/l of manganese, 8.33 mg/l of chlorine per mg/l of sulfide, plus organic demands which may be present
- Sulfur dioxide: Feed rate of 0.25 mg/l to 0.50 mg/l between the first and second one minute reaction vessel


LEGEND
SUPPLIED BY FILTER MANUFACTURER
SUPPLIED BY OTHERS
ELECTRICAL
PNEUMATIC
PNEUMATICALLY OPERATED BUTTERFLY VALVE
FILTRONICS RATE OF FLOW CONTROL VALVE
FILTRONICS PROPELLER FLOW METER
VACUUM/AIR RELIEF VALVE
MANUAL BALL VALVE
NEEDLE VALVE
Y-STRAINER
ELECTRIC MOTOR
MOTOR STARTER
DRAIN
2-WAY SOLENOID VALVE
#1 REACTION VESSEL
#2 REACTION VESSEL
FILTER VESSEL
PNEUMATICALLY OPERATED BUTTERFLY VALVE (5 REQ'D)
FILTER INFLUENT
BACKWASH & PURGE OUTLET TO RECLAIM OR TO WASTE
SIGNAL LINE TO FCP
1/4" CONTROL NEEDLE VALVE
CLEAN FEED WATER 60 PSI BY-OTHERS
1/2" CHECK VALVE
1/4" CONTROL VALVE
1/4" POLY TUBE
DRAIN 1 QUART PER MINUTE (CONTINUOUS)
ROTOMETER VALVE
PRESSURE REGULATOR
CO_2
VAC/AIR RELIEF VALVE
HYDRAULIC LOOP
FILTER EFFLUENT
DISCHARGE TO WATER DISTRIBUTOR SYSTEM OR STORAGE RESERVOIR
LEVEL SWITCHES
WATER SYSTEM RESERVOIR
PRESSURE TRANSDUCER (ALTERNATIVE)
4-20 mA TO FCP
SULFUR DIOXIDE EJECTOR
BACK PRESSURE VALVE
BACKWASH FLOW CONTROL VALVE
BACKWASH FLOW METER
EFFLUENT FLOW METER
EFFLUENT FLOW CONTROL VALVE
ANALYZER SAMPLE TAP
TO FCP
3 PHASE POWER MOTOR STARTER
BACKWASH SUPPLY PUMP
FERRIC CHLORIDE EJECTOR
SIGNAL LINE TO FCP
RAW WATER SAMPLE TAP
CHLORINE EJECTOR
TYPICAL WELL SUPPLY
BACK PRESSURE VALVE
PULSATION DAMPENER
RETURN
PRESSURE RELIEF VALVE
CALIBRATION COLUMN
TO FCP
FERRIC CHLORIDE CHEMICAL
SODIUM HYPOCHLORITE CHEMICAL
SODIUM BISULFITE CHEMICAL
TYPICAL FERRIC CHLORIDE CHEMICAL PUMPING SYSTEM
TYPICAL SODIUM HYPOCHLORITE CHEMICAL PUMPING SYSTEM
TYPICAL SODIUM BISULFITE CHEMICAL PUMPING SYSTEM
AIR LINES TO PNEUMATICALLY OPERATED BUTTERFLY VALVES
POWER
AIR DRYER (OPTIONAL)
3/8" (MIN.) AIR LINE
SYSTEM RECORDER
AIR COMPRESSOR WITH 30 GAL. STORAGE TANK W/ 2 H.P. ELECTRIC MOTOR & PUMP
FCP
SIGNAL FROM TELEMETRY PANEL
SHIELDED CABLE
FROM SIGNAL ANALYZER
WELL PUMP
120 VAC POWER
SIGNAL LINE TO WELL PUMP OR OTHER SOURCE OF SUPPLY
NOTES:
1. THIS DRAWING DENOTES TYPICAL COMPONENTS FOR VARIOUS APPLICATIONS. SEE SPECIFIC QUOTATION FOR ITEMS SUPPLIED BY FILTRONICS, INC.
2. HYDRAULIC LOOP AND ASSOCIATED AIR VACUUM-RELIEF VALVE MAY BE OMITTED PROVIDED DISCHARGE PIPING PRECLUDES THE GRAVITY DRAINING OF THE FILTER VESSEL.
3. BACKWASH PUMP MAY BE OMITTED PROVIDED BACKWASH WATER AT FLOW METER IS 19 PSIG MINIMUM AT REQUIRED FLOW.
4. FILTER INFLUENT MAY BE FROM WATER WELL, STORAGE RESERVOIR, PUMPING FACILITY OR ANY OTHER PRESSURIZED SUPPLY SYSTEM.
5. FOR DESIGN PURPOSES, THE PRESURE DROP ACROSS A CLEAN FILTER CAN BE ESTIMATED TO BE 3 TO 5 PSI MAXIMUM. THE PRESSURE DROP, AT THE END OF A FILTRATION CYCLE IS DEPENDENT UPON THE SPECIFIC APPLICATION AND IS DIRECTLY RELATED TO TURBILITY, CHEMICAL CONSTITUENTS IN THE WATER] AND FILTRATION UNIT RATE. DESIGN ESTIMATES SHOULD BE DISCUSSED WITH FACTORY REPRESENTATIVE.
THIS DOCUMENT IS THE PROPERTY OF FILTRONICS INCORPORATED IT IS LOANED UPON THE CONDITION THAT THE INFORMATION WILL BE USED ONLY AS SPECIFICALLY AUTHORIZED BY FILTRONICS INCORPORATED AND WILL NOT BE DISCLOSED TO COMPETITIVE SOURCES.
NO. DATE DESCRIPTION DRN APPD
REVISIONS
TITLE
AUTOMATIC FILTER STATION
ARSENIC REMOVAL
PROCESS & INSTRUMENTATION DIAGRAM
SCALE: NONE
DRAWN BY: D. W. Behrens
APPROVED BY:
DATE: 12/17/2002
CHECKED BY: W. E. Webb
S-200-AB
FILTRONICS, INCORPORATED
4000 LEAVERTON CT. ANAHEIM,CA.92806
(714) 630-5040
SHEET 1 OF 1
DWG NO. S-200-AB
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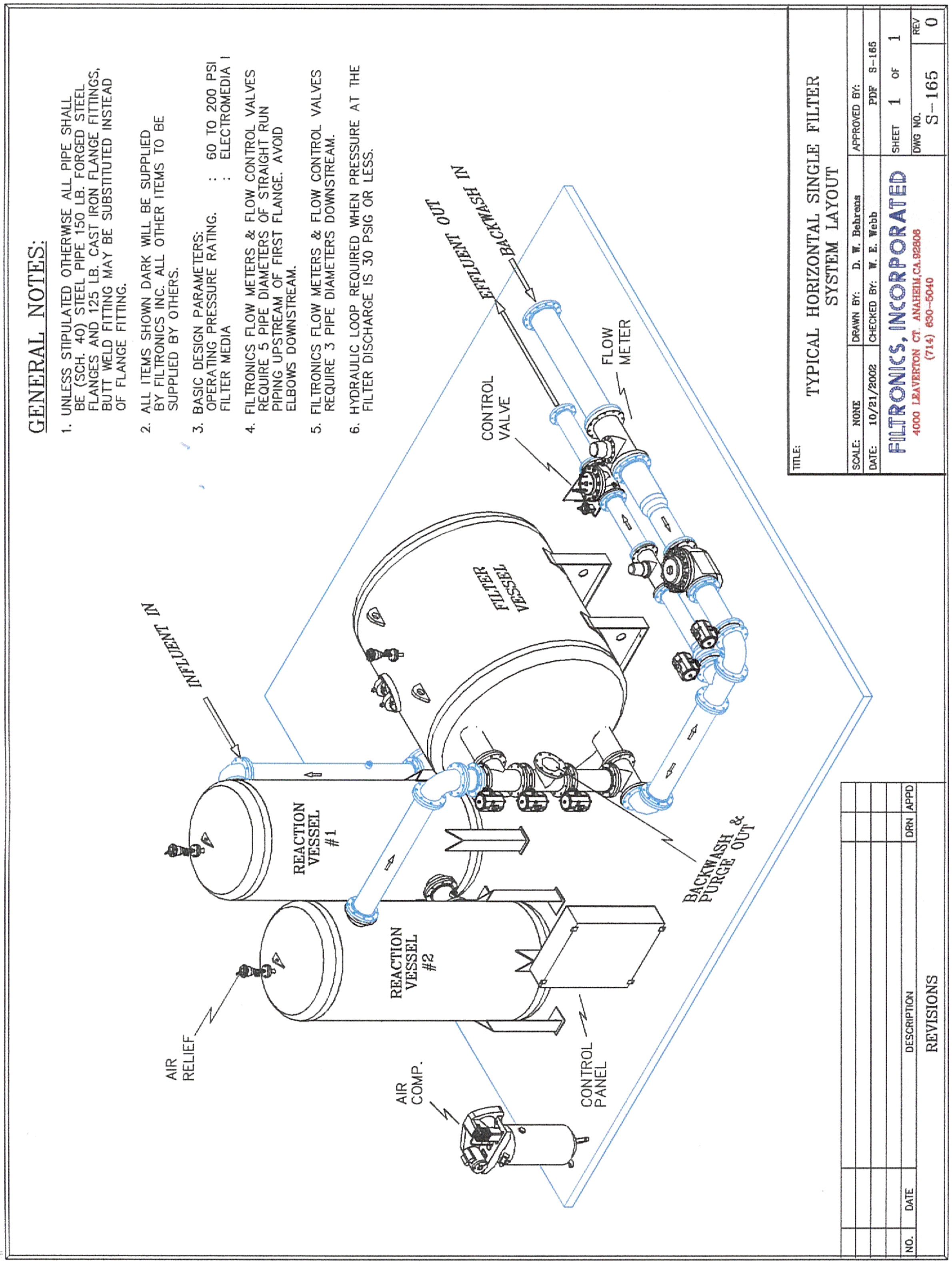
GENERAL NOTES:
1. UNLESS STIPULATED OTHERWISE ALL PIPE SHALL BE (SCH. 40) STEEL PIPE 150 LB. FORGED STEEL FLANGES AND 125 LB. CAST IRON FLANGE FITTINGS, BUTT WELD FITTING MAY BE SUBSTITUTED INSTEAD OF FLANGE FITTING.
2. ALL ITEMS SHOWN DARK WILL BE SUPPLIED BY FILTRONICS INC. ALL OTHER ITEMS TO BE SUPPLIED BY OTHERS.
3. BASIC DESIGN PARAMETERS:
OPERATING PRESSURE RATING. : 60 TO 200 PSI
FILTER MEDIA : ELECTROMEDIA I
4. FILTRONICS FLOW METERS & FLOW CONTROL VALVES REQUIRE 5 PIPE DIAMETERS OF STRAIGHT RUN PIPING UPSTREAM OF FIRST FLANGE. AVOID ELBOWS DOWNSTREAM.
5. FILTRONICS FLOW METERS & FLOW CONTROL VALVES REQUIRE 3 PIPE DIAMETERS DOWNSTREAM.
6. HYDRAULIC LOOP REQUIRED WHEN PRESSURE AT THE FILTER DISCHARGE IS 30 PSIG OR LESS.
EFFLUENT OUT
BACKWASH IN
FLOW METER
CONTROL VALVE
FILTER VESSEL
INFLUENT IN
REACTION VESSEL #1
REACTION VESSEL #2
BACKWASH & PURGE OUT
AIR RELIEF
AIR COMP.
CONTROL PANEL
NO. DATE DESCRIPTION DRN APPD
REVISIONS
TITLE: TYPICAL HORIZONTAL SINGLE FILTER SYSTEM LAYOUT
SCALE: NONE
DATE: 10/21/2002
DRAWN BY: D. W. Behrens
CHECKED BY: W. E. Webb
APPROVED BY:
PDF S-165
FILTRONICS, INCORPORATED
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(714) 630-5040
SHEET 1 OF 1
DWG NO. S-165
REV 0

ELECTROMEDIA® CAPABILITIES

Filtronics ***Electromedia***® systems have been successfully used and/or piloted to reduce arsenic concentrations 27 fold or more. Coagulation & Filtration is an effective method for reducing arsenic in groundwater and has been listed by the EPA as Best Available Technology when the Fe:As ratio of the water is greater than 20:1. This capability is further enhanced in the case of Filtronics systems by the unique adsorptive qualities of ***Electromedia***®. The Fe:As ratio of 20:1 equates to 50 ug/l of arsenic removed per 1 mg/l of iron introduced or present in the raw water which is subsequently removed by the Filtronics ***Electromedia***®.

This ratio is borne out when considering recent piloting results at Park City, UT in which a Filtronics ***Electromedia***® pilot reduced arsenic concentrations of 69+ ug/l to as low as 2.6 ug/l with a ferric chloride feed of 1.4 mg/l added to water with 0.2 mg/l of native iron.

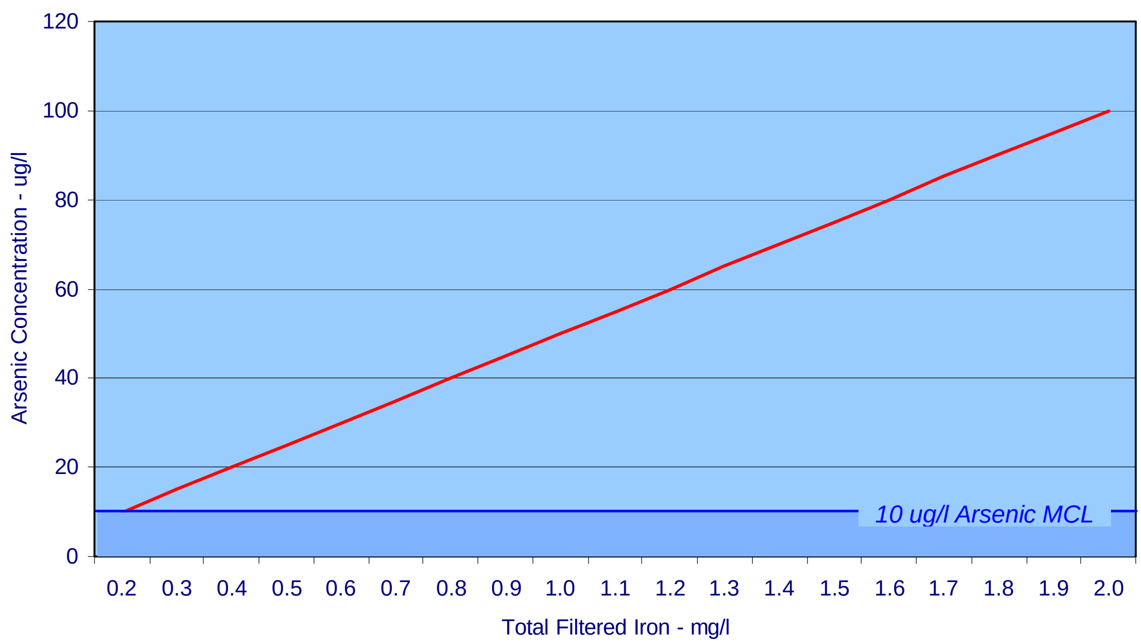


Figure 1 – Approximate relationship of iron present in water (native & introduced) to arsenic reduction following oxidation & filtration.

CAPABILITY OF MEETING THE NEW ARSENIC MCL

Filtronics ***Electromedia***® has been proven to reduce arsenic concentrations to well below the new arsenic MCL of 10 ug/l. This reduction capability has been validated by third-party testing laboratories and is discussed in detail in the next section.

HISTORY OF FULL SCALE AND PILOT-SCALE OPERATION

Filtronics, Inc. is a manufacturer of water and waste-water equipment for municipal and industrial use. The corporation was formed in 1974 with the purchase of a precursor firm. Filtronics developed several unique processes for the filtration of potable water. Among them was the ***Electromedia*® I** system for iron and manganese removal. The adsorptive qualities of ***Electromedia*® I** affect a wide range of heavy metals such as arsenic, lead, copper, gold, silver and zinc, as well as iron and manganese. The media is a specially processed material that is naturally occurring, and was originally developed to filter iron and manganese from municipal water supply sources. The media has an adsorptive surface that attracts ions of iron and manganese. Once attracted to the media, the iron and manganese molecules form a floc which accumulates on the media. The process was used for pilot studies in Park City, UT; Glenshire Mutual Water in Truckee, CA; Cannonville, UT; Hanford, CA; Prunedale, CA; and Pleasant Valley, CA for arsenic removal using the ***Electromedia*® I** process. Both the Hanford and Park City locations have full-scale systems used for the reduction of arsenic among other contaminants. These arsenic removal plants have been featured both in WaterWorld magazine as well as the AWWA OpFlow periodical.

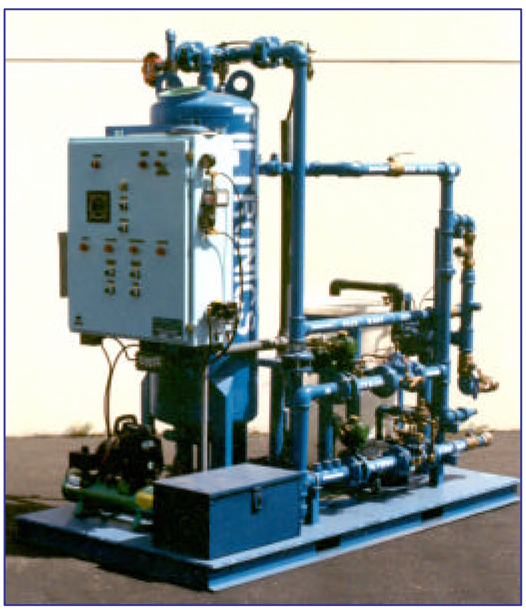


Photo 3 – Filtronics 20” automated pilot unit

Photo 4 – Filtronics 3” pilot unit

PARK CITY, UTAH PILOT PLANT STUDY REPORT

BACKGROUND: In 1990, Filtronics was engaged by the engineering firm of Eckhoff, Watson and Preator (EWP), Salt Lake City, to perform pilot tests for the Park City Municipal Corporation. The purpose of the study was to demonstrate the capability of ***Electromedia*® I** to remove arsenic and turbidity along with iron and manganese.

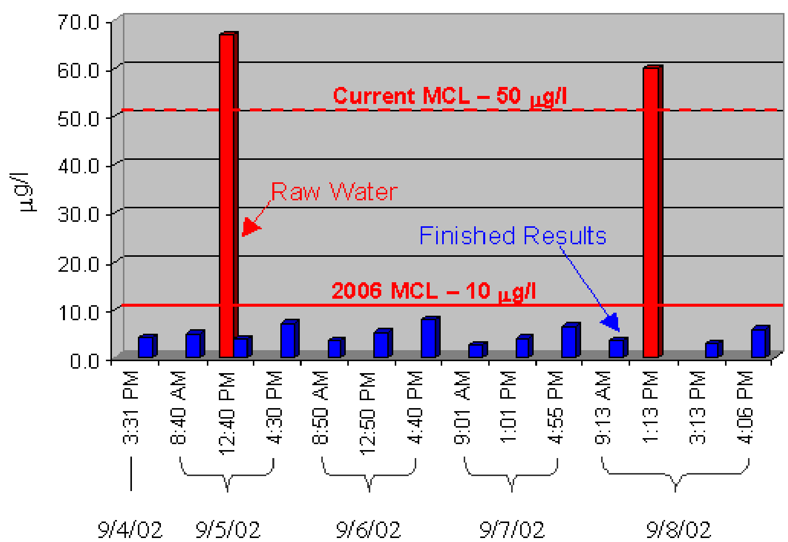
***Electromedia*® I** and the Filtronics designed system is recognized as the "state of the art" iron and manganese removal system. The results of the tests were presented in the engineers' report of which a summary follows. As a result, the corporation ordered the engineers to design a full-scale treatment facility. Filtronics provided a treatment system with a capacity of 1,000 gallons per minute for Park City.

INTRODUCTION: The report was prepared by Eckhoff, Watson and Preator Engineering (EWP) at the request of Jerry Gibbs, Director of Public Works for Park City Municipal Corporation.

OBJECTIVE: This project was conducted to determine the treatability and feasibility of using water flowing from the Spiro Tunnel for municipal supply. The Spiro Tunnel is located to the east of Thaynes Canyon and above Three Kings Drive, adjacent to the Park City Municipal Corporation's Golf Course Maintenance Facility. Water flowing from the Spiro Tunnel amounts to approximately 7,200 acre-feet per year. Some of this water is currently collected from a low-head bulkhead located approximately three miles inside the Spiro Tunnel mine shaft and is used for municipal supply. The remainder of the water flows through the tunnel and is used primarily for irrigation purposes. To determine the feasibility of using this water as a possible source of municipal supply, Park City Municipal Corporation contracted with Filtronics, Inc. to deliver a pilot plant and conduct actual field tests to determine the treatability of the water source.

PILOT PLANT: On Monday, July 30, 1990 the full-scale pilot plant testing began. The full-scale pilot plant is a skid-mounted unit capable of filtering at a rate of 20 gallons per minute. This is achieved using two reaction vessels and one filter vessel. The filter vessel has approximately two square feet of surface area of media which, when loaded at a flow rate of 10 gallons per minute per square foot of surface area, yields 20 gallons per minute. The pilot plant was operated on an automated eight-hour filter run schedule with a four-minute backwash followed by a one-minute purge cycle. The backwash rate was double the filtration loading rate and was equal to 40 gallons per minute. This is a fairly vigorous flow rate and effectively rubs the particles of the media together and dislodges the floc that has formed on the media. The one-minute purge cycle following backwash serves to settle the filter back from its expanded state and to clear out any possible contaminants. Pilot testing was concluded on September 2, 1990. The purpose of the pilot plant was to further document the removal efficiencies and to determine the chemical feed rates and required quantities.

TEST RESULTS: Field tests were conducted on a daily basis by Filtronics personnel to determine changes in operation parameters. The biggest variable in operations is the chlorine feed rate. Chlorine serves the purpose of oxidizing the iron and manganese and prepares these substances for adsorption onto the filter media. Once the field tests indicated favorable removal rates, samples were taken by EWP Engineering personnel to American West Analytical Laboratories (AWAL) and Ford Analytical Laboratories (FAL) for verification. After nearly continuous operation through the month of August 1990, the daily specific laboratory results were reviewed and it was determined the pilot plant was being operated at optimal conditions. On August 31 the testing to meet the State of Utah Department of Health, Division of Environmental Health, Bureau of Drinking Water/Sanitation requirements began. The removal rates for arsenic on the Tunnel Water were approximately 36%, while the removal rate for arsenic on the Portal Water was approximately 66%. This, it was felt, could be attributed to the additional iron present in the Portal Water. In order to determine this relationship, the Tunnel Water was inoculated with a solution of ferric chloride, which effectively increased the iron concentration. The results from the Tunnel Water tested with the ferric chloride addition indicated an approximate 70% arsenic removal rate. When the Portal and Tunnel Water sources were combined, the removal rate was approximately 46%. This would further support the hypothesis of enhanced arsenic removal with the presence of iron.

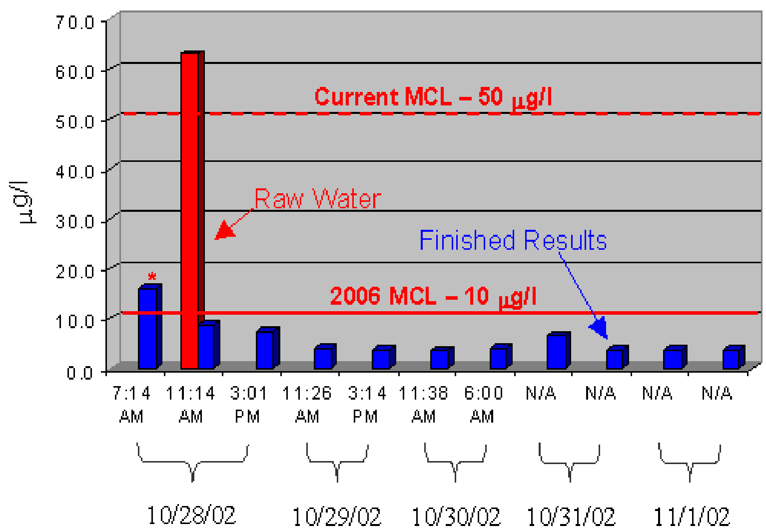


For iron removal, the Filtronics Pilot Plant performed very well. Raw water concentrations of approximately three times the MCL for iron were observed. The resulting iron concentrations in the finished water were below the limits of detection <0.03 mg/l. The MCL for iron is 0.3 mg/l; some raw water iron concentrations were observed as high as 0.8 mg/l. The Filtronics media also performed very well on manganese removal. Raw water concentrations of 0.06 mg/l were observed.

The MCL for manganese is 0.05 mg/l and the resulting finished manganese concentrations again were below detection limits <0.02 mg/l. In addition to iron and manganese removal, the Filtronics media was very effective in reducing turbidity levels. The MCL for turbidity from surface water sources is 1 NTU and 5 NTU for groundwater. Raw water turbidities were witnessed as high as 8 NTU with resulting finished turbidity levels less than 0.5 NTU. The Filtronics filter media is also somewhat capable of filtering bacteria and protozoa.

This is due to the effective size of the filter media, which is approximately 5-8 microns. Giardia has an effective size of 5-25 microns, which would indicate that this filter may be capable of removing the protozoa.

Some bacteria removal could be expected, but due to the variation and smaller size (0.5 to 5 microns), the filter will have a limited effect. However, bacteria is more susceptible to chlorination than the giardia and can be effectively dealt with using conventional chlorination techniques.



INSTALLATION: Park City installed a Filtronics Model FH-14 1,000 gpm system in December, 1992. This system is scheduled to be expanded in 2003 to increase the total plant production to 2,300 gpm. Furthermore, the new plant expansion requires arsenic reduction to comply with the new EPA standard of 10 mg/l (The original plant was designed for reduction levels satisfying the then current MCL of 50 mg/l).

SUPPLEMENTARY TESTING: There were two separate pilot runs conducted in late 2002 to qualify the Park City expansion plant for arsenic removal at the new 2006 EPA standard. The protocol for supplementary testing to reduce arsenic was as follows:

- The flow rate was set at 10 gpm/ft^2

- The chlorine breakpoint was determined on the first day of piloting. Sodium Hypochlorite (5.25 %) was used as the chlorine source.

- Each day raw and filtered water samples were taken and analyzed for Fe, Mn and As. This was done on-site. Concurrent samples were taken and sent to a lab (Chemtech-Ford). An iron based coagulant (ferric chloride) was used to co-precipitate arsenic.

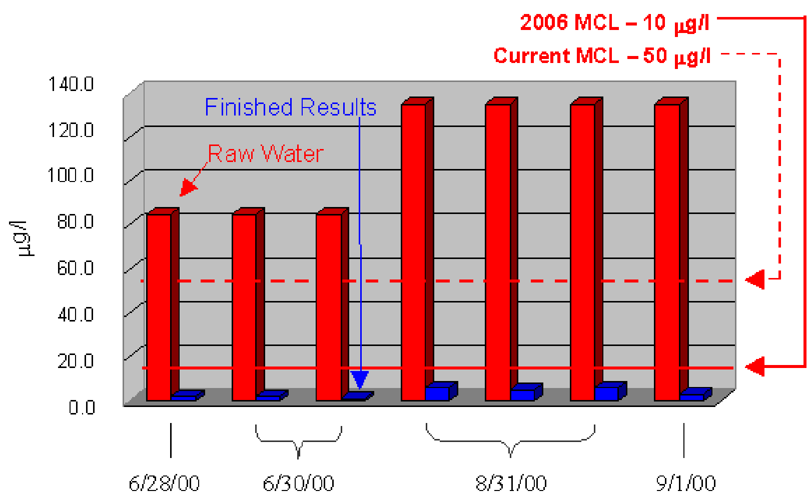
- Contact time was kept constant at about two to three minutes for one set of tests (this is the current contact time at the plant) and then at about 4 seconds for the second set of tests. The ferric feed was set at a rate of about 1.4 mg/l.

- Filter runs were eight hours long.

- Backwash samples were taken and observed for the settling characteristics.

GLENSHIRE MUTUAL WATER DISTRICT, TRUCKEE, CALIFORNIA

BACKGROUND: Filtronics, Inc., in conjunction with Boyle Engineering's Fresno, CA office, conducted a series of investigative pilots at Glenshire MWD to evaluate a number of treatment options and technologies for arsenic removal. The testing covered several months and applied numerous methods to determine the most efficient and practical method for reducing the arsenic to below Glenshire's goal of a proposed MCL of 5 ug/l. Some of the methods employed included sodium hypochlorite alone in various concentrations, ultraviolet light with ferrous sulfate, sodium hypochlorite with ferric chloride, sodium hypochlorite with ferrous sulfate, and ferric chloride alone.



DISCUSSION: The pilot columns were set up at Well #10. The raw water supply to the test unit was provided by a hose faucet connection from the well discharge pipe. The filtration rate was tested at 5 gpm/ft^2 (0.5 gpm) by a ball valve in the effluent line. The flow rate was measured by an in-line rotometer. The backwash rate was set at 18 gpm/ft^2 (1.0 gpm). Backwash flow rates are adjusted according to the temperature of the supply water. The colder the source water, the slower the backwash rate. Well water was used for the backwash. For an installed system, treated water is used. The pilot was performed to reduce the arsenic to the proposed EPA standards of 5 ppb. The raw water analysis showed arsenic at 135 ppb. Filtronics arsenic results with sodium hypochlorite and ferric chloride fell well below MCL at 5 ug/l. The lab analysis showed that the arsenic was 99% pentavalent. The remaining arsenic was trivalent. The lab showed total arsenic at 135 ppb. The dissolved arsenic (+3) was about 3 ppb. Arsenic can be successfully removed using ferric chloride. Filtronics arsenic results with ferric chloride fell well below the MCL at 5 ug/l. This is the method of choice due to the fact that it is the simplest and least expensive.

CANNONVILLE , UTAH PILOT PLANT STUDY REPORT

INTENT: The intent of this pilot test was to determine chemical pretreatment requirements as well as the most effective and most cost efficient filter rate to effectively reduce iron, manganese and arsenic in the raw water to satisfy the State Department of Health Services standards as well as the requirements of the city of Cannonville, UT. This pilot's purpose was also to confirm for the city of Cannonville the feasibility of reducing the iron and arsenic in the water from the wells with Filtronics' ***Electromedia*®** **I** filtration system. Using water analysis data supplied by Jones and DeMille Engineering, the Langelier Index; a measure of water corrosion was calculated in order to make recommendations for corrective action, if necessary.

PILOT UNIT: The pilot unit used on-site to conduct the study consisted of the following:

- Liquid chemical feed equipment for sodium hypochlorite and Filtronics IBF (iron based flocculent)

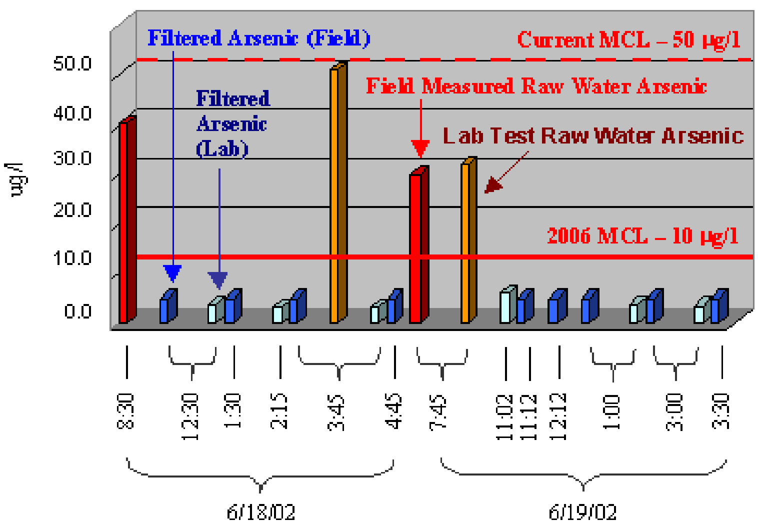
- A free standing combination three inch diameter pilot column with ***Electromedia*®** **I** filter media for iron, manganese and arsenic removal. Two, one minute chemical reaction columns stacked one above the other, used for sodium hypochlorite.

- Manual ball valves and connector tubing to effect backwash and filter cycles.

The three-inch pilot unit has two modes of operation; filtration and backwash. All functions of the pilot unit are manually controlled. During filtration the water flows past the chemical injection position, through the reaction columns to the top of the filter, through the media, then out the bottom of the filter past the rotometer. Flow is measured by the in-line rotometer and is controlled by a ball valve. Back washing the filter is performed by changing the ball valves to bypass the reaction column. First the flow is directed to the rotometer to set the rate. Then it is directed to the bottom of the filter so the water flows up through the media and out the top of the filter column. The backwash cycle lasts four minutes. The chemical feed pumps are shut off during this cycle.

DISCUSSION: The well was pumping at a rate of approximately 90 gpm throughout the testing. The pilot columns were set up at the well site. The raw water supply to the test unit was provided by a hose faucet connection from the well discharge pipe. The filtration rate was fixed at 10 gpm/ft^2 (0.5 gpm) by a ball valve in the effluent line. The flow rate was measured by an in-line rotometer. The backwash rate was set at 18 gpm/ft^2 (1.0 gpm). This was based on the supply water for backwash being at a temperature of 74?F.

Backwash flow rates are adjusted according to the temperature of the supply water. The colder the source water, the slower the backwash rate. Well water was used for the backwash. For an installed system, treated water is used. During the testing, samples were taken to measure the iron, manganese, arsenic and free and total chlorine residuals in the treated water. Chlorine is used by the ***Electromedia*®** **I** system for the oxidation of the objectionable constituents. It is injected into the first chamber of the reaction column. For this test, household bleach (5.25% sodium hypochlorite) was diluted into bottled water to make up the chlorine solution for pretreatment. The dilution and feed rate were varied to provide different dosages. The effluent free and total chlorine residuals were measured. Chlorine breakpoint was found to be at a dosage of approximately 3.5 mg/l. The Iron Based Flocculent was fed at .2 mg/l. It was injected after the chlorine. Iron tests were performed throughout the study on the raw and finished water.



The raw water iron concentration was found to be around 1.0 mg/l (one of the outside labs showed raw water iron levels at 3.8 mg/l). Every test for iron in the effluent water resulted in levels below the 0.3 mg/l MCL (Maximum Contaminant Level). Finished water iron never exceeded 0.03 mg/l. Arsenic tests performed by the HACH Arsenic test kit showed arsenic levels all below 10 ppb. The outside lab results showed levels all at or below 6 ppb. Manganese tests were performed on the raw and finished water. The raw water manganese concentration was found to be approximately 0.042 mg/l (one reading was at 0.089mg/l). The manganese in the effluent water was below the 0.05 mg/l MCL.

CONCLUSIONS: A chlorine dosage of approximately 3.5 mg/l was indicated to be the breakpoint for the well. This dosage was the minimum required for treatment of water from this well and resulted in approximately a 1.0 mg/l free residual from the filter. Filtronics requires a filter effluent free residual of greater than 0.5 mg/l for disinfection purposes. The treatment indicates that chlorine alone resulted in excellent arsenic and iron removal.

The addition of ferric coagulant showed no change in the results. As a result of on-site pilot testing, the ***Electromedia®*** **I** filter system was found to be effective in the removal of arsenic, iron and manganese from the water that was tested. The chlorine alone at 3.5 mg/l is sufficient to reduce the contaminants to below the MCL.

HANFORD, CALIFORNIA FULL-SCALE TREATMENT SYSTEM

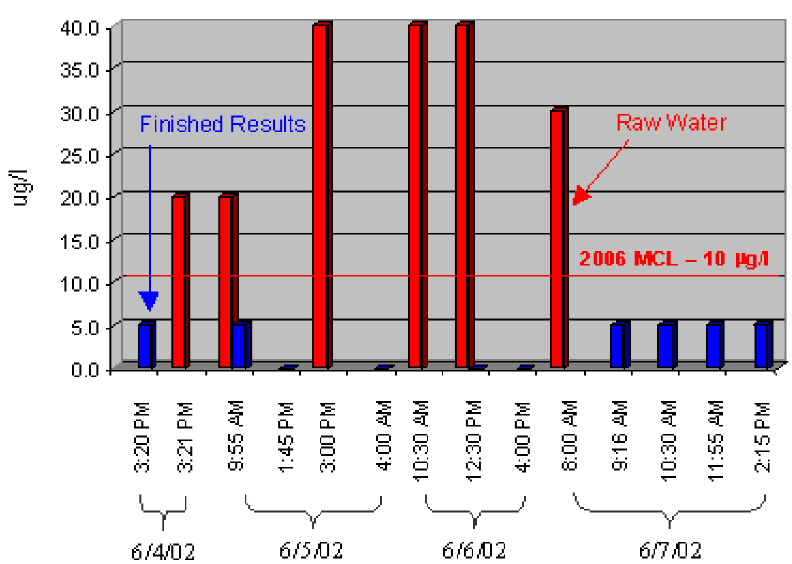
Hanford, CA experienced long-standing hydrogen sulfide and some color difficulties in its 15 active groundwater wells. Many wells also bordered on non-compliance with the old EPA arsenic standards of 50 ppb. Under the new standard, 14 of Hanford's wells are out of compliance. Hanford is a medium sized city in central California serving approximately 40,000 residential, commercial and industrial customers. In anticipation of the new arsenic standard, a pilot study at one of Hanford's wells was conducted in November 1998 using a treatment system manufactured by Filtronics, Inc. The 1,700 foot tested well had been operating 18 months before it began producing colored water in the range of 30 to 60 TCU's. The water also had a noticeable hydrogen sulfide odor and arsenic levels ranging from 25 to 92 ug/l. As a result, the well was never put on-line. When the portable Filtronics pilot plant began treating water from the well, water was produced with non-detectable color, zero hydrogen sulfide and arsenic levels from non-detectable to 3.4 ppb near the end of the test run. Based on the success of the test, a full-scale wellhead treatment plant was designed and constructed in 2000 at an approximate total project cost including installation of $600,000. Built to a 20-year municipal standard, the 1000 gpm system uses a pressure flocculator vessel (with a 10-minute retention time) in which the coagulant and other treatment chemicals react with the contaminants in the water. The water then enters two steel pressure filter vessels (ASME Code approved and epoxy lined using an ANSI approved coating) in parallel at a loading rate of 10 gpm per square-foot of filter area.

Photo 2 – City of Hanford, CA Filtronics arsenic treatment system

Two filters were used to reduce the backwash flow requirement (one filter is backwashed at a time) to reduce demands on Hanford's distribution system. The non-hazardous sludge produced during backwash is discharged to the sewer and processed with other waste-waters normally. The backwash to filtration ratio is 0.2 percent for the Filtronics treatment system, so in addition to being non-hazardous, there is a comparatively small volume of wastewater and sludge of which to dispose versus other possible treatment schemes. The system is fully automated and routine maintenance is limited to checking control valves and monitoring chemical feed equipment. Since Filtronics systems work on multiple contaminants using a single special filtration media, it has proven to be cost effective. For a city like Hanford with several contaminants, multiple treatment schemes aren't necessary, keeping equipment and facility costs down.

PRUNEDALE, CALIFORNIA PILOT PLANT STUDY REPORT

DISCUSSION: The well was pumping at a rate of approximately 90 gpm throughout the testing. 3" pilot columns were set up at the well site. The raw water supply to the test unit was provided by a hose faucet connection from the well discharge pipe. The filtration rate was fixed at 6 gpm/ft^2 (0.3 gpm) by a ball valve in the effluent line. The flow rate was measured by an in-line rotometer. The backwash rate was set at 17 gpm/ft^2 (1.0 gpm). This was based on the supply water for backwash being at a temperature of 20 degrees centigrade. Backwash flow rates are adjusted according to the temperature of the supply water. The colder the source water, the slower the backwash rate. Well water was used for the backwash. For an installed system, treated water is used. During the testing, samples were taken to measure the arsenic, iron, manganese and free/total chlorine residuals in the treated water. Chlorine is used by the ***Electromedia***® **I** system for the oxidation of the objectionable constituents. It is injected into the first chamber of the reaction column. For this test household bleach (6% sodium hypochlorite) was diluted into bottled water to make up the chlorine solution for pretreatment.



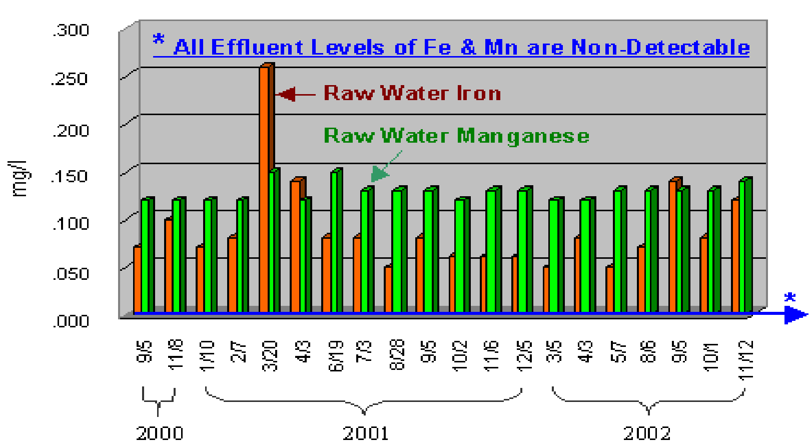
The dilution and feed rate were varied to provide different dosages. The effluent free and total chlorine residuals were measured. Chlorine breakpoint was found to be at a dosage of approximately 3.5 mg/l for the combined wells and 2.5 mg/l for Wells #1 & #2. The raw water had a strong hydrogen sulfide odor. This was not indicated by the general mineral analysis. The Iron Based Flocculent was fed at a rate of 4.5 and 6.2 mg/l. These dosages were too high and there was breakthrough of the iron. The dosage was dropped to 2 mg/l on the following day of testing with excellent results on iron, manganese and arsenic removal. Iron tests were performed throughout the study on the raw and finished water. The raw water iron concentration was found to be around 28 mg/l. There was a breakthrough of iron due to the high levels of IBF. This dose was reduced with no breakthrough. Manganese tests were performed on the raw and finished water. The raw water manganese concentration was found to be approximately 0.38 mg/l. The manganese in the effluent water resulted in levels below the 0.05 mg/l MCL.

Due to the presence of hydrogen sulfide in the water, the chlorine dosage was raised to 7 mg/l to improve the manganese removal. All manganese levels were under the MCL at both chlorine dosages.

CONCLUSIONS: A chlorine dosage of approximately 3.5 mg/l was indicated to be the breakpoint for the well. This dosage was the minimum required for treatment of water from these wells and resulted in approximately a 1.0 mg/l free residual from the filter. Filtronics requires a filter effluent free residual of greater than 0.5 mg/l for disinfection purposes. The testing showed that a dosage of approximately 2 ppm of IBF resulted in excellent arsenic removal.

PLEASANT VALLEY, CALIFORNIA PILOT PLANT STUDY REPORT

The following graph illustrates the ***Electromedia®'s*** consistant superb iron and manganese reduction capability. ***Electromedia®*** performance does not decay over time. Pleasant Valley, California, has a Filtronics system that has consistently produced effluent water with non detectable levels of iron and manganese.



STRENGTH OF SUPPORTING DATA: LAB, PILOT, FULL SCALE

On-site testing is conducted using the following methods:

- Iron: Ferrozine method adapted from Stookey, L.L., ANAL. CHEM. 42 (7) 779 (1970).

- Manganese: P.A.N. method adapted from Goto, K., et al, Talanta 24 7523 (1977).

- Chlorine free and total: DPD powder pillow method, US EPA approved.

- A HACH DR-890 Digital Colorimeter was used to obtain the values for the above constituents.

- HACH EZ-Arsenic, arsenic color match test kit.

All Filtronics piloting is validated through third-party sampling and independent verification using a state-approved or recognized testing laboratory. Split samples are strongly recommended. They offer credibility to our test results and are extremely important with waters that have high hardness levels that may give false high readings. Piloting data is confirmed at full-scale system start-up through on-site testing.

AVAILABILITY OF THIRD-PARTY TEST DATA

Supportive third-party testing data is available in facsimile form upon request for consideration of this proposal.

PRE/POST TREATMENT NEEDS FOR A SPECIFIC HOST SITE (INCLUDING RESIDUALS HANDLING)

Post treatment for the Filtronics process requires backwashing of the media with filtered water at a rate of 17 - 20 gpm/ft^2. Minimum backwashing is required every 8 hours for four minutes and 1 minute of rinsing of the media. Backwash water may be sent to a reclaim tank. The reclaim tank acts as a clarifier allowing the residual matter to settle out over a ninety minute period. After the settling period, the clarified water in the tank will be recycled back into the system. This process conserves water. Backwash solids can be disposed of at a landfill once a year. The residual matter is not classified as hazardous waste because the arsenic concentrations are less than 5 mg/kg and can be disposed to the closest applicable landfill.

O & M COSTS

There are three chemical feeds associated with the treatment of arsenic: sodium hypochlorite for oxidation, sodium bisulfite for sulfide related odor and taste problems, and ferric chloride iron based coagulant for arsenic sequestration. The cost of chemicals varies depending on initial water quality, flow rate, and filter media loading flux rate. Actual costs can only be validated through pilot testing. Based on a 1000 gpm flow, 5 mg/l chlorine dosage, 0.25 mg/l bisulfite dosage and 1 mg/l ferric chloride dosage, we are able to estimate the following chemical costs:

SODIUM HYPO-CHLORITE $0.84		SODIUM BISULFITE $1.25		FERRIC CHLORIDE $0.97		TOTAL CHEMICAL COSTS	
# / Day	$ / Day	# / Day	$ / Day	# / Day	$ / Day	$ / Day	$ / Year
3.7164	$3.12	0.900	$1.13	3.60	$3.49	$7.74	$2,825.10

Filtronics customers have reported that their average inspection and maintenance routine requires about one man-hour per day. Assuming a water system operator's salary is $45,000 per year, this amounts to $21.63 per day ($7,894.95 per year) in labor costs to service the Filtronics system. Assuming a 24/7 operation with three hours of reclaim/booster pump operation per each 24-hour period, the following estimated power costs would apply. Electricity has been projected at $0.10 per kWh.

System Power Draw (kW)	Est. Annual Power Cost
31	**$3,395.00**

The ORP residual analyzer uses about 100 lbs. per year of CO_2 gas as it monitors chlorine residuals. The 50 lb. gas cylinder will therefore need to be refilled twice each year. The cost for a CO_2 refill is about $26.00 for a total of $52.00 per year in carbon dioxide gas. Chart recorder paper is replaced weekly at the Filtronics control panel. This paper is available in quantities of 50 per package (Filtronics part #ID-030) and costs $22.00 per package, for an annual chart recorder paper cost of $22.88.

PRE/POST TREATMENT COSTS

Backwash water is sent to a reclamation tank every eight hours for decanting/clarification. Over a period of ninety minutes backwash solids are allowed to settle to the bottom of the reclamation tank. Though it will generally take between 18 to 24 months to fill the bottom foot of the reclaim tank with backwash solids, it is recommended that this material be removed once each year. There are a number of ways this non-hazardous waste can be removed, including but not limited to a floor drain in the tank to sewer, pumper truck, by hand, etc.

If this waste is removed in solid/dry form it can be taken to an appropriate landfill for disposal. Assuming a landfill disposal cost of $110 per 2,000 lbs., we can extrapolate the following disposal costs for a 1,000 gpm system:

Annual lbs. BW Solids	Est. Annual Landfill Cost
4380	**$241**

NARRATIVE EXPLANATION OF WHY THE TECHNOLOGY OR ENGINEERING APPROACH IS SUPERIOR TO PROVEN CONVENTIONAL TREATMENT IN TERMS OF COST

***Electromedia*® I** arsenic removal is a proven technology with systems in the field; it is not experimental or based solely on piloting data. All Filtronics water treatment systems feature automatic PLC-controlled operation ensuring consistent, thorough, and timely backwash of the filter bed. This reduces expense both in operator time as well as through assuring maximum media life. Filtronics systems allow for greater flow rates through the media with flux rates in the 5, 10, and 15 gpm/ft^2 range. This allows for a much smaller filtering plant footprint saving capital cost in terms of vessel and pipe size. ***Electromedia*® I** only requires a 4 minute backwash with a 1 minute purge cycle as compared to greensand systems which need a minimum 15 minute backwash cycle with a 15 minute purge along with air scour and surface wash. This means that a typical Filtronics 1,000 gpm system will produce about 9,500 gallons of backwash waste versus 67,000 gallons generated by a conventional system. This smaller backwash volume makes reclamation practical for a Filtronics unit where it would not be realistic with a conventional system. This saves money on a number of levels: the cost of the water lost to backwash is significantly reduced, sewer costs (if applicable) are minimal, with reclaim a Filtronics unit can capture and reprocess better than 99% of backwash water, and additional real estate is not required for the massive ponds typical of conventional systems. Filtronics ***Electromedia*® I** does not require chemical regeneration. Also, ***Electromedia*® I** is a permanent media and remains intact for life the of the system. Conventional systems require expensive media bed replacements every five to seven years. With Filtronics ***Electromedia*® I**, arsenic treatment is identical to standard iron, manganese, and sulfide oxidation, and filtration process. Except for the addition of an iron based flocculent (ferric chloride) there are no expensive pre/post treatments required. With ***Electromedia*® I** there is no hazardous waste generated - backwash falls well below the T-CLP 5 mg/kg rule. Other technologies such as greensand with ponds, adsorptive media, and ion exchange can produce hazardous waste which must be specially handled. Filtronics water treatment backwash may be discharged directly to the sanitary sewer and in the case of reclamation, concentrated solids may go to a landfill. There are no membranes or elements to fool with as is the case with reverse osmosis and nano-filtration units. The Filtronics ***Electromedia*®** **I** system utilizes simple, inexpensive chemical feeds. Most any oxidant may be used meaning that the operator may choose less expensive chemicals such as sodium hypochlorite or chlorine. Other systems require more expensive chemical schemes such as greensand which uses far more costly potassium permanganate. For instance, a simple 1,000 gpm ***Electromedia*®** **I** arsenic removal system with a 24/7 operation has an annual hypochlorite, sodium bisulfite, and ferric chloride chemical cost of approximately $15,500 compared to a comparable greensand system which has a potassium permanganate and ferric chloride annual chemical cost of $36,800.

OPERATOR SKILL REQUIREMENTS

Water Treatment Operators should hold a DHS Grade 2 Water Treatment or Distribution Certificate, depending on state requirements. Typical experience and ability would include operating a computer-controlled console to monitor and ensure efficient operation of the water filtration plant. Operating equipment, motors and pumps used in the treatment of water. Regulation and control of the amount of chemicals used to maintain specified water treatment requirements. Take samples and readings at established times, perform standardized water quality analysis and adjust chemical feeders and other plant equipment according to results. Take accurate meter and chart readings, interpret information to determine daily water use. Change recording charts as needed. Observe pumping equipment to identify possible problems, equipment failures, and operating difficulties. Monitor pressure and flow data, perform routine field activities and facilities security. Respond to alarms and take the necessary actions to maintain a reliable water supply. Maintain a variety of records, and logs for the water filtration plant and the distribution system. Collect water samples for laboratory process control testing and perform water quality tests.

AUTOMATION AND PROCESS CONTROL CAPABILITY

All Filtronics ***Electromedia*®** systems provide for automated filtration, backwash and purge cycles as well as automated chemical feed adjustment through an Allen-Bradley programmable controller. Each Filtronics control cabinet includes a remote access modem connection for maintenance and troubleshooting. The PLC provides automatic reset timers for each filter cycle and a time delayed process start signal. The Filtronics Series 6000 recorder/controller includes a seven day, 120 VAC pen drive, with a 4 to 20 milliamps DC input as well as high/low alarm contacts. All pilot lights and switches are NEMA 13 oil tight - there are status lights for each filter mode, a low air alarm/push to test pilot light, and a power status pilot light. The air control system consists of a cabinet mounted adjustable differential pressure switch, adjustable low air pressure switch monitor, 4-way electro-pneumatic solenoid valves with manual override, air filter and air lubricator for pneumatic system, and inlet and outlet pressure gauges for monitoring differential pressure. Interlocking electrical control relays for chemical treatment equipment/associated pumps protect control cabinet circuitry from damage in the case of faulty wiring or shorts. Plug-in components are used for easy servicing and troubleshooting and the control panel is factory wired and completely tested for function prior to shipment. System air is provided by a 2 hp, 1/60/115-230 compressor including V-belt, guard, motor, drive and air tank. The system control panel is UL-508 Certified.

LEVEL OF REQUIRED MAINTENANCE - BACKWASHING, CLEANING, ETC.

DAILY

- Check recorder for proper chemical dosage. When dosage is established, it should require checking only once a week.

WEEKLY

- Dosage should be adjusted to maintain a minimum of 0.50 ppm or the breakpoint value, whichever is greater, for chlorine residual at the filter effluent and maintain the pen in the "green" section of the chart recorder.
- Change the chart paper in the recorder.
- Check the CO_2 bottle in the residual analyzer.
- Check oil level in the valve oiler on the filter control panel. Two to three drops of oil should be seen in the observation globe when the valves change position. The adjustment screw on the lubricator should be nearly closed.
- Check oil level in air compressor (if furnished).
- Check pressure gauges on discharge of chemical injection pump.
- Verify that the differential pressures are the same as those recorded during start-up.

MONTHLY

- Check temperature of backwash water.
- If necessary, adjust backwash flow rate according to the "Backwash Rate Versus Temperature Chart".

YEARLY

- Open filter vessels and measure media depth.
- Compare with original measurement for possible loss of media.

CHEMICAL USAGE AND HANDLING REQUIREMENTS

The proposed system uses sodium hypochlorite for oxidation, sodium bisulfite for sulfide odor and taste issues and ferric chloride as an arsenic complexing agent. Basic handling requirements require hypochlorite storage in a cool, dry place away from acids. It should not be stored in metal containers. Use in a well ventilated area is required. Small spills should be mopped up with water and run to waste. Large spills should be transferred to a salvage container and a professional disposal company should be consulted. Inform local authorities if liquid has entered surface drains or sewers. Handlers of sodium bisulfite should avoid bodily contact, wash thoroughly after handling, avoid breathing mist, and store away from acids and oxidizers. Ferric chloride containers should be kept tightly closed and stored in a corrosive-proof area. Containers of ferric chloride may be hazardous when empty since they retain product residues (vapors, liquid): observe all warnings and precautions listed for these products.

SAFETY REQUIREMENTS

Primary safety concerns involve the chemicals used for treatment (sodium hypochlorite, sodium bisulfite, and ferric chloride). Operators must read and be familiar with MSDS information for each of these substances. Industry standards for chemical handling, use, and disposal must be observed.

PHYSICAL CHARACTERISTICS: DESCRIPTION OF EQUIPMENT

Please refer to page 11 for a typical system layout diagram as well as the section labeled *"Capital costs including engineering and installation"* for a component by component system description. A typical Filtronics water treatment system consists of a filter vessel and two reaction vessels with face piping and valve assemblies. Piping is Schedule 40 steel pipe with 150# forged steel flanged connections. Flow control valves include a hydraulically operated diaphragm backwash flow control valve and a hydraulically operated diaphragm effluent flow control valve. There are five wafer type pneumatically controlled butterfly valves for filtration, backwash and purge cycle control. Automation is provided for by a Filtronics control cabinet which incorporates an Allen-Bradley programmable controller, remote access modem, automatic reset timers, chart recorder, pilot lights and switches, status lights, 4-way electro-pneumatic solenoid valves, and a 2 hp, 1/60/115-23-compressor for instrument air. The control cabinet is UL 508 certified. Three chemical feed packages are provided (sodium hypochlorite, sodium bisulfite and ferric chloride). An ORP residual analyzer monitors chemical residuals for automatic feed control.

UNIT SIZE AND TRANSPORTABILITY: SPACE REQUIREMENTS

Filtronics systems are designed for fixed installations though most systems can be adapted to skid mounting if required. System footprint dimensions can vary depending on site layout and piping interface schemes.

ENERGY REQUIREMENTS

The Filtronics water treatment facility requires power for a 2 hp, 1/60/115-230 compressor; 3 amp, 1/60/115 AC control panel as well as 115v chemical feed pumps and associated 230 VAC reclaim and booster pumps.

ADAPTABILITY TO EXISTING SYSTEM (ADD ON TECHNOLOGY)

The Filtronics unit is intended for installation directly to the wellhead discharge. No special pretreatment or handling is required.

ENGINEERING/INSTALLATION REQUIREMENTS (PACKAGE VS. SPECIALLY DESIGNED SYSTEMS)

Filtronics systems are designed for installation on a reinforced concrete pad or saddles as specified by the design engineer. Pad design factors include fully loaded vessel weight and soils compaction data for the specified site. For areas where freezing conditions may prevail, a filtration building, piping installation, and/or heat tracing may be necessary.

ENVIRONMENTAL IMPACTS

The effect of the Filtronics ***Electromedia*®** **I** system on the environment during normal operation is negligible in the extreme. As previously noted, reduced solids from the Filtronics backwash process are not hazardous (passing T-CLP) and may be removed to a local landfill. There are no chemical by-products produced which require any special treatment. Normal care and disposal of spent sodium hypochlorite, sodium bisulfite, and ferric chloride containers should be exercised according to industry conventions and safe practices.