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ELECTROMEDIA® I PROCESS DESCRIPTION

The **Electromedia® I** iron, manganese, and lead removal process includes oxidation and filtration by an adsorptive media.

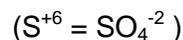
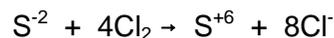
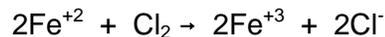
OXIDATION

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

REACTION VESSEL I

Water is received from the well source and treated with chlorine to oxidize the iron, manganese and sulfides present. **Electromedia® I** may be used with any number of oxidants or combination of oxidants. The iron is oxidized to ferric iron and the manganese to the manganic form. The lead is oxidized to lead basic carbonate. And sulfides are oxidized to sulfate. Sulfate is common in water supplies and does not contribute objectionable taste or odor. A sufficient amount of chlorine is added to the water to meet the chemical demand and 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:





The stoichiometric requirements for the above reactions are:

0.63 mg/l of chlorine per mg/l of iron

1.29 mg/l of chlorine per mg/l of manganese

0.34 mg/l of chlorine per mg/l of lead

8.33 mg/l of chlorine per mg/l of sulfide

The chemistry of sulfur is quite complex. In the equation given above the sulfur is oxidized from sulfide with a valence of -2 to sulfate (SO_4)⁻² with sulfur at a valence of +6. This reaction proceeds through intermediate complex forms of sulfur as discussed in the section on hydrogen sulfide. Typically "rubber tire" taste and odor complaints are the result of polysulfide formation. "Earthy" or "musty" taste and odor complaints are from the formation of colloidal elemental sulfur. To preclude the formation of these products, a small dose of sulfur dioxide is added in the presence of excess oxidant. The sulfur dioxide carries the reaction through these intermediate products to sulfate. The same mechanism is used in the production of sulfuric acid. The dosage of sulfur dioxide depends on the chemistry of the water and is determined from the general mineral analysis. It is typically 0.25 mg/l to 0.50 mg/l.

REACTION VESSEL II

The water is received from reaction vessel number one and injected with a small dose of 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 rubber tire" taste and odor.

The introduction of 0.25 mg/l to 0.50 mg/l of 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 and manganese 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 Waals forces
- Hydrogen bonding
- Coulombic bonding
- Chemical bonding

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

The *Electromedia*[®] I system does not require regeneration. The nature and size of the media and the vigorous backwash that is 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 and manganese are backwashed from the media and the surfaces are thoroughly scrubbed. The backwash rate is 20 gallons per minute per square foot for a duration of four minutes.

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

1. 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. 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. Safety. The **Electromedia[®] I** system utilizes an all vacuum distribution of chemicals from cylinder mounted regulators to the point of injection. The only pressure point is at the cylinder. A failure in a vacuum line automatically shuts down the chlorine supply.
6. Efficient. Chemical injection is accomplished by gas at the point of application. This utilizes the maximum chemical oxidation-reduction potential possible and 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".

When the raw water is relatively corrosive a pH adjustment will be required. The final pH will be a function of the Langelier Index and may be determined by a general mineral analysis. A variety of chemicals may be used for this purpose: sodium carbonate, lime or sodium hydroxide.

OPERATION AND DESIGN SPECIFICATIONS

- Filter flux: Up to 15 gpm/ft²
- Backwash duration: 4 minutes regardless of loading
- Backwash initiation: 8 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 oxidize: 0.63

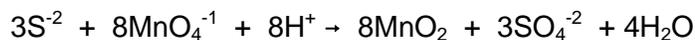
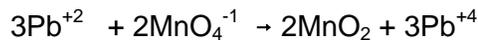
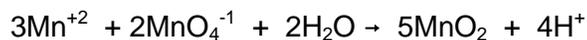
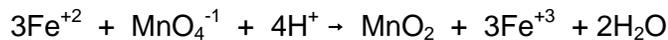


mg/l of chlorine per mg/l of iron, 1.29 mg/l of chlorine per mg/l of manganese. 0.34 mg/l of chlorine per mg/l of lead, 8.33 mg/l of chlorine per mg/l of sulfide plus organic demands which may be present.

- Sulfur dioxide: Feed rate of 0.25 mg/l to 0.50 mg/l between the first and second one minute reaction vessel.
- Media: Filtronics *Electromedia*® I

POTASSIUM PERMANGANATE

The use of potassium permanganate for the removal of iron and manganese is attractive because the reactions are complete and rapid. When iron and manganese are organically bound or complexed they are more difficult to remove. This requires a higher oxidation-reduction potential to initiate the reactions. The reactions for oxidizing iron, manganese and sulfides with potassium permanganate are:



The stoichiometric requirements for the above reactions are:

0.94 mg/l of potassium permanganate per mg/l of iron

1.92 mg/l of potassium permanganate per mg/l of manganese

0.50 mg/l of potassium permanganate per mg/l of lead

12.37 mg/l of potassium permanganate per mg/l of sulfide

The resultant product in every equation is MnO_2 , a precipitate that must be removed by the filter. For every pound of KMnO_4 added, one half pound of manganese dioxide sludge is generated. Most manganese greensand filters are capped with a layer of anthracite to help remove the bulk of the solids so as not to blind the greensand. The filters are equipped with an air scour step to ensure the greensand is scrubbed clean during backwash.

Manganese greensand is a zeolite processing adsorptive qualities when properly treated with



an excess of potassium permanganate.

The manganese resident in the greensand complexes with the excess permanganate to form manganese in the +5 and +6 valence forms. The adsorptive qualities provide the greensand with two features. One, it will attract soluble iron, manganese and sulfide compounds to the surface of the media and retain them in the bed. Two, since energy is stored in the bed though the regeneration process, the bed can oxidize these compounds/elements to form the required precipitates or non-objectionable compounds (such as sulfide to sulfate). The sulfate is a soluble compound and passes through the filter. The iron and manganese form precipitates which are eventually backwashed from the filter.

Regeneration may be accomplished by two methods: continuous regeneration or intermittent regeneration (regeneration at backwash). Regeneration at backwash would occur after a normal backwash sequence consisting of:

- Drain down
- Air scour
- Fill
- Backwash at 12 to 15 gpm per square foot for a period of 10 to 15 minutes.
- Reduce backwash rate to 1 gpm per square foot and inject a concentrated solution of potassium permanganate, 2% is recommended, until the pink color of the solution is detected in the backwash water.
- Run a filter to waste cycle until there is no pink water, ranging from 5 to 20 minutes or longer.

Continuous regeneration is more efficient but more difficult to control. An excess of permanganate must be carried to the filter to accomplish the regeneration. Should the demand vary, an over feed or under feed condition will occur. Continuous over feed conditions result in permanganate remaining in solution and passing through the filter resulting in the classic "pink" water complaint. Under feed eventually depletes the bed and the soluble manganese from the well passes through the filter resulting in the brown or black water complaints. Demand variances from varying hydrogen sulfide concentrations can be particularly troublesome because of the high ratio of permanganate to sulfide required to achieve the oxidation of sulfide to sulfate. It requires 12.37 mg/l of potassium permanganate to oxidize 1.0 mg/l of sulfide. Therefore, a small change in sulfide concentration can result in a large change in the permanganate requirement resulting in "pink" water going to the distribution system if overdosed or rotten egg odor complaints if under dosed.

The AWWA monthly publication Opflow covered the typical operation of a manganese greensand iron and manganese removal plant in their February 1985 Volume 11, issue #2. This



article notes the 'trial and error' operation requested by the operator to maintain performance.

SUMMARY:

Filtronics *Electromedia*[®] I systems are easier to operate and produce consistently high quality filtrate.

Filtronics *Electromedia*[®] I systems save money. Chlorine is much less expensive than potassium permanganate.

Filtronics *Electromedia*[®] I systems use low chemical feeds. For every part per million of:

| | <u>Cl₂</u> | | <u>KMnO₄</u> |
|-----------|-----------------------|-----|-------------------------|
| Iron | .64 ppm | vs. | .94 |
| Manganese | 1.29 ppm | vs. | 1.92 |
| Lead | 0.34 | vs. | 0.51 |
| Sulfide | 8.33 ppm | vs. | 12.37 |

Electromedia[®] I systems don't burden the process by introducing a chemical compound that ultimately must be removed by the filter.

Reliable and built to last.

Efficient - use less backwash water, reclaim backwash systems optional to recover 99.9% backwash water.

Less manpower required to maintain and operate.

WHAT TO DO NEXT?

1. Complete a general mineral analysis form for each source water. The form is in this catalog section.
2. Return the completed general mineral analysis to us. We will review the chemical nature of the water and hydraulic considerations.
3. We will discuss possible options with you and prepare a budget proposal covering the equipment required for this application. We approach it from a "system responsibility" point of view. We will also provide a cost comparison.
4. Fax us your information now to (714) 630-1160.



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