Section I
DESCRIPTION OF SYSTEM OPERATION

This section describes the basic system operation for the ATEC high rate iron and manganese removal system.

SYSTEM DESCRIPTION

The ***ATEC Iron and Manganese Removal System*** [1] is an in-line, pressure filter system that uses *ATEC* AS-741M Filter Media[2], a granular manganese dioxide (MnO_2) with a pyrolusite base, as the filtration media. The typical system contains three to twenty filter vessels with common inlet and outlet manifolds.

The media-bed usually consists of a single 36"-to-48" layer of *ATEC Systems* 741M Filter Media. An anthracite cap is not used over the filter media. The use of a mono-media filter bed, combined with the physical properties of the media, simplifies the backwash operation.

ATEC IRON AND MANGANESE REMOVAL PROCESS

Iron and manganese are relatively abundant in the earth's crust and find their way into many ground and surface water supplies. These metals can result in discolored water, growth of autotrophic bacteria called *ctenophores*, increase chlorine demand, tubercle formation and taste and odors in potable water supplies.

Removal Mechanisms

Two of the most commonly used removal mechanisms for iron and manganese removal include:

- Oxidation, precipitation and filtration, and
- Adsorption.

Iron and manganese found in groundwater systems are predominantly found in their reduced forms: ferrous iron (Fe^{2+}) and manganous manganese (Mn^{2+}). Oxidation of these reduced forms results in formation of ferric iron (Fe^{3+}) and manganic manganese (Mn^{4+}) sometimes Mn^{3+} is formed as well.

Adsorption removal mechanisms sorb dissolved iron and manganese onto manganese dioxide and has also been reported to act as an oxidizing contact medium and filtration medium. Adsorption kinetics are much faster than oxidation kinetics. In laboratory tests performed by Knocke (1990) manganese concentrations of up to 1.0 mg/L found most uptake occurred in the top 6 inches of the media. This finding was also repeated in full-scale plants at Durham N.C.

Knocke's (1991) later findings included:

1. The sorption of Mn (II) by MnOx(s)-coated filter media is very rapid. Both sorption kinetics and sorption capacity increase with increasing pH or surface MnOx concentration.
2. In the absence of a filter-applied oxidant, Mn (II) removal is by adsorption alone.
3. When free chlorine is present, the oxide surface is continually regenerated, promoting efficient Mn (II) removal over extended periods of time.

Media used for adsorption includes pyrolusite; the material from which AS-741M Filter Media are derived. To maintain efficient uptake kinetics, a continuous application of chlorine adequate to yield a free chlorine residual in the range of 0.5 to 1.0 mg/L in the product water is provided as a continuous regenerant.

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1 Patent pending.

2 ATEC Systems 721M and 741M Filter Media is certified by NSF to ANSI/NSF Standard 61.

ATEC High-Rate Iron and Manganese Removal

Iron and manganese are removed by adsorbing partially the reduced forms of the compound onto AS-741M filter media.

This process differs from most iron and manganese removal processes in that iron and manganese are purposely ***not precipitated*** during the process. By avoiding precipitation, loading rates of 7 to 16gpm/ft^2 are commonly achieved.

In order to optimize and maintain removal, chlorine is used to maintain the media in a highly oxidized state. Chlorine is introduced into the water supply at the wellhead or other injection point immediately before the water enters the filters at a level adequate to maintain a free chlorine residual in the treated water. If iron or manganese bacteria are present, a free chlorine residual of at least 1.0 mg/L is recommended to control the bacteria. This oxidation of the manganese dioxide media maintains the adsorption capacity and is effectively a continuous regeneration process.

Application Rates

Typical service flow rates (also referred to as application or loading rates) range from 7 to 16gpm/ft^2. These rates vary depending on water quality. The normal interval between backwash cycles is from 12- to -24 hours under most operating conditions. Operating pressure loss through the filter system at flow rates of 15-gpm or less per square foot of filter surface area is less than 3 psig. The system normally overrides the time setting on the backwash controller when the pressure differential exceeds 5 psig.

Refer to the ATEC Systems, Treatment System Summary Table for the application rate information for your specific system. The application rate for your system may be exceeded during backwash, when all of the well's water output is being run through one less filter.

Backwashing to Maintain Removal Characteristics

After a specified period of adsorption, the vessels are backwashed to remove the adsorbed iron and manganese from the media. In the event that water quality adversely changes, the media will be backwashed when the pressure differential exceeds 5 psig. Backwash is normally performed with filtered system water but the system can be set up to backwash with water from an external source if necessary or desired. Unless required by the specific characteristics of a particular installation, the system remains on-line during backwash. The controller can interface with the customer's SCADA system if desired.

As mentioned above, much of the adsorption takes place in the top of the filter media bed. It follows that it is easier and more efficient to backwash the media before the iron and manganese that is being removed from the source water penetrates to the lowest sections of the media bed. For this reason, we recommend backwashing at least once every twenty-four hours of production and preferably every twelve hours, particularly at the outset. Refer to the ATEC Systems, Treatment System Summary Table for the backwash rate and duration for your specific system.

Proper backwashing is a critical and controllable variable in the treatment process and merits significant operator attention. In excess of 98% of the calls *ATEC Systems* receive from customers having problems with removal, whether it be iron and manganese or particulate matter, are ultimately found to be related to improper backwash operations.