

## **GREENSAND PLUS**

The GreensandPlus process for the removal of iron, manganese and hydrogen sulfide from groundwaters is an enhancement to the original Manganese Greensand process which has been used since the 1950's in the United States. Since then, GreensandPlus has been found to be effective in the removal of arsenic and radium as well. Historically, the original Manganese Greensand product was utilized through two distinct processes, the IR (intermittent regeneration) and the CR (continuous regeneration) process. Today, GreensandPlus is most commonly utilized through a more efficient and cost effective CO (catalytic oxidation) process.

GreensandPlus is processed from a special gradation and purity of silica sand to which a manganese dioxide coating is fusion bonded. This coating provides the GreensandPlus with its special chemical oxidation-reduction properties for the removal of iron and manganese as well as hydrogen sulfide.

The advantages of the GreensandPlus process over aeration and filtration are; single pumping (as the process generally employs pressure filtration), reliability, flexibility, and a high quality effluent coupled with ease of operation. Operational options including CO and IR are uncomplicated in both their design and operation, resulting in efficient and reliable methods for iron and manganese removal.

The mechanism for iron and manganese removal by GreensandPlus in the CO mode is oxidation followed by physical removal of the resulting precipitates by filtration using a GreensandPlus or GreensandPlus-&-anthracite bed. In the IR method, the manganese is removed by contact oxidation. Arsenic, when raised to the +5 state, tends to co-precipitate with ferric hydroxide, a precipitate that is commonly produced in the CO process. Similarly, both radium 226 and 228 tend to co-precipitate with manganese dioxide.

### **CO Process**

The GreensandPlus CO process, as previously mentioned, is applicable on well waters where iron and manganese removal is the main objective. This process can remove iron from water in concentrations up to 15 mg/L or more. However, with such high concentrations, the run length between backwashings would be minimized.

The CO process involves the feeding of an oxidant (generally chlorine) or combination of oxidants to raw water prior to contact with the GreensandPlus bed. Oxidants should be injected into the raw water stream ahead of the filter(s) to insure the greatest contact time. Enough chlorine can be fed to provide the desired residual in the treated water.

The GreensandPlus bed performs a dual function to complete the removal of iron and manganese. First, correct operation of a CO filter requires that a slight residual of chlorine will insure that the oxidant demand has been met. The manganese oxides will then precipitate on the grains, maintaining them in a continually regenerated state. Conversely, a temporary underfeed of oxidant would utilize the oxidizing capacity of the regenerated GreensandPlus to complete the oxidation of iron and manganese as required. Therefore in the CO process the GreensandPlus acts as a redox buffer with capabilities of both oxidation and reduction as required by influent water conditions. Second, it is a well-known fact that in iron and manganese removal by oxidation, the presence of manganese oxide will act as a catalyst whether the oxidizing agent is oxygen, chlorine, ozone, or permanganate, insuring that the reaction goes rapidly to completion.

Extended service with an underfeed of oxidants prior to the filter will eventually exhaust the oxidative capacity of the media with resultant manganese leakage into the treated water, even if the raw water contains no manganese. The media must therefore remain in a continually regenerated form at all times. This is easily accomplished by a visual check for the "orangeish" color in the filter influent and/or the presence of chlorine in the effluent.

The closed pressure filter normally contains a gravel support bed for the proper distribution of backwash waters, and a GreensandPlus and anthracite dual media bed. Dual media beds can range from 15" to 24" GreensandPlus and 12 to 24" anthracite. Deeper anthracite beds are recommended for waters with high iron concentrations, over 2- 3 mg/L. As the run progresses, the pressure drop increases as the filter bed becomes contaminated with the insoluble oxidation products. After either a predetermined number of gallons or when the headloss reaches approximately 8-9 psi, the bed should be backwashed to remove the filtered particulates. Please note that in some instances the precipitated iron is of such a nature that it filters in depth and leaks into the effluent, even after a 2- 5 psi differential pressure increase. In this case backwashing should be initiated on a gallonage basis. In addition, in applications where there is a predominance of manganese, it is also beneficial (although not necessary) to provide some means of periodic air washing to minimize the formation of "mudballs" and/or channeling by maintaining the filter media in a loose, clean condition. Naturally, no regeneration of the media is required prior to returning the unit to service due to the continuous regeneration during service. As with conventional filtration processes such as oxidation by aeration followed by filtration, the backwash waste water can be collected for reuse and the settled precipitates sent to a sanitary sewer or drying bed.

## **IR Process**

When the well water contains all manganese, or mostly manganese with lesser quantities of iron, the intermittent regeneration process can be considered. This process involves passage of the raw water through a GreensandPlus bed where oxidation of manganese occurs directly on the grains utilizing the oxidative capacity of the treated GreensandPlus. Although GreensandPlus will oxidize appreciable amounts of iron directly on the grains as well, iron has a tendency, proportionate to the concentration, to coat or foul the media with iron oxides which then inhibit both the oxidation properties and regeneration reactions of the GreensandPlus. For this reason, waters being treated by the IR process for manganese removal which also contain appreciable concentrations of iron, should have a pre-oxidation step, either in the form of chlorine injection or aeration to convert the iron to its insoluble form. Precipitates of iron are then filtered out and manganese is oxidized on the individual grains and becomes an integral part of the manganese oxide coating. A 12"-15" layer of anthracite is recommended for these type waters.

After treating a specified number of gallons, the oxidation capacity of the media will be consumed and regeneration is required. Prior to regeneration the media should be backwashed to remove collected precipitates and to reclassify the media. Again, with an appreciable iron concentration, a high loading of filterable material indicated by a high pressure drop across the bed will require that the filter be backwashed possibly before the oxidation capacity of the media has been utilized. In such as case as this, the filter can be backwashed without regeneration and then placed back into service.

Regeneration consists of the downflow passage of a dilute oxidant solution through the bed. Following regeneration, the filter will require rinsing until all the excess oxidant is gone. The IR method may also be very flexible with regard to regeneration, as the excess regenerant can be recycled to use for the next regeneration. In this way there are no oxidant disposal problems and chemical costs are minimized.

There are certain limitations with the use of GreensandPlus in either the CO or IR process. The minimum pH with either process is 6.2. At a raw water pH of less than 6.2, pre-pH adjustment would be required. With the CO process, however, pre-pH correction should not exceed 6.8-7.0 to prevent formation of a non-filterable iron colloid, which sometimes occurs

In any circumstance, with questionable waters, it is recommended that a pilot plant study be undertaken to determine the optimum operating parameters.

## **ADVANTAGES OF GREENSAND PLUS VS. OTHER PROCESSES**

GreensandPlus is a specially processed medium for iron, manganese, and hydrogen sulphide removal. GreensandPlus is a premium non-proprietary filter medium which is processed from silica sand upon which a manganese dioxide coating is fusion bonded.

This material has a high buffering or oxidation- reduction capacity due to the well defined manganese oxide coating.

The grains of GreensandPlus are of both the size and shape to capture the fine precipitates of iron and manganese which pass through the upper coarse anthracite layer during normal service conditions. No expensive polymer or other filter aid is needed to prevent leakage of these oxidation products.

Greensand products have been in use for over 50 years and are unequalled in performance. Beware of claims that other medias are "just as good" or "the same as" GreensandPlus.

Other "supposedly" comparable media are formed by adding chemicals, in place, to form manganese hydroxide which is supposed to adhere to the filter media after a 24 hour contact period. Unlike GreensandPlus, there are no specifications or samples for these type media to show the similarity to GreensandPlus.

The GreensandPlus process requires no detention time, no secret expensive filter media, no high concentration of chlorine, and no sulphur dioxide. Greensand Plus catalytic by nature and is not soluble. There is no increase in the total dissolved solids of the treated water. It is not necessary to backwash GreensandPlus every time the well pump starts up.

GreensandPlus can be operated at flow rates up to 12 GPM per sq. ft. on waters with moderate concentrations of iron and manganese. As with any filtration process, the run length to a specified pressure drop is inversely proportional to the flow rate. Pilot tests are recommended, and usually specified by the various regulatory agencies, for operation at these higher rates.

## **ADVANTAGES OF GREENSAND PLUS**

GreensandPlus has many advantages over other iron and manganese removal media.

1. Optimum grain size and shape to retain oxidation precipitation products of iron and manganese.
2. All GreensandPlus grains have the same finite uniform coating which is firmly attached.
3. All GreensandPlus is processed to exact specifications and tested prior to shipment or placement into filters.
4. Unequalled oxidation-reduction buffer capacity. Can tolerate slight over or underfeed of continuously fed oxidants.
5. Unequalled effluent water quality.
6. Adaptable for gravity, vertical, or horizontal pressure filters.
7. No on-site batch chemical preparation required to attempt to form a manganese oxide coating.
8. No "black box" chemicals are required.
9. Not a "secret" expensive filter media.
10. No media reconditioning is required because coating is firmly attached to the GreensandPlus.
11. Manganese oxide coating is not removed during backwashing.
12. No expensive polymer or filter aid is required.
13. No extended seasoning or conditioning period is required.
14. Only chlorine (no potassium permanganate) is required for the catalytic method of operation.
15. No excessive concentration of chlorine and no sulphur dioxide is ever needed.

16. No detention time is required.
17. Filter backwashes are not needed every time well pump starts up.
18. No leakage of alkaline substances which cause increased hardness and high pH under certain conditions.
19. Precipitated products rapidly settle out of backwash water, making wash water reclamation simple and economical.
20. GreensandPlus is not proprietary and samples are available on request for inspection or pilot plant testing.
21. GreensandPlus is NSF (National Sanitation Foundation) listed.
22. The AWWA (American Water Works Association) has developed a standard for greensand.