MINERS AND MANUFACTURERS
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Inversand Company

SINCE 1925

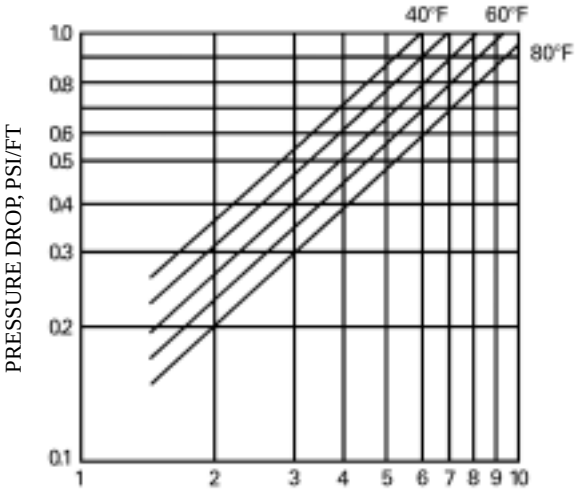
MANGANESE GREENSAND CR & IR

Manganese greensand is a purple-black filter medium used for removing soluble iron, manganese and hydrogen sulfide from well water supplies. It also has the capability of removing radium and arsenic. It is processed from the mineral glauconite which is a zeolite. Using the ion exchange properties of this natural zeolite, a manganese dioxide coating is deposited on the surface of the glauconite grains. Each grain has a finite amount of manganese dioxide coating it. Unlike in-situ treated media, there is no need for any extensive pre-conditioning of the filter media to try to apply a coating. The filter media is ready to install in the filter and be regenerated.

The manganese dioxide coating acts as a catalyst in the oxidation reduction reaction of iron and manganese. The media can be used in two methods of operation: continuous regeneration (CR) and intermittent regeneration (IR). The CR method is recommended for predominantly iron-bearing waters with or without the presence of manganese, and the IR method is recommended for use on groundwaters in which manganese predominates.

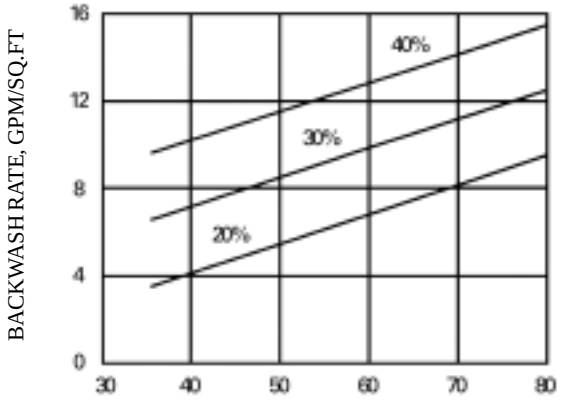
Additionally, manganese greensand is listed under ANSI/ NSF Standard 61 for potable water treatment components.

PRESSURE DROP



The approximate clean bed pressure drop for each foot of manganese greensand bed depth is shown above. Pressure drop increases as the service run progresses. Do not exceed a differential pressure of 10 psi

BED EXPANSION DURING BACKWASHING



Following a service cycle manganese greensand should be backwashed for 10 minutes with a minimum bed expansion of 40%. This requires a 12gpm/sq.ft. backwash rate at a backwash water temperature of 55 °F.

PHYSICAL CHARACTERISTICS

Physical form	*Black, nodular granules, shipped in a dry form*
Apparent density	*85 pounds per cubic foot net (1362 kg/m³ net)*
Shipping weight	*89 pounds per cubic foot net (1426 kg/m³ net)*
Specific gravity	*Approximately 2.4*
Screen grading (dry)	*18 x 60 mesh*
Effective size	*0.30 to 0.35 mm*
Uniformity coefficient	*Less than 1.6*
pH range	*6.2 - 8.5 (see General Notes)*
Maximum temperature	*Above 80°F (27°C) contact Inversand Company*
Maximum pressure drop	*8 - 10 psi (0.6 - 0.7 bar)*
Backwash rate	*Minimum 12 gpm/sq.ft. at 55°F (30m/h at 13°C)*
Service flow rate	*2 - 5 gpm/sq.ft. (5 - 12 m/h)*
Minimum bed depth	*24 inches (0.6 m) - 15 to 18 inches (0.4 - 0.45m) of each media for dual media beds*

METHOD OF OPERATION

CR

Continuous Regeneration (CR)

Continuous regeneration (CR) operation is recommended for well waters where iron removal is the main objective with or without the presence of manganese. This method involves the feeding of a predetermined amount of potassium permanganate ($KMnO_4$), and/or chlorine (Cl_2) directly to the raw water before the filter.

Chlorine should be fed at least 10 - 20 seconds upstream of the $KMnO_4$, or as far upstream as possible, to produce the desired Cl_2 residual in the filter effluent. $KMnO_4$, if required, should be fed to produce a "just pink" color in the filter inlet. This slight excess of $KMnO_4$ or a Cl_2 residual carried through the filter will maintain manganese greensand in a continuously regenerated condition.

The dosage of Cl_2 and $KMnO_4$ may be estimated as follows:

$$\text{mg/L } Cl_2 = \text{mg/L Fe}$$
$$\text{mg/L } KMnO_4 = (0.2 \times \text{mg/L Fe}) + (2 \times \text{mg/L Mn})$$

Without Cl_2 the $KMnO_4$ demand may be estimated by:

$$\text{mg/L } KMnO_4 = (1 \times \text{mg/L Fe}) + (2 \times \text{mg/L Mn})$$

SUGGESTED OPERATING CONDITIONS

Bed Type	Dual media: anthracite 15-36 in. (0.4-0.9 m) and manganese greensand 15-24 in. (0.4-0.6 m)
Pressure Drop	Max. pressure drop 8-10 psi (0.6-0.7 bar)
Capacity	500-700 grains of oxidized iron and manganese/sq.ft. of bed area (350-490 grams per m^2) based on potassium permanganate demand and operation to an 8-10 psi pressure drop. Some ground waters contain iron in a form that filters in depth and the pressure drop may not exceed 4-6 psi before iron appears in the filter effluent.
Backwash	Sufficient rate using treated water to produce 40% bed expansion.
Air/Water Scour	Optional using 0.8-2.0 CFM/sq.ft. (15-37 m/h) with a simultaneous treated water backwash at 4-5 gpm/sq.ft. (10-12 m/h)
Raw Water Rinse	At normal service flow rate for 3-5 minutes or until effluent is acceptable.
Flow Rate	Recommended flow rates with CR operation are 2-5 gpm/sq.ft. (5-10 m/h). Extremely high concentrations of iron and manganese usually require lower flow rates for equivalent run lengths. Higher flow rates can be considered with very low concentrations of iron and manganese. For optimum design parameters pilot plant testing is recom mended.

The run length between backwashes can be estimated as follows:

What is the run length for a water containing 1.7 mg/L iron and 0.3 mg/L manganese at a 4 gpm/sq.ft. (9.8 m/h) operating rate?

$KMnO_4$ demand
= (1 x mg/L Fe) + (2 x mg/L Mn)
= (1 x 1.7) + (2 x 0.3)
= 2.3 mg/L or 2.3 ÷ 17.1 = 0.135 grains/gal.(gpg)
(or 2.3×10^{-3} g/L)
At 700 grains/sq.ft. loading ÷ 0.135 gpg = 5185 gal/sq.ft.
(At 490 g/m^2 loading ÷ 2.3×10^{-3} g/L = 213,000 L/m^2)
At 4 gpm/sq.ft. service rate 5185 ÷ 4 = 21.7 h
(At 9.8 m/h service rate 213 ÷ 9.8 = 21.7 h)

The backwash frequency to an 8 - 10 psi (0.6 - 0.7 bar) pressure drop is approximately every 20 - 24 hours of actual operation.

METHOD OF OPERATION IR

Intermittent Regeneration (IR)

The IR method of operation may be used for well waters where only manganese, or manganese with small amounts of iron is to be removed. Briefly, it involves regeneration of manganese greensand with a predetermined amount of $KMnO_4$ after a specified quantity of water has been treated. With this method, pressure drop is minimized as manganese is removed by contact oxidation on the grains. Anthracite is not required if there is little or no iron present.

SUGGESTED OPERATING CONDITIONS

Backwash Rate	Sufficient rate to produce approximately 40% bed expansion.
Pressure Drop	Max. pressure drop of 8-10 psi (0.6-0.7 bar). If maximum pressure differential is reached before the removal capacity for Mn is obtained, manganese greensand may be backwashed without regeneration.
Capacity	300 grains Mn/cu.ft (690 g/cubic meter). Prechlorination is recommended espe cially if iron is present.
Air/Water Scour	Recommended using 0.8 - 2.0 CFM/sq.ft. (15 - 37 m/h) with a simultaneous treated water backwash at 4 - 5 gpm/sq.ft. (10 - 12 m/h)
Flow Rate	2 - 5 gpm/sq.ft. (5 - 12 m/h), or 1 - 2 gpm/ cu.ft. (8 - 16 BV/h). For higher flow rates contact supplier.

Regeneration

$KMnO_4$ Dosage	1.5 - 2.0 oz./cu.ft. (1.5 - 2.0 kg/m^3)
$KMnO_4$ Stock solution strength ...	2 - 4 oz./gallon (15 - 30 kg/m^3)
$KMnO_4$ Regeneration volume	7.5 gal./cu.ft.* (1 BV)
$KMnO_4$ Regeneration rate	0.25 gpm/cu.ft. (2 BV/h)
$KMnO_4$ Regeneration time	30 minutes optimum
Rinse rate (raw water)	1 gpm/cu.ft. (8 BV/h)
Rinse volume	40 - 50 gal./cu.ft. (5.3 - 6.7 BV) or until all traces of $KMnO_4$ are gone

*Using 0.5 - 1.0 gallons (67 - 134 L) of stock solution and 6.5 - 7.0 gallons (870 - 940 L) of dilution water.

BV = Bed Volume (1 BV = 7.5 gal./ft^3)

Note: Recycle of regenerant and rinse water will conserve both $KMnO_4$ and rinse waste water.

GENERAL NOTES

pH

Raw waters having a natural pH of 6.2 or above can be passed through manganese greensand without pH correction; water with a pH lower than 6.2 should be pH corrected to 6.2-6.5 before treatment with manganese greensand. If a pH higher than 6.5 is desired in the water system, the additional alkali should be added following the filter due to the possible adverse reaction (formation of colloid) that sometimes occures with the iron and alkali at a pH above 6.5

Removing Fines and Initial Conditioning

CR Operation

Prior to placing a CR filter into service, manganese greensand should be thoroughly backwashed and the top layer of finer material removed by undercutting. This is especially important if anthracite is placed on top of the manganese greensand bed. Each bag of manganese greensand as shipped containes sufficient material to compensate for removing 1 inch of finer materal.

CR and IR Operation

Manganese greensand is NOT shipped in a regenerated form; therefore it is necessary, prior to use, to regenerate with a solution of potassium permanganate solution contacting the bed for a minimum of 4 hours. A regeneration level of 4 ounces of potassium permanganate per cubic foot is recommended. Before placing in service the filter must be rinsed of all remaining traces of potassium permanganate.

Radium and Arsenic Removal

The manganese greensand process has been found to be successful in removing radium and arsenic from well water supplies. This occures via adsorption onto the manganese and/or iron precipitates that are formed. For radium removal, soluble manganese must be present in the raw water for removal to occur. Arsenic removal has been achieved with either iron or manganese being present in the water. Pilot plant testing is recommended.

A Partial Listing of Companies Offering Manganese Greensand:

Cochrane Div. Crane Co.	Hungerford & Terry, Inc.	Osmonics
Culligan	Water & Power Tech.	Chematex AB
Ecodyne	Garnet Abrasives	CWG Water Technology GmbH
US Filter	Alamo	Roberts Filter
Graver Water	Matt-Son	Tonka Equipment Co.

A properly operated manganese greensand filter should never have potassium permanganate or “pink water” in the filter effluent. If however, it is felt that insurance against pink water should be provided there are detectors available to signal an alarm or shut down chemical feed equipment should pink water be detected in the filter effluent. Further details are available from your equipment manufacturer.

WARRANTY