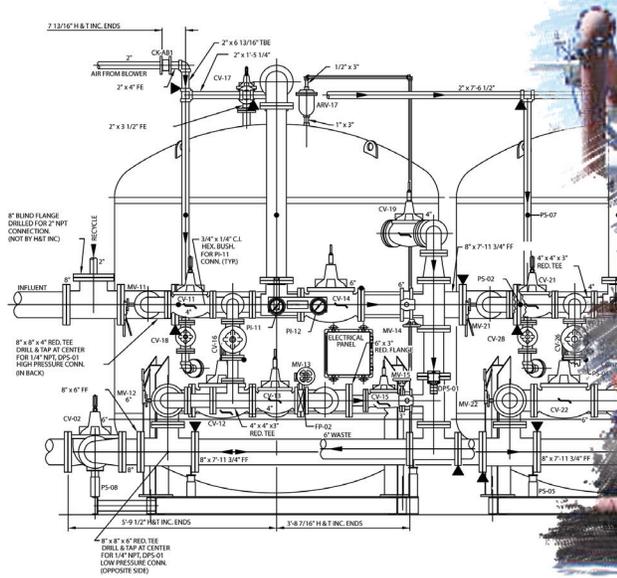


Hungerford & Terry GreensandPlus™ Filtration Systems

A Proven Filtration Method
for reliable, cost-effective removal of
Iron, Manganese and Arsenic
from groundwater



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HUNGERFORD & TERRY GREENSANDPLUS™ FILTRATION SYSTEMS*

GREENSANDPLUS™ FILTER MEDIA

Prior to World War II, researchers in the water-treatment field, working with well-known chemical theories of oxidation and reduction, developed the basic technology of manufacturing manganese greensand from the mineral glauconite. This medium found use in the municipal and industrial water-treatment market for the direct oxidation and removal of iron, manganese and hydrogen sulfide.

By 1965, **Hungerford & Terry** had perfected and patented the predecessor to the GreensandPlus Filter—the Ferrosand CR filter process, an oxidant feed prior to filtration that continuously regenerates the catalytic coating on the media. The Catalytic Oxidation process was developed using a special Catalytic Grade of the media. This system operated at higher loading rates and did not require the use of potassium permanganate, the objective being to produce a top-quality filter system that would reliably remove iron and manganese.

Today, as always, **Hungerford & Terry** custom-designs, builds or reconfigures filtration systems to meet customers' specific requirements. Every system sold is extremely competitive in both capital and long-term operating expenses. H&T has never attempted to sell an off-the-shelf system that almost or barely meets customers' precise needs.

GREENSANDPLUS FILTRATION TECHNOLOGY

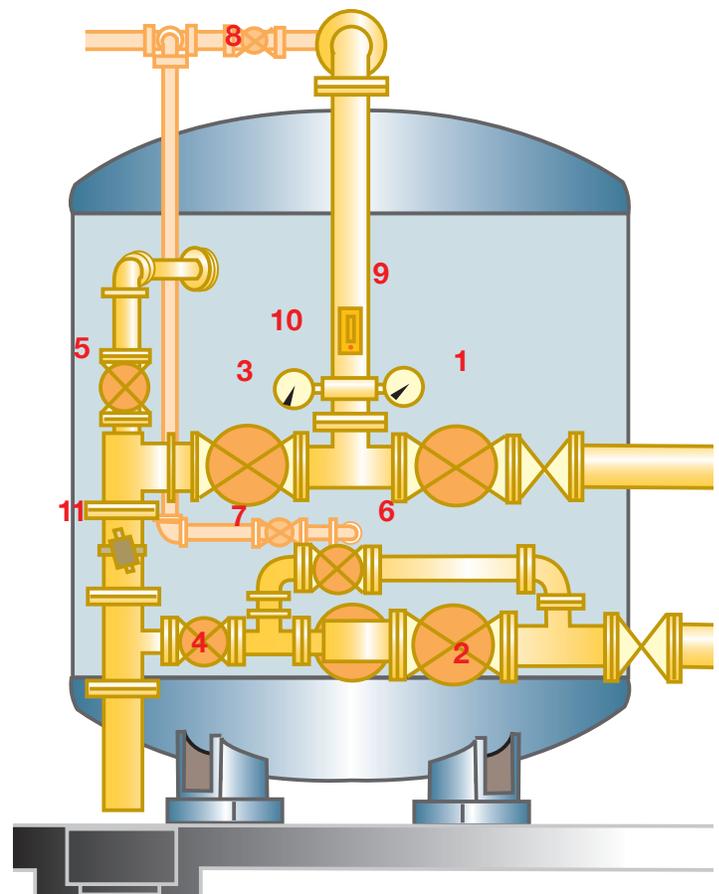
GreensandPlus media is manufactured to exact specifications to ensure the complete oxidation of soluble iron and manganese by using stoichiometric quantities of oxidizing chemicals without the need for long reaction times or high pH levels. GreensandPlus is not one of those "magic media" that have exaggerated claims of magnetic properties for the attraction of iron and manganese. As a filter medium, it operates on the chemical principle of oxidation, reduction and the well-known catalytic effect of manganese oxide. Catalytic oxidation and filtration using a manganese dioxide coated media has demonstrated its effectiveness as the proven technology in iron and manganese removal for over a half a century.

GreensandPlus media performs optimally when combined with our unique filter system design. The GreensandPlus Filtration System is engineered to ensure

the most cost-effective performance while producing outstanding water quality.

1. Inlet Valve
2. Outlet/Backwash Valve
3. Backwash Outlet
4. Rinse Outlet
5. Draindown
6. Slow Refill (Air/Water Wash)
7. Air Inlet
8. Air Pressure
9. Flow Indicator
10. Pressure Gauges
11. ΔP Switch

The external arrangement of a GreensandPlus air/water wash system.



* GreensandPlus™ is a product of the Inversand Company.



HUNGERFORD & TERRY GREENSANDPLUS™ FILTRATION SYSTEMS

TWO METHODS OF DESIGN AND OPERATION – CATALYTIC OXIDATION (CO) FOR IRON AND MANGANESE REMOVAL AND INTERMITTENT REGENERATION (IR) FOR MANGANESE REMOVAL

These two distinct methods of operation allow for flexibility in the design of water-treating systems with specific features tailored to the raw water characteristics and specific applications.

The CO process is used primarily when iron removal is the objective, with or without the presence of manganese. This method provides long-lasting, cost-effective performance when iron predominates in the raw water.

The CO method utilizes a continuous pre-feed of chlorine (Cl₂) to the raw water upstream of the GreensandPlus filter. Soluble iron and manganese are oxidized to the insoluble form and filtered out by a dual-media anthracite/GreensandPlus bed.

The CO process can also be effective for treating moderate levels of arsenic. Utilizing co-precipitation with iron, arsenic is easily filtered out along with the iron. The chlorine oxidizes any arsenite to the arsenate form and up to 95% removal of total arsenic can be achieved. The USEPA's established MCL of 10 micrograms/liter, established in January 2002, can be easily met.

Note: local environmental authorities generally consider the waste stream from a GreensandPlus filter more favorable than those generated by activated alumina, ion exchange or RO systems.

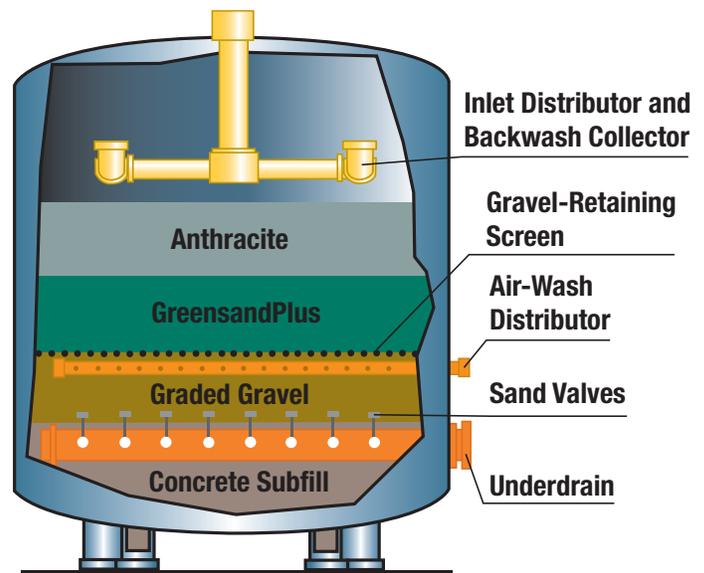
Due to the unique chemical and physical properties of GreensandPlus, which are attributable to the multivalent manganese oxide coating covering the grains, iron and manganese are consistently removed to desired levels.

Manganese oxide has a well-known catalytic effect in the oxidation of soluble iron and manganese and also provides a redox buffer capable of either oxidizing remaining traces of iron and manganese or reducing excess KMnO₄, if that is used as the preferred oxidant. This not only guarantees the consistent removal of iron and manganese but also maintains the GreensandPlus in a continuously regenerated state, without the need for a separate regeneration step. Periodic backwashing is all that is required.

GREENSANDPLUS IR FOR MANGANESE REMOVAL

For groundwaters that contain only manganese, or manganese with small amounts of iron, as well as residential and small commercial applications, the intermittent regeneration (IR) process is recommended. It allows for extended run length, with a minimum amount of head loss experienced during the filter run. In the IR method, a filter bed of GreensandPlus is periodically regenerated (in a manner similar to sodium-cycle softening) with a solution of chlorine or KMnO₄. The frequency of regeneration is a function of raw water manganese and the volume of water treated.

CROSS-SECTION OF A TYPICAL HUNGERFORD & TERRY GREENSANDPLUS FILTRATION SYSTEM



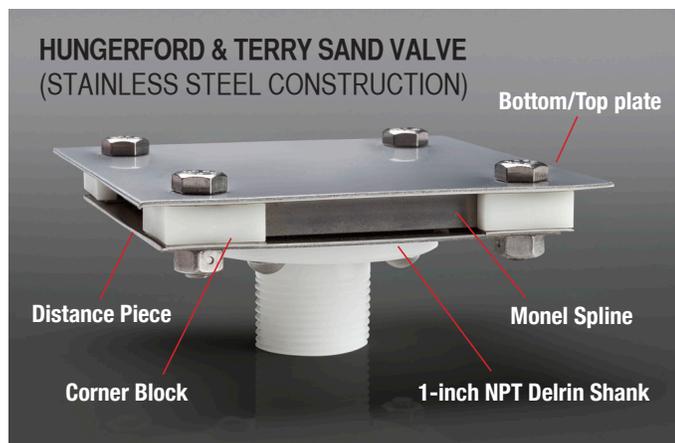
During the service cycle, manganese is removed by utilizing the oxidative capacity of GreensandPlus. Oxidation of soluble manganese occurs directly on the GreensandPlus grains, becoming an integral part of the manganese oxide coating. To prevent fouling of the process by direct oxidation of soluble iron on the grains, varying amounts of accompanying iron should be oxidized by using pre-chlorination prior to contact with the IR filter's bed, consisting entirely of GreensandPlus.

SUMMARY

Either the CO or IR mode of operation consistently removes iron and manganese to levels that are equal to, or below, the MCL.

Proven cost-effective GreensandPlus systems, with built-in flexibility for varying operating conditions, serve municipalities and other industrial and commercial operations worldwide.

For calculating specific chemical dosages and expected run lengths, please refer to the **Hungerford & Terry GreensandPlus Technical Data Sheet**.



THE UNDERDRAIN SYSTEM

The underdrain system is critical to the operation of the filter system. It performs the following functions:

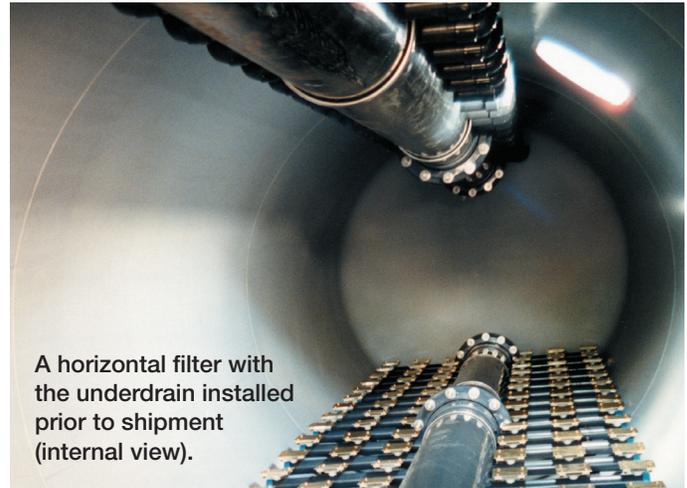
- Dual function of both backwash and inlet water distribution/collection.
- Optimum underdrain system with the header-lateral using H&T sand valve.
- An estimated 50 years life. Corrosion-proof design that cannot clog.
- Stainless-constructed steel, with a Delrin¹ shank and Monel² splines, provides years of trouble-free service without the problems inherent in competitors' products.

While strainers made of plastic or stainless steel are offered by various suppliers, **Hungerford & Terry** is reluctant to offer such a design. This is because the strainers may eventually become plugged and result in poor backwash distribution, which causes channeling, resulting in a premature filter rebuild. The *expansive port* design of the **Hungerford & Terry** sand valve makes it impossible to plug.

Our technology offers a precise underdrain configuration required for optimum distribution and minimal head loss.

¹ *Delrin* is a registered trademark of E.I. DuPont.

² *Monel* is a registered trademark of International Nickel Co.



HUNGERFORD & TERRY AIR/WATER WASH SYSTEM

A supplemental air/water wash is often recommended where the manganese concentration is high. This helps to ensure that the filter bed is effectively cleaned of manganese precipitates.

HOW IT WORKS

Air discharged with a lobe-type air blower is used in conjunction with a simultaneous upflow water wash immediately prior to the full backwash.

The simultaneous upflow water wash should be maintained at 4 to 5 gpm/sq. ft. combined with .8 to 2.0 cfm of air to provide collapse - pulse agitation for maximum scouring action between the individual filter media grains. This design has been used by H&T for over 80 years.

HUNGERFORD & TERRY GRAVEL RETAINING SCREEN

The **Hungerford & Terry** stainless-steel gravel-retaining screen is designed to secure the gravel supporting bed without hindering the necessary service or backwash flow distribution. Securing the gravel bed prevents it from becoming upset during either air wash operations or unpredictable backwash surges. As part of the GreensandPlus CO or IR filter, the **Hungerford & Terry** stainless steel retaining screen has proven its effectiveness and value in over half a century of service.



HUNGERFORD & TERRY GREENSANDPLUS™ FILTRATION SYSTEMS

HUNGERFORD & TERRY, INC.

Specializing in design, manufacture and service of custom-built water treatment systems. Our only business since 1909.

For over a century, Hungerford & Terry has designed and supplied various types of water-treatment systems for municipal, industrial and power-plant applications. Today, H&T, a privately held corporation, continues to specialize in filtration systems for iron and manganese removal, turbidity removal and carbon adsorption. We are at the forefront of

ion exchange technology and can design and manufacture custom-built water-treatment systems for softening, nitrate removal, demineralization, as well as conventional deep bed and sodium cycle condensate polishing. We also offer forced draft and vacuum degasification.

Hungerford & Terry is known for our consistent level of excellence, competitive pricing and state-of-the-art engineering and manufacturing services that can meet or exceed any demands.



This is an example of the 1.5 MGD municipal filter installation with air/water wash, by Hungerford & Terry.



4,000 GPM automatic filter installed in the municipal water works of Dover, Ohio.



HUNGERFORD & TERRY GREENSANDPLUS™ FILTRATION SYSTEMS

HUNGERFORD & TERRY PARTIAL LIST OF CUSTOMERS

	Capacity (MGD)		Capacity (MGD)
Longview Beacon Hill W&S District	21		Municipality of Halton
Longview, WA			Georgetown, Ontario, Canada
City of Zanesville	10		Town of Surf City
Zanesville, OH			Surf City, NC
City of Hutchinson	8		Churchill County Planning Board
Hutchinson, KS			Fallon, NV
Suffolk County Water Authority	6.9		Jackson Township MUA
Bohemia, NY			Jackson Township, NJ
Northern Area Water Authority	6.7		Boro of Paulsboro
Tipp City, OH			Paulsboro, NJ
Suffolk County Water Authority	5.9		South Dallas Water Authority
Oakdale, NY			Sardis, AL
City of New Bern	5.5		City of Urbana
New Bern, NC			Urbana, OH
Suffolk County Water Authority	5.1		Crestwood Village Water Co
Copiague, NY			Whiting, NJ
Jackson Township MUA	4.7		City of Centerville
Jackson Township, NJ			Centerville, MD
Lakewood Township MUA	4.6		Ventura County Waterworks
Lakewood, NJ			Ventura, CA
City of Yerington	4.3		Cook Springs Water Authority
Yerington, NV			Pell City, AL
City of Tallahassee	3.6		Town of Hopedale
Tallahassee, FL			Hopedale, MA
Suffolk County Water Authority	3.4		
Smithtown, NY			

HUNGERFORD & TERRY, INC.

Hungerford & Terry has been designing and manufacturing water-treatment systems for over a century. Contact us for your specific treatment needs. We are ready to assist your engineering staff in pre-design and pilot plant studies, preliminary and final specifications development, as well as equipment start-up and training of operating personnel.

* GreensandPlus™ is a product of the Inversand Company.



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