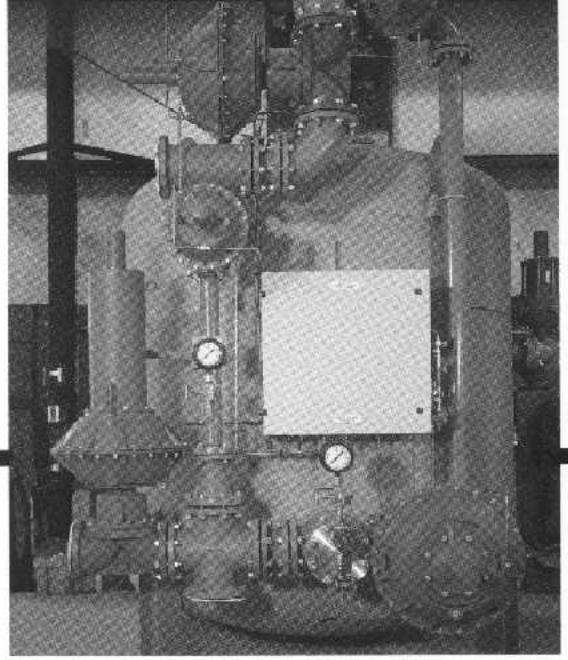


An ion-exchange system skid-mounted and assembled in our shop ready for shipment.

Demineralization Systems

Ion-exchange demineralizers

Our superior custom-designed and custom-built demineralizers provide the very high purity levels required by modern processing applications. Required low levels of mineral contamination — including extremely low levels — are attainable using the right combination of Hungerford & Terry proven demineralizer technologies selected and sized for your application.

A two-bed system works well for most applications even though demineralizers can vary greatly depending on the particular application. For a very high proportion of raw-water contamination levels, the first bed involves the removal of calcium, magnesium, and sodium using a cation exchanger with cocurrent acid regeneration. The second bed uses an anion exchanger with cocurrent caustic regeneration to remove alkalies, chlorides, sulfates, silica, and carbon dioxide. Conductance levels of 5 to 10 µS/cm are typically achieved using well engineered systems of this basic design.

If higher quality water is essential, it is usually appropriate to use a countercurrent regeneration system to achieve conductance levels of less than 2 µS/cm. Hungerford & Terry is an industry leader in the design of countercurrent systems and is among the few companies supplying them in demineralization applications.

Additional and special demineralization problems can be addressed by the application of other supporting technologies. Very high alkalinity levels can be handled through the addition of a forced-draft aerator or decarbonator. Such approaches provide the economical reduction of CO_2 load on the anion unit. When dissolved gases also require reduction, a vacuum degasifier can be added. Still further demineralization is available with the addition of mixed-bed demineralizers in series with a basic two bed installation. Such systems yield conductance levels of less than 1 µS/cm.

Some large installations may require the use of multiple-train systems to achieve the desired capacity. Countercurrent regeneration in both cation and anion exchangers is frequently combined with high-capacity weak-acid cation or weak-base anion units to improve chemical efficiency and reduce waste acid and caustic. Such systems have the additional benefit of permitting the reclaiming of regenerant waste from one unit for use in other units.

Hungerford & Terry, Inc. is also a licensee of the Dowex Upcore® packed-bed ion exchange system. This technology offers all of the advantages of a counter-current regenerated system plus offers greater capacity and reduced waste volumes by making the most efficient use of the vessel size. This system also lends itself to retrofitting existing systems so that old, inefficient demineralizers can benefit from this technology at a fraction of the cost of a new system of equal performance.

High-rate, deep-bed polishers

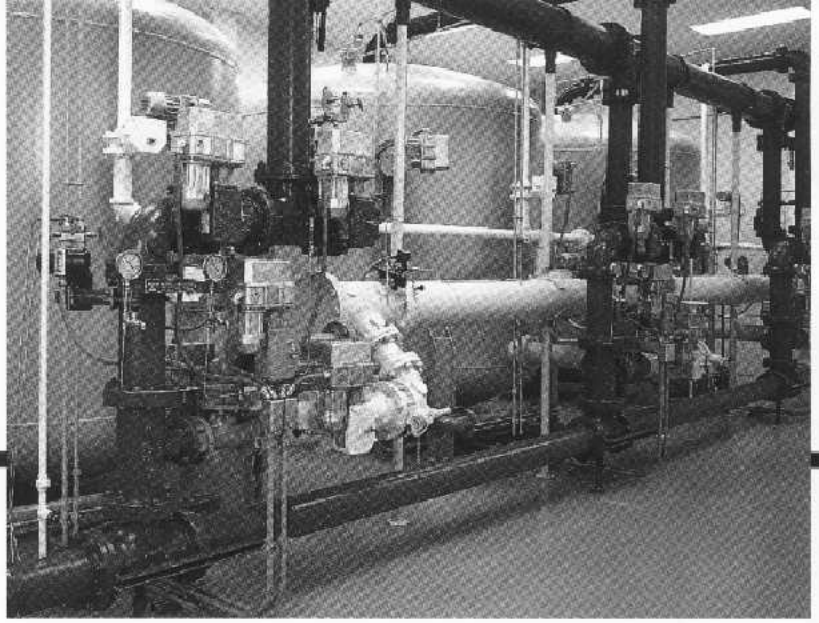
Boilers are protected by Hungerford & Terry's very effective condensate polishers. Our high-rate, deep-bed polishers will remove suspended and dissolved material from returned condensate water through the use of mixed-bed demineralizers. These high-pressure demineralizers operate at flow rates of 25 to 50 GPM per square foot of bed surface area. The boiler is further protected by the external regeneration of the bed which prevents the intrusion of harmful acid and alkali into the return condensate. These polishers can operate beyond the ammonia break in high-pressure utility applications.

Sodium-cycle polishers

Our sodium-cycle polisher combines sodium chloride and sodium sulfite or sodium hydrosulfite during regeneration to remove influent metal oxides from the returned condensate along with any hardness that may have been introduced by a condenser leak. These economical polishers will deliver soft water to the boiler at very reasonable cost and will operate for up to several weeks without regeneration.

Reverse osmosis membrane technology

Hungerford & Terry now designs and builds reverse osmosis systems using the same high-quality, custom-design philosophy. These new treatment plants are offered as stand-alone systems or in conjunction with an H&T demineralizer. We can design and supply any necessary pretreatment equipment such as carbon filtration, softeners, and chemical feed systems. Our typical system will include a cleaning system and cartridge filters for protection of the membranes.



A 2 MGD iron and manganese filter system at work in a New Jersey municipality.

Filtration and Ferrosand Filtration

Drinking water from a wide range of sources can be made sparkling clear and free of turbidity, color, taste, odor, and suspended matter by a well-engineered low-cost system employing the right Hungerford & Terry filter technology.

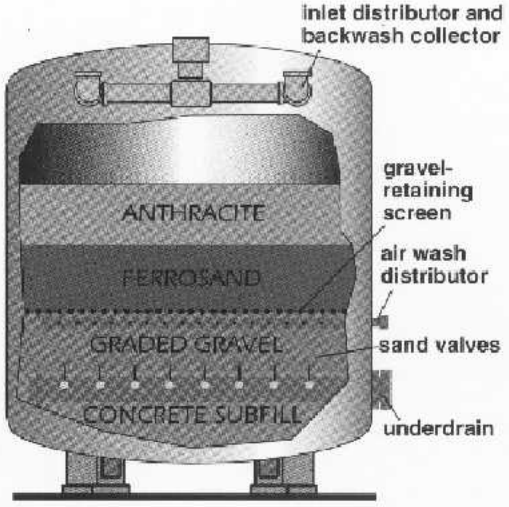
Ferrosand™

Well waters containing iron and manganese can be economically and effectively treated with our own Ferrosand filter technology. Ferrosand is our registered trade name for manganese greensand. The Ferrosand medium employs chemical oxidation and reduction in coordination with the catalytic properties of manganese oxides to achieve the desired filtration. Ferrosand's unique properties permit it to be used in several distinct ways. This gives Ferrosand-based filtration systems an extraordinarily high degree of flexibility that makes our use of them highly responsive to the demands of the particular application and the specific features of the raw water to be treated.

Ferrosand catalytic oxidation

Since 1990, we have been designing systems using the catalytic action of Ferrosand's manganese oxide coating in the presence of chlorine to very good effect. Manganese oxides are maintained in a regenerated condition by the oxidizing environment provided by the chlorine. No potassium permanganate is needed with a catalytic iron and manganese removal process.

The flow rate for catalytic systems is usually much higher than that available in more traditional systems. The higher flow rate is derived from the nature of the process itself, from a special catalytic grade of Ferrosand, and from attributes of the system design. The process yields unusually long operational runs of from 2 to 4 days. An air/water wash prior to backwashing maintains the Ferrosand medium in a loose, clean state with little to no compaction. Because backwash volumes are very small, usually 0.25% to 0.5% of system capacity, no recovery is normally required. However, a recovery system to reclaim approximately 85% of the backwash waste can be provided.



The Ferrosand Catalytic System can be delivered as a completely assembled and packaged unit. It is fully automatic and uses the most advanced PLC controls with condition status fully indicated.

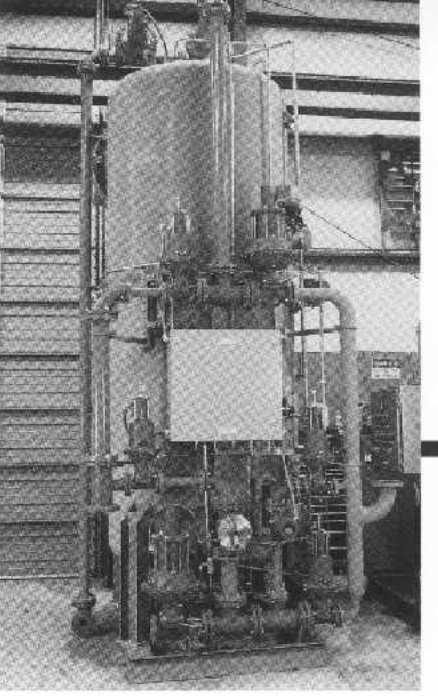
Ferrosand CR and IR systems

Ferrosand systems can be continuously regenerated (CR) or intermittently regenerated (IR). Continuous regeneration is achieved through the introduction of a pre-feed of chlorine and/or permanganate prior to filtration. The method is appropriate for relatively high iron contents.

Alternatively, intermittent batch regeneration with permanganate can be cost effective and works well when iron content is relatively low. The most cost effective and appropriate system will be determined through an analysis of the client's specific treatment situation.

Additional design features

Our systems feature our proprietary header-lateral underdrain system with the non-clogging, non-corroding H&T sand valve for optimum distribution and minimal head loss. A non-ferrous lateral or hub-lateral underdrain is available. All systems feature highly stable filter beds and excellent backwash distribution for extended filter life. A supplemental air/water scour system is available for maximum filter-bed cleaning and longest media life. A stainless steel gravel-retaining screen ensures a stable gravel support bed during air wash operation or unforeseen backwash surges.



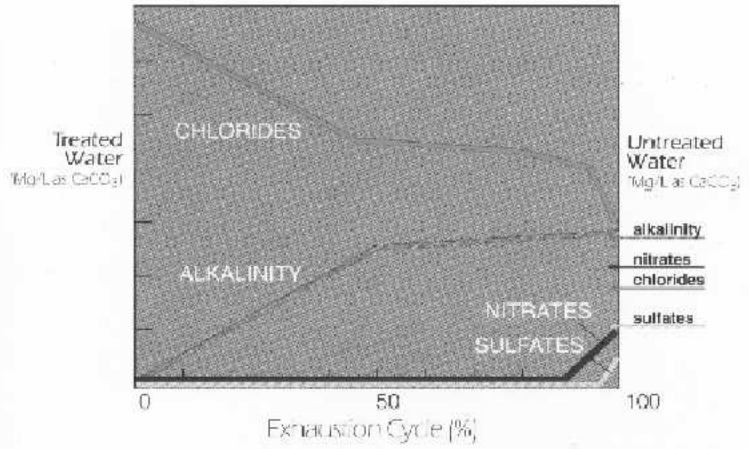
Skid mounted and assembled nitrate removal system ready for shipment to Wisconsin.

Nitrate Removal

Fertilizer runoff, septic tanks, and land disposal of wastes all threaten ground water and surface water with nitrates. H & T achieves very high levels of nitrate removal through a highly effective method involving the exchange of nitrates, alkalinity, and sulfates for chlorides using a strongly basic anion resin.

Only Hungerford & Terry offers the efficiency and economy of a countercurrent regeneration system for nitrate removal. The very high efficiency of our countercurrent system and its low leakage levels, indicated in the graph, allow a maximum amount of untreated water to bypass the system to be blended with treated water. Any amount of nitrate concentration below Federal Standards is thus readily achievable in a plant that is extremely efficient.

Typical Exhaustion Run Characteristics



This innovative nitrate removal system — designed to your specifications — will greatly reduce the size of the treatment plant. It will use as little as half of the regenerant per cubic foot of ion exchange resin used by a conventional system. It provides maximum efficiency and reduced operating costs and waste.

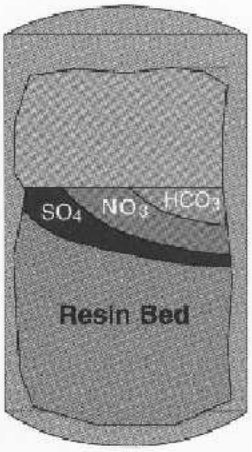
Regenerant cycle of operation

Regeneration begins with a backflow of raw water through the regenerant collector to remove suspended material and to decompact the resin. A brine solution is then injected to remove nitrates and sulfates. A slow rinse then flushes out most of the brine and removes still more nitrate and sulfate. Finally, a fast downflow rinse removes residual levels of nitrate, sulfate, and brine. By fully regenerating the bottom of the ion exchange bed, leakage is reduced to a fraction of a part per million allowing greater input water bypass of the system.

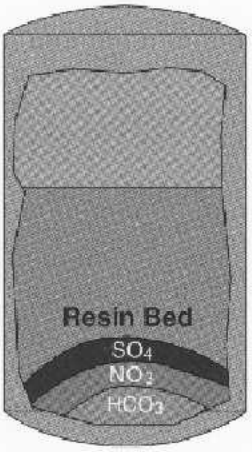
Cocurrent regeneration is appropriate in some cases

Cocurrent systems may be appropriate for smaller systems or when initial capital costs are very important. The basic chemistry is the same as that of a countercurrent system. In the more conventional cocurrent approach, however, regenerant brine enters from the top rather than the bottom. Thus a cocurrent system is normally backwashed after every service run yielding a regeneration sequence that includes an upflow backwash. After the backwash, downflow brine injection is followed by a downflow slow rinse and a downflow fast rinse.

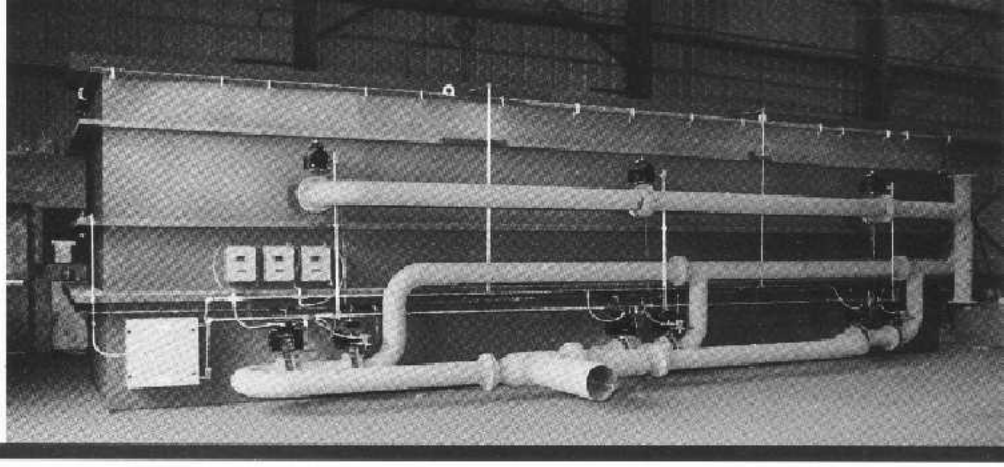
Hungerford & Terry countercurrent regeneration



Hungerford & Terry cocurrent regeneration



The countercurrent system uses automated valve systems controlled by H&T-designed control systems. Actuation can be pneumatic, hydraulic, or electric depending on the customer's preference. Tank linings, painting, man hole sizes, and other features can be specified by the customer. H & T's application-specific configurations include choices of valve operation techniques, exchanger tank options, internal distribution options, and varying degrees of automatic control.



Three-cell gravity filter system for a power plant in Florida.

Pretreatment Systems

Sodium and hydrogen cycle softeners

Hungerford & Terry supplies water softening equipment for a very wide range of industrial and commercial applications. Water is softened by removing the hardness-producing ions (calcium and magnesium) using a cation exchange resin. Systems may be cocurrently or countercurrently regenerated to achieve the lowest possible hardness leakage. During regeneration, sodium ions replace the calcium and magnesium ions on the ion exchange resin bead, restoring the resin's capacity to soften water.

Operating in the sodium cycle, the sodium in the treated water is increased proportionately to the amount of calcium and magnesium in the untreated water. For applications where sodium increase is a concern, Hungerford & Terry produces a line of weak-acid softeners that operate in the hydrogen cycle instead of the sodium cycle. Where total hardness is numerically equal to the alkalinity in the raw water, the hardness can be economically removed using an acid-regenerated weak-acid (carboxylic) cation exchange resin. The quantity of hardness which exceeds the alkalinity will not be removed. The ion exchange mechanism in the weak-acid softening process is an exchange of calcium and magnesium ions for hydrogen ions. Therefore, no sodium is added to the treated water. Either hydrochloric acid or sulfuric acid can be used for regeneration. However, sulfuric acid requires a higher flow rate and lower concentrations to avoid precipitation in the ion exchange bed during regeneration. During the ion exchange process with weak acid resin, carbonic acid is formed and can be stripped off using a forced draft degasifier following the softener. Also, a small quantity of sodium hydroxide can be added following the decarbonator to neutralize any remaining CO_2 and to provide non-corrosive water with a neutral pH. The system can be designed for stoichiometric quantities of acid so that the waste produced does not require neutralization prior to disposal.

Clarifiers

Surface water color, turbidity, and suspended matter are effectively removed with a Hungerford & Terry clarifier. The process involves accurately flash mixing coagulant, polymer, and other chemicals in proportion to water flow and recirculating pre-formed floc via the turbine mixer and recirculation tube. Precipitants are generated in the mixing zone of the downcomer and gradually grow larger forming a sludge blanket. Ultimately, the precipitants settle out as a floc. The clarified water rises and is collected in the launder trough located along the top of the tank sidewall. Cold lime softening uses similar equipment but is designed to remove alkalinity and the hardness associated with alkalinity to produce a water that is clear, colorless, and with reduced hardness, alkalinity, and iron. Equipment is available sized for a flow rate of 200 gallons per minute up to several thousand gallons per minute.

Gravity filters

Following clarification or lime softening, filtration would be required to remove any floc carryover and suspended material. The Hungerford & Terry gravity filter system is available in single or multi-cell rectangular design or circular tanks with self-contained backwash storage. An air scour system or a surface washer can be included to ensure a high degree of agitation of the filter bed during backwashing which ensures that the filter bed is clean and that there are no areas of compaction or cementation. Underdrain systems consist of a flat false bottom plate with distribution nozzles. A full range of sizes is available from 50 gallons per minute up to several thousand gallons per minute.