Water Quality Matters

SLOW SAND FILTER

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SLOW SAND FILTRATION

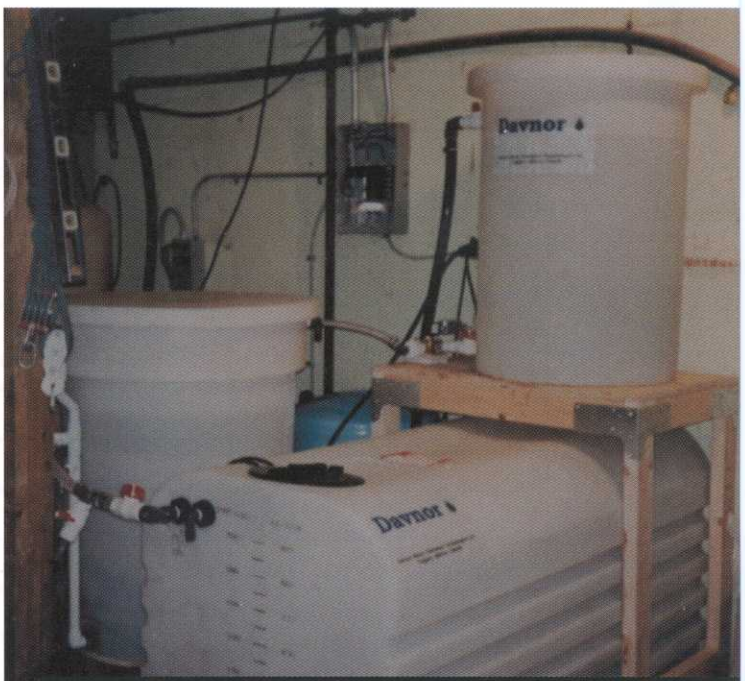
Slow sand filtration has been used successfully in Europe since the early 1900s, and is still a popular method of treating municipal water supplies. Research, and other observations, show that slow sand filtration can effectively remove *Giardia* cysts and coliform bacteria from raw water, and is an innovative, cost effective, low maintenance treatment process. This system works best as part of a multi-barrier treatment approach.

A slow sand filter is comprised of a bed of graded sand which is supported by a layer of gravel. This filter media is confined in a box with openings at both ends allowing water to flow in and out, while operating on a top-down, gravity basis. The filtration process - a form of natural, biological water treatment - is used to remove solids, precipitates, turbidity (muddiness) and in some cases bacterial particles that produce bad taste and odour.

WHY USE A SLOW SAND FILTER?

Slow sand filtration is well-suited to treat farm water supplies that have reasonable raw water quality. It is an ideal pre-treatment process for surface water containing parasites, bacteria and suspended solids. However, pre-screening/settling may be required prior to filtering for water with a high algae concentration or is very turbid. Slow sand filtration is also effective at treating groundwater with high iron and sulphur gases. With iron and dissolved gases removed, other processes such as softening and demineralization, can be incorporated into an overall in-house treatment process.

An automated slow sand filter, operated in demand mode (start/stop as required), was developed to serve in-house needs. Demand mode operation eliminates the need for continuous flow and provides flexibility in storage capacity. A major advantage with this particular slow sand filter is that it does not require systematic backwashing; therefore, there is no large amount of wastewater to dispose of, eliminating the cost of wastewater storage and handling. There are also no chemicals used or produced, and it does not affect on-farm septic systems. This particular filtration process is cost effective and reliable.



An automated slow sand filtration system, operating in demand mode, eliminates the cost of wastewater storage and handling

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SLOW SAND FILTRATION IMPROVES WATER QUALITY

The top layer of the sand is the main contaminant removal mechanism of this filtration process. Depending on the raw water quality, the bioloigical layer develops within three to seven days after filter installation. Experiments and studies show that the process is effective in removing oxidated precipitate of dissolved solids in groundwater, such as iron, and is effective in stripping sulphur gases.

Slow sand filtration also improves water quality by removing some of the unpleasant qualities of surface water supplies from dugouts, irrigation canals, rivers and lakes. These qualities include water-borne parasites, bacteria and suspended solids that cause turbidity, colour, taste and odour.

SYSTEM COMPONENTS

The demand-operated slow sand filter system consists of a head tank, sand filter(s) and a storage unit. The system can be operated manually or automatically from available water pressure on a wide variety of power supplies, such as 100-volt AC or a12/24 volt DC systems with battery or solar power. Depending on filter size, capacities vary from 1 to 10 litres per minute.

Filter Diameters (centimetres)	Flow Rates (litres per minute)
50	1
65	2
80	4
130	10

All filters are approximately one metre in height. The system is also expandable with a modular filter to accommodate future water treatment needs. The demand-operated slow sand filter may be integrated into other water treatment processes, such as those used for small rural communities.

The system is designed to provide quality, non-potable water for the entire household. If necessary, the water can be softened from the storage tank to reduce hardness for washing and bathing. An ultraviolet (UV) water sterilizer can be installed to disinfect the supply once it runs through the softener. For drinking and cooking, a reverse osmosis (RO) unit can be installed as an additional protective barrier at the kitchen sink. The RO unit reduces sulphate, sodium and total dissolved solids that the slow sand filter can not remove.

The biological layer developed on top of sand (2 cm) may require replacement to remove accumulated surface deposits

PERFORMANCE OF SLOW SAND FILTRATION

Sampling results taken from the groundwater treatment system; indicate a constant removal of iron concentration from about 3 mg/L to less than .05 mg/L. The results also show the system effectively removes coliform bacteria.

It is important to use post filtration disinfection, ensuring the potability of treated water.

LIMITATIONS

Additional treatment processes are required for hard and unusually turbid water, as well as water that is high in dissolved solids, such as sodium, nitrite, nitrate, sulphate and fluoride. With water supplies that are high in organic content, the filtration process is not effective in complex iron removal, in which organic compounds may be bound to iron ions and cannot be removed by an aeration/ filtration process. Typically, water that may produce

organic complexing of iron should have a level of organic carbon over 2 mg/L and may also contain ammonia.

Water containing a level of dissolved organic carbon (DOC) over 5 mg/L may cause taste, odour and colour problems. Slow sand filtration can not effectively remove dissolved organic carbon. A carbon filter should be used in addition to the slow sand filter.

An up-to-date water quality analysis is required to assess the suitability of the filtration process. Pilot-scale evaluation of treatment alternatives may also be required.

OPERATION AND MAINTENANCE

The automated systems vary in cost from $600 for a single filter system to several thousand dollars for larger units.

These systems may require minor sand replacement in the top layer and periodic backwashing to maintain their effectiveness.

The demand-operated slow sand filtration system is easy to operate and has a long life expectancy. Proper operation and maintenance are essential to ensure the system's performance.

Without proper maintenance, surface deposits accumulate at the top of the sand layer eventually reducing the water flow. The filter is easily maintained using the clean-in-place procedure. A device similar to a scarifier is used to disturb the top layer and loosen the accumulated fines to form 'muddy water', which is then drained away. Unlike other slow sand filter technologies, no media is replaced. During cleaning, very little wastewater is produced; approximately 100 litres for the 10 litre per minute system. Backwashing may be required if the filter becomes air-locked or contaminated with break-through from deposits. Frequency of maintenance depends on the quality of water being treated, but may only be needed once every 3-6 months.

The advantages to these systems are that there is no need for disposal of large amounts of wastewater, which could damage septic systems and there are no chemicals to handle.

THE BIG PICTURE

The slow sand filtration system effectively removes iron and sulphur gases in groundwater. When used in combination with a softener, ultraviolet (UV) water sterilizer and reverse osmosis unit, the tested systems deliver high quality domestic water, as well as safe drinking and cooking water for individual farms. It is also possible to operate the system seasonally and winterize it to eliminate freeze-up. Filtration systems are modular and may be integrated into any water treatment multi-step process for rural community application.

Further study of slow sand filtration is needed to address the treatment of nutrient-rich water and unusually turbid surface water; to investigate performance on manganese removal; and to assess long-term performance of the system.

For further information on rural Prairie water quality and treatment technology:

- read the other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA Website at www.agr.gc.ca/pfra;
- read Prairie Water News, available from PFRA, or on the Internet at www.quantumlynx.com/water; or
- **contact your local Prairie Farm Rehabilitation Administration office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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