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Slowsand/Nanofiltration

in Small Drinking Water Systems

The patented combination of slowsand with nanofiltration offers benefits that merit considerable discussion. This combination successfully was piloted by the University of Arizona beginning in 1987.It later was patented. Other pilot projects include a recent study by the American Water Works Research Foundation in Tucson, Ariz. Though the final report has not yet been published, the data have been collected. This article describes critical information about slowsand/nanofiltration as a method of providing excellent drinking water at a competitive price.

Slowsand filtration is a great treatment in and of itself. If combined with a sedimentation reservoir and roughing filter, slowsand filtration alone would meet most U.S. Environmental Protection Agency (EPA) requirements for drinking water. When a nanofilter is added then virtually all requirements can be met.

Slowsand filtration, as used on the Colorado River directly from Lake Mead without a roughing filter, produced results comparable to those produced by micro and ultrafiltration membranes. After 18 months, the turbidity from the slowsand filter was found to be 0.05 NTU. The silt density index was 2.5 after two years in a study in Marana, Ariz. Slowsand filtration reduces the TOC by at least 25 percent. To produce a similar result using micro or ultrafiltration would require preparatory flocculation and sedimentation. Slowsand filtration can remove iron when coupled with aeration.

Slowsand as a pretreatment to nanofiltration should not be dismissed on the basis that it is too labor intensive or that it takes up too much land area. Slowsand filters are cleaned by removing the top 3/8 inch of sand after dropping the water level slightly below the level of the sand. A small system, fewer than 40,000 gallons per day (gpd), can be cleaned in about an hour with one person. A 400,000-gpd system requiring 2,000 square feet can be cleaned in one hour or less using a laser-controlled tractor scraper and a single operator, or just over two hours with four men to do the job. The run time between filter cleanings also has been found to be lengthy. When the Colorado River was drawn directly from Lake Mead and then filtered, the run time was one year or more. When the water was first sent through the Central Arizona Project Canal and then filtered, the run time was three to six months from a two-year pilot study in Marana.

A slowsand filter requires just one square foot per person using the water. For a population of 10,000, only 10,000 square feet is needed, or approximately one quarter acre of land. Another quarter acre would be needed for the storage tank and building to house the nanofilter. This is only a fraction of the farmland needed to grow food for the same population. Most small drinking water systems should be able to find a half acre of land, even in the most expensive neighborhoods. The alternative microfilter or rapid sand filter may take up less area but would require additional holding ponds for the prefiltered water and sludge handling facilities for the back wash material. These are not always needed in a slowsand system. In small systems the sand can be returned to the sand and gravel company for reuse. The slowsand filter can be cleaned several times before the sand has to be replenished. The slowsand filter improves with age as the microorganism colonies mature.

The capital cost of building an in-ground slowsand filter using an HDPE plastic liner, plastic pipe drain systems and plastic separating screens is inexpensive, particularly in areas where the sand and gravel are readily available. The amortized capital and operating cost of a slowsand filter is only $0.10/1,000 gallons, according to a recent U.S. Bureau of Reclamation report. This is one-fifth of the cost of using micro and ultrafiltration as presented in the same report.

If nanofiltration is added to an in-ground slowsand treatment train, then present and future EPA standards will be met. This membrane treatment can be added for approximately $0.30–$0.50/1,000 gallons. The cost is dependent on water quality, water temperature and use of reject water.

Nanofiltration has some benefits that micro and ultrafiltration do not. These benefits include removal of uranium, lead, pesticides and herbicides from the water stream.

Slowsand/Nanofiltration with Seawater

Clean Water Products can apply the patented slowsand/nanofiltration combination to seawater. The slowsand takes out the suspended material and 25 percent of the dissolved TOC. The nanofilter operating at low pressure removes the calcium, magnesium and sulfates. In pilot system on Catalina Island, Calif., nanofiltration reduced the total dissolved solids of the seawater from 33,000 to 28,000 ppm. The dissolved solids then consisted primarily of sodium chloride, which was removed with a seawater RO filter. Because this patented system operates without the use of chemicals, the concentrated reject water can be solar evaporated to recover the salt. The value of this purified salt could more than pay for the cost of the desalinization system.

Clean Water Products has designed a combined sea water nanofiltration/sea water RO skid capable of producing 60,000 gpd with 77° F water. This combined patented seawater skid is 4×16×5 ft and portable. The cost of this patented skid is $125.000 FOB Tucson, Ariz. It would require a slowsand filter that would cover about 1,000 sq. ft. The cost of this slowsand filter built in the United States is less than $25,000, excluding the cost of land.

There is not much difference between the costs of nanofiltration and micro and ultrafiltration, particularly if a slowsand filter precedes nanofiltration. However, there are maximal benefits to nanofiltration that are not available when using micro or ultrafiltration. Nanofiltration also removes uranium, lead and manmade chemicals such as pesticides and herbicides. It is an excellent treatment for municipal wastewater.

Nanofiltration sometimes is overlooked because of concern with the reject stream. There are innumerable potential uses for the reject stream when ingenuity is applied. In arid and semiarid regions, it can be blended with irrigation water. In more populous areas, reject water also can be blended back into the wastewater plant effluent stream. This is where the minerals and most impurities would have been even if nanofiltration or reverse osmosis was not used. This process is working in a new reverse osmosis (RO) plant in Julesburg, Colo. Because nanofiltration/RO will reduce the number of salt water softeners used by the population, the salinity of the blended wastewater effluent might even be less than it was before nanofiltration/RO was used.

If nanofiltration primarily is used to eliminate nitrates and organic materials in the water, a large percentage of the reject can be recirculated through the slowsand filter for added treatment before nanofiltration. If it mainly is used for softening, added treatment on the reject stream can recover calcite that can be used by power plants that burn high sulfur coal. Once the calcite is removed the water can be run again into an RO system to recover more water. Using these two methods, the waste stream would be reduced to an amount similar to the 5 percent waste produced by a micro or ultrafilter.

Nanofiltration can be used with most groundwater without using a slowsand filter. However, slowsand can be a very effective pretreatment for problem groundwater including shallow groundwater containing iron or organic matter coming from recharged municipal wastewater. WQP

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About the Author
Dr. Brent Cluff is owner and president of Clean Water Products. Clean Water Products is a company in Tucson, Ariz., available to help facilitate the use of slowsand/nanofiltration systems anywhere in the world. For additonal information, call 520-293-1561; www.cleanwaterproducts.com

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