

## Safeguarding Our Water

### *Membrane filtration protects Great Lakes' drinking water from *Cryptosporidium* microbes*

By [C. Russell Davis](#) Nov 01, 2004

Beautiful and blue, vast, and sometimes violent, the Great Lakes are truly "Nature's Reservoir." They contain 20 percent of the earth's fresh surface water, spanning nearly 900 miles from the headwaters of the St. Lawrence River in Kingston, Ontario, in the east to their western fingertip at Duluth, Minnesota. Within that area is more than 10,000 miles of shore line. The Great Lakes supply more than 40 million Americans and Canadians with water for drinking, industry, recreation, and agriculture.

But beneath the surface lurk microbial contaminants that get into the water through urban stormwater runoff, combined sewer overflows, natural sources like wildlife feces, and the erosion of millions of tons of topsoil into the lakes each year.

These microbes include *Cryptosporidium*, one-celled parasites only 4 to 6 microns in size that originate in human and animal waste. They are resistant to common disinfection practices, and may pass through conventional water treatment filtration processes in sufficient numbers to cause health problems.

When ingested, *Cryptosporidium* can cause an infection and irritation of the digestive tract that leads to acute diarrhea. This can be extremely dangerous for small children, the elderly and adults with health problems, especially those with weakened immune systems.

#### [Cryptosporidium: What It Is, What to Look For](#)

The problem -- never more evident than in 1993 when *Cryptosporidium* infected over 400,000 people in Milwaukee and caused at least 70 premature deaths -- has made it necessary for public drinking water plants to employ the latest in sophisticated water treatment technology to make their water safe.

#### [Cryptosporidium Outbreaks in North America](#)

In response, many Great Lakes coastal communities like Kenosha and Manitowoc in Wis., Marquette and Mackinac Island in Mich., and Chatham-Kent in Ontario have installed continuous microfiltration (CMF) membrane filtration systems from USFilter Memcor Products. These systems use hollow fiber microfiltration membranes as the filtering medium. The fiber walls contain tiny pores, which allow water to pass but trap microscopic particles such as cysts and microorganisms.

Dave Lewis, superintendent of water production for Kenosha Water Utility, helps those visiting his water treatment plant visualize how the membranes filter out *Cryptosporidium* and other particles.

"I ask them to imagine trying to sift golf balls through a spaghetti strainer," he says.

Many public works prefer membrane filtration over conventional treatment technologies because the filtration method treats drinking water without using chemicals to assist in separating minute-sized particles from the water. This benefits plant operators and residents served, in terms of public safety, ease of operation, reliability of treatment, and cost.

In short, the systems provide peace-of-mind. Lewis confesses that since installing the microfiltration system, he has been able to soundly sleep through storms without having to worry when he would be called into the plant.

### **The Rules Rule**

"Membrane filtration has been documented as a highly effective method for removing *Cryptosporidium*," says Dr. Paul Gallagher, vice president of process technology at USFilter Memcor Products. "EPA the U.S. Environmental Protection Agency has included membranes in its 'Microbial Toolbox' in the proposed Long Term 2 Enhanced Surface Water Treatment Rule, and membrane systems will be a process of choice if high concentrations of *Cryptosporidium* are expected in the water source."

Membranes and other advanced treatment technologies have enabled communities around the Great Lakes to meet the new, more stringent surface water regulations, resulting in safer water for people to drink.

In 1993, the Surface Water Treatment Rule lowered the turbidity limits for finished water to 0.5 nephelometric turbidity unit (NTU) in 95 percent of the samples taken every four hours, and established an absolute maximum of 5 NTUs. The Interim Enhanced Surface Water Treatment Rule went into effect in January 2002, and applies to systems with more than 10,000 users. It reduces the finished water turbidity limit to 0.3 NTU and the absolute maximum to 1.0 NTU.

And more regulations are coming, says Larry Landsness of the Drinking Water Systems Section of the Wisconsin Department of Natural Resources.

"The Long Term 1 Enhanced Surface Water Treatment Rule is similar to the Interim Rule, but applies to systems serving fewer than 10,000 people," he explains. "This rule will be effective in January 2005."

Landsness says a Long Term 2 Enhanced Surface Water Treatment Rule has been drafted and was proposed in late 2002. It requires communities to perform two years of monitoring for *Cryptosporidium* in the source water and will require levels of treatment based on the results.

"The systems will be able to choose additional treatment from a 'Microbial Toolbox' that includes membranes, ozone, and ultraviolet (UV)," he continues. "All of these rules have had effects on surface water systems, some more than others. A lot of improvements have occurred because of the rules, but also because of the *Cryptosporidium* outbreak in Milwaukee. It served as a wakeup call and allowed utilities to get the financial backing from their city officials to make the necessary improvements."

### **How Membranes Work**

Water is pumped at low pressure through the porous walls of the membrane; the pores are very small (0.1 microns or 0.000004 inches in diameter). The microscopic particles in the water (including microbial contaminants like *Cryptosporidium* oocysts that are 4 to 6 microns in size) are trapped on the outside of the membrane wall, which acts as a barrier, while the clean water passes through the wall and out of the membrane system.

For example, in the Memcor® CMF systems developed by USFilter, the membranes are actually tiny hollow tubes about 39 inches (one meter) long and 1/64th of an inch in diameter. Similar to a fiber optic cable, membranes are clustered together in a larger tube, or module, with 10,000 to a module. These modules are grouped to form a membrane unit; several units make up a complete system.

To backwash the membranes, the particles trapped on the outside wall are re-suspended by pressurized air before a stream of water flushes them away to disposal. The membrane system is highly automated, including the backwash sequence, with the plant operator controlling key process parameters via computer.

In addition, USFilter has developed a system that automatically monitors the integrity of each of the membrane fibers in situ. The pressure decay test is an effective means of verifying the membrane system's ability to filter out particles as small as *Cryptosporidium*. Conducted on a daily basis in about five minutes, the test uses air pressure to verify that the membrane, seals, valves, and all other potential cross connections between the filtrate and feedwater side of the system are integral. A 15-pounds-per-square-inch (psi) 100-kilopascal (kPa) challenge pressure assures that detection of breaches in integrity as small as 3 microns can be measured. Should a breach in integrity be found, the system includes features to isolate the breach, enabling the operator to effect repairs when it is convenient to do so.

Fiber cut testing has shown the sensitivity of a 15-psi air challenge test to be far better than what conventional water quality instruments such as a turbidimeter or a particle counter might yield. In conventional filtration, which utilizes a granular media such as sand, a filter's integrity cannot be tested. Current regulations require that a turbidimeter be installed on the filtrate line for each individual conventional filter. Adding a turbidimeter or particle counter to an individual filter may help indicate a problem, but it is impossible to isolate a section of a conventional filter and repair it when convenient.

Another example of a recent innovation in membrane technology is the submerged membrane system CMF-S developed by USFilter, which further reduces the complexity and footprint of microfiltration by attaching membrane modules to a stainless steel rack and suspending the membranes into an open tank or cell containing feedwater to be filtered.

While the physical configuration of the membrane modules and the integrity test are the same as in the CMF system, the feedwater is pulled through the membranes by suction rather than being pressure-driven. The elimination of the pressure vessels and accompanying hardware simplifies the mechanical design of microfiltration and reduces the cost for large systems.

### **The Move to Membranes**

Membranes are relatively new to the roster of water treatment technologies, but their application, as well as size of their systems, is growing.

In his article about membrane technology (Jacangelo, Chellam, and Trussell, *Civil Engineering Magazine*, Sept. 1998), Joe Jacangelo, a consulting engineer and manager of the Center for Water and Health at Johns Hopkins University in Baltimore, Md., reported,

"In addition to water quality regulations, a decrease in availability of adequate water resources, and an emphasis on water for reuse have made membrane processes more viable as treatment processes. As advancements are being made in membrane technology, capital and operation and maintenance costs continue to decline, further endorsing the use of membrane treatment techniques."

### **Cryptosporidium: What It Is, What to Look For**

*Cryptosporidia* are microscopic parasites that can live in the intestines of humans and animals. Symptoms include diarrhea, stomach cramps, upset stomach, and a slight fever, although some people never experience any of these symptoms.

Illness can last anywhere from a few days up to a month. No safe, effective cure is available for Cryptosporidiosis, but people who do not have compromised immune systems improve without the use of antibiotic or antiparasitic medications.

A person can become infected with Cryptosporidiosis by drinking contaminated water, eating raw or undercooked contaminated food, or ingesting something that has come in contact with the feces of persons or animals infected with the parasite.

### ***Cryptosporidium* Outbreaks in North America**

During the last decade, *Cryptosporidium* has infected drinking water all across North America. Listed below are some of the largest outbreaks:

1993: Milwaukee, Wis., at least 70 deaths and more than 400,000 illnesses

1993: Waterloo, Ontario, one confirmed death and at least 25,000 illnesses

1994: Las Vegas/Clark County, Nev., an estimated 16 deaths and about 78 illnesses

1996: Kelowna, British Columbia, 164 illnesses, with another 9,000 suspected illnesses

### **A** bout the Author

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