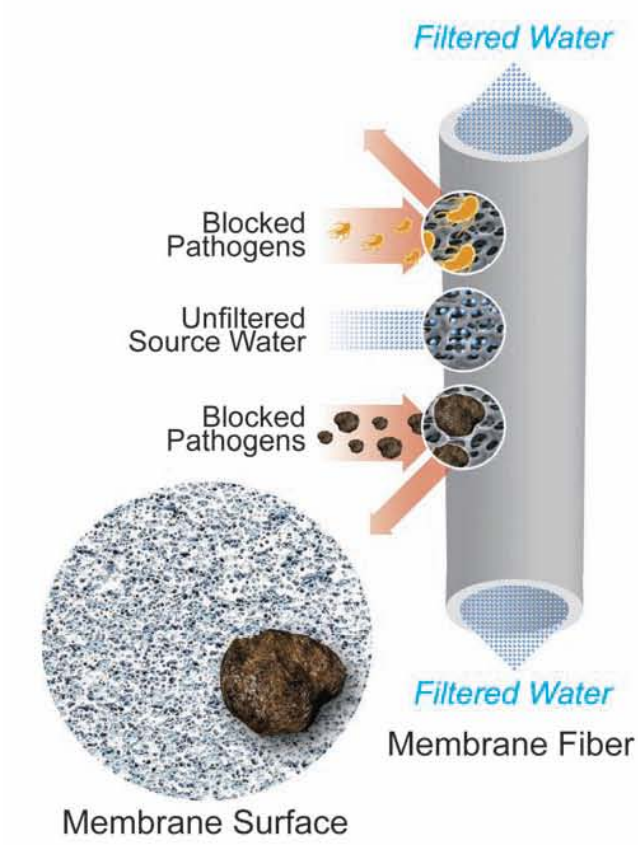
Hollow Fiber Ultrafiltration Membranes

Membrane technology offers advancement in residential water treatment

By Ron Ing

During the past decade, municipalities and industries throughout the world have been adopting ultrafiltration (UF) membrane technology to safeguard public health, protect the environment and create sustainable water supplies. ZENON Environmental, Inc. has recently introduced their ZeeWeed® UF membrane technology into the residential market with the Homespring™ Central Water Purifier.

Hollow fiber (HF) UF membrane technology provides an effective way to purify water by using physical barrier filtration to remove pathogens from water. Ultrafiltration purification requires no chemicals; it is efficient; and does not remove all natural minerals such as calcium and magnesium. Every day, more than a billion gallons of water are being filtered through ZeeWeed HF UF membranes throughout the world.



ZeeWeed UF Membranes

The ZeeWeed HF UF membranes resemble long strands of spaghetti that are hollow on the inside. The membrane wall is made from a polymer composite that has billions of tightly controlled microscopic pores that are 0.02 microns nominal in size. Water naturally flows through the pores from the outside-in through the membrane wall under very low pressure. The pores physically block particles, turbidity and pathogens such as bacteria, viruses and cysts. Most current water treatment technologies are based on absorption, concentration or intensity, which can be affected by sudden spikes in turbidity or pathogen concentration. The ZeeWeed UF membranes provide water filtration using physical size exclusion, resulting in a consistent supply of high quality treated water regardless of the inlet quality. The membrane both filters and disinfects the water in one step.

Outside-in vs. Inside-out HF Membranes

The ZeeWeed membrane uses an outside-in flow path. Among the key advantages of an outside-in flow are the significant increases to the membrane filter surface area, thus improving the permeability. This also reduces membrane fouling, as the flow path ensures there is no trapping of debris on the inside of the membrane.

On an inside-out flow path membrane, larger debris particles can be caught inside the hollow bore, which can cause a stress concentration on the membrane wall as the membrane strands "wave" under normal operation. This stress concentration can eventually lead to a membrane breakage resulting in a breach of membrane integrity. Inside-out membranes usually only use a linear turbulent scouring action along the inner bore for cleaning to prevent the membrane wall from fouling. The outside-in ZeeWeed membrane uses dual-action flushing. The first flushing is a backwashing flush, which uses previously filtered water to flush in the reverse direction of flow from the inside out through the membrane wall. This pushes out any particles that have been lodged in the pores during the filtering process. The second flushing action has water running at a high flow rate along the outside of the membrane to both scour the outside of the membrane and also carry away any particles that were pushed out during the backwash, resulting in a very effective cleaning regime.

Current Residential Water Treatment Market

In developed countries throughout the world, the water leaving municipal water treatment plants is generally in good condition. However, the water typically must travel tens if not hundreds of miles in underground water delivery pipes before it reaches homes. Along the way, the treated water can become contaminated with sediment, iron rust or biofilm growth from within the pipelines or through frequent pipeline breaks. The city of New York typically experiences more than 550 water main breaks every year, which equates to approximately one break in every 10 miles of water line. The situation is worse for cities that experience regular freezing and thawing cycles. The city of Toronto, Canada typically has one break every three miles of water line per annum. Each break results in a breach and possible contamination of the water delivery lines.

Many households do not receive municipal water, and an increasing number of people are building new homes in municipal outreaches that do not receive a treated water supply. These homes require individual water treatment systems to provide people with the assurance of treated water quality and safety.

Over the past two decades, technology for residential water treatment has evolved slowly. Many treatment solutions only deal with taste and odor issues, not disinfection. However, it is the disinfection of the water that is of primary importance, as it is the biological pathogens such as bacteria, viruses and parasitic cysts that will make most people ill and can be fatal to those who are very young or immune compromised.

In addition, people today are looking for convenient solutions that provide purified water throughout the home without limitations. Although many households use pitchers, tap mounts, refrigerator filters or have bottled water brought in, families have had to live with the limitations of these solutions. Ideally, people would like to have purified water delivered throughout their entire house to every tap for all their water needs such as cooking, bathing and general hygiene needs. Similar to the evolution of house cooling, which has gone from a standard fan to window air conditioners and now to central air conditioning for the entire home, the residential water treatment industry is going through an evolution—from pitchers to point-of-use (POU) tap/sink mounts and now to point-of-entry (POE) or whole house central water treatment.

Aging municipal water distributon pipe.

Current technologies on the market can improve water quality, however, with some limitations. While relatively popular, POU reverse osmosis (RO) systems are typically only 25% efficient (75% of inlet water being sent to the drain), and provide a limited amount of treated water at one time based upon holding tank volume. In addition, waters that have high turbidity or high organics can easily foul typical ROs. For people who want whole house purification, ROs may become cost prohibitive due to the high energy cost and water waste, and most homes would require replacement of copper piping with a non-corrosive piping such as PEX. Ultraviolet disinfection will work when applied using proper intensity dosages and flow limiters. However, UV systems must be installed with proper pre-filtration, a separate carbon unit to address taste and odor issues, and will work only when there is power available.

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* Applies to the following models: UFC207, UF209, UF209D, UFC209, UFC209D

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Virus Reduction** > 99.999%

* Applies to the following models: UFC207, UF209, UF209D, UFC209, UFC209D

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Homespring Whole House Solution

In the past, ZENON has primarily focused on the development and application of membrane systems for large-scale commercial and industrial drinking water and wastewater treatment. However, the same industry-leading UF membrane technology could be used in a residential POE system. This led to the introduction of the Homespring Central Water Purifier. The system can be used to purify water from municipal, well and surface water sources. The Homespring purifier incorporates a two-stage filtration process and an integrated patented self-cleaning system all in a self-contained, compact module. The integrated first stage pre-filters the water through a granular activated carbon bed to remove large particles and residual chlorine to provide great-tasting water. The integrated second stage purifies the water by filtering it through thousands of strands of industrial-grade ZeeWeed membranes—the same membranes being used in municipal drinking water plants throughout the world. Using only the existing water pressure from the household line, water passes through the purifier, providing up to 11 gpm of purified water to every tap in the house on demand.

Self-cleaning and Integrity Testing

To minimize maintenance and ensure maximum performance, the Homespring purifier incorporates a patented backwashing system that automatically cleans the membranes daily. By incorporating a pressurized bladder tank on the permeate clean water side, sufficient pre-filtered water is collected to perform a membrane backwash upon depressurizing the system by pushing the water up the inside of the membrane and out through the membrane wall in a reverse direction. This process pushes out any particles or contaminants that have collected in the membrane pores or along the membrane wall. The contaminants are then flushed away using a forward flush in the module. The backwashing system utilizes minimal water resulting in a system that is up to 97% efficient (i.e. 97% of the water delivered to the Homespring system is filtered and provided for use). By incorporating this daily automatic backwash, the system can typically be operated maintenance-free for an entire year.

Upon installation of any water purification system, it is critical that the system be tested to ensure that it is performing correctly. ZENON has developed a hand-held portable Integrity Tester (patent pending) to be used during commissioning of the system immediately after installation and during regular maintenance. The Integrity Tester performs the same ASTM pressure decay test on the membrane that is used on municipal membrane drinking water plants. The test confirms that all membranes are intact and the system is secure from any integrity breaches. This confirms and provides peace of mind to the homeowner upon installation and then again during periodic system maintenance that the system is continuing to provide purified water to the house.

Purifier Testing and Certification

It is important for consumers to select water treatment devices that carry third-party certifications for the claims they are making, especially with regards to water purification. The U.S. EPA's Guide Standard and Protocol for Testing Microbiological Water Purifiers is considered to be the most widely accepted both in North America and internationally as the most stringent test protocol in the water treatment industry today for microbiological purifiers.

According to the EPA, in order to be called a microbiological water purifier, the system must remove, kill or inactivate all types of disease-causing microorganisms from the water, including bacteria, viruses and

protozoan cysts so as to render the processed water safe for drinking. Therefore, to qualify, a microbiological water purifier must treat or remove all types of organisms when tested within the Guide Protocol in various water conditions over a prolonged period of time.

The Homespring purifier is the first and only POE mechanical water filtration device to have been tested and passed by Biovir Laboratories (NELAP and California Department of Health Services approved laboratory) and certified by the Water Quality Association as a Microbiological Water Purifier to the EPA's Guide Standard for Microbiological Water Purifiers. The purifier is also certified by NSF and WQA to ANSI/NSF Standard 42 and ANSI/NSF Standard 53.

Applications

The purifier can be used in residential applications for municipal, well and lake water sources to provide both great-tasting and pure drinking water to every tap in the home. It eliminates the need for bottled water for city dwellers or concerns about biological pathogens such as *E.coli* or *Cryptosporidium* in the drinking water for people on well or lake water sources.

The purifiers can be used in small commercial or industrial applications such as restaurants, bed and breakfast homes or community centers in remote areas. The systems also have been used extensively for disaster-relief aid. In early 2005, more than 50 systems were sent to the Tsunami-ravaged areas in India and Sri Lanka to provide safe drinking water for the relief camps and villages. These systems are still being used today. Recently, 40 systems were sent for Hurricane Katrina relief aid. These systems are being used to supply relief workers with safe water for drinking and bathing.

Summary

In the past decade, HF UF membrane technology has been accepted and adopted as the new industry standard for water treatment technology. The same industrial membrane technology has been packaged into a compact, self-contained POE system and is now available for residential and small commercial applications to provide purified water to every tap in the home or business. As the industry's first certified whole house mechanical filtration purifier, the Homespring system sets the stage to make UF membrane technology the new industry standard for residential water purification. *mf*

About the Author

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About ZENON

Since 1980, ZENON Environmental, Inc. has grown to become a leader of membrane-based water filtration technology. Driven by the founder and current CEO Dr. Andrew Benedek's vision that membranes are the world's answer to increasing water shortages, overuse and pollution, ZENON has focused on a single goal—to provide quality water to the world. More than 500 large-scale municipal and industrial installations in more than 45 countries trust ZENON's membrane systems everyday for quality, safety and reliability. ZENON has installations that range from thousands of gallons per day to plants that produce up to 100 million gal of drinking water per day.

Headquartered in Ontario, Canada, the company has 22 offices in 20 countries and employs more than 1,400 industry professionals who are exclusively focused on membrane-based water treatment solutions. Unparalleled innovations have led to more than 100 patents worldwide for both membrane development and membrane system design.

productshowcase

POE Membrane Water Purifier

The Homespring Central Water Purifier is the first whole house mechanical filtration system to be certified as a Microbiological Water Purifier. It uses industrial-grade ultrafiltration membranes to filter out turbidity and pathogens to produce purified water. The system includes a carbon pre-filter to address taste and odor issues and has an automatic daily backwash for maintenance-free operation.

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