By Matt Migliore

Filtration Economics 101

Innovative Technologies Face Cost Concerns In Struggle for Adoption

In today's bottom-line oriented world, businesses and municipalities can be rather short-sighted when it comes to technology investment. Take, for example, water; while filtration systems for water reuse are being successfully employed in parts of the world where water is scarce, here in the United States, water remains "too cheap" for most organizations to consider implementing reuse systems.

Unfortunately, this wasteful handling of the water supply will likely lead to a point in the near future where the price of water justifies the investment in reuse systems from a business perspective. So, by neglecting to employ water conservation systems in the short run with cheap water, U.S. businesses and municipalities will get to employ such systems in the long run with expensive water. On the positive side, this backing into the proverbial water corner will continue to foster innovation in the area of filtration, which is responsible for some of the more interesting new technology developments in the fluid-handling segment.

The Water Reuse Dynamic

"In areas of the world where water supplies are extremely scarce, like Israel or Singapore, we're seeing creative and aggressive water reuse programs," says Jim Lauria, vice president of marketing and business development for Amiad Filtration Systems (*amiad.com*). "In those regions, a dramatic environmental need has bolstered the political will and economic commitment to aggressively tackle water reuse."

In Israel, Lauria says more than 70 percent of wastewater is reused for crop production, while Singapore's NEWater (*pub.gov.sg/NEWater*) project includes industrial reuse of treated wastewater as well as toilet-to-tap technology. The NEWater program was initiated in 1998 as a joint initiative between the Singapore Public Utilities Board (PUB, *pub.gov.sg*) and the Ministry of the Environment and Water Resources (*mewr.gov.sg*). The program was originally developed to determine the suitability of using "NEWater" as a source of raw water to supplement Singapore's water supply. NEWater was conceived as the brand for treated used water that had undergone a stringent purification and treatment process using advanced dual-membrane (microfiltration and reverse osmosis) and ultraviolet technologies. NEWater could be mixed and blended with reservoir water and then undergo conventional water treatment to produce drinking water (a procedure known as Planned Indirect Potable Use or Planned IPU).

"Water reuse programs are economically driven," says Bob McIlvaine, president of McIlvaine Company (*mcilvainecompany.com*). "When the cost of treating and reusing water is less than the cost of fresh water, then the municipality will spend the money for tertiary treatment and reuse."

While the economics of this scenario have not yet, in most cases, swung in favor of reuse in the United States, there are some signs pointing toward more widespread adoption of reuse systems in this country going forward. For example, McIlvaine says the U.S. Environmental Protection Agency's Great Lakes Initiative has created water discharge limits that are so stringent that the only economical alternative may be zero liquid discharge systems where high-purity water is produced from wastewater by a process of evaporation and condensation with the contaminants disposed of as dry solids.

Screen filters remove solids from a reservoir of treated wastewater that will be used to irrigate crops in Israel. More than half of Israel's agricultural irrigation water is treated wastewater. (Photo courtesy of Amiad Filtration Systems.)

On a more widespread scale, one of the major economic obstacles reuse faces in the United States has to do with infrastructure. Treating wastewater for reuse for cooling systems, irrigation, cleaning, and other processes is quite feasible, but to implement reuse of this sort would require separate pipes for drinking water and reusable water. Currently, most water & wastewater systems in the United States are not configured in this fashion.

"Our existing drinking water and wastewater infrastructure is crumbling around us," says Lauria. "To create a wastewater recycling program like Israel's, where treated urban wastewater is used to produce food and fiber in the countryside, we would need to build and bury thousands of miles of purple pipelines – brand-new piping systems separate from our current potable water infrastructure."

While there are some areas in the United States where reuse systems have been effectively employed – like Orlando and Orange County in Florida, or Monterey County in California – Lauria says that as long as fresh water is relatively inexpensive and the environmental imperative isn't looming over the local economy, "we may have the way, but we don't have the will."

Automatic self-cleaning screen filters in the foreground protect membranes in the background in this regional drinking water plant. Multi-stage filtration and local water treatment illustrate two emerging trends in filtration. (Photo courtesy of Amiad Filtration Systems.)

Other Technology Trends

The past 20 years have brought several key technology trends in the filtration segment. Among the most important have been in the area of membrane technology. Today's membranes are more effective than previous generations of technology, which enables them to more efficiently desalinate or perform other filtration processes at the ultra-fine or even molecular level, thus reducing the cost of reverse-osmosis (RO) treatment, for example. At the same time, Lauria says industry's appreciation for protecting membranes from damage has also improved, with greater focus on multi-stage filtration systems in which each step in the filtration train protects downstream processes.

"It used to be that simple-but-inefficient systems left membranes vulnerable to fouling or relied on fine filtration for all solids removal," says Lauria. "Over the past decade, water treatment experts have gotten much better at employing the best technologies for specific solids – looking at their size and characteristics – to make membrane protection more effective, and more cost-effective, in the long run."

One of the more interesting developments related to membrane filtration is in the area of membrane bioreactors (MBR). MBR technology combines a membrane process like microfiltration or ultrafiltration with a suspended growth bioreactor to produce effluent that can be safely discharged. Using MBR technology, McIlvaine says communities far from a central sewage treatment plant can discharge treated water directly into the ground water, thus avoiding the expense of long sewer transport systems. MBRs are currently receiving significant uptake for municipal and industrial wastewater treatment, particularly in the food processing industry.

Another significant shift in the filtration segment in recent years has been from granular media filters to microfiltration. "Twenty years ago, most municipal water plants used granular media filters as the primary separation device for purifying the drinking water of the nation," says McIlvaine. "An outbreak of waterborne disease in Milwaukee, Wisc., led to the introduction of membrane microfilters to replace the granular media filters." Since many bacteria are just a few microns in diameter, McIlvaine says cross-flow membranes are more effective in capturing them than granular media filters."

Steady improvement in reverse-osmosis filtration performance is also providing hope for cost-effective fresh water in areas where drinking water is in short supply. "Someday we will reach the point where some of the most water-deprived areas of the world will be providing fresh water at or below the world cost average due to improvements in desalination technology," says McIlvaine.

Like many fluid handling technology segments, automation is also making its impact in the area of filtration. According to Lauria, automatic self-cleaning filters, for example, have improved the performance of filtration systems and lowered operating costs, while SCADA systems are now being used to provide automated feedback and control to allow water systems to function more like organic systems. "Now the 'kidneys' and 'circulatory systems' have a 'brain' too," says Lauria.

A Look Ahead

Going forward, Lauria says demand figures to grow for high-purity water for industries such as pharmaceutical and semiconductor. This trend will continue to push filtration suppliers to produce technologies capable of efficiently producing high-purity water for precision manufacturing applications.

Meanwhile, the rising price of water and energy, along with increased pressure to reduce chemical usage, will lead to more filtration of cooling tower water, replacing more chemical- and blowdown-intensive approaches. "Once-through cooling will be a thing of the past," says Lauria. "Companies will be required to conserve cooling water, and good filtration is vital to success."

As clean water supplies continue to disappear, not only will the actual value of water change, but the cost of processing it will become more important. "The cost of water will be measured not only by its scarcity, but by the recognition that water heated, cooled or treated reflects a significant investment in energy," says Lauria. "We'll start capturing that value in our thinking about what's flowing through our pipes."

Lauria says he also expects to see decentralization of water treatment plants in the years ahead, with small neighborhood systems carrying more of the burden of treating potable water, wastewater, and captured rainwater. "Industrial facilities will be even more self-reliant for water treatment," he says. "Control and automation will make this decentralization even more effective – so will smaller footprints."

McIlvaine cites desalination of seawater as the key trend to watch in the filtration segment going forward. "The Middle East, China, and other areas with water deficits will be making huge investments in desalination," he says. "It will change the demographics of the world." McIlvaine sees desalination capability evolving to a point where even some Caribbean islands will become competitive as locations for industry. "As the cost of water per person per year falls from more than one thousand dollars to less than two hundred dollars, [the] obstacle to industrialization disappears," says McIlvaine.

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