by Inge Bisconer

CA Membranes: Under-the-Sink's Best Choice

The nation's water systems are increasingly cited for causing illness due to water-borne bacteria and organisms, creating distrust in the quality of our domestic tap water. At the same time, business opportunities for water treatment vendors are thriving due to the increasing demand in purified water. For residential under-the-sink reverse osmosis (RO) applications, second-generation thin-film membranes (TFM) often are selected due to their superior rejection, flow, temperature and pH characteristics in comparison with first-generation cellulose acetate (CA) membranes. However, it should not be overlooked that CA is superior to TFM in the all-important aspect of chlorine resistance. Instead of removing chlorine prior to the membrane element, CA systems allow chlorine to remain in the system until just prior to the point-of-use, thus providing maximum bactericidal activity. Since CA membrane elements also are characterized by adequate rejection, flow, temperature and pH characteristics for most under-the-sink RO applications, CA should be considered the membrane of choice in the fight against disease in the nation's purified water supply.

Has Our Water Gone Down the Drain?

According to a recent *USA TODAY*/CNN Gallup Poll, a whopping 47 percent of respondents won't drink water straight from the tap. This poll's findings are further supported by the 1997 National Water Quality Survey commissioned by the Water Quality Association (WQA) where one-out-of-five respondents stated dissatisfaction with the quality of their household water supply. This is a significant increase in the level of dissatisfaction compared to a similar survey taken in 1995, with nearly half of those surveyed (47 percent) claiming to want additional information about their water, yet 23 percent not knowing who to contact to obtain that information.

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Does this represent a business opportunity for the water treatment industry? Yes, for both the consumer and municipal segments. A startling response from so many people? Not really, considering the facts.

- During 1994–1995, over 45 million Americans were supplied with tap water that failed to meet basic health standards. The vast majority of violations (12,000 of 18,000) were related to chronic coliform bacteria.
- Only one percent ($5.1 million) of the EPA's enforcement funds ($449 million) were applied to drinking water violations in fiscal 1998; one in 10 water systems have submitted flawed results at least once; and the worst violators have only a one in 10 chance of drawing legal action by the government. Although EPA chief Carol Browner states that 85 percent of the population receives good water, the systems serving small populations pose the largest challenge.
- Although "nobody really has any idea of how many people are getting sick and dying," says Rebecca Calderon, a water-borne-disease expert at the EPA, one soon to be published EPA report suggests that 230,000 people get sick each year from contaminated drinking water, with about 50 deaths.
- From 1993 to 1996, the Centers for Disease Control and Prevention (CDC) confirmed 52 outbreaks of waterborne illness that sickened 408,000 people and killed 111, all the deaths and the majority of the illnesses linked to the 1993 bad water outbreak in Milwaukee.
- Increasing threats from toxic industrial pollutants, pesticides, fertilizers and even radioactive waste further concern the public. A 10.5-million-ton heap of nuclear waste and poison chemicals in Moab, Utah, has recently gained widespread national attention because it sits 750 feet away from the Colorado River, the primary source of water for southern California, Arizona and southern Nevada.

Big Opportunities for the Water Treatment Industry

In response to mounting pressure, Congress and the Clinton Administration revamped the Safe Drinking Water Act in 1996, providing more loans and grants to help water systems and state oversight programs comply with the law. This should help finance the gargantuan task at hand for municipal works.

- Infrastructure improvements to meet legal requirements are estimated to cost $12 billion for the nation's 55,000 water systems that serve residential communities, which equates to nearly $140 billion of upgrades over 20 years.
- About $10 of the $12 billion is needed to protect against bacterial contamination that can cause gastrointestinal illness and, in come cases, death. The three biggest spenders will be California ($1.8 billion), New York ($1.2 billion) and Texas ($1 billion).

An even greater opportunity may lie in the consumer sector, where individuals spend only $18 per month on average for their household water supplies, which is less than what is spent for cable TV. Considering the barrage of recent negative press citing poor infrastructure, new water-borne threats, inaccurate databases and lack of funding for improvements and enforcement, it appears consumers may in fact become willing to secure a safe water supply in the near future.

Table 1: Reverse Osmosis Polymer Comparisons

	Thin-Film (TFM)	Cellulose Acetate (CA)	Cellulose Triacetate (CTA)
pH stability	2–12	2–8	4–9
Chlorine tolerance	Fair-Poor	Good	Fair-Good
Biological resistance	Good	Poor	Fair-Good
Temperature limit, °C	50	35	30
Typical rejection of ionic species, %	>90	90	90

Adapted from "Membrane Technologies in Precision Cleaning Applications" by Peter Cartwright, P.E., Cartwright Consulting Co., published in *Ultrapure Water*, October 1998.

Not surprisingly, use of water treatment devices is up. One-third of consumers (32 percent) surveyed by the WQA currently use a home water treatment device other than bottled water, compared to 27 percent in 1995. Consumers continue to purchase most home water treatment devices from local water treatment dealers, up from 22 percent in 1995 to 29 percent in 1997. The most recent study shows other shifts in the marketplace as well:

- The purchase of water treatment equipment at department/discount stores has tripled since 1995 (up from 7 percent to 21 percent), and the use of "entry level" devices such as pour-through pitchers with filters has grown more than any other type of water treatment device on the market.
- In addition, households earning between $15,000 and $25,000 were twice as likely to purchase water treatment equipment than two years ago.

Further evidence that home water treatment is up are the recent activities of major water companies, such as US Filter (USF) and Glacier Water Services. USF acquired Culligan in 1998, put up mega-dollars to sponsor the Culligan Holiday Bowl, and is running high profile 60-second commercials on national television channels such as CNN. Bottled water giant Glacier Water Services has recently raised $85 million through the sale of securities to fund expansion into major supermarkets where consumers can buy empty bottles, utilize water vending machines, and pay for the water at the checkout counter.

Trouble in Paradise?

As physician James Snow surely discovered in 1854 as he documented the outbreak of cholera in London's water supply, matters of public health are never simple. A recent inspection of bottled water systems in the Los Angeles area revealed elevated levels of bacteria in samples drawn from the vending machines. Health experts in the Los Angeles area say the bacteria levels found in that study were the likely result of removing chlorine (with activated carbon filters) from the tap water that feeds the vending machines, a common practice in many RO water treatment systems since some membranes, TFM in particular, are destroyed by chlorine (see table). Officials representing the bottled water company say the bacteria levels found in their water aren't harmful.

Nevertheless, there are perceived dangers of becoming ill or even dying from ingesting water-borne bacteria. It appears prudent now that, where possible, alternative strategies be employed to maximize disinfection, the most important modern water treatment process. Although UV and ozone are gaining in popularity, the use of chlorine and its compounds is undoubtedly the most common disinfection method in the United States. Most centrally treated tap water is disinfected with chlorine at the treatment plant, and even though chlorine requires short to moderate contact time, it should be allowed to remain in the water treatment system as long as possible.

CA Membranes for Under-the-Sink Applications

For under-the-sink RO applications, the selection of chlorine tolerant CA membrane elements would allow consumers to enjoy the benefits of purified water with maximum exposure to chlorine. CA's noted drawbacks of lower flows, more narrow pH tolerance, and less salt rejection in comparison with TFM are typically not an issue for a residential, under-the-sink application since flows are low, pH values are typically within tolerance range, and salt rejection is adequate for most palates. As an added bonus, CA membrane systems are typically less expensive than TFM systems primarily because one of two carbon filters is eliminated.

In RO systems using CA membrane elements, only one activated carbon filter is required, and it should be fitted just prior to the point-of-use. In this scenario, foul-tasting chlorine is removed before drinking, but not before the CA membrane and storage tank have been disinfected. Allowing chlorine to pass through the CA membrane element also protects the membrane itself from bacterial degradation.

Summary

The nation's tap waters are in disrepair, and will take some time to fix. In the meantime, consumers are increasingly willing to pay for under-the-sink purified water systems to avoid the ill health effects of ingesting water-borne substances such as bacteria. Since it is desirable to allow chlorine to remain in the system as long as possible to maximize its bactericidal effects, under-the-sink RO systems should be fitted with CA membrane elements rather than TFM elements to take advantage of CA's unique capability of tolerating chlorine. In such systems, an activated carbon filter for chlorine removal is necessary only just prior to the point-of-use, rather than prior to the membrane element as well. When RO systems are fitted with CA membranes and one carbon filter, both the membrane element and the storage tank are disinfected with chlorine, and the opportunity for bacterial contamination of the water or the storage tank is minimized. •

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