

Building a Filter Defense Against Zebra and Quagga Mussels

By Jim Lauria

Tiny mussels can create massive problems for intake structures, valves, pumps, screens and other water infrastructure around the US. Some filtration systems can provide chemical-free protection against invasive zebra and quagga mussels, but it is vital to understand the problem and develop the right system to avoid being overrun by the alien species.

Swift invasion

Zebra mussels (*Dreissena polymorpha*) and their larger cousins, quagga mussels (*Dreissena rostriformis bugensis*), are natives of the Caspian and Black Seas, but have spread across Europe, Canada and the US with alarming speed.

Zebra mussels first invaded the US in the mid-1980s, probably entering American waterways as eggs or larvae in ballast water. Quagga mussels were recognized as a distinct species in 1991. Today, these two mussels are found in the Great Lakes, the Southwest, the California Coast and all major river drainages east of the Rockies.

The success of the tiny mollusks—which grow only to the size of a thumbnail but crowd out native species with immense, densely packed colonies—results from their remarkable adaptability. Though they are a freshwater species, they can tolerate salinity of up to 6,000 ppm or even higher, in certain conditions. This makes them a threat in some estuaries and brackish water sites.

They are also highly productive in water temperatures into the mid-80°F range. In fact, warm water conditions in the West can multiply the mussels' reproduction rate by a factor of six.

Life cycle

Zebra and quagga mussels are extremely tiny and mobile during the early stages of their life cycle. The eggs are only 40 microns in size, with newly hatched trocophores (small, free-swimming, ciliated aquatic larva)



Four layers of woven stainless steel screen and a highly effective back flush system keep this filter clean and effective as a safeguard against zebra and quagga mussels. (Photo: Amiad Filtration systems)

starting out at 40 to 60 microns for a day or two before rapidly growing.

These mussels mature into veligers—a planktonic form in which they remain for weeks or months. After reaching 350 microns in size (about 0.014 inches in diameter), they settle down as juvenile mussels.

Mussel control

Many control measures for zebra and quagga mussels rely on chemical means, including chlorine and other strong oxidants. Ozone and UV light have also been shown to effectively control eggs, trocophores and veligers.

However, UV, chemical and ozone measures can be costly and undesirable.



A battery of automatic self-cleaning screen filters strains out juvenile mussels and captures or ruptures eggs and tiny veligers while flushing frequently and efficiently to avoid becoming fouled itself. (Photo: Amiad Filtration Systems)

This is especially true in areas where sensitive species—or sensitive stakeholders—are a concern. Fortunately, well-designed, automatic self-cleaning screen filtration systems at the 40-micron level have been demonstrated to effectively control zebra and quagga mussels.

An independent trial of 40-micron, automatic self-cleaning screen filters at Mississippi Power and Light's Gerald Andrus Station in Greenville, resulted in no viable life forms of the water supply's zebra mussel population in the filtered water. The small proportion of eggs and veligers that slipped through the screen were torn, compressed or deflated—dead or dying, according to Acres International Corporation of Amherst, NY, which analyzed the samples in the study.

Automatic self-cleaning filters have since proven themselves in a variety of installations for zebra and quagga mussel control. Two specific examples are noted:

Mudd Creek Irrigation District, Bad Axe, MI. The district faced closure because authorities wouldn't allow the district to connect Lake Huron to local surface water supplies without a 100-percent effective system to remove zebra mussels from the water. Three 10-inch (254 mm) diameter filters with 25-micron screens handle a flow of 4,500 gpm (17,034 L/m) to keep Mudd Creek's farms supplied with mussel-free water.

Ed Week Fish Culture Station, Grand Isle, VT. The hatchery's shallow-water intake was invaded by zebra mussels in the mid 1990s, forcing managers to draw from a deep-water intake. Because the deeper water is 30°F cooler than the shallow water, switching to deep intakes multiplied the hatchery's heating bill tremendously.

Since 1997, nine of the 10-inch filters have put 8,800 gpm (33,311 L/m) of shallow-intake water through 25-micron screens to protect the hatchery while also protecting its bottom line. In that time, the filters have paid for themselves time and again in reduced heating costs.

Focused back flush

Focused back flush technology keeps these self-cleaning screens clean regardless of environmental conditions, ensuring reliable, nearly maintenance-free operation while minimizing the use of back flush water. The result is efficient, thorough self-cleaning with no interruption of the filtration cycle.

When the pressure differential across the screen reaches a pre-determined level (often seven psi) the system opens an exhaust valve. The exhaust valve drains the suction scanner, a hollow 316 stainless steel tube tipped with nozzles just millimeters from the screen surface.

Opening the exhaust valve to the unpressurized outside environment causes water to flow in a high-velocity stream



Quagga mussels encrusted the penstock gates at Davis Dam in Arizona. (Photo: US Bureau of Reclamation)



When juvenile quagga mussels settle down, colonies form quickly, with devastating results, like these smothered sampling plates from Parker Dam, which holds back Lake Havasu. (Photo: US Bureau of Reclamation)



Tiny zebra mussels and their larger cousins, the quagga mussel, can create huge problems when they colonize waterworks and habitat. (Photo: US Geological Survey Archive, www.bugwood.org)



These zebra mussels colonized wood in Lake Erie. Colonies on inlets, pipes, valves and screens can cripple water intake structures. (Photo by Whitney Cranshaw, Colorado State University, www.bugwood.org)

backwards across the screen into the nozzles. This carries the captured particles or filter cake with it.

The nozzles concentrate the suction effect on less than one square inch (6.45 cm²) of screen at a time, creating a powerful and highly effective cleaning force, called focused back flushing. The suction scanner travels down the screen in a spiral pattern at a fixed speed, cleaning 100 percent of the screen surface in 25 to 40 seconds.

The suction-scanning technology uses a very small amount of water (less than one percent of the flow in most cases) so the entire cleaning process can take place without interrupting system flow. The backwash water can be handled in a variety of ways, including sent back to the source water, sent to an impoundment pond or sent into sewer facilities. Because there are no chemicals, polymers or filter aids to be flushed with the filter cake, suction-scanning technology is truly clean technology.

Triggered by pressure differential, the self-cleaning process is initiated as often as necessary, but no more. For instance, at the Ed Week hatchery, the EBS filters flush 30 to 300 times per day, depending upon water quality.

Other benefits

Automatic self-cleaning screen filters are not oriented exclusively toward mussel control, so they improve water quality across the board by removing algae and particulates, reducing wear and plugging on irrigation or mechanical systems downstream. Because they are continually self-cleaning, there are no buildups of algae mats that occupy headspace in media filters, nor accumulations of mussels that can appear in media tanks.

This screen-filtration technology is clean technology for a variety of reasons. There are no chemicals required for mussel control or filter maintenance and less than one percent of the flow is generally required for back flushing. The filters have minimal energy requirement—just a small electric motor is needed to turn the suction scanner. And the small footprint minimizes the need for costly infrastructure. Most important, the cost of filtration is minimal as insurance against the crippling impact of zebra or quagga mussels.



Zebra mussels are such aggressive colonizers that they overrun native mollusks, like this clam. (Photo by Randy Westbrook, US Geological Survey, www.bugwood.org)

About the author

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