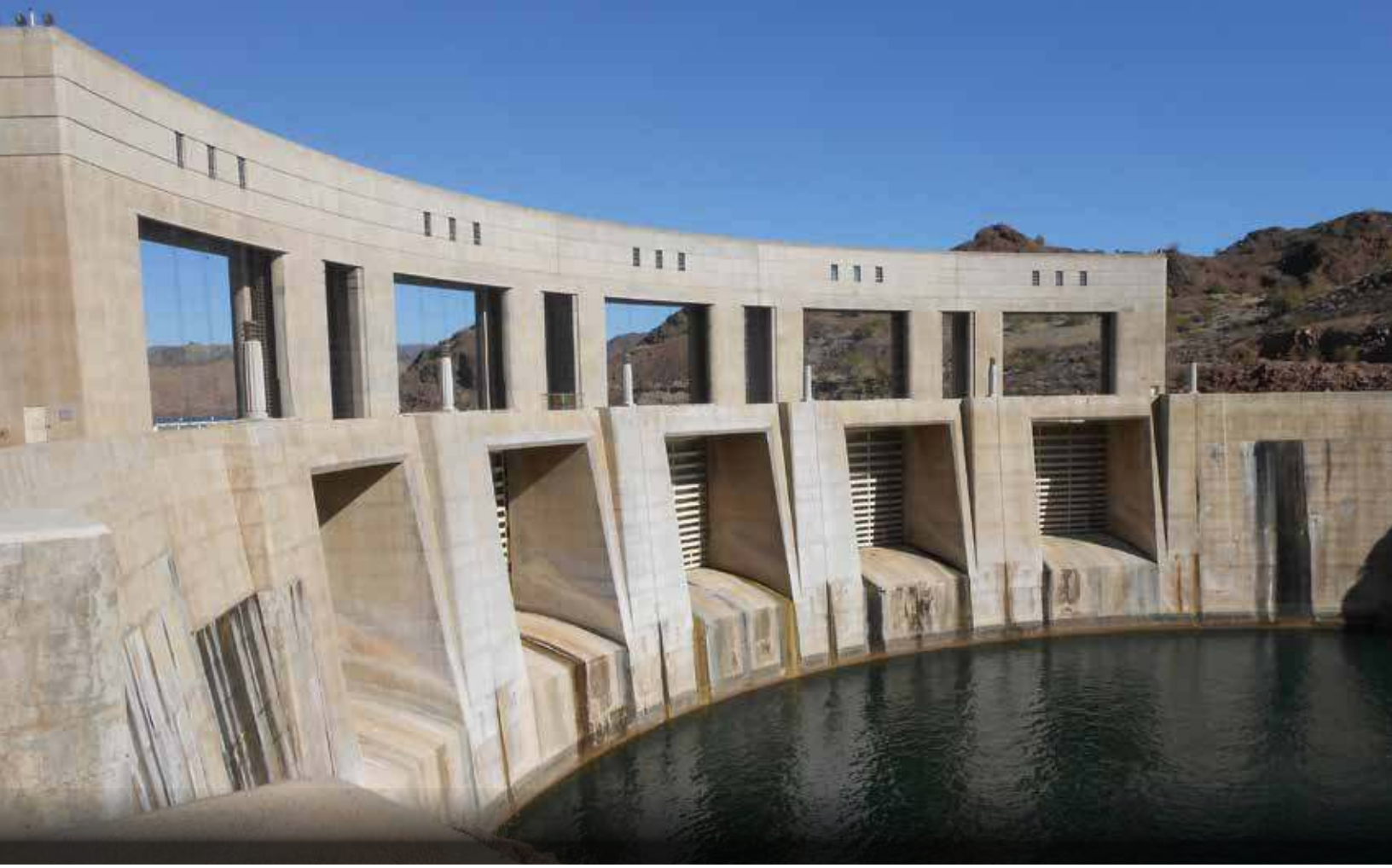
Atlantium
Illuminating Water Technologies

Hydro-Optic™ UV — Proven Biofouling Control of Aquatic Invasive Species

An Environmentally Friendly Hydropower Solution



For more than a decade Atlantium Technologies has been applying its environmentally sustainable Hydro-Optic™ (HOD) ultraviolet (UV) disinfection technology to help hydroelectric facilities prevent biofouling from invasive mussel species and their profound operational effects.

In large numbers, mussels (zebra, quagga, golden, etc.) can devastate aquatic biodiversity and water quality. Because mussels can attach to and quickly clog up water intake and delivery pipes, and foul dam intake and pipes, and the decay of dead mussels can corrode steel and cast-iron pipelines, they pose substantial economic headaches. Particularly at risk are hydropower facilities whose power production can be severely hampered by mussels that can latch onto intake structures and trash racks, penstocks, gates and valves, cooling water systems, raw water fire protection systems, service and domestic water systems, and even instrumentation.

Before the introduction of the HOD UV technology to provide mussel prevention, hydroelectric facilities were predominantly reliant on chemically based prevention or manual cleaning technologies.

Long-term and full-scale commercial evaluation of Atlantium's HOD UV technology has been completed with facilities across Canada and the United States.

The HOD UV technology has achieved extraordinary efficacy in settlement control and mussel mortality not seen with traditional UV systems. Atlantium's HOD UV solution is proven to control aquatic invasive species, such as invasive mussels, with the ability to achieve 100% inactivation even under conditions with less than 50% UV transmittance (%UVT). UV transmittance (UVT) is an indicator of water quality and designates the percentage of UV light that passes through the water.

Reclamation Showcase

Most notable has been the extensive review undertaken by the U.S. Bureau of Reclamation (Reclamation) Lower Colorado Region who began a series of feasibility studies in 2007 to assess risk from mussel fouling, outline best low-ecological-impact management practices for coping with invasion, and identify control options for raw water systems to prevent invasion and infestation.

Following their review of various chemical and non-chemical treatment methodologies, in 2013, Reclamation selected the HOD UV technology as its preferred treatment option.

The HOD UV technology was installed at Davis Dam in 2013, Parker Dam in 2015 and Hoover Dam in 2018.

In April 2019, the Bureau of Reclamation's Science and Technology Program selected the research project, "Control of biofouling in hydropower cooling systems using hydro-optic

ultraviolet light," as Project of the Year.

Continuing with the recognition, in July 2019, Reclamation's Parker Dam was awarded the 2019 Top Water Plant award by POWER Magazine.

In addition to Reclamation, leading environmentally oriented companies such as Ontario Power Generation, the U.S. Army Corps of Engineers, the Salt River Project and others have selected the HOD UV treatment solution to help prevent mussel infestation given its safety and proven performance.

Ontario Power Generation Profile

The Ontario Power Generation (OPG) DeCew II Generating Station, a hydroelectric generating station with a nameplate capacity of 144 MW, undertook an evaluation of innovative environmentally friendly and cost-effective methods to control invasive mussels without the use of hazardous chemicals. As a result, OPG installed and commissioned a HOD UV system in 2017 to undertake a six-month pilot study of a full-scale demonstration of this non-chemical and sustainable disinfection method to control invasive mussels at DeCew II.

During the six months of operation, no viable individual mussels settled in the test biobox while settlement was recorded in the control biobox. The results demonstrated that the HOD UV system is providing settlement control within DeCew II generating station and that the system met and exceeded the treatment objective of achieving 95% control of settlement. This result was achieved under varying UVT conditions ranging as low as 49.79% UVT and as high as 98.99% UVT.

Why HOD UV?

Unlike chemical treatment approaches, UV systems employ a physical process for disinfection. When bacteria, viruses and protozoa are exposed to the germicidal wavelengths of UV light, they are rendered incapable of reproducing.

HOD UV systems feature the unique Total Internal Reflection (TIR) technology that recycles UV light energy, ensures homogenous UV dose distribution and provides superior power (kW) efficiency compared to traditional UV. The system's patented TIR technology, which is similar to fiber optic science, recycles UV light energy within the HOD UV chamber. The core of the technology is its water disinfection chamber made of high-quality quartz surrounded by an air block instead of traditional stainless steel.

This is especially important given that in traditional UV systems metal adsorbs or "detracts" the UV dose the closer it gets to metal, whereas the TIR enhances the UV dose. This configuration uses fiber optic principles to trap the UV light photons and recycle their light energy. The photons repeatedly bounce through the quartz surface back into the chamber, effectively increasing their paths and their opportunities to inactivate microbes.

Hydro-Optic™ (HOD) UV system installed at Parker Dam.

Real-Time Monitoring & Control

HOD UV features a comprehensive control and monitoring system. Atlantium's proprietary UV system includes a dedicated UV sensor per lamp, integrated UVT sensor and feed from a flow meter to maintain the required UV dose to meet application specific needs. This is a feature unique to the HOD UV technology.

The novel control of the HOD UV technology promotes stability, assures water safety, provides operator flexibility and guarantees quality.

HOD UV systems also come equipped with an intuitive, user-friendly and comprehensive control interface to track system operation in real-time. This provides operators with live data on the operation of their system.

Atlantium's All-in-One (AiO) controller sets a new standard in precision, monitoring and operation of UV systems.

Global Service & Support

HOD UV systems are globally supported and spare parts, such as UV lamps, are readily available 24/7.

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