Atlantium
Illuminating Water Technologies

CASE STUDY

UV Water Treatment
Hydro-Optic™ Technology

Ontario Power Generation Controls Invasive Mussels Using Environmentally Friendly Hydro-Optic UV Disinfection Technology

The Ontario Power Generation (OPG) DeCew II Generating Station, part of Niagara Operations in St. Catharines, Ontario, is a hydroelectric generating station with a nameplate capacity of 144 MW. The station has been in operation since 1943. Following the spread of zebra and quagga mussels to the Great Lakes in 1988, OPG installed chlorination systems in the early 1990s to mitigate this threat. In an effort to evaluate innovative, environmentally friendly and cost-effective methods of controlling invasive zebra mussels, OPG installed and commissioned the Hydro-Optic™ (HOD) ultraviolet (UV) system in May 2017. The six-month pilot study was a full-scale demonstration of an environmentally friendly, non-chemical disinfection method to control invasive mussels at the DeCew II Generating Station.

Plant Overview

Water for OPG's DeCew II hydroelectric facility (Figure 1) is supplied from Lake Erie through the Welland Canal. UV Transmittance (UVT) is an indicator of water quality and designates the percentage of UV light that passes through the water.

The station normally has influent UVT values above 90% (highest measured value of 98.99% UVT); however, seasonal variations in water quality impact UVT values, with the lowest measured value of 49.79% UVT. DeCew II Generating Station discharges water into 12 Mile Creek and ultimately, into Lake Ontario at Port Dalhousie.

To control zebra and quagga mussels, OPG utilizes sodium hypochlorite to carry out a periodic end of season chlorination which treats service cooling water coming off the penstocks after water passes through strainers that are used to remove debris.

Because OPG is registered to ISO 14001 and maintains an Environmental Management System (EMS), in support of its EMS and as specified in its Environmental Compliance Approval (ECA), OPG optimized the sodium hypochlorite systems to provide a 24-hour-per-day target dose of less than 0.65 ppm for a minimum of 10 days at the end of the season. Total residual chlorine levels are maintained well below the ECA limit at the end of the cooling water system. The biobox for the bioassays is also placed at the end of the cooling water system to monitor effectiveness of treatment throughout. In total, these process optimizations have reduced the use of sodium hypochlorite by more than 80% since 1990; however, further reductions are not feasible if the same method of treatment is to remain.

Innovative Environmental Solution

Recent OPG efforts to support continual improvement and pollution prevention in its EMS, have resulted in OPG's evaluation of innovative environmentally friendly methods of controlling invasive mussels that do not expose fish, plants and other aquatic life to hazardous chemicals. Additionally, OPG wanted to reduce the hazards of chemical exposure to its staff.

In May 2017, OPG installed and commissioned the medium pressure HOD UV system from Atlantium Technologies, Inc. to undertake a six-month pilot study of a full-scale demonstration of an environmentally friendly, non-chemical disinfection method to control invasive mussels at its DeCew II facility (Figure 1).

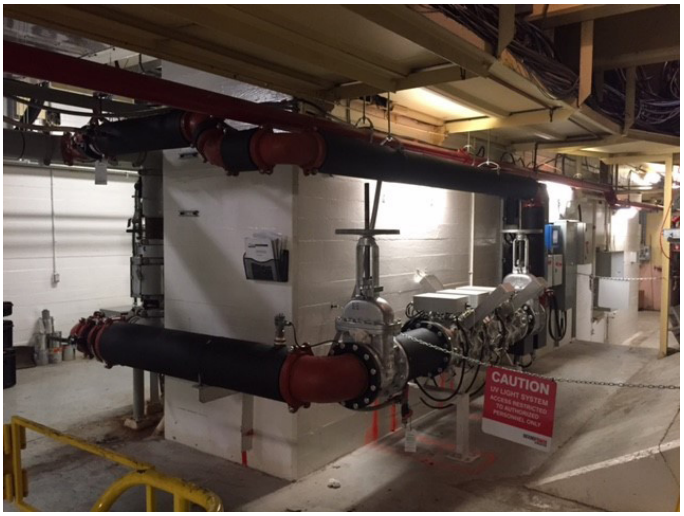

Figure 1:

Atlantium Hydro-Optic UV Demonstration Unit Installed at OPG DeCew II

The proprietary medium pressure UV system contained three lamp sections, each with two lamps for a total of six (4.2 kW) maps in the system. The system was supplied with a deposit control mechanism, percent UVT monitor, UV dose monitor and flow control valves. The UV unit was installed in Cooling Loop #1 where water is taken from the penstock to accommodate a flow rate of 430 cubic meter per hour (1,893 gpm).

Due to space constraints, the unit could not be installed immediately after the strainer of the raw water, cooling water supply. To accommodate the system, the 14-inch piping immediately after the strainer was extended around the wall to the other side and looped back. The HOD UV system was placed horizontally, which provided adequate spacing for maintenance (30 inches on each side for ease of UV bulb removal and was located 3 to 4 feet above the floor). Water was diverted from the strainer through to the HOD UV unit and then returned back to the service water header. Incorporation of isolation valves at the start and end of the loop piping allowed for easy isolation and maintenance of the HOD UV system with no impact to generation/production.

The disinfection efficacy of the HOD UV system to control invasive mussels was measured by monitoring mussel settlement in a biobox receiving UV treated water and comparing the results to a biobox that received untreated, raw water (the control):

1. Control biobox: pre-HOD UV treatment
2. Post-HOD UV biobox: immediately following treatment system

The treatment objective of the HOD UV system was to achieve 95% elimination of settlement in the biobox receiving UV treated water especially during the summer months when lake inversion is known to take place and UVT values can fall to lower levels.

ASI Group Ltd. (ASI), a full-service engineering and marine technology company, was contracted to oversee the demonstration study of the HOD UV unit and monitor mussel inhibition results. ASI conducted onsite visits to monitor mussel veliger presence and mussel settlement in the bioboxes from June 2017 through November 2017 when the ambient water temperature was above 10°C. Once the temperature went below 10°C, the HOD UV system was powered off since mussels are not active at that ambient water temperature.

Operation and Maintenance Experience

Initial start-up and training for the HOD UV technology was completed in less than two days. To initiate treatment and move the UV technology into operational mode, bypass valving was opened to allow cooling water from the penstock coming out of the backwash strainer to flow through the HOD UV unit. Throughout the pilot study, the UV technology required minimal service and maintenance. While in operation, the system control panel was checked weekly by OPG staff to ensure all lamps were functioning and that the units were operating as required. This brief weekly service check totaled less than an hour of effort per month and no additional maintenance was needed. The unit operated during the six months of treatment in 2017 with no significant issues identified.

With the assistance of Atlantium, annual maintenance was performed at the end of the active mussel season, over the winter months, with the system in isolation so as not to impact production. Annual end-of-season maintenance took about one day, which included; cleaning in place using vinegar to remove any debris or mud from the hydro-optic chamber, replacement of all six UV lamps as well as well as the quartz tube gaskets. Additionally, the quartz sleeve was removed and mineral deposits were cleaned from the surface. The wiper pad was replaced and sensors were calibrated on the control panel. Reactivation of the HOD UV technology at the beginning of a new active mussel season is expected to average a half day for completion.

In comparison to treatments with sodium hypochlorite, a key advantage of the HOD UV treatment is the reduced labor and material costs to maintain the equipment and keep it functional and effective. Annual maintenance for sodium hypochlorite treatment requires mechanical and electrical staff to replace, calibrate and verify equipment before and during sodium hypochlorite dosing treatments (Figure 2). Another key advantage of the HOD UV technology is the reduction of footprint needed for the system and the soft costs and personnel safety associated with not having to store and handle sodium hypochlorite.

Figure 2: Components and Materials Comparison

HOD UV 2017	• 6 x 4.2 Kw lamps = 25.2 Kw for HOD UV x 2 units • 10 inch service water piping mods for unit 1 and 2, including valving • Onsite recording of monitoring data (no need for SCADA)
Chlorination Rebuild 2002	• Dedicated kynar piping (supply and install) supply, install and delivery of sodium hypochlorite • 2 prominent dosing skids with 2 pumps each • 2 prominent analyzers with probes • 2 x 800 liter tanks for sodium hypochlorite with containment • Software development to integrate into SCADA

Exceeded Treatment Objective

During the six months of operation of the HOD UV system, no viable individual mussels settled in the test biobox while settlement was recorded in the control biobox. It can be concluded from these results 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 (Figure 3).

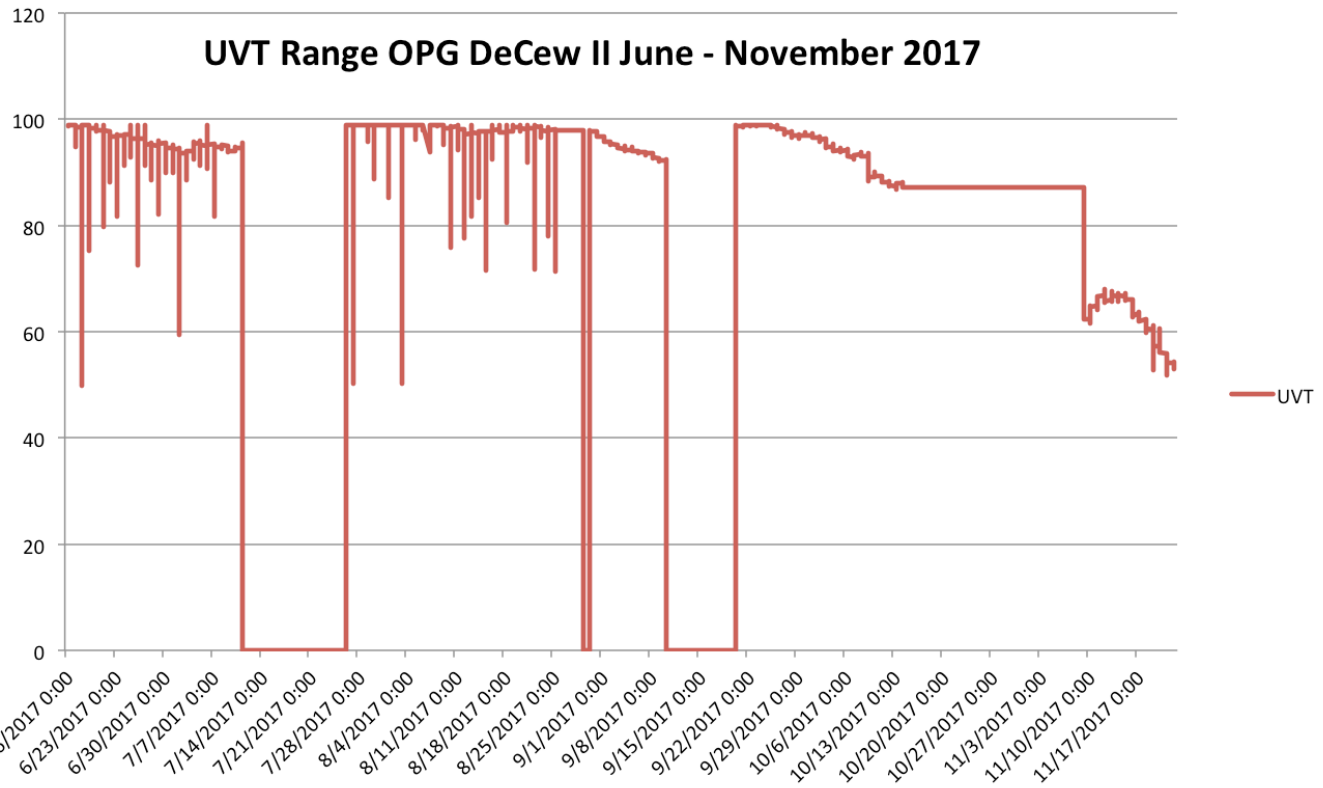

Figure 3:

UVT Range (min = 49.79% UVT, max = 98.99% UVT) at OPG DeCew II From June Through November 2017 During Hydro-Optic UV Pilot Study

Sampling and analysis was carried out at regular intervals in an effort to monitor infestation and mortality rates of settled mussels and help determine the effectiveness of the HOD UV technology. Although some settled individuals were detected on the sampling plates in the test biobox on two occasions (Aug. 17 and 27, 2017), these in-dividuals, although attached, exhibited complete mortality.

The full-scale demonstration has proven the Hydro-Optic UV system to be an environmentally friendly, non-chemical disinfection method to inhibit invasive mussels at DeCew II. Additionally, the HOD UV technology's ease of use, service, and maintenance was successfully demonstrated during this pilot study. Based on historical full-scale performance of the Hydro-Optic UV technology in other hydroelectric applications, Atlantium believes the HOD UV technology will also prove to be a cost-effective mussel mitigation solution for DeCew II.

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