Invasive mussels controlled with environmentally friendly technology

The Ontario Power Generation (OPG) DeCew II hydropower plant is part of Niagara Operations in St. Catharines, Ontario.

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 DeCew II.

Plant overview

Water for OPG's DeCew II hydroelectric facility is supplied from Lake Erie through the Welland Canal. DeCew II discharges water into 12 Mile Creek and ultimately, into Lake Ontario at Port Dalhousie. 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 per cent (highest measured value of 98.99 per cent UVT); however, seasonal variations in water quality impact UVT values, with the lowest measured value of 49.79 per cent UVT.

To control invasive mussels, OPG uses sodium hypochlorite to carry out a periodic end-of-season chlorination, which treats service cooling water coming off the penstocks after water has passed through strainers that are used to remove debris.

OPG optimized the sodium hypochlorite systems to provide a 24-hour/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 the effectiveness of treatment throughout. In total, these process optimizations have reduced the use of sodium hypochlorite by more than 80 per cent since 1990; however, further reductions are not feasible if the same method of treatment is to continue.

A pilot programme has been successfully completed to control invasive mussels at the DeCew II plant in Ontario, Canada.

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. In addition, OPG wanted to reduce the hazards of chemical exposure to its staff.

The HOD 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, per cent 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 m^3/hour.

As a result of space constraints, the unit could not be installed immediately after the strainer of the raw water cooling water supply. The 35.5 cm piping after the strainer was extended around the wall to the other side and looped back. The system was placed horizontally, providing adequate spacing for maintenance on each side, for ease of UV bulb removal and was 91 to 121 cm 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 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 with a biobox that received untreated, raw water (the control).

The treatment objective of the HOD UV system was to achieve 95 per cent 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, 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 visited the site to monitor mussel veliger presence and settlement in the bioboxes from June to November 2017, when the ambient water temperature was above 10°C. Once the temperature decreased to <10°C, the system was turned off, as mussels are not active below 10°C.

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. The system control panel was checked weekly to ensure that all lamps were functioning and that the units were operating as required. This service check totalled 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 being identified.

With the assistance of Atlantium, annual maintenance was done at the end of the active mussel season, during the winter months, with the system in isolation so as not to impact production. Annual end-of-season maintenance took about one day. Reactivation of the technology at the beginning of a new active mussel season is expected to average half a day for completion.

Compared with using sodium hypochlorite, a key advantage of the HOD UV treatment is the reduced labour and material costs, as wel as 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.

Exceeded treatment objective

During the six months of operation of the HOD UV system, no individual live mussels settled in the test biobox while settlement was recorded in the control biobox.

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, these individuals exhibited complete mortality.