Atlantium
Illuminating Water Technologies

CASE STUDY

UV Water Treatment
Hydro-Optic™ Technology

Power Plant in Pinghu, China Installs Hydro-Optic™ UV for Non-Chemical Disinfection of Boiler Feed Make-up Water

A power plant in Pinghu, located within the Zhejiang Province, China has installed the Hydro-Optic™ (HOD) UV treatment system to replace the use of chemical biocides and protect boiler feed make-up water from anaerobic and aerobic bacterial growth and associated biofouling. The HOD UV technology was installed in April 2018 to accommodate a flow rate of 430 m^3/h and since then the facility has achieved non-chemical boiler-feed make-up water disinfection using this environmentally friendly and sustainable approach.

The Pinghu plant uses a multiple barrier treatment approach consisting of clarification, mechanical filtration, activated carbon filtration, micron filters, and reverse osmosis (RO) filtration to treat incoming source water from the Jiaxing Tang River with UV transmittance values of 80% UVT. The plant injects NaOCl (sodium hypochlorite) before the clarifier and used to inject biocide before the guard filter to protect the RO from biofouling. The RO system consists of 4 trains (#A1, #A2, #B1, and #B2) with a capacity of 107.5 m^3/h each. The HOD UV system (Model RZB300-13 HOD-UV system), composed of six (6) 4.2kW lamps, has a maximum total power consumption of 25.2kW. The system was installed in between the activated carbon filters and micron filters in advance of the RO trains. Protecting the RO membrane elements from fouling is essential to minimizing the operational impacts of biological contamination on operating costs; which include increased membrane element and microfiltration cartridges replacement costs, decreased water quality production and/or increased operating pressure.

Hydro-Optic™ UV Technology: Principles of Operation

The HOD UV technology is a physical process for disinfection that exposes bacteria, viruses and protozoa to germicidal wavelengths of UV light, measured in nanometers (nm), to render them incapable of reproducing and excreting extra-cellular polymeric substances that are responsible for biofilm creation.

The HOD UV technology measures four critical parameters including UVT%, flow rate, UV lamp intensity (kW) and apparatus (consisting of Total Internal Reflection and Dose Pacing) in real time to maintain a specified UV dose. The system uses a proprietary Total Internal Reflection (TIR) based apparatus that when coupled with the comprehensive monitoring of critical parameters allows the system to achieve and maintain the specified UV dose.

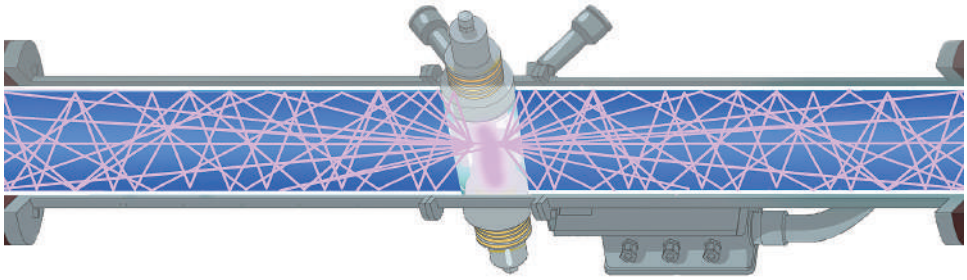

Figure 1: Atlantium Hydro-Optic™ UV Lamp and Chamber

The system's patented TIR technology, which is similar to fiber optic science, recycles UV light energy within the HOD UV chamber. Simply put, the UV wavelength is effectively lengthened (i.e., magnified) and provides a greater opportunity to inactive microorganisms. 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 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 lengthening their paths and their opportunities to inactivate microbes.

Evaluation

Following the installation of the HOD UV system in April 2018 an evaluation study was undertaken to compare operating parameters for a 3-month period before and after the use of the technology (Table 1). The HOD UV system has made a positive impact on membrane performance compared to the use of chemical biocide treatment. With HOD UV the permeate recovery is went from 67% to 73%, a 7% increase and the pressure drop across the micron filters is still zero whereas with the use of chemical biocides the cartridges used to be replaced every 1 to 1.5 months.

Table 1: Pinghu Plant Recovery Rate (m^3/h) and Pressure Drop (Bar) Before and After HOD UV

			#A1 RO	#A2 RO	#B1 RO	#B2 RO	Average
Permeate	Average	Before HOD UV	51.6	52.0	52.2	59.5	53.8
		After HOD UV	57.7	56.9	59.5	63.2	59.3
	STDV	Before HOD UV	8.1	6.5	8.1	10.4	8.3
		After HOD UV	7.5	5.6	8.5	9.5	7.8
Pressure Drop	Average	Before HOD UV	0.39	0.27	0.38	0.26	0.33
		After HOD UV	0.35	0.23	0.35	0.23	0.29
	STDV	Before HOD UV	0.07	0.05	0.07	0.04	0.06
		After HOD UV	0.04	0.04	0.05	0.04	0.04

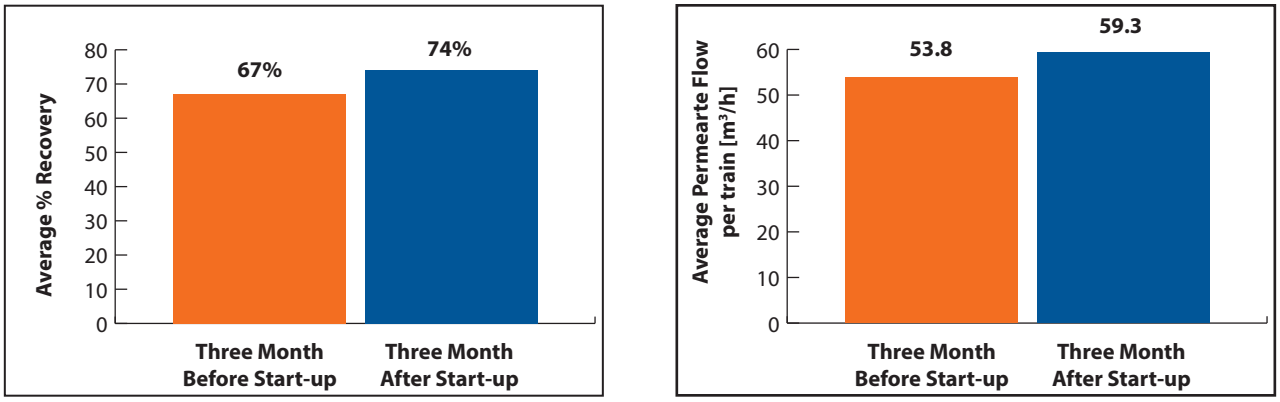

Figure 2: Comparison of Average Recovery Rate and Permeate for 3 months Before/After HOD UV Installation

Given the improvement the facility has experienced since the installation of the HOD UV technology, the facility can expect the following benefits:

- Increased water production, a 47,520 ton increase was seen in just 3 months
- Cost savings from the reduction of biocide consumption, the facility has eliminated the use of biocides (1 ton/month)
- A reduction in the micron filter replacement frequency, the facility was replacing the cartridge filters once a month before the HOD UV installation
- Extended RO membrane life by improving performance and reducing biofouling

A detailed analysis of the expected ROI at the Pinghu Plant is detailed in Table 2.

Table 2: Pinghu Plant Expected ROI After Year 1 of Operation

Item	Unit Price (USD)	Consumption Before HOD UV	Consumption After HOD UV	ROI (USD)
Biocide	3,427	1.5	0	34,266
Cartridge Replacement	4.5	322	161	4,827
Increased Permeate (ton)	0.5	-	22,348-28,307	78,216-99,076
Decrease Brine (ton)	0.5		22,348-28,307	71,514-90,584
RO Membrane (pcs) RO	447	7.7	3.9	11,621
CIP	1,490	0.6	0.3	2,980
			Total Savings on one train per year	**>203,422**
USD/RMD exchange rate of 1/6.71206				

Incorporating the non-chemical HOD UV technology into full-scale operations at the Pinghu Plant has proven favorable for disinfection efforts at the facility. In addition to eliminating the use of chemical biocides, the facility has also minimized the frequency of micron filter replacement. These operational efficiencies are expected to result in a net savings of 1,365,400 RMB/year (approximately 202,000 USD/year), providing less than a one-year return on investment. Moreover, there has been no reduction in performance to the RO membranes with the use of the HOD UV technology.

As power plants look to reduce the transportation, handling and use of hazardous chemicals, the non-chemical HOD UV technology provides an environmentally friendly and economical solution for protecting boiler feed make-up water from anaerobic and aerobic bacterial growth and associated biofouling.

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