AquaWorker replaces biocides in cooling system at Alleima Tubes, Sweden

There are multiple challenges associated with the operation of an open recirculating cooling system. Warm water temperatures and evaporation drive bacterial growth and accumulation of solvents. Significant additions of chemicals, including biocides, are needed to handle Legionella risks and issues with corrosion, scaling and biofouling. The common practice, to dispose toxic "blow-down" streams into municipal sewers, is now prohibited by European chemical legislation. Industries are now under pressure to find alternative solutions.

Alleima Tubes in Sandviken has evaluated Wallenius Water Innovations industrial UV system - AquaWorker, to phase out biocides in their furnace cooling system. The conclusion is that it is both effective and reduce costs.

Strong focus on sustainability
At Alleima Tubes, Sandviken part of the continuous environmental work is to reduce the use of chemicals. For the furnace cooling system, the objective was to replace the use of biocides with UV treatment to control microbiological activity. The benefits are multiple; biological control, reduced OPEX, reduced health hazard risks of personnel and environment and waste stream compliance.

Pre-conditions of the cooling system
When the steel tubes exit the furnace, a controlled cooling process is initiated. This process uses cooling water which is in direct contact with the tubes through several injection points: nozzles, jets and gravity flow. This massive heat rejection (1200°C to 80°C) requires cooling water available during process. The cooling system is not in operation continuously, which is a challenge for an effective water treatment. However, the system volume is relatively small compared to the cooling capacity, giving the potential for an effective treatment. Biocides have been used historically to control biological activity in the cooling system.

To avoid bacterias to develop resistance to the biocide, two different types of biocides have been cycled.

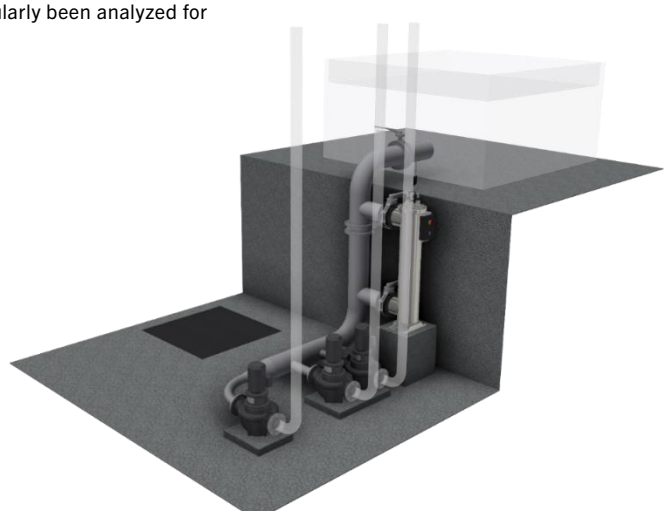
Once a year sanitation of the cooling system is conducted; drained and cleaned. The cooling water is sent for destruction due to the content of iron and biocides.

AquaWorker at Alleima Tubes
For the cooling system at Alleima Tubes, Wallenius Water Innovation made a system analysis based on cooling capacity, system volume and water analysis. In addition, factors such as operational parameters and installation point with presumed greatest effect was considered.

One AquaWorker was installed and in full operation in September 2023. Since October 2023, the cooling system has been in operation without the use of biocides. Water samples have regularly been analyzed for bacteria activity.

Operational expenses, OPEX
– **Total annual savings EUR 14 000**
The operational cost calculations include costs for biocides, electricity, spare parts, and maintenance hours by personnel. The main savings are due to reduced consumption of biocides.

Additional advantages of the upgraded Alleima steel furnace cooling system are:
- Waste stream compliance
- Improved biostability and operational reliability
- Reduced health risks of personnel
- No risk of antimicrobial resistance
- Less risk of corrosion due to biofouling
- Equalizing bacterial fluctuations in case of issues with dosage of biocides



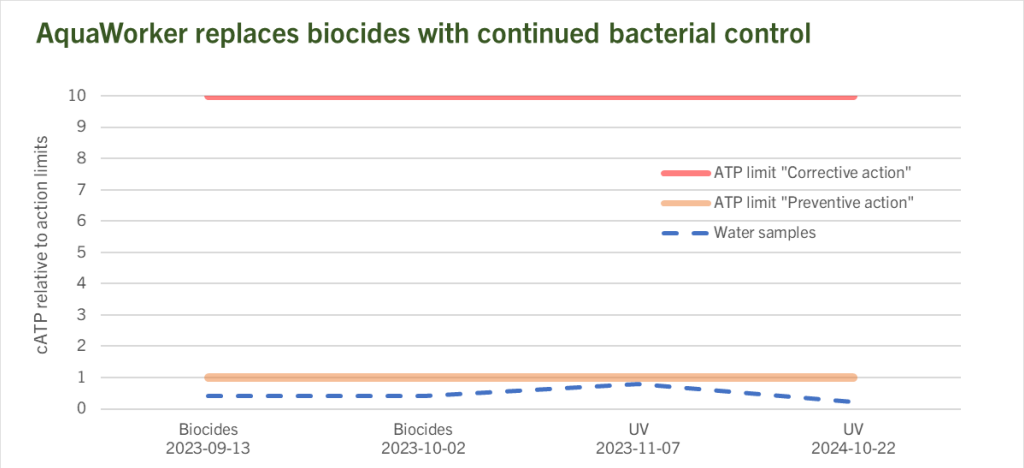


Figure 1. One year follow-up of the installation shows that bacterial activity in the steel furnace cooling system is under control when switching from biocides to UV treatment.

The values on Y-axis have been normalized to respective action limit levels (control ranges with and without biocides) for correct interpretation of cATP measurements.

Return of investment - ROI
Considered the investment of AquaWorker and related installation costs, the annual savings for Alleima results in a ROI of about 7 years using an interest rate of 5%. This doesn't include the additional advantages which are difficult to evaluate. This is considered a good metric for environmental infrastructural investments.

Bacterial control
Since the biocide dosage was shut-off and UV in full operation, water samples were taken regularly in the system. Also, bacteria assessments were done using several methods to detect differences and count trends: dip slide, ATP and laboratory plate count (ISO 6222).
Specifically, Legionella spp. were isolated and analyzed according to ISO 11731 using an external accredited laboratory.

Confirmation of biostability was defined through conformity between the methods **and** when low bacteria concentrations were measured.

After one year of operation, biostability with no use of biocides has been validated.

Summary & Conclusions
The operation of AquaWorker at Alleima Tubes in Sandviken has proven to replace the use of biocides. The following can be concluded:

- **Removed** the use of all **biocides**
- **Reduced operational costs** with more than 90%
- **Less** handling of chemicals and related risks
- **Low and stable** bacteria levels **beneath** recommended action levels
- **Reduced risk** of Legionella outbreaks to the surrounding
- **Less** chemicals in waste streams to meet environmental legislations

EWGLI bacteria levels and guidelines
European Working Group for Legionella Infections guidelines published by ECDC, European Centre for Disease Control give rules for management and maintenance for open cooling systems.

Specifically, the guideline defines bacteria concentration limits when actions are needed to prevent outbreaks.

	Aerobic bacteria (CFU/ml)	Legionella (CFU/100 ml)
Control	$< 10^4$	< 100
Preventive	10^4-10^5	100-1000
Corrective	$> 10^5$	> 1000

These limits have been used in the monitoring of the upgraded system.

	Biocides only	AquaWorker in operation
System data	Total volume=20 m^3, Cooling flow rate=140 m^3/h, Operation=330 days, 16h (not during nights)	
Water treatment	Biocides 100%	UV treatment (no biocides)
Biocide dosage	2 times/week	-
Bacteria levels	Bacteria levels below 10^4 CFU/ml	Bacteria levels below 10^4 CFU/ml
Transmittance of water	11-35% (filter damaged)	80-85%
Water/system appearance	Dirt, flakes, foam	Clear water

WALLENIUS WATER INNOVATION

Wallenius Water Innovation is a Swedish company that develops sustainable and profitable solutions addressing significant health, safety, and environmental challenges within a variety of applications and industry segments. The main product families are, FluidWorker® which offers non-toxic and automated control of industrial process fluids, and AquaWorker® used for chemical free disinfection in water systems.

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