

Statement of Verification



Technology: AQUATRACK® – Early Warning System with automatic sampler.

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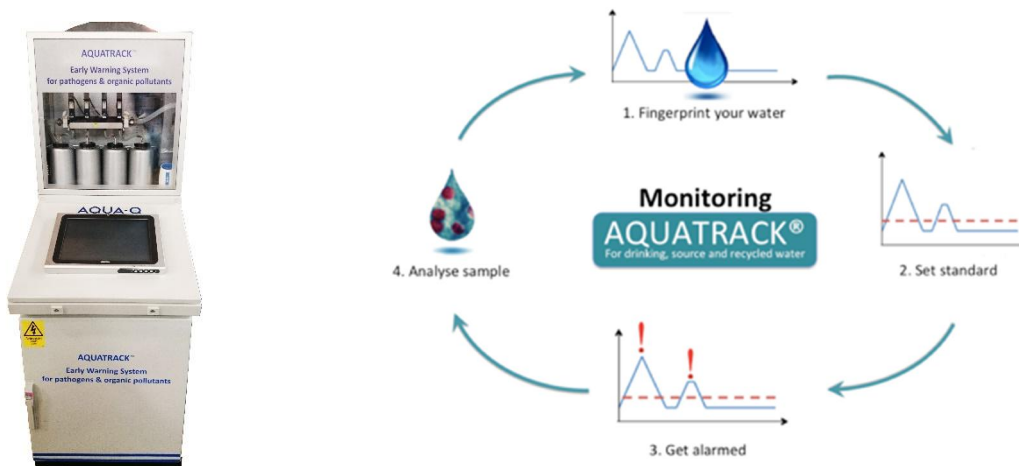
1. Technology description

AQUATRACK® is designed for monitoring and sampling for pathogen detection in drinking water, pre-filtered lake or source water or treated waste water either from a MBR process or from conventional secondary treatment. It controls water in a flow of a process and detects if there are micro particles exceeding the limit and thus indicating harmful contaminants. The detection of micro particles is based on laser beam and software analysing detected values. AQUATRACK® intakes water as a constant flow from the process. The normal amount and variety of particles is detected to set the fingerprint for that water type and from that fingerprint value the threshold lines are calculated up to 50% to 100% above the fingerprint for two particle size clusters, Cluster 1 and Cluster 2. When the amount of micro particles exceeds this threshold line, the technology makes an alarm via mobile network while taking samples of the water at the same time. The taken samples can be used for analysing microbiological, chemical and drug residue contamination in water. This technology provides a simple unmanned detection, warning and sampling which is in use 24/7.

AQUATRACK® combines the strengths of real time, dynamic sampling and an early warning system to create an efficient, cost effective and novel tool for management to mitigate against the significant threat of waterborne pathogen parasites and bacteria.

Random sampling, collective sampling or automatic sampling for example every four hours is the traditional way of water sampling method for microbiological analyses today. These sampling methods have significant drawbacks since they seldom are activated or in place if there happen sudden changes in the water quality. AQUATRACK® bridges this gap to fulfil the need in the market for efficient, cost-effective and real time monitoring and dynamic sampling product for water infrastructure companies and industries that need to be aware of rapid changes in a process and thus need a screening tool.

Cluster 1 represents bacteria size like E.Coli and Cluster 2 parasites like Cryptosporidium and Giardia. Collectively these are called contaminants, and they are key indicators showing problems in water quality. The most significant function of AQUATRACK® is intelligent capturing of water samples having high correlation of contaminants in water.



The following description gives an overview on the functionality and process of AQUATRACK®:

1. Detection of increase of contaminants in water of different qualities.

AQUATRACK® detects deviations in water contamination with micro-organisms like *E.coli*. It is based on a fingerprint for non-contaminated water of the same source.

a. Creation of fingerprint of water

AQUATRACK® monitors 24/7 micro particles in water by an optical laser beam, analyses and determines through the software fingerprint of water quality for two clusters. Cluster 1 represents bacteria size like *E.coli* and Cluster 2 represents size of parasites like *Cryptosporidium* and *Giardia*.

b. Detecting the deviation

AQUATRACK® detects deviations of contaminants from its threshold line (THL), which is set using the fingerprints..

c. Setting the threshold line THL for operation

THL is created by adding a tolerance of 50-100% - depending upon the process - to the fingerprint.

2. Generation of alarm in case of deviation

When the above described deviation happens so that the measured values exceed the threshold line, AQUATRACK® generates alarm along with sample collection after a programmable period of time.

3. Automatic collection of water sample

AQUATRACK® diverts automatically a water sample (10 – 1000 ml/container) to a sterile bottle/filter when the measured values exceed the threshold line with following in high probability of particulate or contaminants.

2. Application

2.1. Matrix

Technology is a monitoring system of water as a matrix. The technology is applicable to the following water types:

- treated waste water (tertiary or secondary effluent), reclaimed water
- drinking water,
- pre-filtered lake or source water

2.2. Purpose

The technology provides user friendly tools for the management of drinking water treatment plants, industrial water treatment plants, reuse of water for irrigation purpose to distribute safe and clean water that are free from pathogens. Automatic sampling at the point of contamination is essential to investigate the inefficiency or uncertainties occurred in the treatment process. Moreover, the quality control and surveillance (24/7) assist in protection of pathogens such as *Cryptosporidium*, *Giardia*, *E.coli*, etc., from outstretching to end-user. The purpose of the system is to give an early warning 24/7 to the management for the possible danger of contamination in water system.

2.3. Conditions of operation and use

The source water is passed through a pre-filter and connected to the internal tubes. The pre-filter is necessary to ensure the performance of the detection, but it is not affecting the accuracy since the particle size in those two clusters is smaller than what filter collects. The maintenance of pre-filter is described in the verification report.

A laser scanner detects the contaminants in a continuous flow of water samples. The technology reacts to a possible presence of micro contaminants and thus provide significant information about the possible microbial growth/biofilm (bacteria, protozoa, parasites) and also different forms of algae formations in the distribution pipeline with indirect measure of organic compounds in water. The information of these microbiological contaminants are analysed in the AQUATRACK®'s software and characterized for its optical behaviour, size, concentration and their occurrence in treatment process. When the real measured values exceed the threshold line after a certain programmable period of time a water sample will be diverted from the main pipe line to a sterile bottle/filter of programmable volume as a sample and is kept in a clean and cold chamber, AQS, and the first alarm is generated. The second water sample is collected if the measured value is still above the threshold line after a certain programmable period of time and the second alarm is generated. The AQUATRACK®'s software algorithm calculates whether the detected particles may cause problems depending on the frequency, amplitude and time point of the contamination in a continuous process.

In addition to accurate particulate monitoring, other sensors such as flow rate, pH and oxidation potential (ORP) assist in maintaining 24/7 water quality and documentation (basic configuration). Other sensors like temp., conductivity and dissolved oxygen can be added according to customer's requirement and process.

A limitation of the technology is that it doesn't give positive identification of bacteria or/and parasites, only the probability. This technology works as an Early Warning System. The water samples collected have to be analysed for positive identification.

2.4. Verification parameters definition summary

Performance parameters description

1. Fingerprint of Cluster 1 and 2 is determined
AQUATRACK® analyses and determines through the software fingerprints of water quality for two clusters. The fingerprints are created on the testing loop by the above mentioned criteria, and to that water different % of natural contaminants are added to observe and record the deviation. Based upon the natural standard contaminants in different water a fingerprint is created when sufficient measured values are obtained. Creation of fingerprint is done under normal conditions of a process and taking into consideration the measured value.
2. Deviation from the threshold line THL is detected
THL is created by AQUATRACK® for a fingerprint of that water type which is monitored. AQUATRACK® detects deviations of contaminants from its THL, which means here that the measured value of micro particles goes above the threshold line.
3. Alarm is generated
When the above described deviation happens, AQUATRACK® generates alarm along with sample collection after a programmable period of time.

4. Samples are taken automatically

AQUATRACK® diverts automatically a water sample (10 – 1000 ml/container) to a sterile bottle/filter when the alarm happens. The first water sample is collected at this stage after a programmable time and the second water sample is collected if the measured value is still above the threshold line after a certain programmable period of time and the second alarm is generated. Each water sample taken will have the recorded number of micro particles/ml at the time of sample collection.

Operational parameters description

1. AQUATRACK® works at an intake flow rate 3-5 L/min and at pressure 1.5- 2.0 Bar.
2. All the incidents / events are stored on the internal server with remote access abilities and retrieval of data can be performed anytime.
3. Automatic dynamic samples are collected in sterile bottles and kept in a cold chamber until analysis. For further tracking of water quality/process, the time and date are recorded along with the collected samples.

Environmental parameters description

No environmental parameters were verified.

Additional parameters description

1. Additional parameters pH, flow rate and ORP (Oxidation Reduction potential) are recorded 24/7 in the developed software package as independent sensors. Conversely provisions for additional sensors like TDS (Total Dissolved Solids), DO (Dissolved Oxygen), conductivity and temperature measurements can be provided.
2. UPS which will give a security against electrical spikes and electrical drop down and gives protection against failure due to electrical blackout.
3. Manual periodic CIP cleaning to minimize the formation of biofilm in the tubings.
4. Automatic backflush of pre-filter which ensures the availability of water.
5. As an option it is possible to control the calibration of the sensor by having an absolute cut-off filter.
6. MBS MultiReader for analysing total viable count, *E.coli* and Coliform.
7. Energy consumption is presented by the proposer. Energy consumption may be checked by connecting an energy meter to the power intake. Life Cycle Costs are estimated to be low. The technology is more accurate than conventional methods. The technology does not have any negative environmental impact.
8. Amount and type of detergents needed for periodical cleaning is described correctly by the proposer.

3. Test and analysis design

3.1.Existing and new data

No existing data was used in verification.

3.2.Laboratory or field conditions

Tests were conducted at a laboratory of IVL, Stockholm, Sweden.

3.3. Matrix compositions

Drinking water (DW) - Drinking water used has been produced by Stockholm Vatten water company.

Lake water (LW) – untreated water from Lake Mälaren that has already screened with 0.2 mm filter before our collection.

Membrane bioreactor treated water (MBR) – The cleaned effluent water, i.e. after membrane filtration from a Membrane bioreactor for treatment of municipal wastewater at Hammarby Sjöstadsvik demonstration site.

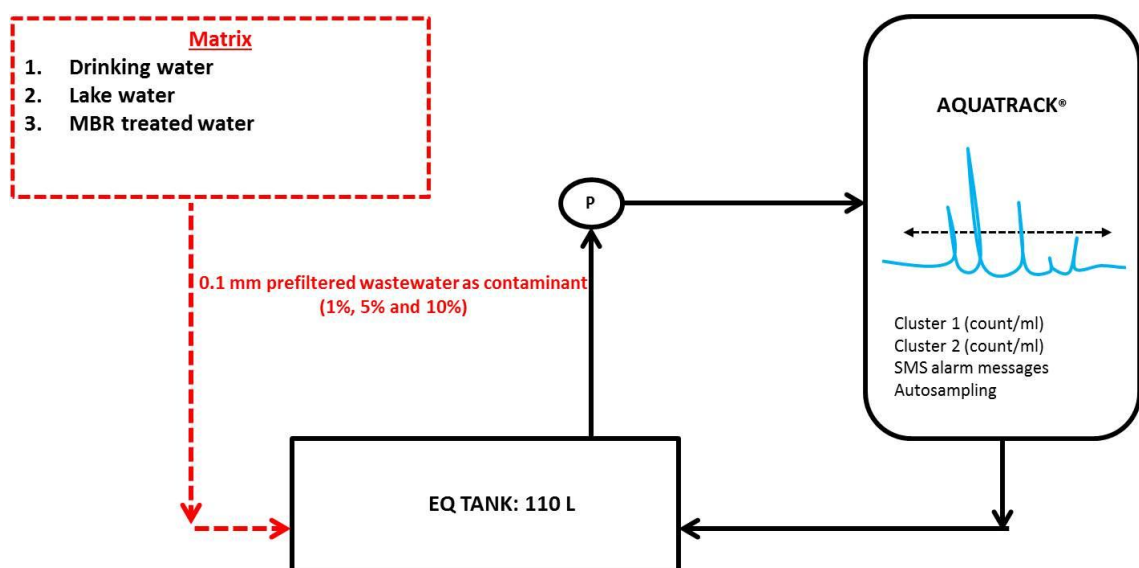
The selected matrixes [DW, LW) and MBR] were tested 3 times each and with 1%, 5% and 10% addition of pre-filtered (100 µm) wastewater as contaminant.

3.4. Test and analysis parameters

See the table of results

3.5. Tests and analysis methods summary

The test setup is an in-house method developed to verify the ability of AQUATRACK® to detect contaminants on a closed loop system. See the figure below and the verification report for details.



3.6. Parameters measured

See the table of results

4. Verification results

Verified parameters

Parameter	Claimed Performance	Verified Performance	Notes
Performance parameters			
1. Fingerprint of cluster 1 and cluster 2 is determined	Yes	Yes	
2. Deviation from the threshold line is detected	Yes	Yes	
3. Alarm is generated	Yes	Yes	
4. Samples are taken automatically	Yes	Yes	
Operational parameters			
1. Works at intake flow rate 3-5 L/min, 1.5 to 2.0 Bar	Yes	Yes	In the testing it was noted that a stable monitoring takes place if the flow is 3-5L/min. The pressure is between 1.5-2.0 Bar,
2. Incidents are recorded	Yes	Yes	
3. Samples are traceable and are kept in cold 5-6 oC	Yes	Yes	
Environmental parameters			
N/A			
<u>Additional parameters</u>			
1. pH, flow rate and ORP are recorded 24/7		These were applied during the testing	
2. UPS			
3. Manual CIP cleaning			
4. Backflush of pre-filter			
5. Control of calibration			
6. MBS Multireader			
7. Energy use	Watts	60 W	measured from power input
8. Amount and type of cleaning detergents	As per user manual		

The testing made for this verification gives an evidence that, when threshold line is passed due to addition of a certain amount of microbial contaminants, a sample will be taken by the AQUATRACK® system and alarm will be generated.

Samples will be taken correctly and are useful for the further analysing. The analysing report from the external laboratory shows that samples collected in all water matrixes showed contamination for biological growth. It was verified that sampling was done correctly.

MBS MultiReader also confirmed biological growth in the water samples. AQUATRACK® will work as an early warning system for different water matrixes. Further details are explained below.

For the verification it is stated that the following claims described in this document are verified and they are true.

Performance parameters

1. Fingerprint of cluster 1 and cluster 2 is determined
2. Deviation from the threshold line is detected
3. Alarm is generated
4. Samples are taken automatically

Operational parameters

1. Works at intake flow rate 3-5 L/min, 1.5 to 2.0 Bar
2. Incidents are recorded
3. Samples are traceable and are kept in cold 5-6 °C

5. Additional information

As a summary of the benefits compared to the conventional methods, the following additional remarks can be made. These remarks are here as expert opinions to provide information about the key performance and usability of the technology.

- The verification of patented AQUATRACK® shows the technological benefits like automatic collection of correct water sampling both for microbiological and chemical analyse. Real time correct water sampling reveals nature of contamination at the first stage and saves money and gives high confidence on the results. The present practice of taking periodic or random sampling may not ensure that the relevant sample gets collected at the time of contamination. They are well defined and designed to give statistical information but there are significant limitations for real time information. AQUATRACK® was innovated for this purpose and tested to have the benefits of real time sampling and gathering of information of contamination. Samples collected by AQUATRACK® are preserved in sterile bottles, cold and clean integrated chamber having temp 5-6 °C (refrigerator) to avoid secondary contamination. Samples collected will always have information of time and concentration of contaminants.
- The verification of AQUATRACK® shows that it can be used to keep continuous track of biological contaminants in drinking water, source water, treated wastewater (MBR effluent). It can also be used to keep record of contaminants (e.g. micro-debris, biological contaminants, planned/unplanned discharge of waste water treatment plant). This performance can be considered as an important feature of an environmental monitoring technology.
- Information from AQUATRACK® can be used to make intelligent decisions about the amount and kind of disinfection, hence avoiding over-disinfection and thus saving money. AQUATRACK® can establish daily, monthly, and seasonal contamination patterns which can be used to improve the efficiency of your treatment process, thus saving electricity and chemical costs and gives you real-time warning of possible contamination events, which can help you avert epidemics, and costs & liabilities associated with epidemics.
- AQUATRACK® can be claimed as an innovative and novel early warning system of monitoring and sampling for pathogen detection in drinking water and reclaimed water.

6. Quality assurance and deviations

The verification was carried out according to the quality assurance plan as presented in the verification protocol. There were no deviations from the verification protocol or in test procedure.