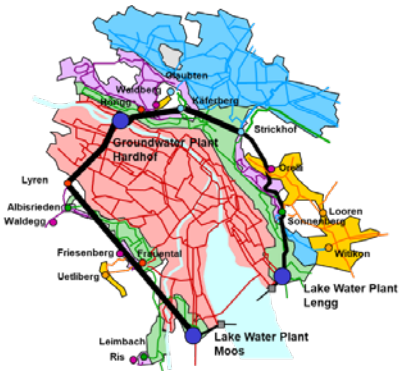
Batch-Processing of Drinking Water Samples for Microbial Testing

—How Zurich Water Works saved time, labor and costs using ATP analysis

Promega Corporation



Challenge: Microbial contamination is a major concern for WVZ, but their current single-sample microbial testing method requires excessive time and labor.

Solution: The Water-Glo™ 96-well batch method allows them to process 90 samples at once and get results within an hour.

For Zurich Water Works (WVZ), monitoring microbial load in their water distribution system is a huge challenge. They manage a large and complex water system and need to test a high volume of water samples throughout their system. Microbial testing is especially important for WVZ because the water is not chlorinated before distribution, making microbial regrowth a major concern. If microbial contamination is not addressed quickly enough, it could potentially jeopardize public health and be costly to resolve. They found that batch processing using ATP analysis is the ideal microbial monitoring method for their needs, allowing them to process 90 samples at once and get results within an hour.

A complex system in need of a simple solution

WVZ serves the city of Zurich and its surrounding communities with a total population close to 1 million within an area of 660km^2 (254mi^2). Their water supply is made up of 70% lake water, 15% spring water and 15% groundwater. A total of 480,000m^3 (12.7 million gallons) of water is treated per day and stored in 21 reservoirs for daily use with 24 pump stations. The distribution system is comprised of 1,100km (583 miles) of pipes with 450km (279 miles) of house connections. All of this is managed through one central control room.

Microbial regrowth in the WVZ distribution system is a constant threat because they do not chlorinate the water. To monitor their system, WVZ decided to collect water samples from 30 locations representative of critical steps in the treatment process and major source water locations. The sampling locations consist of reservoirs, distribution system points, as well as different stages within their main drinking water treatment plants: Lengg Lake Water Plant, Moos Lake Water Plant, and the Hardof Groundwater Plant. To ensure quality results, all samples must be analyzed in triplicate, which adds up to 90 samples per week. With the high number of samples, WVZ needed a simple, fast, efficient and cost-effective method. Ideally, this method would directly assess whether treatment is effective and whether there is regrowth potential in their system.

Advantages of ATP analysis

Several methods exist for detecting biomass in water. However, measuring turbidity or Total Organic Carbon (TOC) does not give direct information on the number of live microbes in the water sample. Using plate culturing, Heterotrophic Plate Count (HPC), takes days to get results, and many bacterial species will be missed because >90% of viable species cannot be cultured on a plate. WVZ decided to test a newer method that measures ATP (adenosine triphosphate), a marker for viable cells. ATP levels in water samples correlate with the number of active microbes and can be measured in minutes without the need for culturing bacteria. They worked with Promega scientists to develop an ATP-based assay that allows them to process samples in batches—up to 96 samples at once.

Saving time, labor and costs through batch processing

The Water-Glo™ 96-well batch method involves loading samples onto a filter plate (2ml maximum per well); filtering the sample and retaining the biomass on the filter plate; adding lysis reagent; and finally filtering and collecting the ATP containing lysate in a white luminometer plate (Figure 1). Once the white plate is loaded into a plate luminometer (equipped with an auto-injector), ATP detection reagent is injected into up to 96 sample wells and luminescent signal is measured. This signal, represented in relative light units (RLU), is converted to ATP concentration using a set of triplicate blanks and triplicate ATP standards to build a one-point calibration curve.

Before WVZ started using the batch method, it took one technician a whole day to manually process 90 samples. Using the Water-Glo™ 96-well batch kit, processing the same number of samples takes only 1 hour (Table 1). The batch method not only saves time and labor, the cost per test is lower—roughly that of a standard plate culture test. This is because less of the plastic consumables and reagents are needed.

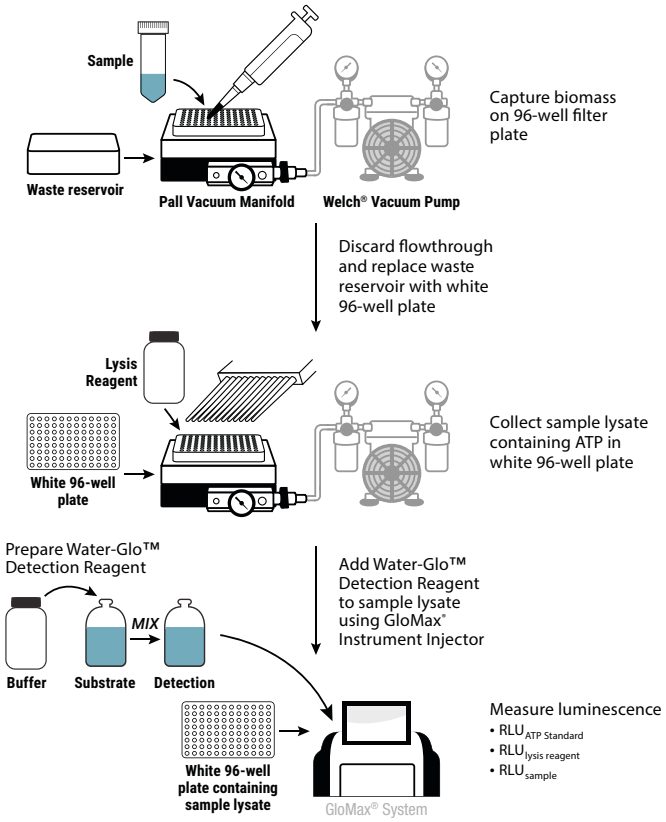


Figure 1. Water-Glo™ 96-well batch protocol.

Table 1. Batch Method vs. Single Test Time-Saving Comparison.

	Batch Method	Single Test
Samples per Week	90	90
Time Required	1 hour/90 samples	5 minutes/per sample
Weekly Analysis Time	1 hour	7.5 hours

Establishing Water-Glo as an early warning system

WVZ tested the Water-Glo™ 96-well batch for 14 months and analyzed the data to fully understand the microbial dynamics of their system. With this data, they correlated ATP concentration with existing total cell count (TCC) numbers (Figure 2). They were then able to set action levels and appropriate responses based on ATP concentration at critical control points throughout treatment (Figure 3). The Water-Glo™ method thus serves as an early warning system in which an ATP concentration above a critical level can trigger immediate action.

With this ATP monitoring system in place, seasonal microbial changes in lake water or unexpected contamination sources that enter the treatment plants can be detected in a timely and efficient manner. Since 2016, WVZ has continued to use batch ATP analysis to monitor microbial load throughout their treatment process and distribution systems with no issue. This is a practical example of how the Water-Glo™ 96-well batch method can serve as an early warning system for microbial contamination and save time, labor and costs for water treatment facilities.

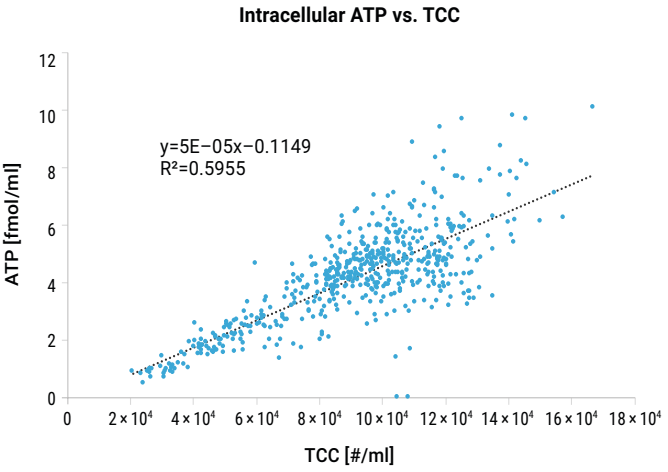


Figure 2. Correlation analysis between intracellular ATP and total cell count (TCC).

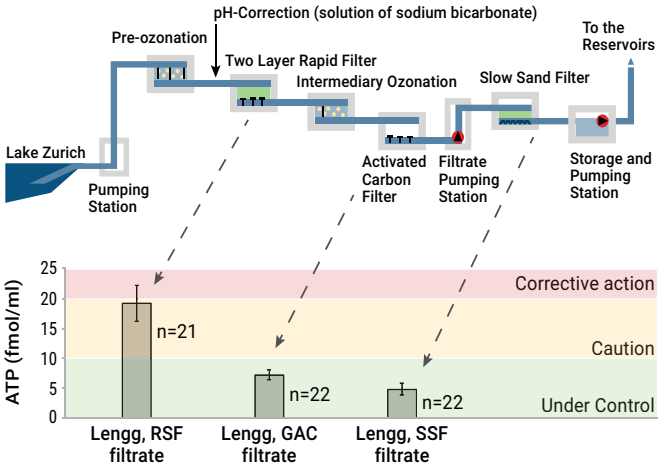


Figure 3. Threshold ATP ranges for critical control points.

