Microbial Monitoring in Seawater Desalination

—How ATP Analysis Can Improve Desalination Processes

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Challenge: Microbes in seawater can cause problems throughout the desalination process. Microbial monitoring is important to reduce risks, but most existing methods are either too slow or do not provide useful, actionable data.

Solution: ATP analysis is fast and provides informative data that allow immediate corrective actions and process improvements.

The Risk of Microbes in Seawater Desalination

Microbes are omnipresent in the environment and can survive in a range of extreme conditions. Even seawater that is pulled in for desalination can contain relatively high populations of microbes. The microbes can cause significant problems throughout the desalination process. At the beginning, microbes present in the intake lines can cause clogging and biofouling. Microbes can also cause biofouling on the seawater reverse osmosis (SWRO) membrane. This reduces membrane efficiency, leading to pressure issues and the need for high amounts of biocide treatment chemicals, which is costly and could damage or shorten the membrane lifetime. Further downstream, microbes can cause corrosion, clogging, and affect water odor or taste in the storage and distribution systems, particularly if disinfectant is not used or is ineffective. Because of the risks associated with microbes, it is important to monitor microbial levels (bioload) throughout the desalination process.

The Importance of Microbial Monitoring

The goal of microbial monitoring is to ensure that bioload within the system is consistently under control, indicating that treatment and processing methods are effective and appropriate. Having a routine monitoring system will allow you to establish a guideline of proper performance. The guideline can be used to alert operators of developing microbial growth issues or potential biofouling before a problem occurs, so it can be resolved quickly and appropriately.

While a system that is functioning efficiently may only need routine monitoring for regular maintenance, systems that face challenges or are recovering from problems may need more systemic testing. If there is a microbial issue somewhere in the desalination process, a thorough systematic testing of the process from intake to distribution can help pinpoint where the problem occurred and guide you to respond accordingly.

Methods for Microbial Monitoring

The ideal microbial monitoring system should be both informative and timely. However, most common methods do not deliver on either or both of those aspects. Indirect methods such as temperature, pressure, and flow, are not informative enough. If the water pressure changes or the flow slows down, there is no indicator as to the cause. Direct culture-based microbial tests, like heterotrophic plate counting (HPC), can give information about microbial load and potential cause. But waiting for bacteria to grow on a plate can take days. In addition, many bacteria species cannot be cultured and therefore are not counted—so the results are not actionable. **A newer method that is both informative and timely is ATP analysis.**

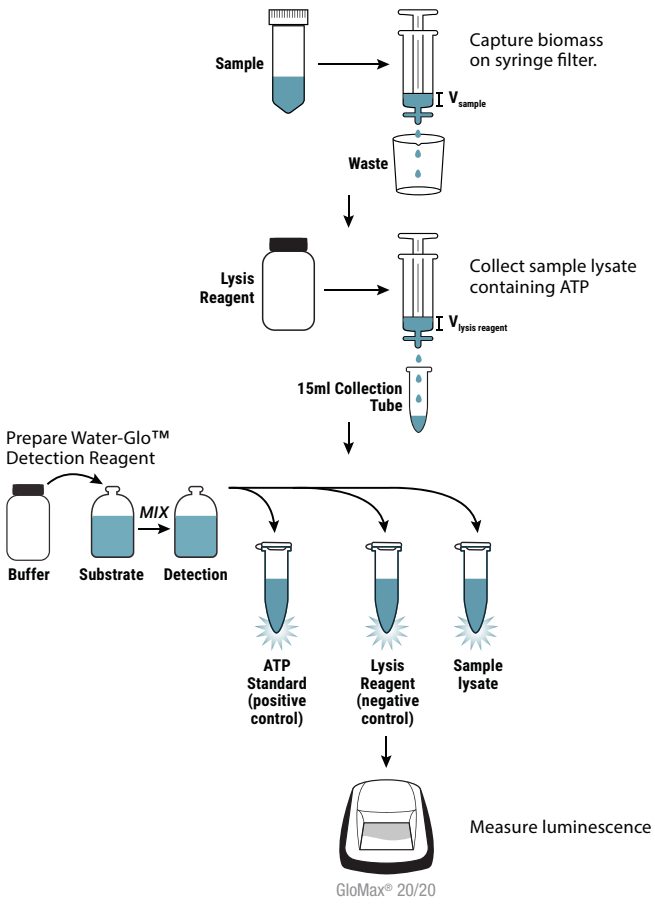

Figure 1. Procedure of Filtration Method Using the Water-Glo™ Kit.

Why Use ATP to Monitor Bioload?

Adenosine triphosphate (ATP) is the energy currency of cells. All living cells require ATP, and it quickly degrades once a cell dies. Thus, ATP level roughly correlates with the number of live microbes present. **With ATP, you can directly measure all living microbes in a sample.** This is unlike HPC, in which only microbes that can be cultured in a dish are counted. **ATP analysis is also fast.** A single test can be done in less than 15 minutes; a batch analysis of 90 samples can be done in approximately 1.5 hours; and online ATP measurement can be done automatically up to every 7 minutes.

ATP analysis cannot tell you the exact population number of microbes present. This is because each microbe will have differing amounts of ATP based on their species and where they are in their lifecycle. However, **you can easily use trending data to uncover significant changes in ATP levels indicating a change in microbial population.**

How to Measure ATP

There are two different methods for measuring ATP in seawater:

Filtration Method

The filtration method for ATP analysis works by separating microbes from the water sample using a filter. The microbes are broken open using a lysis reagent, releasing intracellular ATP. A detection reagent is added that produces light when in contact with ATP, and the light is measured using a luminometer. An ATP standard (positive control) and blank (negative control) sample set must be included to calculate the ATP concentration (Figure 1).

We developed the Water-Glo™ Kit to support the filtration method. This kit includes the reagents and plastics needed for filtration, allowing you to remove the sample matrix and get better results. We also provide the batch-processing Water-Glo™ 96 System, which uses a filtration plate so that 90 samples (plus three blanks and three ATP standards) can all be processed at once, significantly reducing the time and effort required.

Direct Method

The direct method requires two steps. First, "free ATP" in a sample is measured. Free ATP can come from dead microbes that have broken open, or other environmental sources. Then, lysis reagent is added to a second sample to break open all the microbes, releasing ATP from the cells. This allows "total ATP" in the whole sample to be measured. The ATP from only the live cells is calculated by the following equation:

Intracellular ATP = Total ATP – Free ATP

The direct method is suitable for understanding how the sample matrix affects the samples and results. In some cases, the direct method must be used because filtration is not an option, such as online ATP systems. The AppliTek EZ-ATP Online Analyzer (or EZ7300 from Hach; Figure 2) uses Water-Glo™ technology for ATP analysis using the direct method.

Figure 2. The Applitek EZ-ATP® Online Analyzer (or Hach EZ7300) is an automated system that detects bioload in water using ATP analysis.

Improve Your Process with ATP Analysis

ATP analysis is becoming more widely used and accepted at SWRO desalination plants. Several plants in the Middle East and Australia are currently using Water-Glo technology to assess their operation (1,2). **Using ATP to regularly monitor desalination processes can lead to process improvements, save time and costs, protect infrastructure, and potentially extend the lifetime of RO membranes by reducing their cleaning needs.** The method is valuable for those seeking a solution for regular maintenance, and for those troubleshooting to improve their processes. With ATP data, you can investigate process challenges, identify the cause of issues, and determine appropriate treatment or improvement options.

References

1. Abushaban, A. *et al.* (2019) ATP measurement in seawater reverse osmosis systems: Eliminating seawater matrix effects using a filtration-based method. *Desalination* **453**, 1–9.

2. Abushaban, A. *et al.* (2017) Direct measurement of ATP in seawater and application of ATP to monitor bacterial growth potential in SWRO pre-treatment systems. *Desalination and Water Treatment* **99**, 91–101.

Learn more about ATP testing for water at:

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