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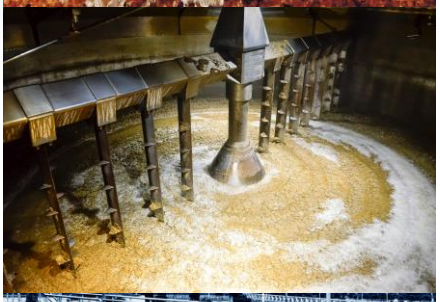
Process, Air & Water



Disinfection in Industrial Process Water

Process water is water that is used in a variety of manufacturing operations such as: washing and rinsing; thermal management of process equipment; fire protection in sprinkler systems, etc. Typically, industrial water use mainly consists of use of process water in boilers, cooling towers and thermal electric generation. Although not technically "industrial", water use can also include something as personal as the liquid cooling ventilation garment used by astronauts during a spacewalk at the international space station. In general, water is being used for thermal management; fire protection; storage; or direct processing, where the water is itself used as part of the product being produced.

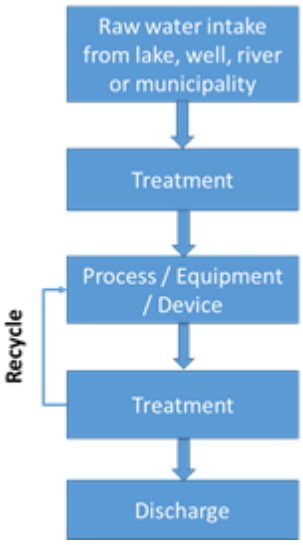


Fig. 1. High-level process of water flow

Referring to the high-level process water flow in Fig. 1, we can discuss the main ways that the microorganisms can enter the water supply. Microorganisms can enter through the raw water intake. By treating the water after intake, we can meet the process water quality requirements and provide overall defense against the threat of microorganisms. Use of recycled water containing process contaminations or the use of secondary wastewaters for makeup can also be an entry route for microorganisms, if these waters are themselves inadequately treated. Thus, it is essential to run an adequate treatment plan tailored to the water source and planned use. This treatment is often a combination of physical and chemical means and consists of the overall removal of the threat of the microorganisms initially, called primary disinfection, together with secondary disinfection where a maintenance dose (in chemical treatment) is administered at prescribed intervals to maintain a disinfectant residual to inhibit the growth of microorganisms. In any case, wherever water is used, it is important to consider the removal of biological organisms in finished water, for the following reasons:

1. To prevent or mitigate biofilm formation. The presence of biological organisms can lead to the formation of biofilms, which in turn can lead to such process issues as reduced hydraulic diameter, reduced flow, reduced heat transfer and thus increase fuel usage in heat transfer equipment, like boilers. In cooling towers, biofilms are regions where microbes feed and find a place to propagate. These microbes are often harmful to human health as the water provides a way to release the microbes in aerosolized form leading to respiratory illnesses, like Legionnaire's disease.

Contents

Welcome

Hello! Thank you for reading the Process, Air & Water newsletter. In this issue we discuss the need for water disinfection in industrial processes and provide some information about the types of biocides currently in use. Also, featured in the Highlights is information about Water Lens™, NEW in in-field water quality testing. We invite you to contact us with your questions or feedback.

- Keisha Antoine, PhD, PE

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Antoine Technical Consulting LLC offers solutions to help clients improve their primary and auxiliary processes using chemical process simulation to perform process engineering and design, energy assessments, troubleshooting and scale-up

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Highlights

Ask Antoine Technical Consulting about **Water Lens™ – the best in in-field water quality testing!**

Get **accurate, reliable** and **affordable results** for **20 parameters** in **just 10 minutes.** A water quality test kit that is:

- Portable
- Reliable & accurate
- Low-cost
- *FAST!*

Antoine Technical Consulting presented on "Biological Control of Water", at:

- STS AIChE Section Meeting on September 8, 2016
- AIChE Southwest Process Technology Conference on October 6-7, 2016

In fact, biofilms in process equipment, whether pipelines or pumps, act as sites for microbiologically induced corrosion (MIC). MIC can lead to leaks and tuberculation and therefore shortened equipment lifespan. Ultimately, biofilms prevent smooth process operation, can negatively affect human health, and can shorten equipment life.

2. To enable discharge of process water after use to a receiving body in accordance with EPA National Pollution Discharge Elimination System (NPDES) or EPA NPDES delegated state guidelines (in the case of states authorized by the EPA to administer permits. TX is an NPDES delegated state).
3. To meet the quality required for process water use or reuse in the process and in the prevention of 1) above.

Disinfection is the killing of pathogenic organisms in water and can be carried out via physical or chemical methods – often a combination of both means are employed. Physical means of biological treatment can include filtration, reverse osmosis, sponge pigging (in pipelines) and UV dosing. Whether used by itself as a primary disinfectant or as secondary disinfection with a primary chemical disinfectant, UV dosing is becoming more popular as a means of biological control given ever-tightening compliance regulations on biocide residual concentrations in the finished water and in water to be discharged (effluent). We will focus the rest of this article on chemical disinfection.

The goal of biocide use is to prevent the formation of biofilms and to inhibit the existence of pathogens. It is best to stop biofilms from even forming as it is much easier to kill the bacteria while they are still mobile and not under cover of the biofilm. This is hard to do, however, as the build-up of the biofilm begins immediately after the metal or water-contact material is immersed in the aqueous environment. Judicious choice of the bill of materials can reduce the proclivity to form a biofilm, though not eliminate it. A biofilm is a gel containing ~95% of water and a matrix of exopolysaccharidic or extracellular polymeric substances (EPS) suspending microbial cells and inorganic waste. Biofilm build-up begins when the mobile bacteria in the water stream become adhered to the water-contact equipment surface and become sessile. In this state, the bacteria start to propagate, creating a biofilm which protects the propagating bacteria beneath.

There are several types of biocides: oxidizing, non-oxidizing or surfactants, biodispersants and biopenetrants. Oxidizing biocides like chlorine, ozone or sodium hypochlorite are an essential component to maintaining a disinfected system for drinking water, cooling tower systems and surfaces. They kill microorganisms through the process of oxidation and are applied continuously or intermittently in the water treatment process. The use of chlorine, regardless of application method, is by far the most ubiquitous biocide in use for disinfection and is very effective against Legionella bacteria. It is also effective in algae control. For more broad spectrum, biological control, oxidizing biocides can be used in tandem with non-oxidizing biocides when considerations such as elevated water pH, removal of algae, fungi and anaerobic bacteria are present. Non-oxidizing biocides like isothiazolines, DBNPA and carbamates, are usually shot-fed as required. When a biofilm already exists, biodispersants and biopenetrants like DTEA II, DMAD and polyquaternary amines, are used to loosen the biomass and break them down to be flushed out of the system. Their action allows for the oxidizing and non-oxidizing biocides to go to work and kill the pathogens that have been protected by the biofilm. These types of biocides are usually shot fed and applied when heavy duty cleaning is required or to maintain a clean system.

All biocides have drawbacks to their use: oxidizing biocides are corrosive and can form disinfectant byproducts (DBPs) with organic material naturally present in the raw water. DBPs, in the form of trihalomethanes, are themselves contaminants and must not exceed maximum contaminant levels (MCLs) set by the regulating entity. Oxidizing biocides are also ineffective against anaerobic bacteria, which cause microbiologically induced corrosion. Non-oxidizing biocides tend to be more effective in high pH environments and are not as effective in the presence of high organic loads or heavy metals.

Finally, to assess the effectiveness of the disinfection program, the treated water effluent is tested for an indicator organism to ensure that its concentration is below the permit limits. There are several choices of indicator organism; however, the one selected depends on the eventual use or discharge site of the water. Note that in accordance with 30 TAC 309.3(h), TX changed the indicator organism from fecal coliform bacteria to E. coli for freshwater discharges and Enterococci for saltwater discharges.