Wastewater Disinfection
Best Practice For Chlorination - Dechlorination Controls

Introduction

Wastewater is disinfected to reduce pathogens in order to lower the risk of downstream uses of the water, but the impact of the disinfectant can also have adverse effects on the environment. Therefore, water resource recovery facilities (WRRF) will typically add a disinfectant but also add a reducing agent to remove the disinfectant. Per WERF[1] approximately 80% of the water resource recovery facilities (WRRF) disinfect with some form of chlorine and dechlorinate with a sulfur compound. This is an effective strategy but can be difficult to control, as the USEPA Echo website lists 4,235 bacterial violations and 1302 chlorine violations between 2016 and 2019.

The important metric to ensure adequate disinfection is known as CT, which is the concentration of chlorine multiplied by the time it is in contact with the water. Often this is calculated by measuring the total chlorine at the end of the contact chamber and determining the hydraulic residence time (HRT) of the chamber by dividing the volume of the chamber by the flow rate. While simple, this approach has many variables that are difficult to account for such as dynamic chlorine demand, effects of pH and temperature, along with turbulent flow that can cause back mixing and a significantly different HRT than is simply calculated from the available data. These variables make it difficult to manually operate the disinfection process and can lead to inconsistent treatment, increased risk of noncompliance and decreased resiliency of the process. For these reasons, using a process management system to automate the disinfection process is an important step to ensure compliance while operating efficiently.

Best Practice

The *Automation of Wastewater Treatment Facilities* (MOP 21) published by WEF, details the best practices for implementing automation and should be reviewed before starting an automation project. An automation project requires a system advocate who leads the project, obtains management support, organizes stakeholders, and creates a written plan that includes goals, system testing and a maintenance plan. The system advocate should work with operations and other stakeholders to determine the possible control methods and select the method that best satisfies their needs. Below are three methods for automated process control of chlorination/dechlorination.

Constant Chlorine Residual/Load Proportional Dechlorination

This control method relies upon the operator to choose an appropriate setpoint for total chlorine residual at the end of the contact tank. This means that as the flow through the contact chamber changes due to diurnal patterns, sidestreams, or other sources the CT changes as well. At times of high flow and low loading, the CT could drop below the necessary CT to inactivate the pathogens.

Instrumentation for this method is simple and would require a total chlorine analyzer at the end of the contact chamber, along with a flowmeter to measure volumetric flow. The control logic here is simple and efficient, driven by a flow weighted PID loop with the chlorine dosage as the control variable. As with any control logic, appropriate limits need to be defined and fallback strategies programmed.

Dechlorination is controlled through proportionally dosing the dechlorinating agent in proportion to the chlorine dose, with an operator adjusted factor to ensure complete dechlorination. Optionally a bisulfite analyzer or total chlorine analyzer can be employed to trim the dechlorination dosage.

Constant Chlorine Residual with a Minimum CT/Load Proportional Dechlorination

This control method is similar to the one above, but an operator will also need to define a minimum CT that should be maintained during high flow situations in order to ensure proper pathogen destruction. For this method to work, CT needs to be calculated in real time and logic needs to be included that allows the controller to use a static chlorine residual setpoint when the CT is above threshold, but a variable chlorine residual setpoint when the CT is at the minimum allowable value. This is a more complicated control logic since it requires the calculation of the contact tank HRT and should include inputs such as baffle factors to compensate for the less than ideal plug flow conditions.

Dechlorination controls are the same as the constant chlorine residual method.

Constant CT with Chlorine Residual Limits/Load Proportional Dechlorination

This is the most efficient control method, as it allows the chlorine dosage to be minimized during low load situations but ensures the process is not overchlorinated during wet weather events.

Dechlorination controls are the same as the constant chlorine residual method.

In all three of these control methods, both feed forward and feed back controls are employed. Feed forward control logic analyzes what is entering the process and use a model to determine the chlorine dosage. A common model uses an operator entered chlorine dosage, in milligrams per liter, and calculates the proper chlorine flow rate based upon the volumetric flow of the water through the contact chamber. Additional measurements that can be employed to create a more accurate feed forward model are organics (UV absorbance/TOC), pH and temperature.

Feedback controls analyze the water leaving the process and adjusts the feed forward model to achieve the contact chamber effluent chlorine concentration setpoint. The most common form of feedback control is using a PID loop, but only using the proportional and integral coefficients. Ideally, the feedback control loop should only make slight adjustments, and the control logic should rely heavily on the feed forward model.

[1]Leong, L.Y.C, J. Kuo, C. Tang "Disinfection of Wastewater Effluent-Comparison of Alternative Technologies." 2008. IWA/WERF

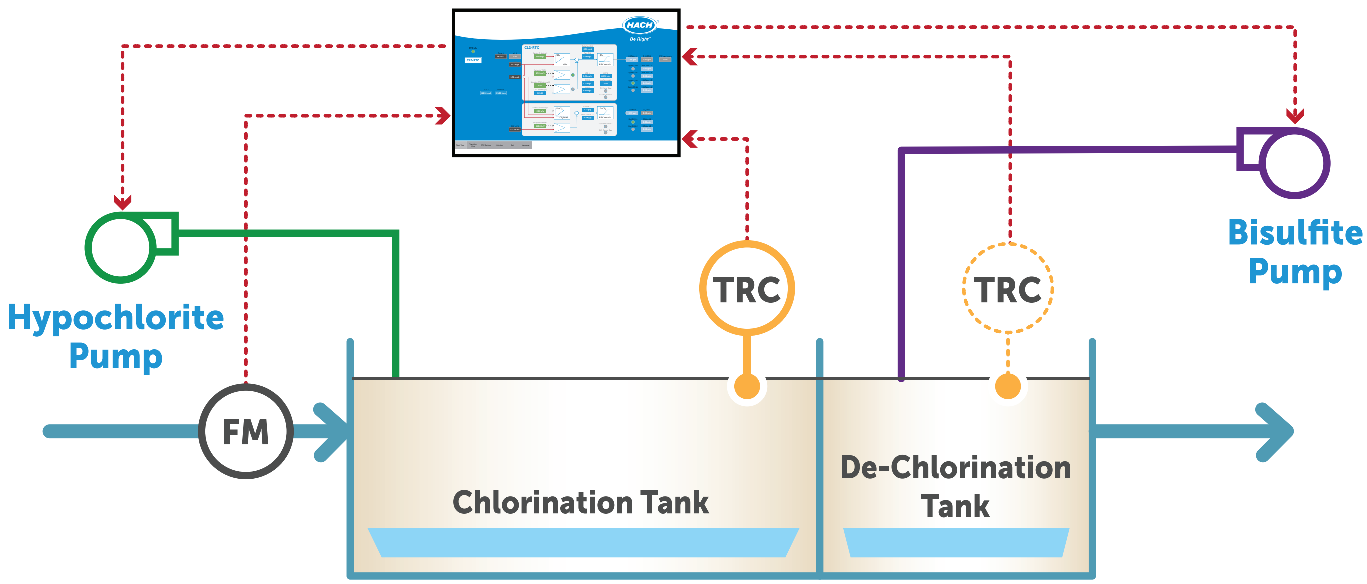
Predesigned Control Systems

Chlorination/Dechlorination control systems, such as the Hach RTC-C/DC systems, are available on standardized hardware that are designed with multiple control options to ensure flexibility to meet variable application demands. They also include important process management calculations that increase process visibility and understanding, such as total chlorine demand, instantaneous chlorine demand, chlorine decay demand, and a log inactivation estimate.

These systems are fully pretested with years of "lessons learned" built-in, which avoid expensive and unnecessary reprogramming. The time required for a predesigned system to be installed, integrated, and tested is minimized so that the benefits of automated chlorination/dechlorination controls can be realized rapidly. Support is offered for installation guidance, commissioning, full scale system testing, maintenance planning and training, which minimizes risk and increases process resiliency.

Operators can utilize CL17sc Chlorine Analyzers with the Hach RTC-C/DC software and applicable controllers to precisely monitor chlorine levels in the process. These ongoing readings can then be used to automatically control chemical feed dosage. The hardware platform on which these control systems operate is flexible and allows for inclusion of other process management modules like Solids Retention Time (SRT), Ammonia Based Aeration Control (ABAC), Denitrification Controls for internal recirculation and/or external carbon, Phosphorus Precipitation, and more.

The result of predesigned control systems is that they offer three important benefits; visibility into the process with unique process control data; a consistent operation that produces consistent results; and support for instrument maintenance, process control and troubleshooting.



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