**Quaternary Ammonia Job Aid**

What are Quaternary Ammonia Compounds?

Quaternary Ammonia Compounds (commonly called Quats or QACs) are a class of organic compounds used in a wide variety of products, including:

* Disinfectants
* Surfactants
* Fabric softeners
* Anti-static agents
* Wood preservatives

QACs – especially those used in cleaning and disinfecting products – are powerful and long-lasting antimicrobials. This property makes them very effective and popular disinfectants, but also makes them destructive to biological wastewater treatment systems, particularly onsite systems that may receive more concentrated loads.

Because they are a general class of organic compounds, there are thousands of different chemicals and formulations that are classified as QACs and it can be difficult to determine if a product contains QACs just by looking at the label or ingredients list. Some example of products that use QACs:

* Antimicrobial disinfectants commonly found in antibacterial soap, toilet bowl cleaner and other household disinfectants. Common QAC active ingredients in these products are:
	+ ADBAC (alkyl dimethyl benzyl ammonium chloride)
	+ benzalkonium chloride
	+ benzethonium chloride
	+ methylbenzethonium chloride
	+ cetalkonium chloride
	+ cetylpyridinium chloride
	+ cetrimonium
	+ cetrimide
	+ dofanium chloride
	+ tetraethylammonium bromide
	+ didecyldimethylammonium chloride
	+ ammonium chloride
	+ domiphen bromide
* Food service establishment sanitizers. Most nationally franchised restaurants, convenience stores and grocery chains require the use of QAC sanitizer
* Automatic dishwashing and laundry detergent
* Fabric softeners (both liquid and dryer sheets)
* Antistatic agents, usually found in shampoos
* Septic tank additives used to control septic odors by killing bacteria

Why the use of Quaternary Ammonia Compounds may not be the best choice

Operators of restaurants, convenience stores and grocery chains may voluntarily choose, or their business plan may require them to use, a QAC sanitizer.

Homeowners may unknowingly use QAC products for cleaning and sanitizing.

Septic tank additives, utilized by both food operators and homeowners, may typically contain QAC compounds. The use of septic tank additives is counter-productive to the purpose and function of septic tanks, which is to promote anaerobic bacterial growth.

Subsequently, these practices may increase the overall load of QAC to any onsite wastewater treatment systems.

*The use of QAC-containing products can result in the failure of an onsite wastewater treatment system*

How Toxic are Quaternary Ammonia Compounds?

QAC toxicity in onsite systems depends on the type and quantity of the compound applied as well as the type of microbial environment that exists in the system. Generally, anaerobic and nitrification processes are more sensitive to QAC toxicity compared to conventional BOD oxidation processes. Consult the system’s O&M manual if you are not sure what type of process the system utilizes. The following table includes approximate concentration levels at which QACs have been reported to be inhibitory to wastewater treatment processes. The information in the table is based on research by Tyson Fresh Meats to study the effects of QAC compounds on wastewater treatment systems.

|  |  |
| --- | --- |
| Wastewater Treatment Process | QAC inhibition level (mg/l of active ingredient) |
| Anaerobic treatment | 5 - 15 mg/l |
| Aerobic BOD removal | 10 - 30 mg/l |
| Aerobic nitrification | 2 - 5 mg/l |

QAC concentration can be measured using commercially available test strips; however, these are only capable of measuring minimum concentrations of 50 to 100 mg/l. Hach sells reagent kits for low-range testing (up to 5 mg/l). The most accurate method for low-range measurement is ASTM Method D5806-95 for QACs used as disinfectants. These analytical methods may be useful for routine maintenance of onsite systems or as a diagnostic tool for a failing system, but directly measuring/monitoring the concentration of QACs entering an onsite system is unlikely to be practical for most homeowners and commercial facilities (restaurants, food processing plants, etc.).

Homeowners and commercial facilities with onsite systems are advised to avoid QAC-containing products altogether. For homeowners, natural-based cleaners such as baking soda, vinegar, and borax are preferred. These cleaners can be combined with small amounts of bleach or other biodegradable non-QAC cleaners. For commercial facilities with onsite systems, oxidative sanitizers like bleach or iodine are recommended. Note that chemical sanitizers used by food-service establishments and other commercial kitchens regulated by the Virginia Department of Health must meet the requirements described in 12VAC5-421-1700.

Some commercial kitchens, especially national chain restaurants and grocery stores, may prohibit individual locations from discontinuing use of QAC products. In this case, users should be extremely careful to avoid over-application of these products. Commercial kitchens that prepare QAC sanitizing solutions from a concentrated product can roughly estimate the average concentration of QAC entering their system by comparing the volume and strength of sanitizing solution used to the total volume of water used on a given day. This method is outlined below.

How to Estimate the Concentration of QAC Entering the Onsite System of a Commercial Kitchen

Restaurant and commercial kitchens typically use a concentrated QAC product to create a sanitizing solution for wiping-cloth buckets and 3-compartment dishwashing sinks. Single-QAC tablets (such as Steramine) and multi-QAC concentrates (such as Ecolab Oasis 146) are commonly used products for this application. The product labels include instructions for preparing a solution to a specific strength (typically 200 ppm for single-QACs and 400 ppm for multi-QACs). Kitchen managers should ensure that employees follow the instructions on the label when preparing a solution.

Since the strength of the QAC solution is known and the volume of the bucket(s) and dishwashing sink is known, the kitchen manager only needs to know the number of times per day the buckets and sinks are emptied to know the mass of QAC entering the system. This will likely vary from day to day and crew to crew, so it is recommended that the kitchen manager establish a standard routine and have employees make note of when the buckets and/or sinks are emptied.

Once the mass of QAC entering the system is known, only the daily total volume of water used by the facility is needed to calculate the concentration of QAC entering the system. This information can be found on the facility’s water bill or on a well meter, depending on the facility’s source of water. If a water meter is not available, then estimating the flow as a percent of the design flow of the onsite treatment system may be sufficient.

Summary of Information Needed:

* Concentration of QAC solution
* Volume and number of wiping-cloth buckets used
* Volume of sanitizing sink
* Number of times per day buckets and sink are emptied
* Total water volume used by facility per day

An example with step-by-step instructions on how to perform this calculation is included in Appendix A. Additionally, a simple Excel-based QAC concentration calculator is available on VDH’s website[[1]](#footnote-1). Users enter the information above and the tool calculates the QAC concentration entering the onsite system.

What Are the Strategies to Minimize QAC Use and Mitigate Impact to Onsite Systems?

Onsite systems are especially sensitive to “slug loads”, which typically occur as an overreaction to a contamination issue, accidental spill of QAC product, or draining of a sink or bucket that contains a QAC sanitizing solution.

One strategy that can help protect onsite systems is to use a spray bottle to apply the QAC sanitizer and a paper towel or rag (if laundry is contracted to an off-site facility) to wipe the sanitized surface. This method should minimize the volume of QAC entering the onsite system, as most of the QAC will be absorbed to the towel or rag that ends up in the trash or off-site laundry and there will not be a bucket of QAC to empty.

Bacteria can become resistant to QACs, and continuous application of these products can result in the need to use greater amounts to avoid contamination issues. A strategy to avoid this is to alternate between using a QAC for 1 week and an alternative sanitizer for 1 week.

Summary:

* Avoid “shocking” the system
	+ Avoid dumping multiple loads of QAC product at the same time. Stagger the timing of bucket dumps, sink drains, etc. if possible.
* Minimize overall use
	+ Follow the manufacturer’s instructions for making a solution (do not exceed the recommended concentration)
	+ Use just enough to be effective
	+ Determine if there are alternate ways to apply the product that result in less QAC down the drain (spray bottles for example)
	+ Alternate between QAC and non-QAC products to minimize bacterial resistance

If an onsite treatment system is diagnosed with toxicity issues from QACs, options that may be considered are:

* Discontinue or reduce use of QACs to a safe level, pump out the treatment system, and restart the treatment system.
* Neutralize the QACS in the treatment unit using a product such a Neutra-Quat from Anua. However, there are also numerous QAC-based cleaning products (with **neutra**l pH) also called NeutraQuat so ensure the correct product is used.

**Appendix A – Calculation Example**

A restaurant uses a QAC sanitizing solution in its wiping-cloth buckets and 3-compartment dishwashing sink. The solution is made from a concentrated QAC product, and the restaurant follows the directions on the label to make a solution with a concentration of 200 mg/L (or 200 ppm, 1 mg/L and 1 ppm are the same thing).

There are two 1.25 gallon buckets, and the dishwashing sink is 7.5 gallons.

Starting with the buckets, 1 gallon = 3.785 liters, so each bucket is 4.73 liters.

$$1.25 gal × \frac{3.785 L}{1 gal} =4.73 L$$

Since the concentration is 200 mg/L, we know that each bucket has 946 mg QAC in it.

$$\frac{200 mg}{L} × 4.73 L =946 mg$$

There are two buckets, and each bucket gets dumped and refilled every 3 hours. The restaurant operates for 18 hours each day, so that means each bucket gets dumped 6 times a day for a total of 12 bucket-dumps per day. Each bucket-dump has 946 mg QAC, so we know that **the buckets add a total of 946 x 12 = 11,355 mg of QAC to the system every day.**

$$\frac{946 mg}{bucket} ×\frac{2 buckets}{dump} × \frac{6 dumps}{day}=\frac{11,355 mg}{day} $$

Now repeat the same process with the sink. The volume of the sink is 7.5 gallons x 3.785 L/gal = 28.4 liters.

$$7.5 gal × \frac{3.785 L}{1 gal} =28.4 L$$

The QAC concentration is still 200 mg/L, so the sink contains 5,678 mg of QAC.

$$\frac{200 mg}{L} × 28.4 L =5,678 mg$$

The sink is also drained and refilled every 3 hours (6 times per day), **so the sink adds a total of 5,678 x 6 = 34,065 mg of QAC to the system every day.**

$$\frac{5,678 mg}{sink} × \frac{6 sinks}{day} =\frac{34,065 mg}{day}$$

We can add the two together and now we know that there is a total of 45,420 mg of QAC entering the system every day.

$$\frac{11,355 mg}{day} + \frac{34,065 mg}{day} =\frac{45,420 mg}{day}$$

Now we need to convert this to a concentration, so we need to know how much water is entering the system every day. The restaurant’s water bill for last month is for 30,000 gallons total. Since the restaurant is open 7 days a week (30 days a month), we can estimate that they use about 1,000 gallons per day.

*If the restaurant was closed 1 day a week (truly closed, no prep work or cleaning), then that 30,000 gallons would be divided by the 26 days that month that they were open instead of 30, and we would get about 1,150 gallons per day.*

Like before, convert 1,000 gallons to liters and we get a total water use of 3,785 liters per day.

$$\frac{30,000 gal}{month} × \frac{1 month}{30 days} × \frac{3.785 L}{gal} = \frac{3,785 L}{day}$$

Now that we know the mg of QAC and the liters of water, we just divide mg by liters to get the concentration.

$$\frac{45,420 mg}{day} × \frac{1 day}{3,785 L} = \frac{12 mg}{L}$$

This restaurant puts about 12 mg/L of QAC into their treatment system every day.

1. QAC calculator created by Colin Bishop of Anua and used with permission from Anua [↑](#footnote-ref-1)