

Quat Absorption Onto Textiles

Introduction

Proper disinfection is a function of different variables, such as the concentration of disinfectant applied to surfaces, disinfectant interaction with wipes and mops, volume of product applied, cleaning procedures, and use of appropriate tools.

The type of disinfectant used, particularly the active ingredient, is clearly also an important aspect of proper disinfection. Disinfectants based on quaternary ammonium chloride surfactants (quats) have been the primary means of disinfecting environmental surfaces in medical facilities for several decades. They exhibit the following benefits:

- Broad-spectrum germicidal efficacy against vegetative bacteria, fungi, and numerous viruses
- Relatively low toxicity at use levels
- Good compatibility with most environmental surfaces
- Long shelf life
- Low odor
- Economical: good value vs. other disinfectants

Because of this combination of properties, it is anticipated that quat disinfectants will remain a mainstay for hospital disinfection for years to come.

Issue of Quat Absorption

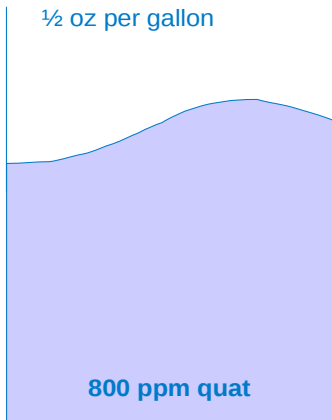
Recently, concern has arisen around the discovery that the active ingredient (quat) has a tendency to become attracted to and absorbed into fabrics. Furthermore, quaternary ammonium chlorides (quats) are cationic, or positively charged, surfactants, and they are attracted to fabric surfaces which are anionic, or negatively charged. This results in a portion of the quats becoming unavailable to disinfect hard surfaces.

For example, a pail is filled with one gallon of disinfectant solution diluted at $\frac{1}{2}$ oz/gal, and the active ingredient concentration is measured at 800 ppm. After a cotton wipe is placed in the solution and allowed to soak for 10 minutes, the quat level remaining in solution may decrease to 400 ppm or less. This drop in concentration occurs because the quat is absorbed into the cotton fabric. When the wipe is removed from the liquid and excess solution is wrung out, the collected solution is also 400 ppm or less (see figures below for visual example). Therefore, the solution applied to the surface to be disinfected contains less than the intended 800 ppm quat.

#1

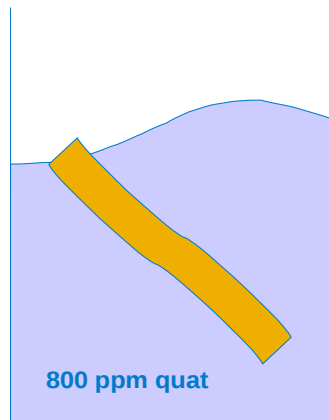
Quat disinfectant

½ oz per gallon



#2

Cotton wipe placed in disinfectant

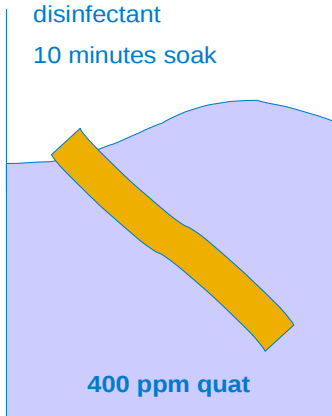


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#3

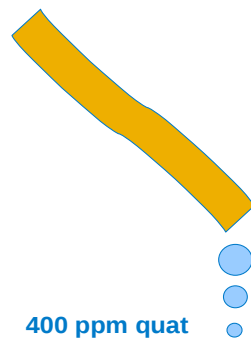
Cotton wipe placed in disinfectant

10 minutes soak



#4

Cotton wipe taken out of solution and wrung out



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Disinfectant application

Disinfectant can be applied to surfaces in several ways, including:

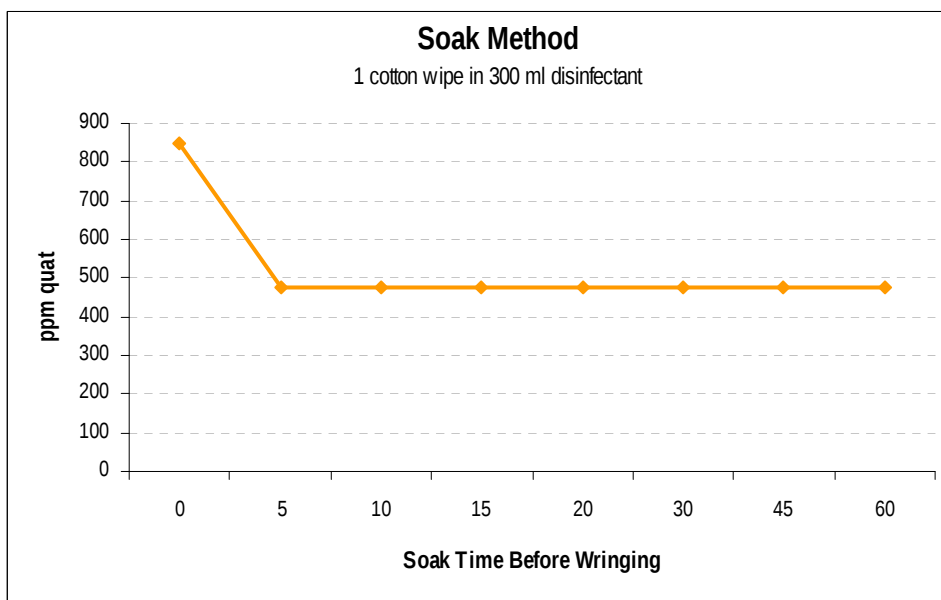
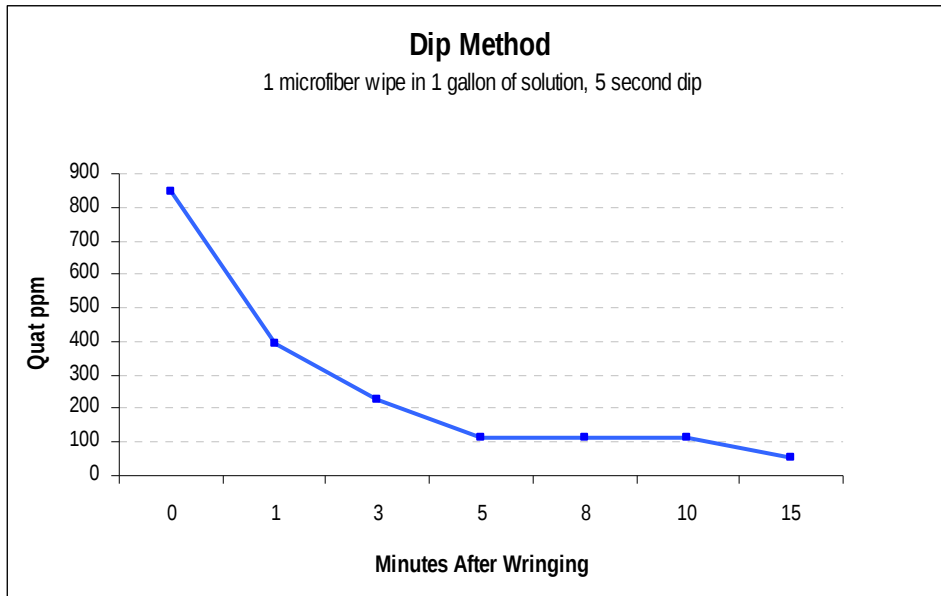
- Spraying
- Dip & Wipe
- Soak & Wipe

Spraying has the advantage of direct disinfectant application, which bypasses the issue of quat absorption. However, spraying has several disadvantages, including ergonomic concerns, overspray, and difficulty in covering surfaces such as the undersides of bedrails. In addition, if not done properly, spraying can atomize a portion of the disinfectant into the air and can subsequently be breathed in by workers and patients.

The Dip & Wipe method involves dipping a dry wipe into disinfectant solution for 5-10 seconds, then wringing out excess solution. The wipe is then immediately used to disinfect hard surfaces. In this method, a wipe weighing 50 grams dry is dipped into a pail holding one gallon of disinfectant solution. After wringing, the wipe may hold approximately 150 mL of disinfectant solution, some of which will be spread over the surfaces being wiped. Wiping the various surfaces in a hospital room takes approximately 10 minutes. A disadvantage of this method is that it carries the possibility of quat absorption over the time that the wipe is used.

In the Soak & Wipe method, the wipe is allowed to soak in the disinfectant solution before use for anywhere from 10 minutes to 8 hours. At the beginning of a shift, a number of wipes are placed in a container of disinfectant solution. The wipes are taken out as needed throughout the shift and any excess solution is wrung out. The wipe is then used to clean and disinfect. Again, an average hospital room may take 10 minutes. A key concern around this method is the issue of quat absorption occurring while the wipes soak in the solution, sometimes for up to 8 hours.

The following graphs illustrate the drop in quat concentration with the Dip & Wipe and Soak & Wipe methods.



Factors affecting quat absorption

Several factors affect quat absorption, including the following:

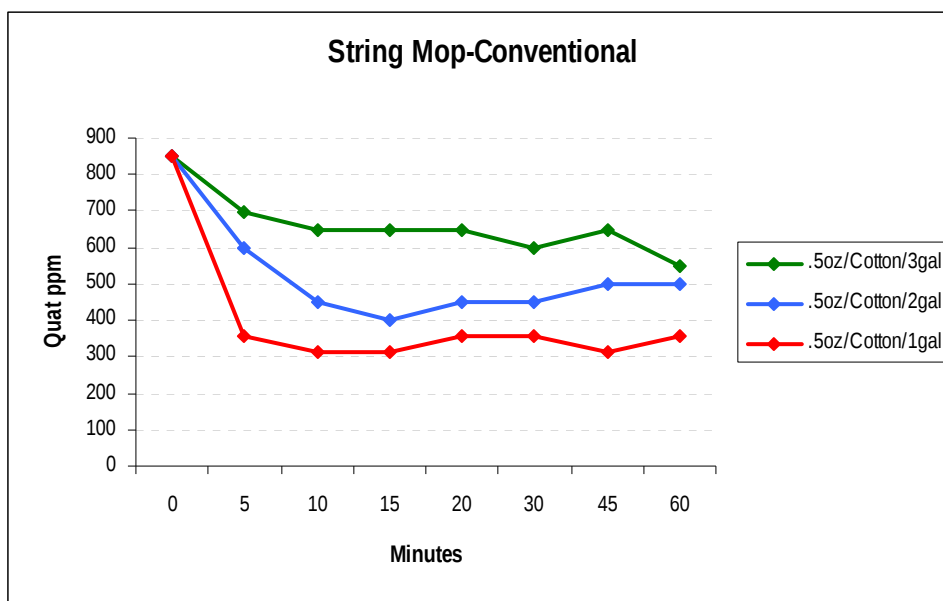
- Soak time
- Volume of disinfectant solution per wipe or mop
- Fabric type
- Time spent in disinfectant solution

Soak Time: Fabric absorbs quat fairly quickly. Much of the absorption may occur in less than 5 minutes.

Volume of Disinfectant Solution Per Wipe or Mop: This is one of the most important factors. The greater the volume of disinfectant solution per wipe, the less is the relative absorption. As an example for illustrative purposes only, if one wipe were dipped into a 5 gallon bucket of disinfectant solution and left for one hour, the overall ppm quat in the bucket would not be affected very much. The wipe could be removed from the bucket, wrung out, and used. In this case the quat concentration in the bucket and in the wipe would still be very high, due to the large amount of disinfectant (5 gallons) in comparison to fabric (1 wipe).

If, however, if a 32 oz (large) cotton string mop were soaked in 1 gallon of disinfectant solution for one hour, the quat concentration in the disinfectant solution in both the pail and the mop would be reduced to a very low level, since the mop would have absorbed much of the quat. This is because there was not as much quat available relative to the large amount of fabric.

In the following graph, cotton mops were soaked in 1, 2, or 3 gallons of disinfectant solution. As can be seen, the most quat absorption occurred in the 1 gallon soak, and the least quat absorption was observed in the 3 gallon soak.



Fabric Type: Different textiles absorb quat differently based on composition.

Time Spent in Disinfectant Solution: In the Soak & Wipe method, the cloth has time to absorb quat from the entire bucket of solution. In the Dip & Wipe method, once the wipe is dipped and wrung out, it begins to absorb quat only from the solution in the wipe. The amount of solution in the bucket is not as important for the Dip & Wipe method as it is in the Soak & Wipe method, since the cloth does not remain in the solution to continue to absorb the active ingredient.

Factors Impacting Required Quat Concentration

The amount of quaternary ammonium chloride required to disinfect depends on several factors:

- The specific disinfectant formula
- The organism targeted for disinfection
- Water hardness

Formula: A disinfectant formula typically contains several components, including a quat active ingredient, surfactants, detergent builders, possibly solvents, fragrance, etc. Different formulas vary in the selected surfactants and builders and their levels, and they also utilize different quat compounds, some of which are more effective than others with regard to specific microorganisms. The way the product is formulated affects its disinfecting efficiency, in terms of quat levels required to effectively achieve bactericidal and virucidal activity.

Organism: Some organisms are more difficult for quats to kill than others. For example, *Pseudomonas aeruginosa* generally requires a higher concentration of quat to disinfect than does *Salmonella choleraesuis*.

Hard Water: Some disinfectants claim a hard water tolerance, which means they have been tested for use in hard water. If a product does not carry a hard water claim, there is no assurance that it will be effective if diluted in hard water. Disinfectants approved for use in hard water generally contain more quat than those that are not listed for use in hard water.

When a disinfectant is registered with the federal Environmental Protection Agency (EPA), the registrant must supply data verifying that the formula effectively kills the organisms claimed on the product label. The data is generated at the lowest dilution concentration listed on the label. There is no assurance that a product is capable of disinfection at levels less than those at which there is data to support. Therefore, it is important to ensure that a disinfectant is used in a manner that provides the required level of actives to the surface being cleaned and disinfected.

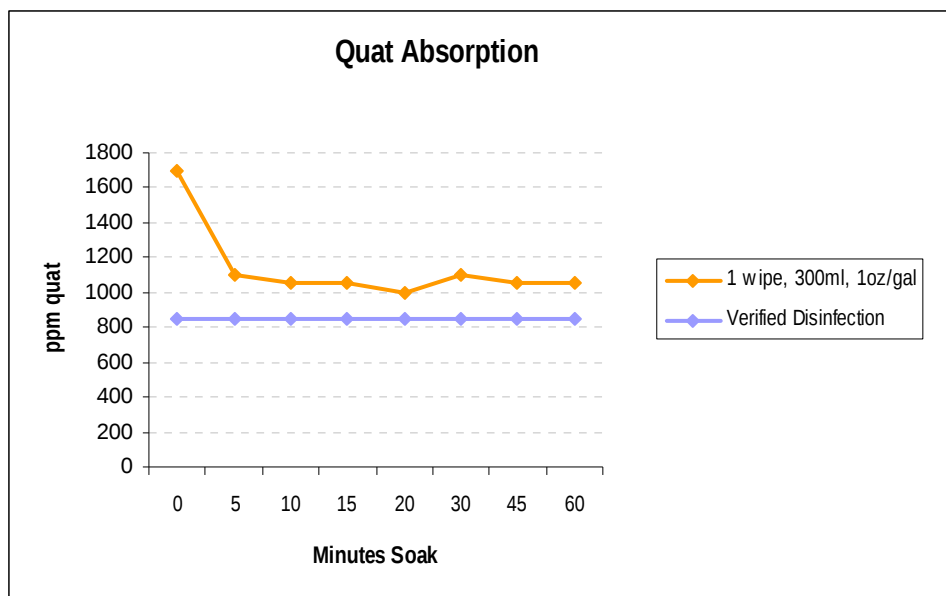
Solutions

Given the concern around quat absorption, solutions have been proposed to ensure that a sufficient concentration of quat is applied to surfaces to adequately disinfect.

- At least two manufacturers have promoted wipes made from specific textiles that exhibit less quat absorption. In some cases these wipes may prove useful for environmental surface cleaning, though they typically do not hold enough liquid to be practical.
- A quaternary disinfectant registered for use at concentrations sufficient to compensate for quat absorption. For example, the Ecolab Quaternary Disinfectant Cleaner has germicidal efficacy at 848 ppm quat. The product is diluted at 1.2 oz per gallon, providing 2035 ppm quat, when the wipes and mops are to be soaked and subsequently absorb quat. After the textiles have absorbed quat, there is still a sufficient concentration to provide the required 848 ppm for

disinfection. This dilution flexibility is not true of most disinfectants. EPA regulations require that a disinfectant is used in accordance with its label. Furthermore, the Ecolab microfiber wipes provided are designed to hold enough solution to clean large areas

- Ecolab's system addresses all aspects that impact proper disinfection:
 - Disinfectant: Ecolab Quaternary Disinfectant Cleaner
 - Proper dilution: Titrate dispensing equipment to ensure appropriate disinfectant dilution
 - Textiles interaction: Interaction of the Quaternary Disinfectant Cleaner with the Ecolab microfiber wipes and mops to ensure the correct amount of Quaternary Disinfectant Cleaner disinfectant is being applied
 - Training: Detailed training for staff to ensure the correct amount of Quaternary Disinfectant Cleaner disinfectant is being applied
- The following graph illustrates that when Quaternary Disinfectant Cleaner is diluted at 1oz/gal, the initial quat level is 1700 ppm. After a microfiber wipe has finished absorbing quat, there is still at least 848ppm available for disinfection. Generally, it is recommended that Quaternary Disinfectant Cleaner be diluted to 1.2 ounces per gallon to account for variances in the textile condition.



As stated earlier, quat absorption is one key element that affects proper disinfection. However, effective disinfection of environmental surfaces is best considered to be a combination of the proper disinfectant and its interaction with specific textiles used at the proper concentration, applied in a sufficient quantity, and left to stand for a given period of time. To ensure that all of these elements are present and that surfaces involved in microbial transmission are being treated, proper training on application procedures is vital. Also, if equipment and cleaning systems including carts, mops, wipes, and dispensers are systematized or configured in such a way as to make proper procedures convenient, it is reasonable to expect improved results.

Conclusion

The absorption of quaternary ammonium compound has been recently recognized as an issue of concern for the cleaning and disinfection industry. While the extent of quat absorption varies by the volume of solution per wipe, the textile type, and the disinfectant application method, it has been established that textiles typically absorb so much quat under regular use dilutions that a level of active ingredient lower than that supported by data is often applied to hard surfaces. Ecolab's system addresses all issues that impact the disinfection process, helping ensure that it is done properly.