World Spotlight

The HPC Debate

Bacterial Re-Growth in Post-Treatment Devices

By Drs. R. W. Schubert, C. Fricker and J.M. DeLattre

Summary: *The following article represents the "position paper'[1] of Aqua Europa published this past spring in Europe with respect to the debate over heterotrophic plate count (HPC) bacteria and any potential health effects for them in water treatment devices in the home.*

OPINION

There has been much reported on the "regrowth" of bacteria in water distribution systems after the water has been treated. Water treatment is not intended to produce sterile water, but rather aims to remove microbial pathogens to reduce the risk of infection in consumers.

After water is released from a [municipal] treatment plant it enters a water distribution system to be delivered to consumers and when it enters the consumers' premises, it may then be stored in tanks or be introduced into a system of pipes. In any case, after water has left the treatment plant the bacteria that remain in the water or others present in the system of pipes may be able to grow, using nutrients in the water. Well [or properly] treated water contains relatively little "food" for bacteria and the amount of available nutrients can be measured using tests for "Assimilable Organic Carbon" (AOC) or "Biodegradable Organic Carbon" (BDOC), which represents a small part of the "Total Organic Carbon" (TOC). Nonetheless some bacteria are able to "regrow" after water treatment and this can occur in "after treatment devices" such as water softeners or filters. This growth of bacteria is often referred to as 'Regrowth in post treatment devices" [or point-of-use/point-of-en-try (POU/POE) equipment]. This growth of bacteria has led to debate over whether the increased bacterial count represents a hazard to consumers. In order to understand this issue, it is necessary to appreciate differences between bacteria.

The number of bacterial types or "species" is enormous and indeed many of the bacteria that are present in natural environments have not yet been classified. The number of species that cause infection in human beings represents a tiny proportion of the total number of bacteria. Water can act as a vehicle for infection of human beings and three routes of infection are recognized:

1. *Fecal-oral*—This route of infection means that microbes of fecal (intestinal) origin have contaminated the water which is subsequently drunk by consumers allowing the pathogenic bacteria, viruses and other parasites, to establish infection (in some cases). Traditional water treatment practices are designed to eliminate these organisms. Bacteria can only regrow in some instances in the water distribution system; viruses and parasites cannot regrow at all in such systems. Bacteria which can be transmitted in this way include *Salmonella, Campylobacter, Shigella* and some strains of £. *coli.*

2. *Respiratory*—Transmission of this type of infection by water has only recently been recognized. Bacteria that can be transmitted by water and cause respiratory infection include *Legionella pneumophila* and *Mycobacterium avium* complex (MAC). Epidemics are usually associated with water systems in large buildings such as hotels and hospitals. *L. pneumophila* is typically associated with poorly maintained hot water systems and not usually with cold water supplies.

3. *Contact*—Some bacteria are able to cause infections of the skin and other organs such as eyes and ears. However, many of these infections are not usually associated with drinking water but rather with water in swimming pools (bathing water). One bacterium, *Pseudomonas aeruginosa,* can be responsible for skin infections that are difficult to treat, but these infections usually occur in hospitalized patients who have severe burns. It may also cause less severe infection such as otitis media and mild skin rashes.

Bacteria are generally adapted to a particular type of environment and indeed are broadly classified in this way. Organisms that cause infections in humans must be capable of growth at 37°C and this is usually their optimum growth temperature. They also usually prefer environments with high nutrient concentrations. Conversely, bacteria that occur natural in water tend to have a lower optimum growth temperature and are often adapted to grow well in low nutrient conditions. There are, of course, exceptions to this. Bacterial growth in water tends to favor organisms which prefer to grow at low temperatures in low nutrient environments and therefore when bacteria which have "regrown" are identified, they tend to be in this category. Because they are well adapted to low temperature and low nutrients, they will tend to "out compete" those bacteria which cause infections in humans and, therefore, prevent their establishment.

Ultimately, the question which needs to be answered is "Does bacterial regrowth in post-treatment devices represent a significant risk to human health?" It is the opinion of this group that the answer to that question is "No"—particularly for the fecal-oral risk. Whilst it may be possible for some pathogens to regrow, the likelihood of this is low and limited to bacterial pathogens. Indeed, if there was a significant risk, this would have been identified by epidemiological units around the world. Essentially, the risk of

HPC: The European Experts' Verdict

Twelve months ago the water softener standard being drafted within CEN—the acronym for the body within the European Union in charge of standards harmonization—was blocked. The drafting group could not obtain consensus, primarily because of the longstanding question over inclusion of requirements to assess and control microbial re-growth in the resin bed.

The controversy is significant not only to the softener standard but to others standards being drafted such as activated carbon, reverse osmosis and particulate filters.

Consequently, Aqua Europa—the federation of water trade associations—underthe presidency of FrankTorfs, resolved to convene atask group of European microbiological experts to review and adjudicate on the issue.

A meeting was arranged with Professor R.W. Schubert of the Institute of Hygiene, Frankfurt, Germany, Dr. C. Fricker, Thames Water Utilities, Reading, U.K., and Dr J-M Delattre of the Pasteur Institute, Lille, France. The meeting was introduced by Yves Henderyckx, convenor of WG13 (the working group of the Comite Europe de Normalisation, or CEN, responsible for developing the softener standard—amongst others), based on a task definition prepared by the Aqua Europa Board. The meeting was also attended by three delegates from active drafting groups. Dr. Delattre couldn't attend in person due to a transportation strike in Paris, but was included in the discussion by conference call.

The three experts subsequently collaborated in preparation of a position paper that's reproduced here.

The paper clearly vindicates HPC bacteria from their notoriety as a health concern and paves the way for harmony in the drafting of standards as well as dispelling historical doubt and myths about health concerns.

A more comprehensive treatise on the issue is under preparation as a "peer review paper" that will shortly be published in professional microbiological journals.

—Tony Frost, President Aqua Europa

regrowth of bacterial pathogens in post-treatment devices is extremely unlikely due to their removal during water treatment, and due to the prevailing conditions which are not optimal for their regrowth such as temperature and nutrient level.

Thus, if water which meets the current EU Directive (see *Footnote)* on drinking water quality is supplied to a post-treatment device, there is little possibility of bacteria transmitted by the "fecal-oral" route since this water should contain no *E. coli,* which is a good indicator of this type of pathogen. When water treatment fails, there maybe a release of bacterial pathogens into the water distribution system and when this occurs, there is some degree of risk to consumers. However, the risk is almost certainly not dependent on regrowth in post-treatment devices. The risk from direct consumption or use is much higher.

Two organisms which require special mention, because of their ubiquity, are *Legionella pneumoplila* and *Pseudomonas aeruginosa. Legionella* can cause respiratory infection and the immunocompromised population are the most vulnerable. It prefers warm water systems, such as cooling towers for air conditioning or industrial applications. *P. aeruginosa* is primarily a nosocomial (hospital acquired) pathogen where respiratory and wound infections can occur. Contamination of the water supply is retrograde in that the source of the organism is the infected patients who then contaminate the water supply at the point of use (taps and dispensers). For both of the organisms, conditions for growth (temperature, assimilable organic carbon, etc.), exposure (route and level) and vulnerability of the exposed population are specific to the application (i.e., hospitals, etc.) and the whole water distribution system must be designed accordingly. They do not pose a risk to the domestic environment.

The issue of whether a microbiological standard should be adopted for water treated by post-treatment devices has been raised and the suggestion made that this should be made on the basis of heterotrophic plate count (HPC). Not only would such a standard be difficult to enforce, but it would largely be meaningless. Firstly, a high HPC does not reflect a health threat to humans. Many of the foods we eat have HPC counts much higher than untreated river water! Secondly, the HPC which would result from post-treatment devices is dependent on the water quality supplied to it. Waters with high HPC to begin with and with a higher level of nutrients (AOC or BDOC) would tend to give water of higher HPC after "stagnation" in post-treatment devices. Rather than set a microbiological standard, it is more relevant to concentrate on the functional aspects of devices. For example, devices should meet the manufacturer's claims (e.g., water softeners must soften water, dechlorinators must dechlorinate), and should not release any toxic substances into the water. There has also been a suggestion that a specific frequency should be set for regeneration of water softeners. The regeneration frequency which is set should be specific to the particular device, adjusted to the hardness of the local water supply, and should ensure that the device is functional and not be based upon any issues relating to microbiological regrowth.

In conclusion, it is the opinion of this group that growth of bacteria in post-treatment devices does not represent a significant human health risk and that any European standards relating to these devices should be based upon functionality and not on microbiological parameters. □

Footnote

The EU Directive here refers to the European Drinking Water Directive, which sets the quality standards for drinking water supplies to which each European Union (EU) member state must comply.

Acknowledgement

This consensus position was prepared following a meeting, and subsequent communication between the following experts: Professor R.W. Schubert, Institute of Hygiene, Frankfurt, Germany; Dr. Colin Fricker, Thames Water PLC, Reading, United Kingdom, and Dr. J.M. Delattre, Pasteur Institute, Lille, France. Aqua Europa can be contacted through Ivef Henderyckx, the secretary general, at +32 10 245 236 or email: henderyckx. aqua@skynet.be

More on Microbes and POU/POE

The following is an abstract for an article on a study (unrelated to the attached position paper) on "the effect of domestic ion exchange water softeners on the microbiological quality of drinking water" by Simon A. Parsons, of the School of Water Sciences at Cranfield University, Bedfordshire, U.K. The article appeared in the June 2000 issue of *Water Research,* the journal of the International Water Association:

"Water quality was assessed in two situations, firstly in normal domestic use and secondly under microbial shock loading conditions in the laboratories at Cranfield University. This study was undertaken to determine whether the passage of water through an ion-exchange softener would lead to a significant change in the total bacterial count of the softened water. Samples taken from the outlet of the water softener had on average higher total viable count (TVCs) than samples taken from the inlet. The average inlet TVC was 300 CFU/ml* whilst the average outlet TVC was 1330 CFU/ml, a less than 1 log increase in CFU/ ml between inlet and outlet. This trend was the same for samples incubated at both 22 and 37°C. There was no evidence for proliferation of coliform and/or *Pseudomonas* species in the water softener. Tests were undertaken to investigate what effect periods of stagnation and regeneration had on the TVC. These tests showed no significant increases in colony counts after 20 days' stagnation. As expected, regeneration led to decreased colony counts in the softened water. To further test whether the water softener could act as a growth site for micro-organisms, a series of microbial shock loading experiments were undertaken using a 90 litre batch solution containing 1.90 x 10^5 *Escherica coli/ml* Tests showed that after day 1 there was no £ *coli* in the softened water although there was a steady increase in the total viable count."

"Colony forming units per milliter

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