FILTRATION AND PLANT-SCALE MICROBIAL RISK: A Research Overview

UNIVERSITY OF WATERLOO

WATER Science, Technology & Policy Group

KEY MESSAGES

- Understanding operation of multiple filters in different filter cycle phases is critical to improve plant-scale performance
- Filtration performance is not only about how well a system can remove pathogens during stable operation
- Filter cycle phases with poor performance drive overall treatment performance
- A modeling framework is provided to be used as a tool in water utilities with site-specific data.

FOR WHOM IS THIS RELEVANT?

This research overview is designed for people concerned about operations in water treatment plants, such as operators, engineers and decision-makers. It may also benefit researchers and risk analysts interested in microbial risk management in drinking water.

"A thorough treatment plant evaluation and improvement program is the best way to ensure pathogen-free drinking water"

Bellamy, Cleasby, Logsdon, and Allen, 1993
"Assessing Treatment Plant Performance"

WHY WAS THIS DONE?

Granular media filtration is critical for the provision of microbiologically safe drinking water, especially for protozoa removal. Typically, treatment optimization studies have focused on maximizing protozoan (oo)cyst removals by individual filters and applying those values in quantitative microbial risk assessment (QMRA). However, filtration is a dynamic process comprised of several recognized phases that filters regularly (i.e., ripening, stable operation) or occasionally (i.e., breakthrough, sub-optimal coagulation) experience. Moreover, operations in water treatment plants usually involve multiple filters in parallel instead of a single filter. Tools to evaluate plant-scale microbial risk are needed to account for the dynamic and combined nature of the filtration process.

WHAT WAS THE APPROACH?

A modeling framework was developed to evaluate the effects of design and operational practices on plant-scale microbial risk. Using reported data, eight analyses were carried out to assess the impact of the following factors on instantaneous and overall filtration performance: number of filters in operation, duration of stable operation and breakthrough, removal during stable operation and breakthrough, different backwashing schedules, filter-to-waste operation, and coagulation.

WHAT WAS SHOWN?

PRACTICAL IMPLICATIONS

Increasing the **number of filters** attenuates variability in plant-scale performance over time but does not change overall performance

Engineers and decision-makers can evaluate the effect of the number of filters when designing water treatment plants or operating their system

Extraordinary peak performance during stable operation may not increase overall performance if periods of deteriorated performance (e.g., ripening, breakthrough) are not avoided

When seeking to improve filtration performance, operators and managers should first tackle filter cycle phases with poor removal, as they drive overall treatment performance

Increasing the **duration of stable operation** improves overall filtration performance

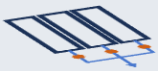
It is recommended to avoid prematurely terminating stable operation with unnecessary backwashes

Limiting the onset of breakthrough and **progressive deterioration in performance during breakthrough** is critical to improve filtration

Individual filter monitoring and timely backwashing are important operational strategies

Unoptimized **coagulation** can have substantial impacts on plant-scale performance

Chemical pretreatment cannot be overlooked when optimizing filtration performance



From a performance perspective, **filter-to-waste operation** is beneficial if the removal during ripening is much lower than the overall removal during the remainder of the filter cycle

This finding can be taken into consideration when investigating the benefits of filter-to-waste operation for a particular water utility

Different **backwash staggering schedules** may change instantaneous pathogen removal, but minimal changes are observed in overall plant-scale performance

When scheduling backwashes, it is recommended to avoid overlapping periods of deteriorated performance when filters are being backwashed

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