Manitoba
Sustainable Development
Office of Drinking Water
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Filtration and Disinfection Log Reduction Credits

The Drinking Water Quality Standards Regulation introduced water quality and water treatment standards for drinking water systems in Manitoba. These standards, as well as disinfection requirements outlined in the Drinking Water Safety Regulation, require water treatment systems to be assessed for their ability to remove or inactivate pathogens.

This information bulletin provides guidance on determining log reduction credits for filtration and disinfection systems.

INTRODUCTION

For water systems in Manitoba using surface water or groundwater under the direct influence of surface water (GUDI), treatment barriers must be in place that are capable of providing at least 3-log (99.9%) reduction of *Cryptosporidium* and *Giardia*, and 4-log (99.99%) reduction of viruses that may be present in the source water. These microbial standards are met using filtration (physical removal) and disinfection (inactivation). Removal and inactivation capabilities vary depending on the filtration technology or disinfectant applied. Organizations such as Health Canada and the U.S. Environmental Protection Agency (EPA) have recommended procedures to determine log removal and log inactivation credits for filtration and disinfection processes. In keeping with a multi-barrier approach to drinking water treatment, the Office of Drinking Water recommends that UV disinfection systems be designed and operated to provide at least 3.0-log inactivation of *Cryptosporidium* and *Giardia*, and chlorination systems be designed and operated to provide at least 4-log inactivation of viruses.

PATHOGEN INACTIVATION CREDITS (DISINFECTION CT CALCULATIONS)

The effectiveness of most disinfectants including chlorine depends on the concentration of the disinfectant (C), water temperature, water pH and the amount of effective contact time (T) between the water and the disinfectant. Manitoba's *Chlorine and Alternative Disinfectants Guidance Manual* includes an explanation of the CT (Concentration × Time) concept. The guidance manual is available on the Office of Drinking Water website.

In completing contact time and CT calculations, the following operating or design conditions must be assumed:

- Minimum temperature of the water undergoing disinfection
- Maximum pH of the water undergoing disinfection
- Storage volume at the minimum normal operating level of the reservoir, clearwell or tanks
- Baffling factor to determine the effective storage volume accounting for short-circuiting

- Peak hourly flow based on water use records (highest pumpage hour) or distribution pump capacity, or estimated based on average water use and peaking factors (ex: Harmon Peaking Factor; Ontario Design Guidelines for Drinking-Water Systems 2008, Section 3.4)
- Minimum disinfectant residual specified for the system (ex: 0.5 mg/L for free chlorine)

Baffling factors can be determined by conducting a tracer test on an existing storage system or can be estimated using a computational fluid dynamics (CFD) computer model; otherwise, the baffling factors in Table 1 should be applied based on the water storage system configuration.

Table 1. Baffling Factors for Water Storage Systems

Storage System Configuration	Baffling Factor (T_{10}/T)
Hydropneumatic tank with single inlet-outlet	No contact time can be claimed
Unbaffled retention tank or multiple unbaffled tanks in parallel	0.1
Unbaffled reservoir cell, treated inlet and pump suction/outlet at same end	0.1
Unbaffled reservoir cell, treated inlet and pump suction/outlet at opposite ends	0.2
Two unbaffled storage tanks in series	0.2
Two unbaffled reservoir cells in series, treated inlet and pump suction at opposite ends of separate cells	0.3
Three or more storage tanks or reservoir cells in series	0.3-0.5
Baffled tank or reservoir cell	0.3-0.6
Piping	1.0

UV disinfection systems are validated by the manufacturer to achieve specific log inactivation levels if operated within validated flow, water quality (UV transmittance) and UV light intensity conditions. Where used in combination with filtration to meet microbial standards, UV disinfection system should be designed to achieve 3-log inactivation of *Cryptosporidium* and *Giardia*. Additional information on validation of UV disinfection systems and log inactivation credits can be found in the US EPA Ultraviolet Disinfection Guidance Manual and Manitoba's *Chlorine and Alternative Disinfectants Guidance Manual*.

PATHOGEN REMOVAL CREDITS (FILTRATION)

Log removal credits for filtration systems are assigned based on accepted credits determined through the ongoing use, testing and validation of various technologies. Guidance on filtration technologies, performance and removal credits is available in Health Canada's technical document for the Turbidity guideline issued for the *Guidelines for Canadian Drinking Water Quality*. Manitoba's filtration credits are provided in Table 2. In order to qualify for the maximum credit, the filtration system and water treatment plant must meet the following criteria:

- Filter design in general conformance with the Recommended Standards for Water Works (Ten State Standards)
- For particulate filters, effective filter cleaning systems involving air scour and backwashing
- For particulate and slow sand filters, filter-to-waste capabilities that ensure post-backwash spikes are eliminated preferably through automatic control based on turbidity

- For particulate filters, application of pre-treatment chemicals (i.e., chemically assisted) at all times and procedures to adjust dosages in response to raw water quality conditions
- For slow sand filters, maintenance of an active biological layer at all times and filter cleaning procedures that minimize disturbance of this layer
- Online turbidimeters for each operating filter tied into a data management system that records measurements at an interval of 5 minutes or less, immediately alerts an operator to a turbidity exceedence, and allows reporting as per Office of Drinking Water requirements
- Compliance with provincial turbidity standards
- For microfiltration and ultrafiltration systems, daily direct integrity testing, and procedures to isolate and address a failed test

Table 2. Log Removal Credits for Filtration Technologies

Filtration Technology	Log Removal Credit *Cryptosporidium*	Log Removal Credit *Giardia*	Log Removal Credit Viruses
Conventional treatment *coagulation, flocculation, clarification, filtration*	3.0	3.0	2.0
Direct filtration *coagulation, filtration*	2.5	2.5	1.0
Slow sand filtration	3.0	3.0	2.0
Cartridge filtration (1µm absolute stage, certified to NSF Standard 53) *small systems only*	2.0	2.0	0
Microfiltration and Ultrafiltration	3.0+ Demonstrated through challenge testing	3.0+ Demonstrated through challenge testing	0 1.0 if pre-coagulation
Nanofiltration and Reverse Osmosis (only GUDI systems)	3.0+ Demonstrated through challenge testing	3.0+ Demonstrated through challenge testing	0
No filtration	0	0	0

Alternative credits may be considered based on third-party challenge testing or documentation of credits assigned by other drinking water regulatory agencies. Such evidence must be provided for membrane and cartridge filtration systems.

Pressure filters are not accepted as a primary filtration barrier for the treatment of surface water or GUDI, and are not eligible for log removal credits.

FURTHER INFORMATION

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