Surface water quality and cleaning milk equipment

JUNE 2008

Background

The National Dairy Regulation and Code requires that water used to clean surfaces that have contact with milk must meet the same standards as for drinking water. The general requirement is that the water must be tested annually for bacteria and be pathogen free.

The National Dairy Regulation and Code Section 9 (1a) states:

*"A milking parlour shall be equipped with or have ready access to a pressurized hot and cold running **potable** water system that is protected from any source of contamination"*

Interpretive guidelines further state:

*"There must be a safe, sanitary, and adequate supply of water for use in a milking parlour. **The water supply source should meet Health Canada's "Guidelines for Canadian Drinking Water Quality".** These guidelines include standards for microbiological, chemical and physical contaminants. In addition, the water source must be protected from potential sources of contamination."*

Dairy farmers in Nova Scotia are required to participate in the Canadian Quality Milk (CQM) program. This is an on-farm food safety program that helps producers prevent and reduce food safety risks on their farms using a Hazard Analysis Critical Control Points (HACCP) approach. This program requires the monitoring of critical production areas to effectively cool and store milk, safely ship animals, closely monitor the use of medicines and chemicals to prevent residues in milk and meat, and ensure cleanliness of equipment and clean wash water.

The CQM program requires water used for milking equipment sanitation to meet provincial potable standards for bacteria. The most cost-effective way to meet this standard is to start with the best water possible in the farm pond. Producers should test their water and then treat the water as required. Treatment to potable standards requires clear or low turbidity water to ensure effective disinfection. Additional water treatment may be required to produce aesthetic or non-health related properties for effectively cleaning of milk equipment. This fact sheet provides an overview of treating surface water for cleaning milk handling equipment.

Surface Water Sources

Surface water can come from either a natural or constructed farm pond or a flowing stream. Flowing streams will have greater variation in water parameters, especially in the amount of suspended sediment. High silt loads are common during high flow periods (e.g. following snow melt or precipitation events). During lower flow periods the water may be quite clear. The amount of nutrients and bacteria will also vary with flow. If you use a flowing stream you must be aware of water quality changes related to drought or heavy rainfall, and manage your treatment system depending on the conditions.

A typical constructed farm pond should have consistent water quality, although seasonal water quality shifts can be expected. Farm pond water quality is usually determined by the water used to fill it and by management techniques. High-nutrient water will drive algae growth and sediment-laden water will require time to settle. Management techniques should reduce

Canada
Nova Scotia Agricultural College
NSFA 1895
NOVA SCOTIA

external nutrient loading and use techniques such as aeration. A farm pond can have consistent water quality if the water introduced into the pond is managed and basic beneficial management practices are followed.

Design, Operation and Management of a Farm Pond

Proper design, operation and management of a farm pond are important prerequisites for high quality water. A quality source can reduce the number of treatment steps required.

Design features that protect water quality include gated inlets, an aeration system, floating intakes and multi-celled ponds. Nutrient management and erosion control in the inflow channel and around the farm pond are also important.

A gated inlet structure allows you to fill the pond with higher quality water. An aeration system helps to maintain oxygen levels by keeping the water mixed. Aeration helps to prevent taste and odour problems, and keep nutrients such as phosphorous trapped in soil sediment. The aeration system should be maintained to ensure proper functioning of the air pump check valves and diffuser. A floating intake requires frequent adjustment and cleaning. Wet wells need to be cleaned and sanitized periodically to manage microbiological growth.

A well maintained and healthy farm pond ensures better quality water

Management techniques should focus on nutrient management in the catchment area. Minimize trees and shrubs growing within 30 m of the farm pond to minimize contribution of organics from leaves. Sediment removal may be required occasionally and annual water testing is recommended. See the publication *Managing Water Quality in a Farm Pond* and *Quality Farm Dugouts* for additional information regarding proper design, operation and management of a pond. (See references in conclusion).

Treatment of Surface Water for Cleaning Milk Equipment

The goal is to provide pathogen-free water with good cleaning properties. General water quality problems include particulates, dissolved minerals and bacteria. Water analysis is used to identify water quality parameters that exceed guidelines and require treatment. Some parameters are health related, while others are aesthetic. Although there are overlaps in treatment approaches, each water quality problem is dealt with through various physical and chemical treatment methods.

Disinfection is required to ensure **pathogen-free water**. Common methods include chlorination and ultra-violet (UV) radiation. Chlorine disinfection is the least costly. It is advantageous because it maintains a residual and will destroy bacteria introduced into the pipeline at a later point or time. Unfortunately, chlorine can deteriorate rubber compounds in the milk equipment. On the other hand, UV light is only effective in water with low tannins and low suspended solid concentrations, and does not have any residual. Membranes in ultra-filtration, nano-filtration and reverse osmosis systems also physically remove pathogens.

UV light disrupts DNA of the bacteria and prevents reproduction

Surface water is rarely of sufficient quality to allow direct chlorination or UV treatment. Particles in the water shield the pathogens from treatment. Metals such as iron and manganese precipitate on surfaces after chlorination. Organic matter, especially with high percentages of tannins, absorbs UV rays, consumes chlorine and prohibits rays from penetrating the water layer.

Water with good cleaning potential is free of dissolved metals and scaling properties. Dissolved metals, especially iron and manganese, tend to precipitate metal oxides on the milking equipment. Tiny rust flakes attach to the stainless steel and can initiate pitting and rusting. Pitting reduces the life of equipment and provides attachment points for bacteria, leading to high bacteria counts in the milk. Pond aeration is an effective way to pre-oxidize metals and reduce iron and manganese problems.

Scale or corrosion is of particular interest in the maintenance of A3 stainless steel piping systems. The "aggressiveness" of the water is its tendency to be either scaling or corroding. Hardness and the Langlier Saturation Index (LSI) are ways to measure the aggressiveness of the water. Hardness between 80 and 100 mg/L (as calcium carbonate) or a LSI between +0.5 and -0.5 is viewed as a good balance between scaling and corrosion. The LSI can be determined with calculators available on the web. Be aware that the LSI will change under winter ice, as minerals are excluded during freezing and are concentrated in the remaining water. Total dissolved solids, calcium and alkalinity increase and shift the Index. A softener may be required in winter to reduce scaling potential.

Treatment Options

One treatment method rarely deals with all types of surface water problems. Multiple treatment components placed one after the other increase the effectiveness of subsequent treatment. Selection of treatment methods depends on the contaminants in the water. Surface water always contains bacteria and particles and may have significant levels of dissolved compounds such as metals and tannins. There are several methods to remove these contaminants from water. They include:

- Filtration (large particles only);
- Coagulation (particles and dissolved constituents like metals and tannins);
- Granular activated carbon (certain particles, tannins and bacteria, and chlorine);
- Ultra-filtration membranes (particles, metals, pathogens and some tannins);
- UV radiation (pathogens); and
- Chlorination (pathogens).

Four treatment alternatives for surface water are:

- Screened intake, coagulation, storage, filtration, chlorine or UV disinfection (see *Quality Farm Dugouts* for a system schematic);
- Screened intake, filtration, ultra-filtration, storage, chlorine or UV disinfection;
- Municipal treatment plant serviced by a regional pipeline; and
- Slow sand filter

Coagulation effectively removes particles, metals and tannins

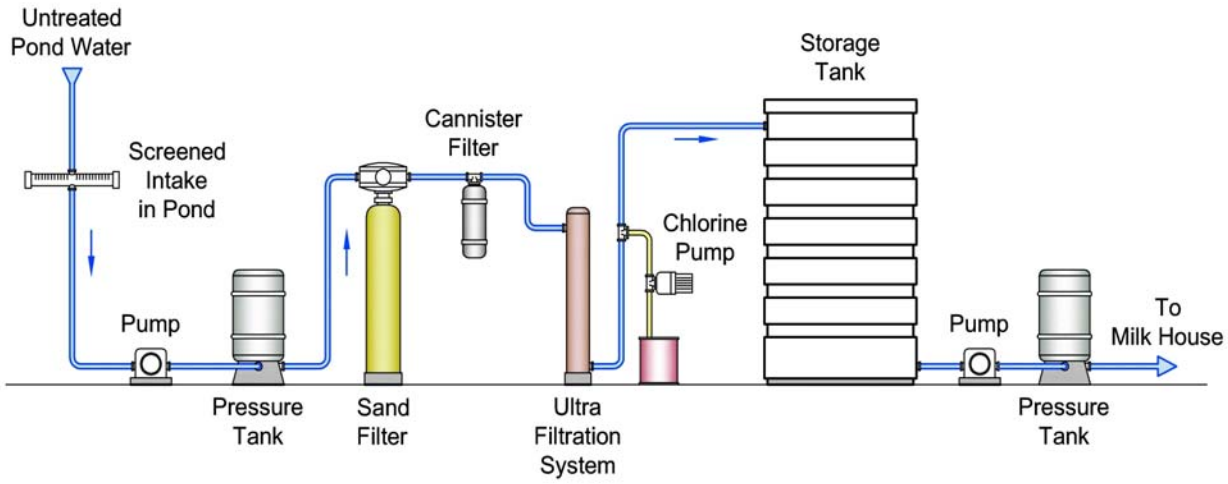

Figure 1: Typical Treatment Train for Ultra-Filtration System

Table 1: Advantages and Disadvantages of Various Treatment Methods

System	Advantages	Disadvantages
Coagulation	• good removal of particles, metals and tannins • simple, little maintenance • produces clean, clear water	• requires chemicals • large footprint • 20% water loss
Ultra-filtration	• removes pathogens therefore may not require disinfection • removes particles, metals and pathogens • very compact • low power consumption	• may be challenged by hard water containing iron, manganese and organics • may require frequent maintenance • 15% water loss
Regional Pipeline	• little required maintenance • higher level of treatment and monitoring	• may not be readily available • requires significant coordination • may require permits • high capital cost in sparsely populated • regions
Slow Sand Filter	• simple and inexpensive	• fine particles found in soils in NS may either pass through the filter or cause plugging

Table 2: Approximate Treatment Cost Comparisons (in 2008 Dollars)

System	Capital Cost	Annual Operating & Maintenance Cost	Total Annual Cost*
Coagulation	$9,500	$850	$2,100 ($2.90/m^3)
Ultra-filtration	$8,000	$1,000	$2,100 ($2.90/ m^3)
Pipeline	$10,000 to $25,000	$600	$1,600 to $3,100 ($2.20 to $4.20/ m^3)

* Includes depreciation and interest

Assumptions: 10-year life, 2 m^3 (440 Igal) /day consumption for 50 dairy cows, includes storage tank and pressure system, chlorine disinfection. Costs will vary depending on water type.
Note: A UV system would likely add about $1,200 to capital cost and $250 to annual cost for a $400 increase in total annual costs. The slow sand filter was not included in the cost estimates as it performed poorly in tests and is not recommended for the Nova Scotia surface water.

Ultra-filtration systems remove bacteria and viruses

Operation and Maintenance

Operation and maintenance is critical to ensuring potable water and longevity of the treatment system. The following table identifies the minimum operation and maintenance needed for the specific systems. The manufacturer's operation and maintenance manual should be consulted for additional required procedures. Frequency of maintenance depends on the water quality.

System	Operation & Maintenance
Coagulation	- monthly addition of chemical
Ultra-filtration	- monthly cleaning - annual inspection
Chlorine System	- bi-annual inspection of diaphragm - monthly flow rate inspection
Filters	- replace cartridges or sand in filters
Pipeline	- annual tank cleaning

As with any potable water treatment system, water analysis and record keeping are important. A log book of problems and solutions to build experience with your particular set-up is also helpful. Although the National Dairy Regulation and Code only requires annual testing of the water for bacteria, more frequent testing may be necessary depending on the variability in the quality of the water supply. Maintenance schedules and operational guidelines provided in this document are generalized and should be considered a starting point.

Conclusion

Every surface water source is unique and treatment systems must be tailored appropriately to ensure safe potable water for the dairy. The most cost-effective approach is to firstly ensure the selection of the best possible water. A water test is important to determine the type and concentration of contaminants and identify appropriate water treatment systems. Water testing, record keeping and maintenance are critical practices which help to ensure potable water for cleaning milk equipment.

Additional information on treatment of surface water and pond management can be found in:
Quality Farm Dugouts at: **www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/eng4696**

Managing Water Quality in a Farm Pond at:
www.nsfa-fane.ca/

Authored by Larry Braul and Rob Butler, PFRA with thanks to Yvonne Thyssen-Post, Rob Gordon, Wendy Pratt, Carla MacKay and Heather Rand

This factsheet was funded through the Canada-Nova Scotia Water Supply Expansion Program, an initiative under the Federal–Provincial-Territorial Agricultural Policy Framework.

Canada Nova Scotia Agricultural College NSFA 1895 NOVA SCOTIA