A3609

Milking center wastewater management

David C. Payer and Brian J. Holmes

Estimating the volume of wastewater

This fact sheet is part of a series for dairy farmers and others in the dairy industry concerned about managing wastewater generated during milking activities. The series introduces practices and devices that help conserve water, energy and cleaning chemicals. Ways to treat and dispose of milking center wastewater are also discussed. The goal is to help dairy farmers operate in a more profitable and environmentally-sound manner.

The information presented here reflects state-of-the-art concepts in milking center resource conservation and wastewater disposal. As research into new technologies goes forward, advances in milking center wastewater management will continue.

Titles in this series include:

Controlling Milking Center Wastewater: An Overview (A3608)

Estimating the Volume of Wastewater (A3609)

Managing Waste Milk (A3610)

Treating and Disposing of Wastewater (A3611)

Reducing Phosphorus Levels in Wastewater (A3612)

Conserving Water in the Milking Center (A3613)

This series was developed by the University of Wisconsin–Extension with cooperation and financial assistance from the Water Quality Demonstration Project–East River.

Accurately estimating how much wastewater your milking center generates is an important part of planning wastewater treatment system renovations, as well as selecting and designing new systems. The best way to estimate wastewater volume is to meter the water flowing into the milking center and deduct the amount not entering floor drains. Where this is not practical, the methods described here will give you a good estimate of daily milking center wastewater production.

The amount of milking center wastewater varies greatly from farm to farm. Some factors that affect the volume include the type of equipment used and the farm's size and management practices. In Wisconsin, wastewater estimates generally range from 200 to 1,000 gallons/day (gal/day).

Any of the following activities may be a source of wastewater:

- cleaning the milking system
- cleaning the bulk tank
- cleaning and stiumulating udders
- pre-cooling milk
- recharging the water softener
- washing down the milkhouse, milking parlor and holding area
- miscellaneous activities, such as washing hands and boots, cleaning equipment, etc.

In the following section, ways to estimate the daily wastewater contribution of these activities and examples of each are presented. Use the worksheet on the last page to estimate the total daily milking center wastewater generated on your farm. The worksheet summarizes the calculations you will need.

Sources of milking center wastewater and ways to estimate the quantity

Cleaning the milking system

The volume of water used to clean milk pipelines, receivers and milking units is influenced by pipeline length and diameter, the use of air injectors, volume and complexity of the milk receiver group, and the number of cleaning cycles. Most producers with clean-in-place (CIP) milking systems use four cycles per milking: rinse, wash, acid rinse and sanitize.

To estimate water use per milking, first estimate use per cleaning cycle. This is the same as the sink-fill water volume. For unmodified CIP systems, the sink-fill volume can be found on the system's cleaning chart. If you clean manually or use a modified CIP system, measure the sink-fill volume by collecting all water from one sink-fill into buckets of known size. Multiplying the sink-fill volume by the number of cleaning cycles per milking provides an estimate of water use per milking, and multiplying this by the number of milkings per day yields an estimate of daily water use for cleaning the milking system.

Daily water use (gal/day) = sink-fill volume (gal/cycle) x no. cycles/ milking x no. milkings/day.

EXAMPLE

Suppose cows are milked twice a day and the milking system is rinsed, washed, acid rinsed and sanitized after each milking, requiring four cleaning cycles for each milking. If sink-fill volume is 25 gallons, daily water use for pipeline cleaning is:

(25 gal/cycle x 4 cycles/milking) x 2 milkings/day = 200 gal/day.

Cleaning the bulk tank

Bulk tank cleaning requires approximately 5% of the tank volume with automatic washing systems and 3% with manual systems. To estimate water use per cleaning, divide the bulk tank volume by 100%, then multiply by 5% (for automatic systems) or 3% (for manual cleaning).

Per-cleaning water use (gal/cleaning) = [bulk tank size (gal) ÷ 100%] x 3% (manual) or 5% (automatic).

You can calculate an estimate of the average daily water use for cleaning the bulk tank by multiplying the estimated volume used per cleaning (above) by the number of tank cleanings per week, then dividing by 7.

Average daily water use (gal/day) = [per-cleaning water use (gal/ cleaning) x no. cleanings/week] ÷ 7 days/week.

EXAMPLE

Suppose there is a 1,000-gallon bulk tank with an automatic washing system and three milk pick-ups per week. Estimated daily water use for bulk tank cleaning is:

1. (1,000 gal bulk tank ÷ 100%) x 5% = 50 gal/cleaning.
2. (50 gal/cleaning x 3 cleanings/week) ÷ 7 days/week = 21.4 gal/day.

Cleaning and stimulating udders

The most economical way to clean udders and stimulate milk letdown is to use moistened single-service towels. With this method, water use averages 0.25 gal/cow before each milking. Daily water use is estimated as follows:

Daily water use (gal/day) = 0.25 gal/cow-milking x no. cows x no. milkings/day.

EXAMPLE

A herd of 60 cows is milked twice a day. The estimated daily water use for pre-milking udder cleaning and stimulation with moistened single-service towels is:

0.25 gal/cow-milking x 60 cows x 2 milkings/day = 30 gal/day.

More water will be needed if cattle are excessively dirty. When towels are used with buckets, a more accurate way to estimate water use is to determine the volume of water per bucket and multiply by the average number of buckets used per day.

Daily water use (gal/day)
= gal/ bucket x avg. no. buckets used/day.

If cows are hand sprayed or prepped in automatic stalls, larger quantities of water are used (0.25-2 gal/cow per milking). To estimate the amount of water used, you should first capture in containers all water used to clean and stimulate several cows. Measure the volume of water and determine the average volume of water needed per cow. Then, use the following equation:

Daily water use (gal/day)
= avg. volume of water used per cow before each milking (gal/cow per milking) x no. cows x no. milkings/day.

EXAMPLE

Water used for hand spraying five cows prior to milking was measured as follows:

Cow	Water used (gal/milking)*
A	1.50
B	1.25
C	1.50
D	1.00
E	1.25
Total	6.50

*Note: Pouring water used from each cow into a calibrated container to obtain a total can save measuring the volume from each container separately.

Estimated water use per cow before each milking is:

6.5 gal/milking ÷ 5 cows
= 1.3 gal/cow per milking.

With twice a day milking, daily water use for cleaning and stimulating 60 cows is:

1.3 gal/cow per milking x 60 cows x 2 milkings/day = 156 gal/day.

Pre-cooling milk

A pre-cooler is an in-line heat exchanger that uses well water to cool milk en route to the bulk tank. One to two gallons of water is often used to cool each gallon of milk. Pre-cooler water is warmed but remains potable and can be reused to water cattle, wash floors, etc. If any pre-cooler water is diverted to milking center drains, it should be counted in the estimate of total wastewater generation.

To estimate wastewater generated from a pre-cooler, you must first determine the water-to-milk-flow ratio in the heat exchanger. This ratio is then multiplied by average daily milk production.

1. Determine the flow rate of the milk transfer pump between the receiver jar and the bulk tank. This information should be available from the equipment dealer or from pump specifications. It can also be calculated during cleaning by measuring the time required to fill a bucket of known volume with washing solution from the bulk tank end of the milk transfer line.

   Transfer pump flow rate (gal/min)
   = bucket size (gal) ÷ time to fill (min).

2. Determine the volume of milk pumped during each pump cycle.
   a) During milking, record the amount of time the transfer pump runs for one cycle.
   b) Multiply the transfer pump flow rate by the pump cycle time to determine the volume of milk delivered per pump cycle.

   Milk pumped per cycle (gal/cycle)
   = transfer pump flow rate (gal/min)
   x pump cycle time (min/cycle).

3. Determine the volume of pre-cooler water used per milk transfer pump cycle. Do this while milking by filling buckets of known volume with used pre-cooler water as it flows out of the heat exchanger during one pump cycle.

4. Divide the volume of pre-cooler water used per cycle by the volume of milk pumped per cycle to determine the ratio of water to milk flow through the heat exchanger.

   Ratio of water to milk flow = pre-cooler water used per cycle (gal water/cycle) ÷ milk pumped per cycle (gal milk/cycle).

5. To estimate the volume of pre-cooler water used daily, multiply average daily milk production in gallons by the water-to-milk flow ratio.

   Daily pre-cooler water use (gal/day) = average daily milk production (gal/day) x ratio of water to milk flow.

   Note: To obtain gallons of milk produced per day, divide pounds of milk sold per day by 8.2 lbs/gal.

6. In the final estimation, include only pre-cooler water that enters milking center drains. If some of the water is diverted to other uses, estimate the percent that enters the drain and use the following equation:

   Wastewater from pre-cooler (gal/day) = [pre-cooler water use (gal/day) x % pre-cooler water entering drain] ÷ 100%.

EXAMPLE

A dairy produces 3,075 lb milk/day on average and a milk pre-cooler that uses 1.5 gallons of water to cool each gallon of milk. None of the pre-cooler water is recycled for other uses. Estimated daily wastewater generation is:

1. 3,075 lb milk/day ÷ 8.2 lb/gal = 375 gal milk/day.
2. 375 gal milk/day x 1.5 gal water/gal milk = 562.5 gal water/day.

   Note: Milk pre-coolers can generate large quantities of wastewater. Recycling this water is recommended. See *Conserving Water in the Milking Center* (A3613))

Water softening

Water softeners generate 70 to 120 gallons of wastewater per regeneration cycle. Reasonable estimates are 90 gal/cycle for 30,000-grain softeners, and 110 gal/cycle for 24,000-grain softeners. Daily water use is estimated by dividing per cycle use by the number of days between regeneration cycles.

Daily water softener wastewater (gal/day) = wastewater per regeneration cycle (gal/cycle) ÷ no. days between regeneration cycles (days/cycle).

EXAMPLE

A dairy has a 24,000-grain softener that regenerates every third day. The wastewater is not recycled for other uses. Daily wastewater generation is:

110 gal/cycle ÷ 3 days/cycle = 36.7 gal/day.

Water softener wastewater can be diverted to a reservoir and reused for washing down the milking center floor and walls. If it is reused, this wastewater will be included in the washdown estimate and water softening itself will not contribute to milking center wastewater.

Milkhouse, milking parlor and holding area washdown

The volume of water used to wash the floor and walls after milking depends on the type of milking system (pipeline vs. parlor), water pressure and flow rate, amount of scraping prior to hosing, operator attentiveness and floor condition. For parlor systems, water requirements for floor and wall washdown range from 50 gal/milking to 200 gal/milking. Use the following procedure to estimate water use:

1. Calculate the flow rate (at operating pressure) for each hose used to wash parlor, holding area and milkhouse floors and walls by recording the time required for each to fill a bucket of known volume. Use the following equation:

   Flow rate (gal/min) = bucket size (gal) ÷ time to fill (min).

   Note: A high pressure hose or high flow rate pump may cause excessive splashing. Consider using a drum instead of a bucket.
2. Record the amount of time each hose is used for several days. Calculate the average amount of time each hose is used per day.
3. To estimate daily water use on a per-hose basis, multiply the flow rate of each hose by the average amount of time it is used daily.

   Daily water use (gal/day) = flow rate (gal/min) x avg. time used (min/day).
4. Add individual hose estimates to obtain the daily water use from all hoses.

EXAMPLE

1. One hose is used to wash a holding area, and it requires 90 seconds to fill a 5-gallon bucket at operating pressure. The flow rate is:

   5 gal ÷ 1.5 min = 3.3 gal/min.

   There is also a hose used for parlor washdown and one for the milkhouse, and both have the same flow rate as the hose used in the holding area.
2. The amount of time each hose is used after milking for 4 days is illustrated in the table below.
3. Estimated daily water use for each hose is:
   a) Holding area:
      18.5 min/day x 3.3 gal/min
      = 61.0 gal/day.
   b) Parlor:
      25 min/day x 3.3 gal/min
      = 82.5 gal/day.
   c) Milkhouse:
      8 min/day x 3.3 gal/min
      = 26.4 gal/day.
4. Estimated daily water use for parlor, holding area and milkhouse washdown is:
   61.0 gal/day + 82.5 gal/day
   + 26.4 gal/day = 169.9 gal/day.

Day	Milking (AM or PM)	Time hose is used (min/milking)		
		Holding area	Parlor	Milkhouse
1	AM	8	12	4
	PM	11	14	4
2	AM	9	11	5
	PM	7	9	4
3	AM	12	15	3
	PM	10	13	4
4	AM	8	12	5
	PM	9	14	3
Average time hose used per milking (min/milking)		9.25	12.5	4
Average time hose used per day (min/day; 2 milkings/day)		18.5	25.0	8

Miscellaneous sources of wastewater

You should account for any other significant sources of milking center wastewater. These might include hand and boot washing, manual equipment cleaning, milk discarding, etc. The contribution of these miscellaneous sources varies greatly from farm to farm.

For more information

For a more detailed discussion of milking center wastewater management, see the other titles in this series (listed on page 1) and *Pollution Control Guide for Milking Center Wastewater Management* (A3592) by R. E. Springman, D. C. Payer and B. J. Holmes, available from your county Extension office or from Extension Publications at the address listed on the back. You may also obtain more information from:

- University of Wisconsin–Extension county agents
- your local county land conservation department
- Soil Conservation Service field offices
- dairy plant representatives
- Department of Natural Resources district offices

Worksheet: Estimating daily milking center wastewater volume

Use this worksheet to estimate the amount of wastewater entering milking center drains and wastewater handling facilities daily. *Do not include wastewater diverted to manure storage or recycled for other uses.* Complete all applicable categories. Refer to the previous pages for an explanation of the calculations.

Category	Description	Wastewater volume (gal/day)
A	Milking system cleaning sink-fill volume (gal/cycle) x no. cleaning cycles/milking x no. milkings/day	
B	Bulk tank cleaning [(bulk tank size (gal) ÷ 100%) x 3% (manual) or 5% (automatic) x no. cleanings/week] ÷ 7 days/week	
C	Udder cleaning and stimulation a) Single-service towels and bucket: 0.25 gal/cow-milking x no. cows x no. milkings/day, *or* gal/bucket x avg. no. buckets used/day b) Hand spraying or automatic prep stalls: avg. gal/cow-milking x no. cows x no. milkings/day	
D	Milk pre-cooling avg. daily milk production (gal/day) x water-to-milk-flow ratio x fraction of water discharged to drain	
E	Water softening [wastewater per regeneration cycle (gal/cycle) x no. cycles/week] ÷ 7 days/week	
F	Milkhouse, parlor and holding area washdown* Sum of water used at each hose, estimated as follows: flow rate (gal/min) x avg. time used (min/day)	
G	Other wastewater sources hand and boot washing, manual equipment cleaning, milk discarding, etc.	
	Total wastewater generated (gal/day)	

**May be zero if 100% recycled water is used.*

Authors: David C. Payer was formerly an outreach specialist and Brian Holmes is a professor with the Department of Agricultural Engineering, College of Agricultural and Life Sciences, University of Wisconsin-Madison and the University of Wisconsin–Extension, Cooperative Extension.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Wisconsin–Extension, Cooperative Extension. University of Wisconsin–Extension and the Water Quality Demonstration Project-East River provide equal opportunities in employment and programming, including Title IX and ADA requirements. If you need this information in an alternative format, contact the UWEX Affirmative Action Office or call Extension Publications at (608)262-2655.

This publication is available from your Wisconsin county Extension office or from Extension Publications, Rm. 245, 30 N. Murray St., Madison, WI 53715. Phone: (608) 262-3346.

A2609 Milking center wastewater management:
Estimating the volume of wastewater I-05-94-4M-40-E