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Drinking Water for Dairy Cattle

Water is the single-most important nutrient for dairy cows.

April 5, 2011 - Author: Craig Thomas, Michigan State University Extension

Do you know which land-based mammal has the highest daily drinking water requirement (per unit pound of body weight)? Elephant? Rhinoceros? Hippopotamus? These may be good guesses, but the answer is the modern dairy cow. A milking dairy cow drinks about 30 to 50 gallons of water each day. During periods of heat stress water intake may double. Water weighs 8.35 lbs/gal, so a milking dairy cow may consume as much as 420 (or more) pounds of water daily. Thus, the intake of water on a per pound basis is far greater than that of protein, carbohydrates, fats and minerals a cow consumes in what we normally think of as "ration." This means what we usually focus on (dry matter intake) accounts for only about 12% of the cow's total nutrient intake; while water accounts for about 88%! Thus, water IS the most important nutrient in a cow's total daily intake.

Armed with these facts, how much focus should drinking water receive on your farm? The first water criterion you should examine is drinking water quality. Is your water fit to drink based on its chemical and mineral composition?"). In this regard, Michigan State University dairy nutritionists tell us that the most important constituents to evaluate are: total dissolved solids (TDS), sulfate (SO_4), chloride, (Cl), iron (Fe), and nitrate-nitrogen (NO_3-N). Therefore, it is important to have a laboratory analysis done for your cows' drinking water.

TDS: measures the sum of all inorganic matter dissolved in water, and is an indicator of water salinity. Levels above 1,000 ppm should be investigated further and potentially be corrected to prevent and/or correct problems like diarrhea and dehydration.

Sulfate + Chloride: if the combined SO_4 + Cl content of drinking water is greater than 500 ppm further testing and evaluation also are needed. At these, or higher levels, these minerals may lead to health and production problems.

Nitrate-nitrogen: nitrate-nitrogen levels in drinking water should not exceed 20 ppm. High nitrate-nitrogen levels have been associated with long term reproductive problems in dairy cows; such as higher services per conception, lower first service conception rates, and longer calving intervals.

Iron: cow drinking water containing over 0.3 ppm iron may cause subclinical chronic iron toxicity, or more severe problems. Most dairy rations provide adequate iron. Thus, when drinking water contains excess iron (soluble iron called ferrous-iron in drinking water) the total iron may rise in the cow's tissues causing "oxidative stress." This may lead to a host of problems including increased retained placenta, mastitis, metritis, and a general compromising of the animal's immune system. Excess soluble iron in the animal's gut also ties-up and reduces absorption of other key minerals like zinc and copper.

Excess content of these mineral constituents in water may also contribute to problems with your farm's water delivery system (i.e., pumps, pipes, etc.) and decrease the effectiveness of cleaners and sanitizers (e.g., pipeline cleaning and sanitizing). The later could lead to milk quality problems (e.g., increased bacteria counts) and buildup within pipes that restrict water flow.

By weight, water is the most important nutrient in a milking cow's ration easily making up greater than 80% of the ration's total weight. Further water testing and/or treatment should be considered if the above named constituents are greater than acceptable levels (see Table 1), because at these higher levels these constituents may negatively affect animal health and/or milk production, interfere with the germicidal activity of cleansers and sanitizers (e.g., chlorine) and cause problems with water system components (e.g., pipes and pumps). In fact, some water quality problems such as excess iron can lead to such poor animal performance (e.g., health problems, reduced milk production) that it can be a "business-breaker" (2). High levels of some constituents (e.g., iron, nitrate-nitrogen) can also endanger human health if people are drinking from that water source (1). If levels of these constituents reach "retest levels"; further testing is warranted and one should even consider sending multiple samples to multiple certified laboratories to confirm/deny whether these constituents are problematic. If on further testing a constituent reaches or exceeds "actionable levels" dairy producers should consider consulting professional water treatment options for their cattle's drinking water.

Water treatment options vary somewhat depending on the water quality issue involved. A major difficulty in treating drinking water on dairy farms is posed by the huge volumes of water involved. Recall that high producing dairy cows may consume up to, or even greater than, 50 gallons of water per day. Multiplying this use over hundreds, or thousands of cows, quickly results in a staggering daily volume of water requiring treatment. Thus, one of the best water "treatment" options may be finding an alternate water source that isn't plagued with the offending constituent (2).

Water treatment options include distillation (too costly), reverse osmosis (RO), ion exchange resin system (traditional water softener employing salt), oxidation + filtration via aeration (often called an "iron curtain") and **hydrogen peroxide (H_2O_2) injection systems (2).**

Removal of excess TDS and excess sulfate + chlorine usually employs traditional water softeners or RO systems. Reverse osmosis systems remove 80-90% of these constituents depending on their design. Conventional water softeners are effective, but are not designed to handle large volumes of water and require an acceptable place to dispose of the brine flush water needed to recharge the system. Depending on the number of animals served, it may be necessary to design a water treatment system in such a way that large volumes of "treated" water can be stored for use at times of peak demand (2).

Oxidation systems are mainly employed to remove excess iron from cattle drinking water. The "iron curtain" system employs aeration to convert the iron to a precipitate (Fe^{+3}) which is then subsequently filtered from the water. The hydrogen peroxide (H_2O_2) system employs the Fenton Reaction which converts iron from Fe^{+2} (soluble in water) to Fe^{+3} (insoluble in water) and then filters out the Fe^{+3} as a precipitant. This system injects H_2O_2 into the drinking water (8 oz of 35% H_2O_2 per 1,000 gallons of water). This system is quite cost effective. A suitable injection pump costs around $500 and the cost of 15 gallons of 35% H_2O_2 solution is around $100 (enough to treat ~240,000 gallons of water)(2).

When working with water treatment vendors it is absolutely essential they understand the following items about your farm's situation (2):

1) *Do they know how much water your dairy uses?* More than likely, your dairy uses much more water per day than the typical water treatment professional is accustomed. I have put together a short paper, *Estimating Water Usage on Dairy Farms,* that helps producers understand the volumes of water needed on a modern dairy farm. The paper also has an accompanying spreadsheet that producers can use to estimate daily water needs on their operations. To get a copy of the paper and/or the spreadsheet, send me an e-mail request specifying your request.

2) *What is the treatment rate (volume/time) of their system?* Again, your dairy will most likely consume water, particularly at peak demand periods, with which typical water treatment professionals are unaccustomed. Can their systems keep up and provide enough treated water to meet your peak demand?

3) *Does the water treatment provider guarantee their system will meet peak demand and reduce the undesirable constituent to acceptable levels?* Will their system meet this requirement throughout the expected useful life of the system? Are they willing to provide such guarantees in writing?

4) *What is the expected useful life of their system and what are their system's maintenance requirements and costs?* Who is responsible for maintenance—you or them? Do they offer a service contract, and if so, what does it cost and what does it cover?

5) *What chemicals (e.g., other mineral elements) does their system/method add to the water and at what concentrations?* They may add nothing, but some systems add significant amounts of constituents (e.g., chlorine) that may cause an entirely new set of problems.

6) *Ask potential water treatment providers to allow you to contact other customers using their system.* Visit these other installations of this provider's system to determine whether their products, services and warranties are as good as advertised. Run from any water treatment provider not willing to provide you this information.

Caveat Emptor: "Buyer beware!" Unfortunately, the field of water treatment is filled with an abundance of people and companies willing to sell water treatment systems of every size, shape and treatment method, whether your water needs treatment or not, and whether their method actually works or not. Most water treatment methods offered to solve purported bad water problems in commercial dairy farms were first available and/or sold to homeowners and consumers. To quote from the website about *Junk Science* in the *Market Place*:

"Magnets and "catalysts" for softening water, magnetic laundry balls, waters that are "oxygenated," "clustered," "unclustered" or "vitalized" (purporting to improve cellular hydration, remove toxins, and repair DNA), high zeta potential colloids and vortex-treated waters to raise you energy levels, halt or reverse ageing and remove geopathic stress --- all of these wonders and more are being aggressively marketed via the Internet, radio infomercials, seminars, and by various purveyors of new-age nonsense. The hucksters who promote these largely worthless products weave a web of pseudoscientific hype guaranteed to dazzle and confuse the large segment of the public whose limited understanding of science makes them especially vulnerable to this kind of exploitation."

Hopefully you are routinely sending water samples of your cow's drinking water to a certified laboratory on a quarterly basis and maintaining a historical record of those analyses. If your water test results suggest that you may need to consult a professional water treatment company to rectify a problem, an appropriate closing message on water treatment methods would be, *"Show me the science and the proof of improved cow health and performance before I show you five or six figures in George Washington's finest dollars."* (1)

Table 1: Actionable levels of important water constituents (1, 2, 3).

Constituent	Retest Level	Actionable Level
Total Dissolved Solids (TDS)	>500 ppm	>5,000
Sulfate (SO_4), + Chloride (Cl)	>250 ppm	>500 ppm
Nitrate-nitrogen (NO_3-N)	>10 ppm	>20 ppm
Iron (Fe)	>0.15 ppm	>0.3 ppm
pH	<6.5 or >8.0	<6.5 or >8.5
