Water Softeners and Septic Systems

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Why Soften Water?

Water with high levels of calcium and magnesium is termed “hard water”. Groundwater is usually hard water since it contains dissolved minerals from the soil and rock it passes through before reaching your well. Hard water poses problems to home appliances and household chores. The calcium and magnesium in the water deposit and form scale in household plumbing and appliances. As well, the minerals in the hard water reduce the effectiveness of household soaps and detergents. As a result, more cleansing product is needed, scum is formed from the reaction of soap with calcium and magnesium, and clothing that goes through the laundry loses some of its brightness to the scum.

To solve the problems caused by hard water, water softeners are often used. Most of these use some form of salt. Water softeners remove calcium and magnesium from the water by ion exchange with sodium. Sodium chloride, or table salt, is added to the water softener to provide the source of sodium ions. Although soft water eliminates the problems associated with calcium and magnesium, it increases the levels of sodium chloride in the water used and produces a large volume of highly saline water in the regeneration process (the backwash). This backwash also contains high levels of calcium and magnesium.

In rural areas where septic systems are used, the water source is typically groundwater. Thus, many homes using septic systems also use water softeners. Home owners often wish to know whether or not the use of a water softener is detrimental to their septic system. A common question is: “should the backwash from the water softener be directed away from the septic system?” The following provides information on relevant studies regarding the effects of water softeners on septic systems.

Water Softeners and Septic Systems

In the late 1970's, two studies were carried out on the effects of water softeners on septic systems. One study was performed at the University of Wisconsin and the other was performed by the National Sanitation Foundation (NSF). The results of these studies indicated that there were no detrimental effects of water softeners on septic systems. Based on these conclusions, the Water Quality Association (WQA) and the Environmental Protection Agency (EPA) have both taken the stance that water softeners do not have a negative impact on septic systems. However, more recent studies show that the extra sodium added to the system may cause problems for the anaerobic digestion in the tank and for the hydraulic conductivity of the leaching bed. Another concern associated with water softeners is that the additional hydraulic loading of the septic system may cause system failure as they may not be designed to handle the extra water produced during the regeneration of the water softener. Finally, it has been suggested that the additional salt associated with the water softening process causes concrete tanks to corrode. These four issues are discussed in detail below.

Effect of Softened Water on the Septic Tank

Softened water and regeneration backwash increases the sodium chloride levels in the septic tank. There is concern that higher salt levels may kill tank bacteria. Since the bacteria work to digest solids in the tank, reducing the number of bacteria would result in poorer wastewater treatment.

The study performed by the NSF in the late 1970's found that there were no adverse effects on microorganisms exposed to higher levels of sodium chloride in aerobic tanks (Moore, 2001). The report from the Centre for Water Resources Studies (2001) went on to say that increased salt levels may even encourage tank bacteria. This report argued that higher salt concentrations reduce the osmotic potential difference between bacteria and the wastewater, thus lowering the stress on bacteria.

However, other studies do not support these findings. David Pask of the National Small Flows Clearinghouse points out that the NSF study used aerobic tanks instead of anaerobic tanks (Moore, 2001). Since septic tanks are anaerobic, the results from the NSF study may not be applicable to septic tank bacteria. Pask believes that the sudden increase in the sodium chloride level due to regeneration backwash induces metabolic shock in septic tank bacteria (Moore, 2001). This stems from his observation that less cellulose is digested in septic tanks of homes using water softeners.

Terry Bounds of Orenco Systems Inc. notes that the NSF study was performed under conditions not representative of the field (Moore, 2001). He suggests that actual field conditions include anaerobic tanks, water softener malfunctions and too frequent water softener regeneration. He has noted through observation that septic systems receiving softened water and regeneration wastewater contain less scum and more suspended solids as well as higher quantities of solids and grease in the leaching bed (Centre for Water Resources Studies, 2001).

Another study, cited in the report by the Centre for Water Resources Studies (2001), showed that regeneration backwash caused stratification in the septic tank. A saline layer forms at the bottom of the septic tank and wastewater flow does not enter this layer. This suggests that the performance of the septic tank may be reduced; however, as of yet, there is no experimental evidence to support this theory.

Although the WQA and the EPA support the NSF study, more recent observations suggest that water softeners do indeed pose a threat to the proper functioning of the septic tank.

Effect of Softened Water on the Leaching Bed

In terms of the leaching bed, the problem to be considered is whether or not the increased sodium levels in the effluent reduce the hydraulic conductivity of the soil. The effect of sodium on soil permeability is dependent on the quantity and type of clay in the leaching bed. Swelling of soil due to sodium is known to occur when significant quantities of montmorillonite clay is present in the soil (Corey et al., 1977). As the soil swells, its hydraulic conductivity is reduced. The sodium adsorption ratio (SAR) of a water, a measure of the quantity of sodium ions in solution compared to calcium and magnesium ions, may be used to determine whether or not hydraulic conductivity of a soil will be adversely affected by the septic tank effluent. According to Crites and Tchobanoglous (1998), for soils with a clay content of 15% or more, the sodium adsorption ratio should be less than 10 to prevent deterioration of hydraulic conductivity. In soils with less clay or with non-swelling clay, the SAR can be as high as 20 without adversely affecting hydraulic conductivity.

Swelling in clay soils is caused by interactions between charges on clay particles and dissolved ions. The clay particles are flat plates arranged in piles. Positively charged sodium ions are adsorbed onto negatively charged clay particles. When the concentration of sodium between clay particles exceeds the concentration of sodium in the soil solution, water moves between the clay particles by osmosis. This causes the soil to swell. Dispersion occurs when soil aggregates break apart due to the influx of water.

Calcium and magnesium ions counteract the unfavourable effects of sodium on hydraulic conductivity. Calcium and magnesium ions adsorb more readily to clay particles than do sodium ions. Since calcium and magnesium ions are divalent, they occupy less space per charge than do sodium ions. This helps reduce the swelling of clay. As well, calcium and magnesium ions increase soil permeability whereas sodium ions reduce soil permeability (Centre for Water Resources Studies, 2001).

According to Winneberger and Weinberg (1975), addition of sodium to septic systems is not deleterious to the hydraulic conductivity of the soil in the leaching bed. Two factors help to reduce the impact of sodium on the soil structure. First of all, sodium is positively charged and thus it adsorbs to negatively charged sewage particles; sodium acts as a coagulant to increase sedimentation in the septic tank. Secondly, dead zones in the septic tank can store sodium for gradual release. This has the effect of diluting any highly concentrated additions of sodium to the septic tank (i.e. during the regeneration process). While the sodium is stored in these dead zones, it can also act as a coagulant. Thus, the sewage and the dead zones in the septic tank effectively prevent large amount of sodium in soft water from entering the leaching bed. The University of Wisconsin study of the late 1970's also showed that hydraulic conductivity should not be adversely affected by water softeners (Corey et al., 1977). Some swelling of the soil may occur but dispersion should not.

However, if the waste from the water softener regeneration is not added to the tank, hydraulic conductivity may be reduced. This is due to the removal of all calcium and magnesium ions. Calcium and magnesium ions increase soil permeability whereas sodium reduces soil permeability (Centre for Water Resources Studies, 2001). The regeneration water contains all the calcium and magnesium ions that were removed from the original water supply.

If this water is not added to the septic tank, the SAR of the soil will increase and soil permeability will decrease. As a result, hydraulic conductivity will be greatly reduced.

Effect of the Hydraulic Load of the Water Softener

Water softeners produce regeneration wastewater when the system is periodically backwashed. Concern has been voiced that this additional hydraulic loading of the septic system disturbs the settled solids in the tank. This, in turn, increases the quantity of solids entering the leaching bed. The overall result is a reduction of hydraulic conductivity due to blockage of soil pores.

Three studies have shown that these concerns are largely unfounded. Although regeneration frequency depends on the initial water hardness and the proper functioning of the water softener, estimates have been made of the additional hydraulic load on the septic tank due to the backwash. The NSF study from the late 1970's asserted that regeneration flow was less than or equal to the water flow associated with an automatic dishwasher (Moore, 2001). A report written by the Centre for Water Resources Studies (2001) noted that the regeneration flow was normally equal to an extra two loads of laundry per week. This study also pointed out that water softener regeneration is set to occur at night when there is very little other flow to the septic tank and that the regeneration wastewater is added to the tank gradually. Siegrist et al. (1976) looked at the volume of water associated with water softener regeneration and found that it accounted for only 6.2% of the total flow through the tank. This number was low compared to other water uses such as laundry (24.7%), bathing (23.5%), and toilet flushing (21.5%). Overall, it is evident that water softener regeneration flow is small enough in volume, and is added slowly enough to the tank, that it does not pose a problem in terms of hydraulic loading of the septic tank - provided the system is designed to accept this small increase in hydraulic load.

Impact of Water Softeners on Tank Corrosion

It has been suggested that the salt from the water softening process creates a saline environment resulting in tank corrosion. However, there are no studies to confirm that water softener salt increases the degradation of concrete tanks. Even without additional salt from water softening, the septic tank environment is very caustic due to the production of gasses such as methane and hydrogen sulfide. Following discussions with representatives of the Concrete Precasters Association of Ontario, it may be concluded that water softeners pose no problem to a properly constructed concrete tank.

Steps to Lessen the Impact of Water Softeners

In situations where water softening is necessary due to the degree of water hardness, certain steps may be taken to minimize the impact of the water softener on the septic system.

1. A more efficient water softener will reduce the amount of sodium chloride used. In general, new water softeners are more efficient than older models.
2. The softener should be set to regenerate depending on the water flow instead of being set to regenerate at regular time intervals. This ensures that regeneration occurs only when required.
3. Water conservation practices should be established to reduce the quantity of sodium chloride sent to the septic system.
4. Soften only the water necessary. For example, outdoor water does not need to be softened.
5. Potassium chloride may be used instead of sodium chloride in the water softener. Although potassium chloride is about twice as expensive as sodium chloride (Grasso et al., 1992), its use will reduce the quantity of sodium sent to the septic system as well as the quantity of sodium in the diets of residents. As well, far more potassium is needed than sodium to cause the same deleterious effects on soil hydraulic conductivity (Grasso et al., 1992). Another advantage of potassium chloride is that potassium, unlike sodium, is a plant nutrient and thus will fertilize the plants over the septic bed.
6. Design the septic system to accept the higher hydraulic load due to water softener (increase 5-10%).

7. In constructing a leaching bed, avoid using soils with high contents of swelling clay (montmorillonite). This will reduce the detrimental effects of sodium on hydraulic conductivity. However, soils with high clay contents have lower hydraulic conductivities than non-clay soils and should not be used for leaching beds anyway.

More Detailed Information?

Copies of the references cited in the above are available from the ORWC at:
http://www.orwc.uoguelph.ca

Do you have information?

If you have information regarding water softeners and septic systems that you would like to share? If so, please send it to us at the address below.

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