
# Technical Information

## DEALING WITH SODIUM AFFECTED SOILS

**Throughout the United States, many state and local governments place restrictions on the use of potable water for irrigating turfgrass landscapes. For many golf course superintendents, use of reclaimed, or other secondary water sources is the now the norm. Unfortunately, much of the recycled water used for irrigation contains high concentrations of dissolved salts that are potentially toxic to turfgrasses. More importantly, the use of effluent or reclaimed water sources often precedes the loss of soil structure resulting from the effects of high levels of sodium, bicarbonate and carbonate salts.**

But not all salts in irrigation water are bad. Calcium and magnesium serve important roles in turf production and play a key role in maintaining the structural integrity of clay-containing soils. Both these cations are considered as essential to soil porosity – promoting soil particle aggregation through the establishment of strong electrostatic bonds. Calcium also displaces the weaker sodium cation from the soil particles, where it is leached from the rootzone by rainfall or irrigation events.

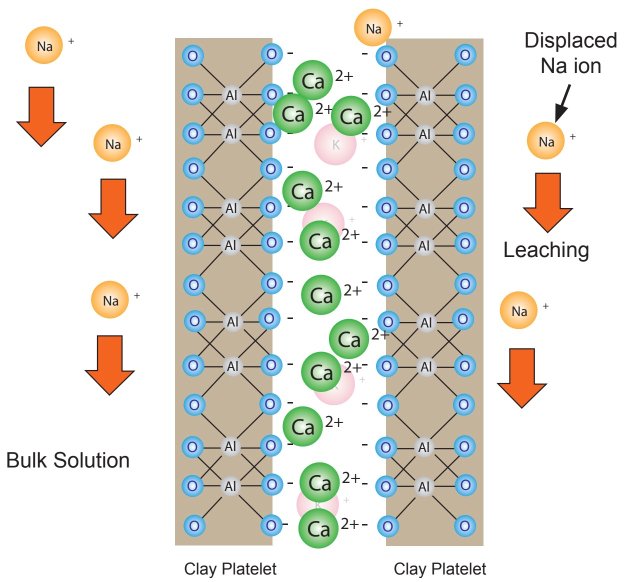
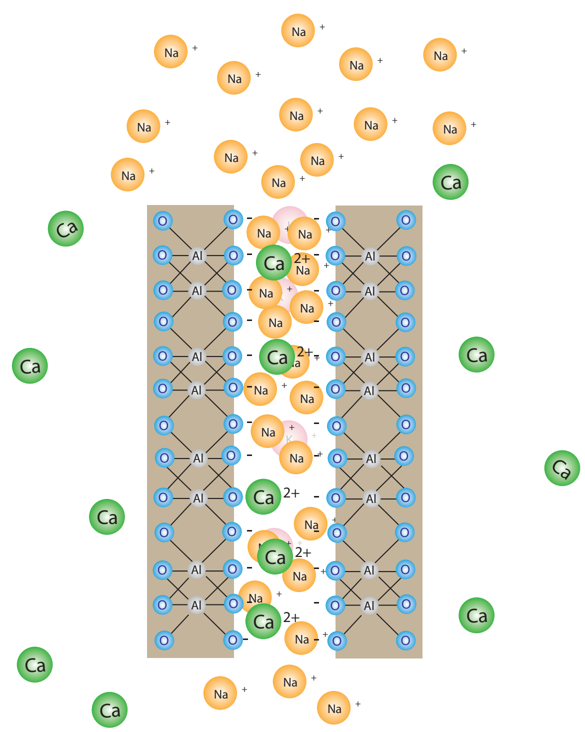



*Illustration of clay platelets held together by strong electrostatic Ca bonds.*

The balance between calcium and sodium in soil and irrigation water determines if water infiltration and soil aeration will be impaired by sodium.

**Problem #1 –Sodium.** Sodium exists in nearly all irrigation water. High concentrations of sodium in irrigation water can be detrimental to both turf and soils. If water with levels of sodium that exceed 70 ppm (>70 mg/L) and low calcium and magnesium is applied frequently to clay soils, the sodium will tend to displace calcium and magnesium on clay particles. As the amount of exchangeable sodium in a soil increases, clay particles become increasingly unstable, leading to a disruption of the soil structure.



*Graphic showing how high levels of Na cations from irrigation water can displace Ca cations – creating a clay domain held together by much weaker bonds.*

$Na^{+}$ ions are quite mobile and have smaller electric charges than $Ca^{++}$ ions, hence they are adsorbed less coherently to the surface of the clay particle. The sodium weakens the bonds between the soil particles when wetted, resulting in clay swelling and dispersion (particles becoming detached).

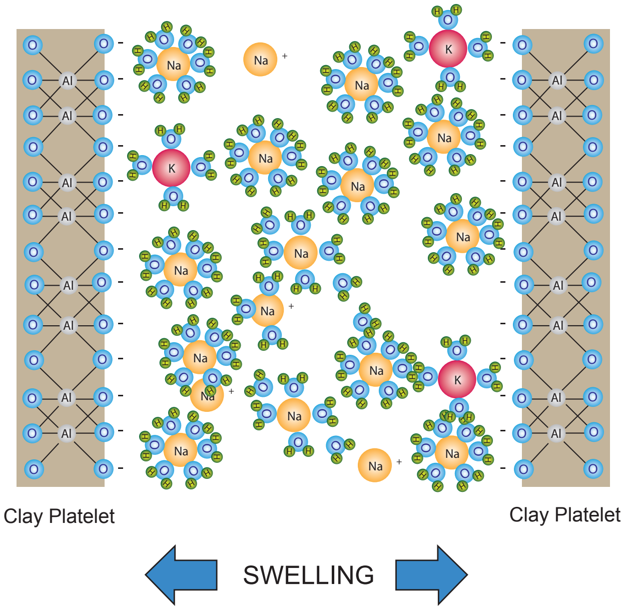
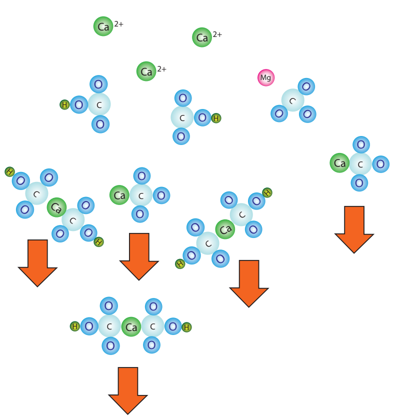



*Illustration of particle disruption and "swelling" of clay platelets under sodic conditions.*

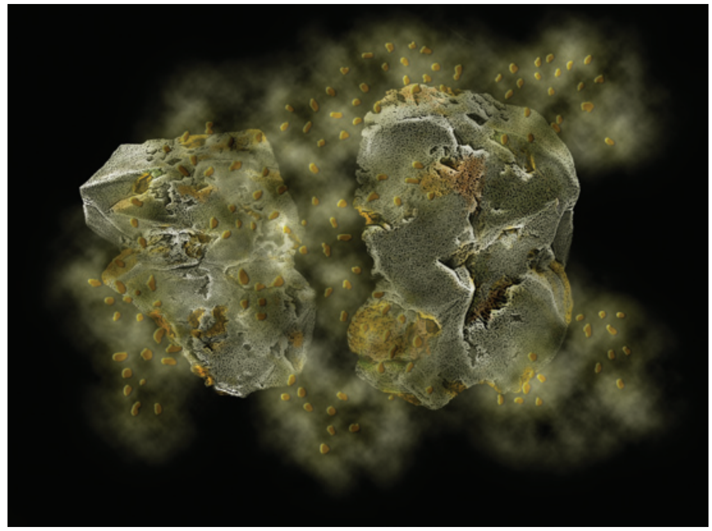
Turfgrass is also quite susceptible to sodium toxicity because it is frequently mowed a very short heights, irrigated frequently and is frequently subjected to other stresses. The relative concentrations of sodium, calcium, and magnesium in irrigation water are measured and reflected in the Sodium Adsorption Ratio (SAR).

**Problem #2 –Bicarbonates / Carbonates**. Of all the mineral constituents in irrigation water, bicarbonates and to a less extent carbonates are often underestimated in terms of their potential to synergize soil degradation and disrupt water movement through soils. Further, bicarbonate is considered by many as the most toxic anion that exists in relation to plant health.

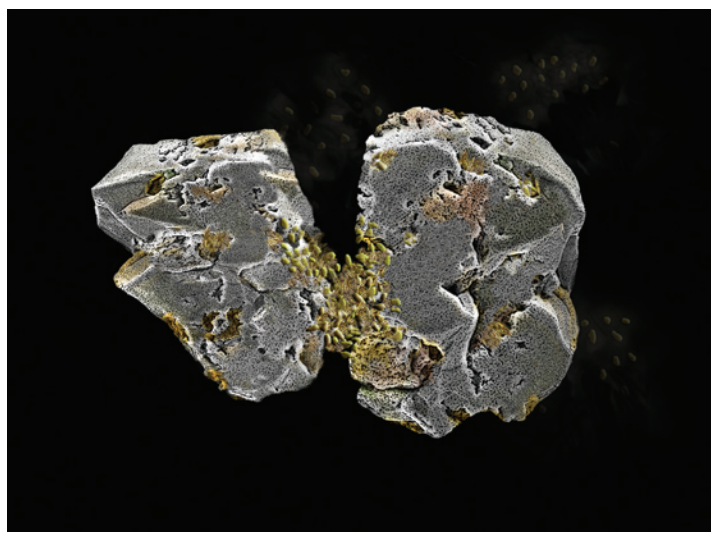
Bicarbonate ($HCO_3^-$) and carbonate ($CO_3^{2-}$) anions are found in high pH water and are collectively referred to as carbonates. If bicarbonate ion levels exceed 150 ppm (> 150 mg/L, respectively), they will react with calcium and magnesium in the soil to form insoluble calcium carbonate (lime) and magnesium carbonate (dolomite) that precipitate from the soil solution.



Carbonates greatly complicate the management of excessive Na. Their reactions reduce the amount of free calcium and magnesium in soil, allowing sodium to displace calcium from the negatively-charged exchange sites on clay particles. As the amount of exchangeable sodium in a soil increases, clay particles become unstable, leading to a disruption of the soil structure (deflocculation) and blocking of pores of a soil.



*Graphic depicting deflocculation and dispersion of clay particles into bulk soil solution*



*Graphic depicting blockage of pore channel by dispersed clay particles and organic matter*

But the problems with carbonates doesn't stop with their disruption of water through the soil profile. When water containing carbonates collect and dry at the soil surface, Ca and Mg carbonate (lime) deposits are formed (crusts) that inhibit infiltration of water into the soil profile.

## TREATING SODIUM-AFFECTED SOILS

The use of calcium amendments is a common recommendation for soils with depleted calcium ($Ca^{2+}$) and magnesium ($Mg^{2+}$) levels and high sodium ($Na^+$) levels. This is not surprising since, Ca and Mg are known to flocculate clay particles and counteract the negative effects of Na.

Today, many soil scientists recognize that poor water penetration is directly caused by a chemical imbalance in the soil and irrigation water. Their recommendations now suggest that many cases involving soil deterioration should be addressed by first amending the irrigation water in an effort to reduce the carbonate threat in irrigation water and in soils.

$$H^+ \text{ (from acid)} + HCO_3^- \text{ (in water)} \dashrightarrow CO_2 + H_2O$$

This order of correction does not imply that soil amendments be abandoned. However, since the problem of sodium affected soils goes beyond correcting abnormal carbonate levels, using soil amendments containing calcium is usually required.

It is essential that optimum soil levels of calcium be maintained to promote good soil structure and optimum growing conditions for turf.

Elimination of the threat by carbonates to tie up calcium and magnesium allows (a) Ca and Mg in irrigation water to remain soluble so it can displace Na from soil sites , and (b) it allows soil applied amendments to be more efficient and effective in producing soluble calcium (versus being precipitated as lime or dolomite).

pHAcid
IRRIGATION AND SOIL WATER ACIDIFIER

***pHAcid is a unique combination of a blend of acidifying agents combined with a multi-purpose, high molecular weight surfactant. This combination of complimentary technologies is designed to be applied either through the irrigation system or in a tank spray to provide the superintendent with a proactive approach to:***

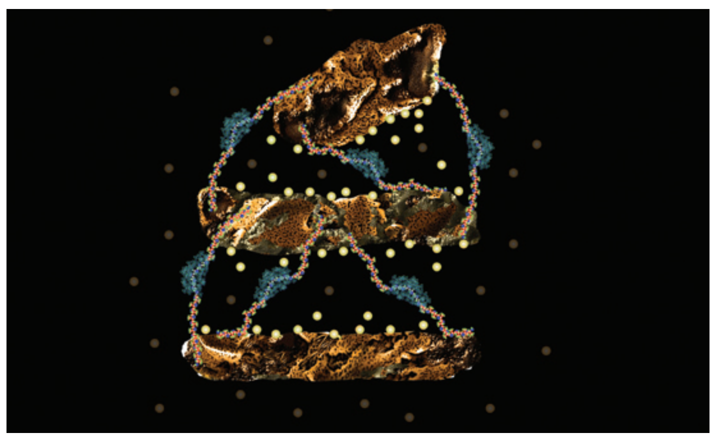
- Neutralize the negative effects of high bicarbonate and carbonate levels in irrigation water and the soil solution
- Lower pH of irrigation water and soil water
- Maintain the solubility of Ca and Mg in irrigation and soil water
- Dissolve calcium carbonate and magnesium carbonate salts on the surface (crusts) and in the soil profile
- Improve the ability of soil-applied Ca-based amendments to produce soluble Ca
- Flocculate dispersed colloidal-sized clay particles

## pHAcid SURFACTANT

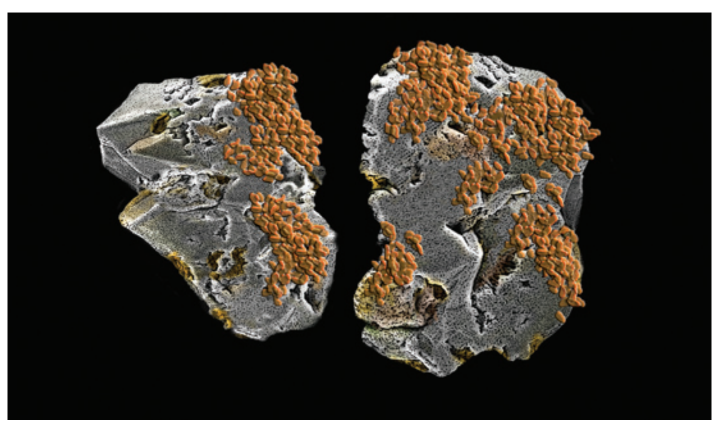
The non-ionic, "block" surfactant used in pHAcid was chosen specifically for its ability to enhance infiltration, percolation and drainage characteristics of the soil profile. This facilitates the coverage of the pHAcid treatment as well as enhances the "leaching" of sodium and carbonate salts from the rootzone.

This unique surfactant has also been placed into the pHAcid formulation due to its ability to form an interconnected structural pattern that encourages dispersed clay platelets and organic matter to merge and initiate reformation of clay aggregates.

As the clay platelets are drawn together, calcium cations are electrostatically attracted to their surfaces and replace the sodium cations. This forms the basis for a stronger and longer lasting aggregate assembly.



*Graphic showing surfactant, dispersed clay platelets and calcium cations initiating reformation of clay aggregate*



*Graphic depicting later stage of flocculated clay aggregate reassemblies on surface of mineral particle surfaces*


## USE DIRECTIONS

We strongly recommend that water and soil samples be taken and analyzed on a routine basis in order to develop and maintain a comprehensive management plan to correct sodium-affected soils.

Any soil receiving irrigation water with high sodium (Na) and bicarbonate levels should be amended with a soluble source of calcium in addition to the pHAcid spray program. In addition, irrigation water high in bicarbonates (> 1.5 - 2.0 meq/L (bicarbonate level = 90 - 120 ppm) should be amended with the pHAcid irrigation treatment schedule.

**pHAcid Sprayable** application program: 32 to 64 ounces per acre in a 1 to 2 gallon spray solution per 1000 $ft^2$ (24 ml per 100 sq. meters). Apply sufficient water to move product into the soil profile.

**pHAcid Injectable** irrigation water program:

1. Inject pHAcid at the rate of 1 gallon per 20,000 gallons (1 L per 80,000 liters) of applied water every month if the RSC index of source water is more than 150 ppm (> 1.50 meq/L ).
2. Inject pHAcid at the rate of 1 gallon per 20,000 gallons (1 L per 80,000 L) of applied water every two weeks if the RSC index of source water is more than 250 ppm (> 2.5 meq/L ).

pHAcid treatments (in combination with soluble sources of calcium if needed) should be continued until sodium-affected soil levels are below hazardous levels. A good seasonal and annual monitoring program is recommended.

pHAcid

IRRIGATION AND SOIL WATER ACIDIFIER

### TAKE ADVANTAGE OF WHAT pHAcid CAN OFFER *YOU*

- **Water that now flows through the soil profile in a uniform manner**
- **Improved CEC**
- **Less water is wasted due to run off and/or ponding on the soil surface**
- **The flexibility of a spray program or an injection program – as your situation dictates!**
- **Improved water use efficiency.**
- **Enhanced air-to-water ratios**

NUMERATOR

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*Staying on top of the technology equation*