



SOIL WATER REPELLENCY
MANAGEMENT SYSTEM

*keeping the progressive nature of water repellency
under control*



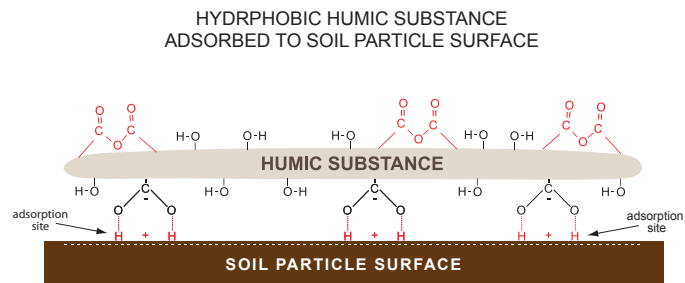
REVERT is a combination of a best-in-class surfactant complex with a blend of organic coating removal agents designed to provide the golf course superintendent with a broad, proactive approach to address the cause and problems associated with soil water repellency (SWR). REVERT represents a new concept of deploying complementary technologies directed at providing relief from localized dry spots, poor infiltration of applied water and non-uniform water movement into the root zone (the symptoms of water repellency) and controlling the progressive build up of water repellent organic coatings on sand particles (the cause of water repellency).

WHAT CAUSES SOIL WATER REPELLENCY?

Highly managed turfgrass produce large quantities of soil organic matter (plant materials, humic substances, root exudates, thatch, and roots). Once subjected to microbial action, soil organic matter (SOM) becomes the primary source of problematic hydrophobic compounds that coat the surface of soil particles.

The build-up of water repellent, non-polar organic coatings on mineral surfaces in the upper root zone has been identified by the general scientific community as the primary cause of soil hydrophobicity.

Many scientists point to humic substances as an example of organic polymer materials that will adopt conformational changes in order to facilitate their adsorption to the soil particle interface and ultimately form non-polar (water repellent) films. As a result, the surface of the soil particle surface can quickly be covered with adjoining sequences of these adsorbed, non-polar polymer chains.



Development of water repellent organic coatings on soil particles is progressive in nature. As a result, these coatings exist as thin films on the particle surface (early stages of development) that progress to a layer-on-layer build up (“caking”) of water repellent organic substances during later stages of development.

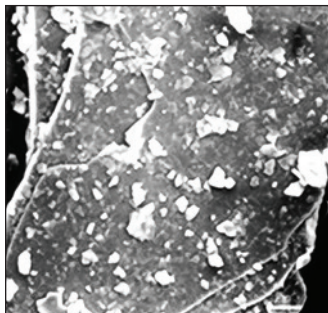
MANAGING SOIL WATER REPELLENCY

The standard practice for treating water-repellent sand root zones is the systematic application of non-ionic soil surfactants. The use of block copolymers have become the preferred surfactant treatment chemistries. However, it should be remembered that these treatments are used to address the symptoms of water repellency – localized dry spot, infiltration and water movement problems.

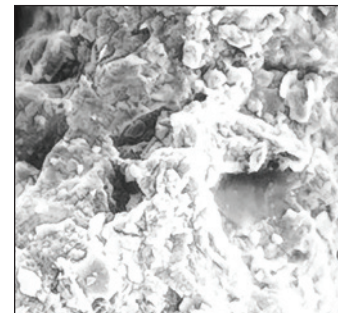
Addressing the cause of water repellency – the build up of water repellent organic coatings – will require newer technology. **And that technology is available now! REVERT Soil Water Repellency Management System.**



In REVERT’s Soil Water Repellency Management System, both its surfactant complex and its **DEPRO**¹²⁹⁹ organic coating removal agents participate in the dissolution of hydrophobic organic coatings on particle surfaces – both the tightly bound early stage “films” and the layer-on-layer build up (“caking”) of organic polymers during later stages of hydrophobic development.



Electron micrograph of wettable (hydrophilic) soil particle. Little humic substance is visible.



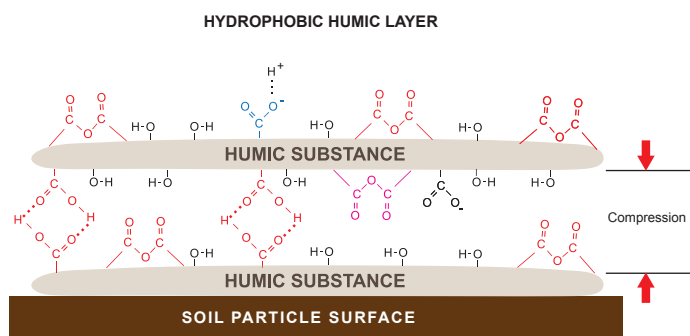
Electron micrograph of non-wettable (hydrophobic) soil particle. Layer-on-layer deposition of humic substances is very visible.



Layer-on-Layer Polymer Build up (“Caking”)

DEPRO¹²⁹⁹ Organic coating removal agents. Where layer-on-layer coating of water repellent organic polymers occurs, REVERT’s formulation components act together to separate the molecular fractions of these layers (primarily humic substances in combination with other organic materials) and solubilize these parts into the bulk soil solution.

Hydrogen-based intermolecular bonds form the attraction between individual molecules of humic substances. They also confer a rigidity to humic associations and depress molecular reactivity (non polarity).



DEPRO¹²⁹⁹, REVERT’s organic coating removal agent deprotonates (removes) critical hydrogen atoms from areas on humic substances. Removal of the hydrogen atoms promotes structural decay. Deprotonation also increases the net negative charge on the humic substance molecules (increasing reactivity) that leads to *layer separation and dissolution due to repulsive forces*.

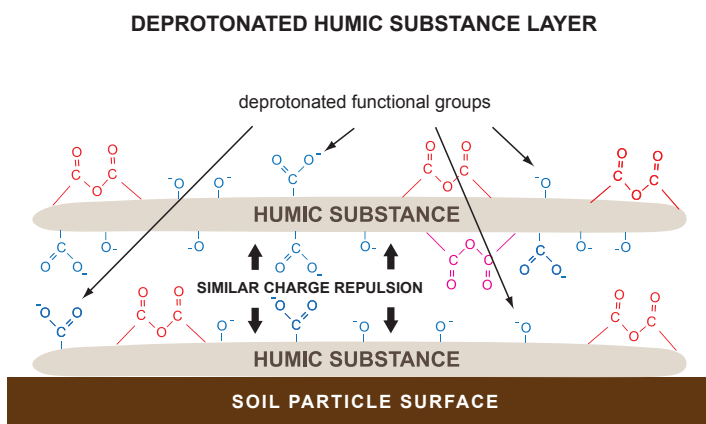
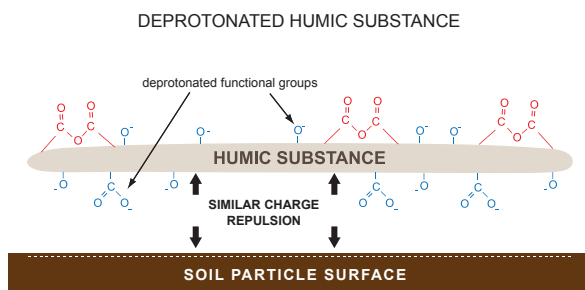


Illustration depicting separation of humic substance layers following deprotonation by organic coating removal agents found in the REVERT formulation.

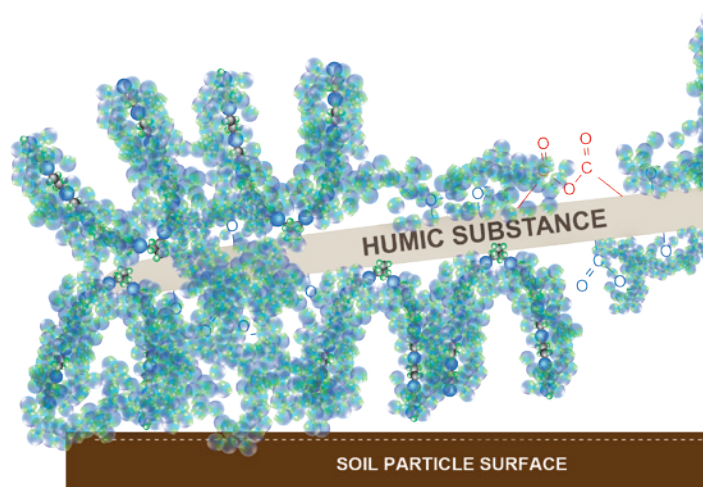
Particle Surface Film Coating

DEPRO¹²⁹⁹ Organic coating removal agents. The organic coating removal agents found in DEPRO¹²⁹⁹ also deprotonate (remove) hydrogen atoms at the organic coating - soil particle surface interface. As a result, the net negative charge of the humic substance is increased. Since most soil particles have a negative charge, both the surface and the humic substance repel each other. This begins the process of separating the humic film from the soil particle surface. The negative charge on the humic substance also makes it more water soluble.



Surfactant Complex. The surfactant complex used in the REVERT formulation has an affinity for humic substances. They are included in the REVERT formulation to enhance the removal process by loosening and solubilizing the humic substances into the bulk solution as well as to facilitate the movement the coating removal agents in a uniform manner throughout the rootzone.

The surfactants also stay attached to humic substances that remain on the particle surface. Subsequent irrigations will rehydrate the surfactants and aid in additional removal of humic substances as well as contribute to a return of uniform patterns of infiltration, percolation, retention and favorable wetting patterns.



Graphic showing how surfactants in REVERT aid in the removal of hydrophobic humic substance from surface of soil particle by following deprotonation and initial separation from surface by organic coating removal agents.



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Surfactant Complex. The amphiphilic nature of surfactants and humic substances can easily lead to their mutual attraction. The binding can be through either electrostatic or hydrophobic attraction. Surfactants in the REVERT formulation attach to hydrophobic fractions of the humic substances. As these surfactants attract water molecules (hydrate), **they facilitate further separation of layered humic substance molecules.** The surfactant complex also promotes transport into the bulk solution. This is often referred to as “flaking off” of the non-polar organic layers.

Where water repellent layers and film remain, REVERT’s surfactant complex is quick to establish sites for adsorption of water molecules – resulting in a return of uniform patterns of infiltration, improved percolation, retention and favorable wetting patterns.

EASY TO USE

The use of REVERT poses no additional management resources than those associated with surfactant applications used to treat symptoms of water repellency in soils. When used on a monthly basis, it’s best-in-class non-ionic surfactants will overcome hydrophobic conditions and promote a consistent and effective pattern of hydration and re-hydration of the soil profile. Following its use in a well-designed rootzone management program, turfgrass managers should expect:

- Relief from localized dry spots and water repellent soils
- Uniform movement of water through the rootzone
- Improved drainage
- Healthier roots and increased stress tolerance
- Enhanced water use efficiency

KEEP WATER REPELLENCY UNDER CONTROL

To entirely remove humic substances from the soil ecosystem would not be beneficial, inasmuch as decomposition of organic materials are an essential component of a healthy soil. However, in highly managed greens and tees, controlling organic matter build up on soil particles is particularly important to maintain adequate infiltration, hydration and drainage. ***And this is the designed purpose for REVERT – providing the golf course superintendent with a soil management tool to keep the progressive nature of water repellency under control.***



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Humic Substance Removal Trial May - 2007



Picture above shows elutant collection of 2% solutions of REVERT compared to OARS and water (control). Color difference is result of humic substance contaminant removal from the soil.

PROCEDURE

1. Prepare a 2% solution of the formulations to be tested in deionized water.
2. Mount a simulated soil tube (5.5 cm of simulated soil in a clear plastic tube; 6 cm in diameter and 15 cm long) vertically in a glass test tube, using a clamp to hold it at least 2 inches off the bottom of the bottom of the tube.
3. Inject, as nearly simultaneously as possible, 2 ml of wetter solution into the top of the soil tube.
4. Start timing immediately and note the time that the first drop of elutant exits the bottom of the tube. End the timing when the last drop of elutant comes through. Note the color and the depth of color in the elutant. Use a Gardner Comparator, if necessary.
5. Allow the tube to stand and drain and dry at ambient conditions for 72 hours (3 days).

USE DIRECTIONS

Apply REVERT at 6 oz. per 1000 sq. ft. in 2 gallons of water (180 ml. per 100 sq. meters in 8 liters of water). For best results, apply monthly throughout the growing season. No watering is required when used at recommended rates.

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STAYING ON TOP OF THE TECHNOLOGY EQUATION