Understanding The Different Wetting Agent Chemistries

A surfactant is a wetting agent but a wetting agent may not be a surfactant. surprised?

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Wetting agent: "Any compound that causes a liquid to spread more easily across or penetrate into the surface of a solid by reducing the surface tension of the liquid."

Today's golf course superintendent has a dizzying array of wetting agent products available to purchase. As a general class of turf care products, wetting agents are one of the more frequently used on golf courses. Common sense would suggest that not every surfactant or wetting agent is the same. Ironically, all of our turf care fungicides, herbicides, and insecticides are organized into their own classifications, i.e., the DMI fungicides, the strobilurins, the phosphites, etc. Wouldn't it be nice if we could also group wetting agents and surfactants into the appropriate category of the different chemistries from which they are derived? That is the purpose of this article.

Over the years, there has been a gradual change in the type of soils used for golf course construction and maintenance. We have evolved from using the old, blended topsoils of years ago (typical manufactured topsoils were 1-1-1 by volume mixes of sand, soil, and peat) to near straight sand soils used today. Sandier soils are used for the construction of greens and tees and even sand capping of fairways. The same sandier soils are used for topdressing of these areas as well. Sands have replaced soils. That's the bottom line. Sandy soils tend to naturally be, or become, hydrophobic (water repelling) in contrast to topsoils, which are less so inclined.

One of the most frequently asked questions of USGA Green Section agronomists is, "Which is the best wetting agent product to use?" In a

Diagnosing localized dry spot and hydrophobic dry patch in the field can be relatively straightforward, especially when noting dew patterns on the grass. Where dew exists, there is good soil moisture. By contrast, only a few inches away, there is no dew on the turf. It is time to test the areas using a soil probe. See next image. The grass is "talking to you."

Areas without dew are powder dry (on left) whereas samples taken in the adjacent area with dew shows good soil moisture. The powdery dry soil is hydrophobic, or water repelling. No amount of water will rewet the dry area. A wetting agent is needed, preferably in combination with some form of surface aeration, to rewet the soil, control turf wilt (and decline), to save labor in hand watering, and to improve turf appearance and playability.

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(Left) Note the dew pattern on this wetting agent and soil surfactant test area. While a wetting agent is a surfactant, it only wets. A surfactant can do more than just rewet the soil. (Right) Dry spots and uneven wetting can be a problem on any area of the golf course, including greens, tees, roughs, and, in this case, a fairway. While all soil types can become hydrophobic, sandier soils (which inherently hold less water anyway) seem to have the most severe problems. While there is a trend towards "firm, dry, and fast," there are situations where turf suffers permanent wilt. Turf loss is the result, especially when golf carts drive through wilting grass. Wetting agents and soil surfactants can be used to rewet the area, allow for more even soil wetting over time, and keep the problem from reoccurring in the future.

word, it "depends." Specifically, it depends upon what you want that product to accomplish. Is it to rewet a dry, water-repelling soil as the result of isolated dry spot development? Is it to prevent isolated dry spots from developing in the first place? Is it to make, "water wetter" as an injectable material into your golf course's irrigation system to try to move water through the soil? Is it to improve irrigation efficiency and turf performance using less water? Is it to use wetting agents (rightly or wrongly) as a spray adjuvant when applying herbicides, insecticides, growth regulators, or fungicides? Is it to improve rootzone placement of soil-directed pesticides and fertilizers or to reduce their leaching? These are not easy questions to answer because, again, there are so many different wetting agent/soil surfactant chemistries available to our industry. *Note: While a wetting agent is a surfactant, it only wets. A surfactant can do more than just wet a dry soil.*

SOIL SURFACTANTS – 101

Soil surfactant products are made with several different classes of surfactant chemistries. These classes of chemistry have molecules with different structures and therefore they have different modes of action in how they interact with water and soil. This article will discuss the different classes of surfactant chemistries and their varying molecular structures. By defining the capability of each class of surfactant chemistry and defining which class or classes of surfactant chemistry each particular soil surfactant product contains, golf course superintendents will better understand the best product to use to address their particular management problem.

Note: This article is not intended to recommend one product over another. All wetting agents/surfactants have specific uses. The goal is to provide information to better understand these products, which allows the end users, golf course superintendents, to decide which product best fits their needs.

SURFACTANT CHEMISTRIES

In no special order of priority.

1. Anionic and Blends with Anionics. Anionic wetting agents are negatively charged surfactants. They can offer fast wetting but, depending upon application rate, can be phytotoxic to turf. Because of their negative ionic charge, anionics can cause dispersion of clay particles, which can negatively impact soil structure in fine-textured native soils. In the agricultural chemical industry, these compounds are often used to aid in the dispersion of clays in flowable or suspension concentrate formulations. Sometimes referred to as "old chemistries," anionic wetting agents were introduced into the turf care market in the 1950s.

Commercially available anionic blends include: AquaAid, Naiad, Penterra, and Prevade.

2. Nonionic Surfactants.

2-1. Polyoxyethylene (POE) Surfactants. A POE (also referred to as alkylphenol ethoxylate, or APE) are also "old chemistry" wetting agents. The original AquaGro contained a POE. Like the anionic group of surfactants, POEs also can be phytotoxic to fine turf when used in some situations. POEs were originally developed to correct localized dry areas, so they do help treat water repellency, but not nearly as well as newer chemistry wetting agents that were developed and introduced in the 1990s. This class of chemistry can enhance water movement into the soil. The original products in this category were introduced as turf management tools in 1954.

Commercially available POEs wetting agents include: APSA-80, E-ZWet, FloThru, Injector, Lesco Wet, Mizer, One Putt, PenMaxx, Surfside, Water-in, and Wet-Sol.

2-2. Block Co-Polymer Surfactants. This class of wetting agent chemistry is the most commonly used in the turf care market today. These compounds are significantly safer to fine turf than POEs and are very effective in reducing soil water repellency and improving soil water content and plant-available water. Two basic chemical structures are used:

Straight Block Co-Polymers. Field observations show enhanced water movement in the soil and can be helpful in leaching programs.

Commercially available straight block co-polymers include: Brilliance, Capacity, Cascade Plus, Conduit 90, Hydro-Wet, LescoFlo Ultra, Remain, and Sixteen90. Injectable formulations of Straight Block Co-Polymer wetting agents include: Drench, Duplex, Fairway ISP, InfilTRx, IrriCure, Syringe, UniWet, and UniWet 25.

Reverse Block Co-Polymers. Field observations show enhanced moisture retention in the rootzone, which can be particularly helpful in soils that do not hold much water. Some companies have referred to the compounds as "retention-type surfactants." These materials were introduced into our industry in 1995.

Commercially available reverse block co-polymers include: Primer Select, Magnus, ReLoad, Rely II, Respond 3, Retain, TriCure AD, and TriCure Micro.

Blends of Straight and Reverse Block Co-Polymers. Industry scientists have attempted to find ways to exploit the characteristics of the respective surfactant chemistries. Research conducted by Aquatrols on the blended block co-polymer product Aqueduct showed that the blend was more effective in correcting localized dry spots and improving turf quality than either the straight or reverse block co-polymer used alone. To date, this blend remains the standard by which all experimental formulations are compared in Aquatrols internal research.

Commercially available products based on blends of these two block co-polymer categories include: Aqueduct, Resurge, and ReWet.

Note: "Field blends" of different wetting agent chemistries are becoming more commonly used. That is, two or more wetting agents/soil surfactants are tankmixed to try to achieve rewetting, retention, and moving excess

A wilt and dew pattern on a sand-based tee. With sandier soils, water management always is a challenge, especially during hot and dry weather.

"Firm, dry, and fast" conditions are good for golf, but it is a challenge for the golf course superintendent to find ways to use water as efficiently and effectively as possible while avoiding excessive dryness, which can damage the turf, especially under cart traffic, as this image clearly shows. Wetting agents and soil surfactants can be important management tools to achieve this goal, whether they are sprayed onto the turf or injected into irrigation systems.

water through the soil profile. Such blends are typically recommended by company technical advisors.

2-3. Alkyl Polyglucoside Surfactants are made from a sugar molecule reacted with a fatty acid and are considered naturally derived surfactants (but not to be confused with organic). Like many surfactants, alkyl polyglucosides can reduce soil water repellency. However, when blended with a block co-polymer surfactant, these formulations have been shown to increase infiltration more than either wetting agent component alone. This phenomenon of synergistic surfactant wetting activity, the first such activity reported for soil wetting agents, has resulted in patents being granted on this technology in the U.S. and globally. This blend of wetting agent chemistries improves water penetration rates through the soil compared to straight block co-polymer products. These materials seem to improve water availability in the rootzone for better growing conditions and enhanced irrigation efficiency. Independent university research has demonstrated that treatment resulted in improved plant-available water and turf quality even when irrigation inputs were reduced to less than 50% evapotranspiration (ET) replacement. This chemistry was introduced in 2000.

Commercially available alkyl polyglucoside and straight block co-polymers include: Dispatch Injectable, Dispatch Sprayable, and Tournament-Ready. Note: Tournament-Ready contains a blend of alkyl polyglucoside, standard and reverse block co-polymer. Tournament-Ready imparts multiple modes of action by making use of three different types of surfactants.

2-4. Modified Methyl Capped Block Co-Polymer. This class of wetting agent is a patented variation of the block co-polymer class. The structure of the molecule was modified by replacing -OH terminal groups with $-CH_3$ (methyl) caps. This small change in molecule structure modified the hydophilicity of the terminal groups. The -OH groups are hydrophilic, or water loving, while the CH_3 (methyl groups) are hydrophobic, or water repelling. As a result, the methyl groups impart a small hydrophobic characteristic to the terminal groups. This modification changes how the

surfactant attaches with the hydrophobic coatings that cause water repellency. This results in thinner, more continuous films of water around soil particles and surfaces of organic matter, which balances air-to-water ratios in the soil for (hopefully) a better growing environment in the soil. Field testing has demonstrated a diversity of benefits in soil water availability, turf performance, and turf stress tolerance. This chemistry, granted patents in the U.S. and globally, was introduced into our industry in 2004.

The sole commercially available modified methyl capped block copolymer wetting agent is sold under the brand name Revolution.

2-5. Humic Substance Redistribution Molecules. This class of wetting aids was patented by Milliken & Co. and introduced to the turf industry by Aqua-Aid in 2003. These molecules allow water penetration through the soil profile by disrupting the hydrophobic supramolecular humic associations, most prevalent in the top one to two centimeters (0.40 to 0.80 of an inch) of the soil, which led to localized dry spots. Reduction in size of the large hydrophobic associations into smaller, more soluble conformations results in increased water penetration and allows for redistribution of these "smaller compounds" from the surface, where they cause water management issues, through the soil profile, where they may be beneficial to moisture control.

Examples of these compounds are found in the OARS® product line.

2-6. Multibranched Regenerating Wetting Agents. These molecules differ from the traditional linear copolymer molecules in that they are much higher in molecular weight and have multiple interactive sites, such that each branch is essentially a wetting agent in itself. Branching, coupled with higher molecule weight, not only increases the interaction between the wetting agent and the soil, but also affects the biodegradation profile. As one branch is removed via biodegradation, a new lower molecular weight surface active species is regenerated to continue to manage the water in the soil profile.The use of these molecules on turfgrass was patented in 2005 by Milliken & Co. Examples of these compounds are found in PBS-150® and the OARS® product line.

3. Cationic Surfactants. This group of surfactants is not commonly used as soil wetting agents due to their strong biocidal activity. Many of these compounds are effective disinfectants and may be particularly aggressive to plant tissues, resulting in severe plant damage when applied at rates effective for water repellency mitigation. As a positively charged molecule, they tightly bind to soil particles and have been reported to cause treated soils to become more water repellent when used repeatedly. To the best of our knowledge, no cationic surfactants are sold as soil wetting agents in our industry.

4. New Chemistries. There will no doubt be new wetting agents/surfactants and blends available to our industry in the future. The ability to modify and manage water more efficiently and more effectively continues to be a long-term goal. Equally, new products will no doubt be developed that will allow for more even wetting of the soil and more efficient use of water in that soil, while better managing ongoing problems with fairy rings, isolated dry spots, and poor soils. Stay current.

MANAGEMENT

One major management topic not discussed in this article has been how wetting agents and soil surfactants are managed and used. Oftentimes, these products are added as spray adjuvants, "just because." This creates a whole new set of interactions that are difficult to measure. For instance, does a little extra wetting agent in the tank aid in fungicide placement or compromise fungicide effectiveness? These are all good topics to discuss with your com-

(Left) Turf loss due to localized dry spots, or LDS. The solution is a wetting agent or soil surfactant program that allows the grass to recover and to keep the problem from reoccurring in the future. See next image. (Right) Complete recovery. LDS has not reoccurred due to adjustments in the way the turf is managed using wetting agents and soil surfactants.

pany technical representative, supplier, and USGA agronomists.

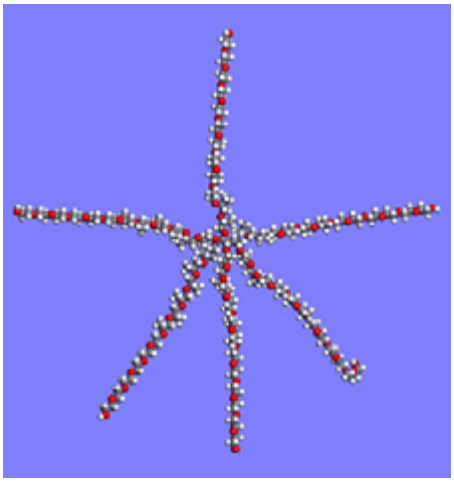
How best to manage irrigation is another important management topic. Specifically, if your goal is to rewet a dry, hydrophobic soil, it is best to prepare the area with some form of surface aeration, pre-wet the area, apply the wetting agent or soil surfactant, and water it into the soil profile. For maximum efficiency and effectiveness in this case, it is best not to let the wetting agent dry. Rather, water it in rapidly and liberally. The addition of other products could therefore compromise the action of those materials either by too much water or compromise the wetting agent/surfactant product by not using enough water. Again, when in doubt, ask for advice.

In preparing this article, almost every contributor made the following point: With the wetting agent options we have today, you either treat the water or treat the soil. There are different wetting agent chemistries to solve whatever problem you may have. Also, the wetting agents and soil surfactants available today are much more sophisticated than the products used years ago. In the "good old days" of turfgrass management, we used to add a quart of wetting agents to every spray tank. We have come a long way since then.

Wetting agent and soil surfactant products are used in many ways and for many different reasons on golf courses today. It is important to think about what you are trying to accomplish when applying any turf care products, including wetting agents and soil surfactants. **READ THE LABEL**. If your questions are not answered, contact the company. It is a call or email worth making to ensure the product you are using is being properly applied.

FINAL THOUGHTS

Still awake? As you can see, this article is technical in nature. Most of us are not chemists. We rely on research results from our state universities along with field trials of side-by-side product comparisons, testimonials from fellow golf course superintendents who have used these products, and product



A stylized view of what a branched wetting agent molecule looks like. Surprised? There is a whole lot more to selecting a wetting agent or surfactant than the average person might know. It is a complicated science. (Image courtesy of Milliken & Co.)

information from technical representatives of the companies who formulate, develop, produce, and sell wetting agents and soil surfactants. This information (hopefully) allows all of us to make informed decisions on which wetting agent chemistry helps solve the problems you have, as it pertains to soil water repellency, enhanced soil moisture retention (or not), the prevention of isolated dry spots, or the treatment of dry patch and fairy ring once they develop. One key thing to remember is to ask your sales representative for research reports on field evaluations of the product. That third-party confirmatory testing is the only way to ensure you can count on a product to do what is claimed.

In summary, there are many different wetting agent and surfactant compounds and chemistries available. Hopefully, by knowing some of the strengths and weaknesses of the various commercially available products, the right choice can be made by you, the consumer, on which product to purchase and use.

DISCLAIMER

All the information contained in this article comes from the best possible knowledge available at the time of writing. We apologize if a product was not mentioned, if a product is miscategorized, or if a product is no longer available. At least the superintendent will know which question to ask the next time a representative tries to sell a wetting agent or surfactant. You can ask, "Is it a straight or reverse block co-polymer? A modified methyl capped co-polymer? An APE or a POE? By the way, are your wetting agents anionic or cationic?"

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