3 MOONS

30 60 90

90 DAY SOIL SURFACTANT

TECHNICAL INFORMATION BULLETIN

3 MOONS is an extended term surfactant formulation constructed of specialized triblock copolymers that when applied to soils susceptible to water repellency, will function to improve infiltration; enhance hydration and retention; promote uniform water distribution; and encourage better air-to-water ratios for up to 90 days. 3 MOONS soil surfactant is the result of applying leading edge polymer technologies to create longer acting surfactant multiphase systems capable of addressing a number of problems associated with water repellency.

SOIL WATER REPELLENCY

It is well documented that natural organic matter in soils interacts with surfaces of inorganic materials, primarily aluminosilicates or clay minerals, to form a strongly associated organo-mineral composites that can form "coatings on soil particle surfaces. These "coatings," when subject to wetting and drying cycles, can rapidly become water repellent (hydrophobicity) and severely disrupt the uniform movement of water through the rootzone. Oftentimes, this disruption of the uniform wetting front can create areas of preferential flow (sometimes referred to as "fingered flow") that rapidly move water the rootzone -- leaving sections of the soil profile without an adequate supply of water and nutrients.

The standard practice for addressing water-repellent sand root zones is the routine application of non-ionic soil surfactants. Block copolymers have become the preferred surfactant chemistries because of their effectiveness and plant safety. However, not all surfactants (even block copolymer constructions) are the same, as each chemistry produces it's unique pattern of hydration on the mineral particle surface. Further, each chemistry is unique in how well it can withstand the challenge of microbial attack in the soil profile.

WHAT LIMITS HOW LONG SURFACTANTS WILL LAST?

Regardless of the efficacy of a surfactant, how long it will maintain its promised performance is usually determined by how rapid its polymer structure is degraded and disassociated by microbes and chemical interactions in the soil profile.

It is common for soil microbes to begin their degradation of surfactants through enzymatic cleavage of bonds at oxygen sites of the surfactant. This can result in the rapid separation of the hydrophobic part of the surfactant molecule that attaches to the water repellent surface of the soil particle from its hydrophilic molecular counterpart that attracts water molecules. As a result of this separation, the surfactant is rendered ineffective and its surfactant performance is lost. The biodegradation sequence is usually completed with the stepwise degradation of the remaining molecular chains.

Soil microbes that proliferate in the rootzone of turfgrass consider surfactants as a viable food (carbon) source needed to provide the energy necessary to sustain life. Since microbial populations are normally quite high and active in turf soil rootzones, few surfactants -- even those that contain higher concentrations of surfactants to overcome microbial degradation -- can be expected to deliver consistent performance for a full 60 to 90 days.

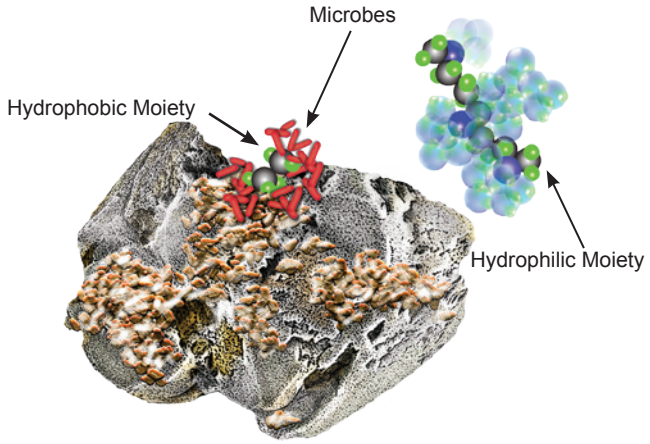

Illustration showing cleavage and disassociation of hydrophilic part (site of hydration) from hydrophobic part (site of attachment) of surfactant molecule by microbial degradation.

3 MOONS SURFACTANT TECHNOLOGY

Unlike many soil surfactants that utilize single surfactant technology or contain simple mixtures of different surfactants (polyblends), the 3 MOONS 90 Day Soil Surfactant formulation exploits the unique patterns of self-assembly associated with select triblock copolymers to obtain superior performance over a 90 day period.

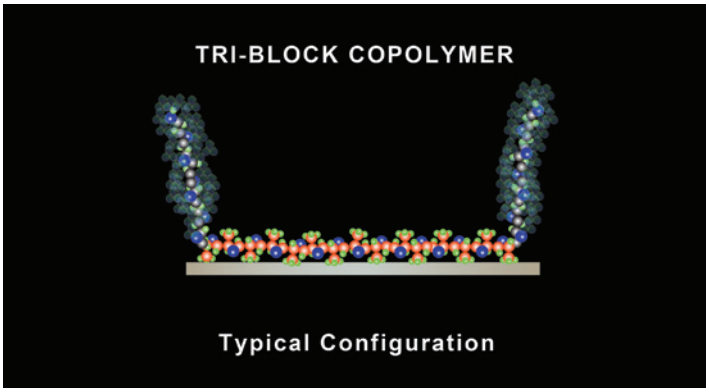

Illustration showing typical configuration of triblock copolymer. Hydrophillic "blocks" are shown as hydrated. Hydrophobic "block" (site of attachment) of surfactant molecule is shownvvv attached to solid surface.

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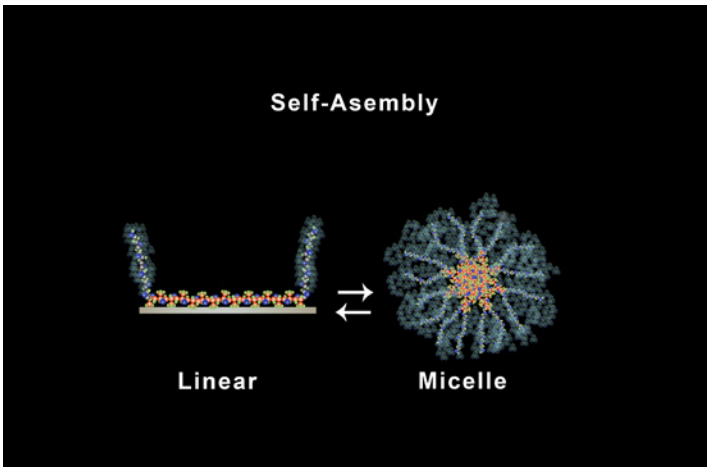
"Tuned Surfactant"

The number of variations produced by triblock copolymers provides an array of performance characteristic that can be applied to surfactant formulations. The triblock copolymers used in 3 MOONS are capable of dynamically reconfiguring their polymer patterns between their nonaggregated state (linear arrangement) and a complex aggregated state (micelle arrangement).



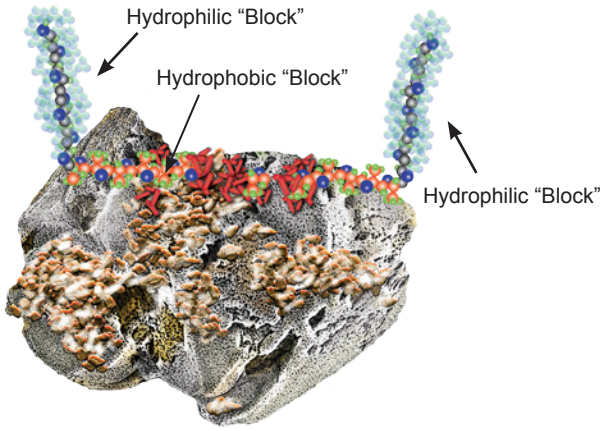
Graphic depicting linear state of triblock on left and aggregate state on right.

Perhaps the most significant feature of triblock copolymers used in the 3 MOONS formulation is that they offer a predictive approach to dealing with surfactant self-assembly. ***The ability to forecast detailed features of surfactant aggregation opens up the opportunity to "tune" the 3 MOONS surfactant blend in order to optimize its performance characteristics.*** Indeed, by carefully choosing the triblock surfactants in the 3 MOONS surfactant, we create very unique a network of copolymers that provide adequate hydration, air: water ratios and uniform movement of water through the profile.

Extended Performance

The extended performance traits associated with the 3 MOONS product is not the result of the elimination of microbial and chemical degradation of its surfactant molecules. It is the result of an orchestrated number of delays in the degradation process associated with its triblock molecular constructions and other factors associated with its unique reversible self-assembly properties.

- Like most surfactants, the 3 MOONS surfactants contain a number of bonds that can be easily broken down by microbial enzymatic catalysis. But the huge number of bonds with the megamolecular structure of the triblock surfactant (size of their polar "blocks") delays the microbial process.
- A number of soil surfactants are constructed of easily clevable bonds located between the hydrophobic tail and the polar head group. Disassociation of the hydrophobic tail (which anchors the surfactant to the water repellent surface of soil particles) from the polar head group (which attracts water molecules) destroys the surfactant nature of the molecule. Triblocks have covalent bonds between their "blocks" that are much more resistant to microbial or chemical cleavage. This extends the time required for dissociation of the molecular "blocks" to halt surfactant activity.
- A third factor to take into account is the degree of branching of the non-polar part of the surfactant molecule. Extensive branching of the hydrocarbon tail often leads to a reduced rate of biodegradation. Normally methyl branching does not slow the degradation process. However, if many methyl branches appear in a row, they delay the degradation process. Triblock surfactants are characterized by extensive methy branching throughout their hydrocarbon-based "block(s)."



Graphic illustrating that even under heavy microbial attack, the triblock's multibranched hydrophobic "block" delays dissociation of the surfactant from the soil surface and its hydrophillic "blocks." This maintains surfactant performance for an extended period.

- Reversible self-assembly in soil solution such as found in triblock surfactants also delays degradation since the surfactants are not normally subject to microbial attack in the soil solution. This limits degradation exposure.

Biodegradation is the most important mechanism for the irreversible removal of chemicals from the aquatic and terrestrial environments. Therefore, all triblock surfactants used in Numerator products are biodegradable.

USE DIRECTIONS

ACTIVE INGREDIENT: 100% Alkoxylated Polyols
NOT A PLANT FOOD INGREDIENT

DIRECTIONS FOR GENERAL TURF USE

GREENS, TEES, FAIRWAYS, LAWNS AND SPORTS TURF

Localized Dry Spot and Water Repellency Conditions: Apply 3 MOONS as a preventive program. 3 MOONS should be applied in two applications. Apply at 8 ounces (240 ml.) per 1,000 ft^2 (100 sq. meters). Wait 7 to 30 days to reapply second application. Under two split applications, each 3 MOONS application should be sprayed at 8 ounces (240 ml.) per 1,000 ft^2 (100 sq. meters) and should be applied in 2 gallons (8 liters) of water per 1,000 ft^2 (100 sq. meters) spray solution

3 MOONS can also be applied at 16 ounces (480 ml.) per 1,000 sq. ft. (100 sq. meters) in 5 gallons (20 liters) of water per 1,000 ft^2 (100 sq. meters).

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