TechLink Research Summary #3339

Natural and Biologically-Based Mesh for Compost Filter Socks

INTRODUCTION

We are living in a cultural and societal paradigm shift toward the use of materials and practices that are more environmentally sustainable (Teuten et al, 2009). By nature, the erosion and sediment control (E&SC) and stormwater management (SWM) industries are based on environmental sustainability due to their core purpose of protecting water quality and the ubiquitous nature in which we apply best management practices (BMPs) and materials to the soil, often left in perpetuity (US EPA, 2006). Filtrexx has been an industry leader for two decades in developing environmentally sustainable technologies by using biomimicry as a core value – innovation inspired by nature – and by leading in the development beyond best management practices (BMPs) toward truly sustainable management practices (SMPs) (Faucette, 2019).

Since 2010, US federal agencies, state regulatory and transportation agencies, green building certification programs, and sustainability forward engineers and architects have asked our industry to provide products and materials that are 100% natural and biodegradable. Collectively, these groups are motivated to reduce petroleum based products, micro-plastics, materials in landfills, labor costs to remove products and materials at the end of projects, wildlife entrapment, landscape equipment entanglement, and materials and products not compatible with the permanent landscape. Filtrexx compost filter socks are approximately 90% natural material (by weight), and are already a USDA Certified Biobased Product; however, achieving 100% has always been our ultimate goal.

MATERIALS AND METHODS

In 2017, Filtrexx began experimentation with a variety of natural and biologically based materials. In addition, we set up three field research stations designed in locations for maximum environmental exposure from high moisture, high UV, and high temperatures – the three limiting environmental conditions in land based microbiological degradation processes (biodegradation). Two land/soil based research sites were located in Southern California and Southern Georgia, respectively, and one marine research site was located on the Central Coast of North Carolina (Figure 1 and Figure 2).

Figure 1. Map of Field Research Site Locations.

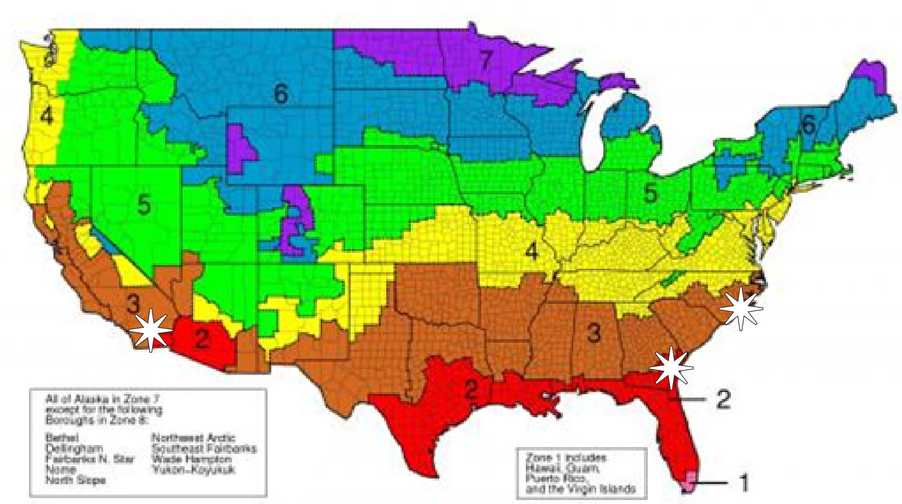

Figure 2. Field Evaluation of Biodegradable Mesh Filled Soxx at Beginning of Study.

Test materials included cotton fiber, flax fiber, wood fiber, and PLA (polylactic acid) – a compostable bio-based plastic. Test materials were received as yarns and knitted into 8-inch diameter mesh. Each mesh material was filled with compost filter media compliant with federal agency standards (Archuleta and Faucette, 2010) on a Filtrexx FX machine, and installed on bare soil, as they would typically be used in the field. After installation, experimental compost filter socks were left untouched and inspected monthly for 18 months. All materials at all research sites were tested in triplicate to remove the potential for conclusions based on outliers. Evaluations included visual inspection for material biodegradation, material photodegradation, and material hydrolysis (for marine based application in North Carolina only), including weakening of material, small holes, large holes, brittleness, and estimated functional longevity. Estimated functional longevity is defined as the time period in which the compost filter sock no longer serves its intended function as a BMP. The bio-based, natural content for cotton fiber, wood fiber, and PLA mesh materials was evaluated under ASTM D-6866 conducted by Beta Analytic, and the tensile strength for these same materials were evaluated under ASTM D-5035 by TRI Environmental.

RESULTS

Tensile strength for the cotton fiber mesh was 44 lbs/square inch (psi), wood fiber mesh was 76 psi, and PLA was 79 psi. Bio-based content for each mesh material was 100%. Results from each field research site and for each material based on major milestone reached over time are presented in Table 1. Figure 3 provides a visual representation at select time periods during field evaluation for each material.

Moisture is the chief driver of biodegradation of natural materials and predominantly occurs where the mesh material is in contact with the soil. Because the top of the compost filter sock is not directly in contact with the soil and dries quickly after rain events, biodegradation is slower on the top and where the BMP is not in direct soil contact. Slow biodegradation on the top also works in conjunction with surface photodegradation from UV exposure. Degradation from hydrolysis of the mesh materials in the marine marsh environment was likely a major contributing factor, due to constant salt water saturation and submersion, as well as friction from regular tide and wave action. The combination of these environmental pressures degraded the cotton and flax meshes in the marine environment in approximately 1 month. These same environmental pressures also degraded the PLA mesh, albeit over a much longer time period; whereas, in the soil environment no biodegradation or photodegradation of the PLA was exhibited, meaning hydrolysis and friction were likely the leading drivers for the degradation of the PLA mesh. The cotton fiber, flax fiber, and wood fiber mesh materials all biodegraded and photodegraded in a similar manner, although at different rates, with the wood fiber mesh exhibiting the slowest biodegradation and photodegradation rates and cotton exhibiting the fastest rates. Also, due to the uneven rate at which biodegradation and photodegradation occur (due to differing contributing environmental factors and processes), use in concentrated flow applications, such as channels and ditches, should be used with caution unless additional stabilization measures are used such as vegetation.

Table 1. Major Milestones in Field Evaluation by Month for Each Material.

	Biodegradation Start Underside	Biodegradation Complete Underside	Photodegradation Start Top	Photodegradation Small Holes	Photodegradation Large Holes	Photodegradation Brittle	Functional Longevity (estimated)
Cotton Fiber – C	2	5	13	14	16	18	up to 12
Flax Fiber – C	5	7	10	14	16	18	up to 12
Wood Fiber – C	6	9	15	17			up to 18
PLA – C							18+
Cotton Fiber – G	3	5	9	10	12	12	up to 12
Flax Fiber – G	5	7	9	10	12	16	up to 12
Wood Fiber – G	6	9	12	12	18	18	up to 18
PLA – G							18+
Cotton Fiber – N	<1	1	<1	<1	1	<1	1
Flax Fiber – N	<1	1	<1	<1	1	<1	1
Wood Fiber – N	6	16	10	12	16		up to 18
PLA – N*	9	21	9	13	21		up to 24

Key: C = California research site, G = Georgia research site, N = North Carolina research site. *Indicates degradation stages from hydrolysis. No value = milestone has not been reached during 18 month evaluation period.

Figure 3. Biodegradation and photodegradation of each material at A) 6 months, B) 12 months, and C) 18 months (from left to right – cotton fiber, flax fiber, wood fiber, PLA).

A.

B.

C.

REFERENCES

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