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The Effects of PU Coated Rubber Mulch on the Leaching of Contaminants Compared to Uncoated and Acrylic/Latex Coated Rubber Mulch

The Effects of PU Coated Rubber Mulch on the Leaching of Contaminants Compared to Uncoated and Acrylic/Latex Coated Rubber Mulch

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Abstract

This experiment was designed to determine whether polyurethane (PU) or acrylic/latex coated rubber mulch would inhibit the leaching of contaminants into the soil. Two tanks were filled with distilled water and allowed to recirculate over the rubber: uncoated rubber mulch in the first tank and PU coated rubber mulch in the second tank. Water samples from each tank were then analyzed by an environmental laboratory over the course of twelve weeks. In addition to this primary experiment, a TCLP test was performed on new samples of uncoated rubber mulch, PU coated rubber mulch, and acrylic/latex rubber mulch. The results of the testing indicate that PU coated rubber mulch inhibits the leaching of zinc by 30 – 69% over both uncoated and acrylic/latex coated rubber mulch.

Introduction

A new type of mulch has recently made its way to store shelves. This new rubber mulch offers the consumer several advantages over wood mulch. For example, "… wood mulch and bark biodegrade and, thus, must be replaced annually. Once rubber mulch is put down, it's there to stay. Aging studies show that rubber mulch can remain in good shape for a decade or longer… " [1]. Rubber mulch also tends to be more dense than wood mulch and is therefore less likely to be blown away by wind or rain [1]. Besides its uses in the garden, rubber mulch provides a safe playground surface because of its high critical fall protection [2]. Because of these advantages, rubber mulch has increased in production with, ". . . dramatic market growth rates of 10 to 20 percent a year or more." [1], and with this gain the concern over the environmental effects of using shredded tires has been voiced by some environmentalists.

The primary concern over using shredded tires as rubber mulch is the fact that the tires contain elements such as zinc. During the manufacturing of rubber tires, "Zn is added to tire tread rubber mostly as zinc oxide (ZnO), and in lesser quantities as a variety of organozinc compounds, to facilitate vulcanization of the rubber." [5]. Zinc may negatively affect plant life if leached from the rubber mulch and into the ground [4]. One way to reduce this leaching may be to coat the rubber mulch with PU. The hypothesis of this experiment was that a PU coating acts as both a colorant as well as a sealant that prevents undesirable contaminants such as zinc from entering the soil beneath. With these experiments, the leaching effects of PU coated rubber mulch were compared to acrylic/latex coated as well as uncoated rubber mulch. In addition to Zinc, Cadmium, and Lead, Polycyclic Aromatic Hydrocarbons (PAHs), Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs), Benzene, Phenols, Nitrosamines, and Phthalate levels were also analyzed.

These experiments were designed to address the question of whether rubber mulch coated in PU would inhibit the leaching of contaminants as compared to acrylic/latex coated and uncoated rubber mulch. To test this hypothesis, a simulated leaching environment was constructed in two aquariums to approximate a twelve week constant water exposure. In addition to the primary experiment, samples of uncoated, PU coated and acrylic/latex coated rubber mulch were submitted for TCLP testing.

Methods and Materials

Two 5 gallon fish tanks were filled and labeled as "Tank 1" and "Tank 2". Both tanks were covered to prevent evaporation. A

common aquarium pump was placed in the bottom of each tank to recirculate the water. Two plastic bottles (HDPE) were perforated on the bottom and filled with rubber mulch (100 grams per bottle), then placed inside each corresponding tank above the water level. The bottle in Tank 1 was filled with uncoated rubber mulch (100 grams), while the bottle in Tank 2 was filled with PU coated rubber mulch (100 grams + 3.0% PU coating). The plastic tubing from the pumps was then placed above the plastic bottles so that the water from each tank was drawn up and over the rubber mulch which then drained through the holes in the bottom, reentering the water in the tank. The perforation of the bottles as well as the flow rate of the pumps was adjusted to allow the bottles to be nearly full of water so that the rubber was entirely submersed. This process occurred continuously for three months.

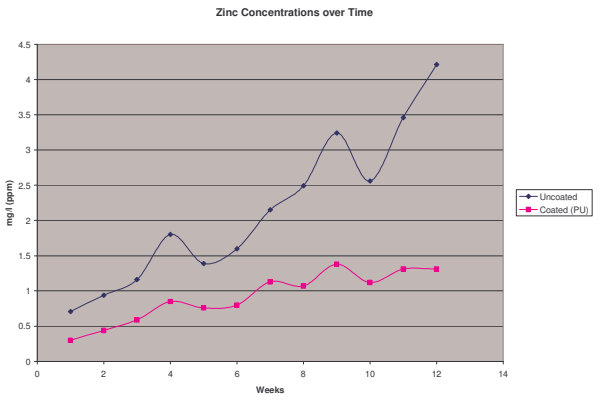
Before the rubber mulch was added to the plastic bottles, the tank setups were allowed to recirculate for one week, and then samples of the water were taken from each tank and analyzed to determine blank values. These blank values were subtracted from all proceeding results to eliminate any preexisting detectable quantities of the analytes of interest. All metals testing was performed by Reliance Laboratories, Inc. located in Bridgeport, WV. After the initial blank values were determined, a sample was collected from each tank once a week and labeled according to the tank from which it originated. The samples were sent to the lab and labeled as "Sample 1" and "Sample 2" to eliminate any bias. These weekly samples were tested by Reliance for metal content.

In addition to the weekly metal content testing, each sample was tested monthly for VOCs, PAHs, PCBs, Benzene, Phenols, Nitrosamines, and Phthalates. Reliance Laboratories tested VOC content and then outsourced the PCB and Semi-Volatiles (including PAHs) testing to AC & S, Inc. located in Nitro, WV. This system of measuring metals each week and monthly VOC, PAH, and PCB testing continued for twelve consecutive weeks. At the end of this testing, an additional TCLP test was conducted by Reliance Laboratories in conjunction with AC & S, Inc. with three new samples: PU coated rubber mulch, acrylic/latex coated rubber mulch and uncoated rubber mulch.

Results

Of all analytes screened, only zinc was found in detectable quantities for both the PU coated and uncoated rubber mulch (EPA method 6010C*). The following table (Table 1) illustrates the increase in zinc levels between the two samples over the twelve week duration.

Table 1: Zinc Concentrations over Time



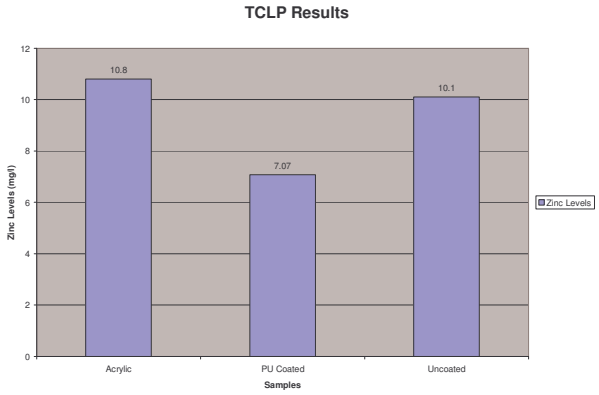
Note: The small fluctuations in results are most likely due to testing error.

The results of the metal testing illustrate that neither the PU coated or uncoated rubber mulch exceeded the Secondary Maximum Contaminate Levels (SMCLs) set by the Environmental Protection Agency of 5 mg/l [3] during the twelve week testing procedure; however, the uncoated rubber mulch leached more than three times the amount of zinc (4.21mg/l) than the PU coated rubber mulch (1.31 mg/l) by the twelfth week.

* See Appendix A for descriptions of EPA Methods

In addition to the three month experiment in which metals, VOCs, PAHs, PCBs, Benzene, Phenols, Nitrosamines and Phthalates were tested (EPA methods 8260B, 8082A, and 8270), a separate Toxic Characteristics Leaching Procedure (TCLP) with a 48 hour extraction time (EPA method 1311) was performed at the conclusion of the primary experiment. The TCLP test was conducted on three new samples: uncoated rubber mulch, PU coated rubber mulch and acrylic/latex coated rubber mulch. Because the TCLP test is conducted under much more aggressive conditions than was the primary experiment, higher concentrations of zinc were found for each sample. The following table illustrates the levels of zinc in each sample.

Table 2: TCLP Zinc Level Results



By TCLP method, similar levels of zinc were found in the acrylic/latex coated and uncoated rubber mulch samples; while the PU coated rubber mulch leached 30% less zinc than the uncoated and 34% less than the acrylic/latex coated. These levels exceed the EPA's SMCLs for zinc (5mg/l)[3], but were detected after an aggressive leaching procedure that is designed to simulate leaching in acidic conditions not normally found where rubber mulch would be used (e.g. playgrounds and landscaped areas).*

Discussion/Conclusion

As a result of all tests performed, only zinc was detected in significant quantities. Zinc poses a concern because it can hinder plant growth in high quantities [4]. The results of this test indicate that the leaching of zinc is inhibited by a coating of PU. In the case of our tank method of simulating leaching over time, the PU coated rubber mulch leached 69% less than did the uncoated rubber mulch. According to the aggressive TCLP method, the PU coated rubber mulch reduced the leaching of zinc by 30% compared to uncoated rubber mulch and 34% compared to acrylic/latex coated rubber mulch. The data from this test indicates that all types of coatings do not necessarily inhibit the leaching of zinc, because the acrylic/latex coating exhibited no inhibiting effect. Conversely, a PU coating significantly inhibited the leaching of zinc. In conclusion, if the level of zinc is a concern to consumers of rubber mulch, PU coated rubber mulch will decrease this effect compared to uncoated rubber mulch, while acrylic/latex coating displays no significant decrease in the leaching of zinc.

* A note about the EPA's SMCLs: These levels are only guidelines and not enforced standards such as the National Primary Drinking Water Regulations. They pertain to contaminants that pose no health danger but may be aesthetically undesirable in the water supply[3]

Literature Cited

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Appendix A: Descriptions of EPA Methods Used

EPA METHOD	Description
6010C	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES): Used to determine trace elements in solution.
1311	Toxicity Characteristic Leaching Procedure: the TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid and multiphasic wastes.
8260B	Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS): used to determine volatile organic compounds in a variety of solid waste matrices.
8082A	Polychlorinated Biphenyls (PCBs) by Gas Chromatography: used to determine the concentrations of polychlorinated biphenyls (PCBs) as Aroclors or as individual PCB congeners in extracts from solid, tissue, and aqueous matrices, using open-tubular, capillary columns with electron capture detectors (ECD) or electrolytic conductivity detectors (ELCD).
8270	Semi volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): used to determine the concentration of semi volatile organic compounds in extracts prepared from many types of solid waste matrices, soils, air sampling media and water samples.

***SOURCE: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm**