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**The Myth of Polyacrylamide Hydrogels Revisited:**

*"Are polyacrylamide hydrogels environmentally safe substances that reduce irrigation needs?"*

**The Myth**

When this column first ran in June 2001, I was threatened with a lawsuit from a hydrogel manufacturer. Fortunately, I was able to substantiate my comments with journal literature and the issue was dropped. Since then, I continue to receive emails from students, Master Gardeners, nursery and landscape professionals, medical doctors, researchers, and concerned individuals all over the world. It's time to look at the recent literature and see what's new.

Details on hydrogels are offered in the original June 2001 column (which is on my web page\*). PAM hydrogels help create larger soil aggregates which reduces erosion and improves water holding capacity. Water is released slowly to the surrounding soil, reducing the need for irrigation. In addition to their soil applications, PAM hydrogels are also used extensively in municipal water treatment, paper manufacturing, pesticide formulations, and food processing.

**The Reality**

Briefly, here is what is currently known about polyacrylamide hydrogels (PAM):

***Characteristics:***

- 1) PAM hydrogels are made of acrylamide, a potent carcinogen and neurotoxin. During manufacture, there is a small percentage of acrylamide still present (generally 0.01-0.05%).
- 2) Neither PAM, acrylamide, nor any other degradation product appears to be taken up by plant roots.
- 3) PAM hydrogels are not considered hazardous (but see below), but several of the identified degradation byproducts are.

***Environmental interactions:***

- 1) PAM hydrogels do not work well in clay soils.
- 2) Fertilizer salts and saline soils decrease the water uptake and holding capacity of PAM hydrogels.
- 3) Positively charged ions such as potassium, calcium, magnesium, and iron decrease water absorption by PAM hydrogels by as much as 90%. These minerals are plant nutrients that naturally occur in the soil and are contained in fertilizers.
- 4) Since lower (more acidic) pH levels increase the solubility of cations, especially metals such as magnesium and iron, hydrogels in acidic soils are even more likely to be ineffective.
- 5) PAM hydrogels were found to decrease plant uptake of several essential nutrients in field studies.

***Degradation:***

- 1) Both fungal and bacterial species commonly found in the soil are capable of degrading PAM hydrogels. In the lab this degradation can be rapid, but is probably slower in the field.
- 2) Ultraviolet radiation from sunlight will degrade PAM hydrogels.
- 3) Tilling and other shearing forces will degrade PAM hydrogels.
- 4) Acrylamide can be a degradation product, though it is detoxified in a matter of days.

- 5) Though PAM hydrogel degradation may not generate large amounts of acrylamide, it can produce acrylonitrile (also an EPA-regulated substance) and unknown, uncharacterized polyacrylate units of various sizes.
- 6) Lack of information on the possible toxicity of degraded PAM hydrogels makes it impossible to assess health risks to humans, animals, or ecosystems.

***Impacts on aquatic and human health:***

- 1) PAM hydrogels used as flocculants in water treatment systems affect all water ecosystem components, especially certain types of algae, invertebrates and adult fish.
- 2) Contamination with acrylamide prevents PAM hydrogels from being used in drinking water treatment or for medical applications.
- 3) Even though they are considered nontoxic, PAM hydrogels can cause lung injury if inhaled.
- 4) A plastic surgeon in Taiwan informed me that PAM hydrogels are routinely used for human tissue enhancement in China, Eastern Europe, and the Balkans. He has seen first-hand evidence of the damage done when PAM hydrogels are injected into the human body. (It speaks volumes that in this country we don't use PAM gels in plastic surgery - we use starch-based compounds.)

From the available scientific literature, it appears that PAM hydrogels are not as ubiquitously useful for field applications as was previously assumed. There are a number of environmental factors that hamper the functionality of PAM hydrogels, and their environmental degradation is firmly substantiated. What is actually produced during this degradation is unknown, as is the environmental and human health impact.

There are alternatives to PAM hydrogels that could be adapted to landscape uses. Recently, a research group explored using waxy corn and tapioca starches instead of PAM hydrogels for oil recovery. They found these starches to be more efficacious, more economical, and more environmentally sound. Here's hoping that the next time this subject is reviewed that some of these alternatives will have become industry standards.

**The Bottom Line**

- PAM hydrogels are widely used in a number applications through which humans, animals, and ecosystems may be exposed
- Many environmental factors can limit the efficiency of PAM hydrogels and speed their degradation.
- PAM hydrogels are not long-term solutions to droughty conditions
- While the toxicity of acrylamide is well known, the hazards posed by PAM hydrogel degradation products are not
- There are agricultural alternatives to PAM hydrogels, including starch-based gels

For more information, please visit Dr. Chalker-Scott's web page at <http://www.theinformedgardener.com>.