ENCAP professional

PAM-12 Plus TECHNCIAL BULLETIN

What are Polymers?

(http://encappro.com/wp-content/uploads/2010/06/polyacrylamide1.jpg) Polymers are generally defined as large molecules composed of repeating structural units typically connected by covalent chemical bonds. While *polymer* in popular usage suggests plastic, the term actually refers to a large class of natural and synthetic materials with a variety of properties. Polymers are used in numerous applications and many specialized polymers have been developed over the last several decades, including a group called water-soluble polyacrylamides, which is commonly synthesized from natural gas.

What are Polyacrylamides and Water-soluble Polyacrylamides?

Polyacrylamides (PAMs) are synthetic polymers made from monomers of acrylamide. There are hundreds of specific PAM formulations that vary in polymer chain length and the number and kinds of functional group substitutions. After ***Soil Science*** published a set of papers in 1952 that introduced water-soluble polymers (WSPAMs) as soil conditioners (Bear, 1952), the Monsanto Chemical Company spent about $10 million producing and marketing the water-soluble polymer Krilium. Although Krilium was able to reduce soil erosion and other problems associated with furrow irrigation run-off, it was deemed to be too expensive, as the recommended application rates were too high to be economically practical. Since then, more extensive research has been done, identifying WSPAMs for a range of agricultural uses and at cost-effective application rates, with the new generation of agricultural WSPAMs having ultra high molecular weights and being moderately (18%) anionic (Sojka, 2007). The three most common forms of PAMs are dry granules, solid blocks (cubes), and emulsified liquids.

Are PAMs safe?

Questions regarding the toxicity of polymer soil conditioners or break-down products are often asked. However, PAMs have been used in municipal water treatment systems, food packaging, adhesives, boiler water control systems, film formers in the imprinting of soft-shell gelatin capsules, and adjuvants in the manufacturing of paper and paperboard for many years. Similarly, PAMs have been sold since 1995 to reduce irrigation-induced erosion and enhance infiltration.

Environmental studies of toxicity in fish with fathead minnows, rainbow trout, yellow perch and bluegills have shown no adverse effects of anionic PAMs. The functional anionic groups do not interfere with the functioning of fish gills or daphnia respirators, but adverse effects are observed at concentrations over 100 mg/liter, primarily because of the viscosity of the test medium. It should be noted that low charge density PAMs demonstrate lower toxicity to aquatic and microorganisms. The anionic PAMs used by ENCAP contain <0.05% acrylamide monomer (AMD). AMD is a neurotoxin, but PAM products below these AMD concentrations are considered safe for applications to water (Barvenik, 1994), AMD is easily metabolized by microorganisms in soil and biologically active waters and PAMs do not revert to AMD in the natural environment upon degradation (MacWilliams, 1978). Photolysis also leads to the degradation of the polymer chain and the formation of much smaller molecules, or oligomers, which are accessible to microbial attack.

What benefits are provided by Polyacrylamides?

The benefits of PAMs have been widely documented in peer-reviewed scientific literature. The soil stabilizing and flocculating properties of PAMs improve runoff water quality by reducing sediments, N, dissolved reactive phosphorus (DRP) and total P, chemical oxygen demand (COD), pesticides, weed seeds, and microorganisms in runoff. High effectiveness and low cost of PAM for erosion control and infiltration management, coupled with easier implementation than traditional conservation measures, has resulted in rapid adoption. About 800,000 hectares of irrigated land in the United States uses PAM for erosion and/or infiltration management. In recent years, PAM as been deployed for uses beyond agricultural erosion control, including construction site erosion control, use in storm water runoff ponds to accelerate water clarification, soil stabilization and dust prevention in helicopter-landing zones, and other high-traffic military situations (Sojka, 2007).

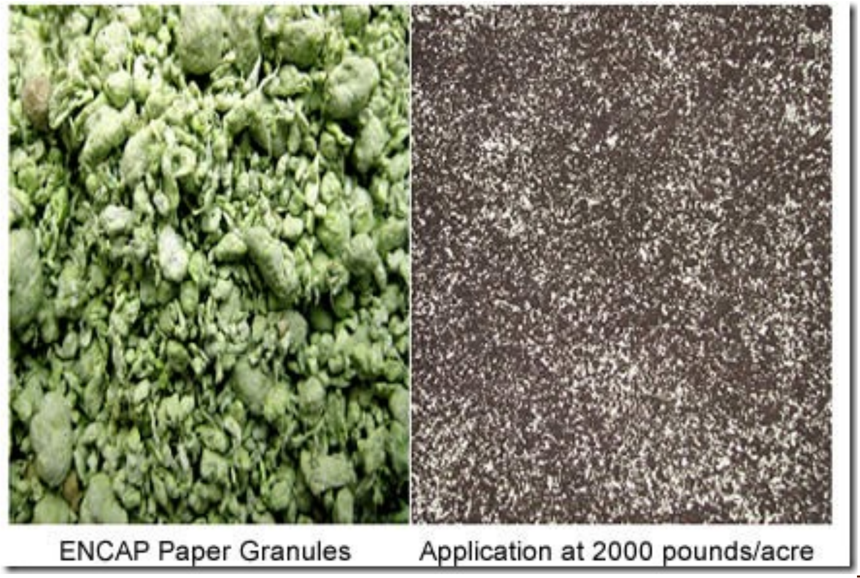
How are PAMs applied?

Historically, the application method for PAM has been dependent upon the form of PAM selected. For use in furrow irrigation systems, one of the most common applications for PAMs, dry granules can be applied by either dissolving directly in the irrigation ditch or applying directly in the furrow using what is known as the "patch method". In order for the PAM to dissolve properly it must have proper agitation. Unlike sugar or salt, which dissolve fairly quickly in water, granular PAMs need to be agitated thoroughly in order to dissolve. If not agitated, PAM globules form, and in time the globules can float down the furrow with little effect on reducing the furrow erosion. Similarly, the use of dry granular PAM in irrigation water is facilitated by the use of an augured metering system, but excellent mixing is again required for the PAM to completely dissolve before reaching the irrigation system. Alternatively, liquid PAM can be metered from a container into the irrigation ditch, directly into the furrow, or through a pipe line or injector pump. However, adequate mixing is again necessary to ensure that the PAM application rates are consistent and uniform. The problems with the dry application of PAMs can be seen below, which is eliminated with ENCAP technologies.

(http://encappro.com/wp-content/uploads/2010/06/traditionalapplication.jpg)

Why is the granular application of Polyacryamides a superior method?

In an effort to make PAMs more useful in multiple applications and to provide more consistent and uniform application rates, ENCAP has developed a patented carrier technology for PAMs (U.S. Patent 7,503,143, U.S. Patent Application 20,040,074,271, U.S. Patent Application 20,040,069,031 and other foreign filings). The ENCAP technology allows PAMs to be incorporated into granules made from any inorganic and/or organic materials at a known rate. The carrier materials could consist of fertilizers or other similar inert materials. These granules provide a visual indicator of where the product has been applied, which improves the uniformity of the application, while also providing a known amount of PAM in each unit of product.



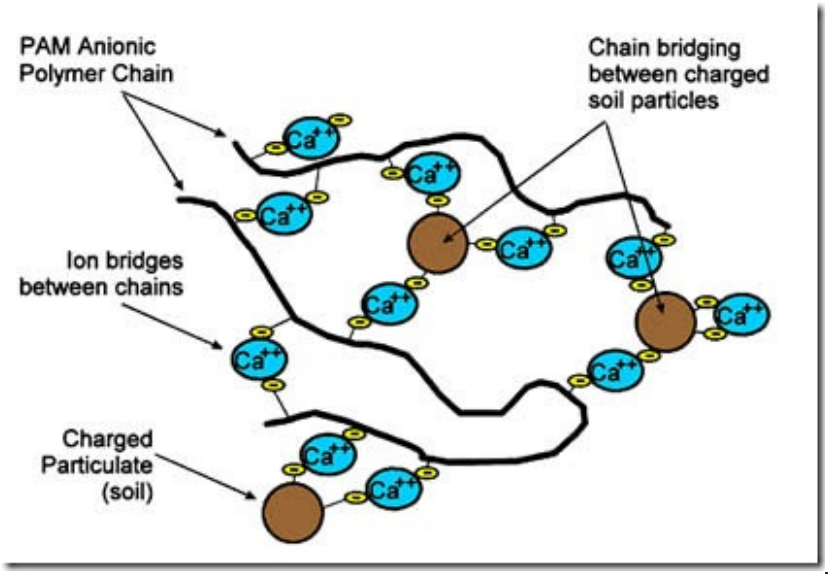
[(http://encappro.com/wp-content/uploads/2010/06/applicationrate.jpg)](http://encappro.com/wp-content/uploads/2010/06/applicationrate.jpg)

Additionally, ENCAP products can be used in hydroseeding applications, thereby creating a product with multiple application methods that provide consistent and uniform application rates.


[(http://encappro.com/wp-content/uploads/2010/06/pam12applicationtechniques.jpg)](http://encappro.com/wp-content/uploads/2010/06/pam12applicationtechniques.jpg)

What is PAM-12 Plus and why is it better than other products?

Combined with the ENCAP production capabilities, the patented ENCAP carrier technology allows for the uniform application of PAM and other additives at known rates, which provides a significant technical advantage when compared to previous technologies. It should be noted that ENCAP products also include calcium, which when mixed with PAM has been shown to increase infiltration by a factor of four and reduce erosion by 70% or more. Therefore, ENCAP products offer proven performance and economic advantages when compared to other available products.



[(http://encappro.com/wp-content/uploads/2010/06/pam12chain.jpg)](http://encappro.com/wp-content/uploads/2010/06/pam12chain.jpg)

Performance Tests

The soil stabilization granule shall be PAM-12® *Plus*, as manufactured by ENCAP®, LLC, and shall conform to the following performance tests.

DESCRIPTION	TEST	RESULTS
Erosion Control Performance	ASTM D 6459: 2+4 in/hr	0.075*
Erosion Control Performance	ASTM D 6459: 2+4+6 in/hr	0.356*
Vegetation Establishment	ECTC Test Method #4	>338%
Toxicity (Survival %> 75)	EPA-600-R-99-064	H.azteca - 98.8%
Toxicity (Survival %> 75)	ASTM E 1706-05	C. dubia - 100%

*C-Factor - The effect of surface cover and roughness on soil erosion as calculated using RUSLE

[(http://encappro.com/wp-content/uploads/2010/06/pam12performancetests.jpg)](http://encappro.com/wp-content/uploads/2010/06/pam12performancetests.jpg)

References

Barnevik, F.W. (1994) Polyacrylamide Characteristics Related to Soil Applications. *Soil Science*. 158, 235-243.

Bear, F.E. (1952) Synthetic soil conditioners. *Soil Science*. 73:419-492.

MacWilliams, D.C. (1978) Acrylamides. In Encyclopedia of Chemical Technology, 3rd Edition, Volume 1. Wiley, New York, pp.298-311.

Sojka, R.E., D.L. Bjorneberg, J.A. Entry, R.D. Lenz, W.J. Orts. (2007) Polyacrylamide in Agriculture and Environmental Land Mangement. *Advances in Agronomy*, Volume 92.

Tags: **ENCAP Technology**, **hydro seeding**, **hydroseeding**, **PAM-12**, **Polyacrylamides**, **Polymers**