
Erosion & Sediment Control Technical Bulletin #2

APPLICATION OF ANIONIC POLYACRYLAMIDE FOR SOIL STABILIZATION AND STORMWATER MANAGEMENT

Introduction

Anionic polyacrylamide (Anionic PAM) is a non-toxic chemical material that is being marketed nationwide for controlling soil erosion and sedimentation on construction sites. Current independent research by state and federal institutions has indicated that application of Anionic PAM in conjunction with conventional erosion and sediment controls (seed, mulch, perimeter controls, sediment basins, etc.) can be a safe, effective, and economical (applied cost of ~\$100-\$300/acre) technique for addressing problem soils on construction sites, when compared to conventional ESC measures alone. This technical bulletin is **not** an official ESC State Standard & Specification or an endorsement of a specific Anionic PAM product; specifications advocated for land-disturbing activities are listed in Chapter 3 of the *Virginia Erosion & Sediment Control Handbook*. However, based on the recent number of inquiries regarding Anionic PAM and, most importantly, it's potential to prevent off site damage and aid compliance with the Virginia Erosion & Sediment Control Regulations, this general guidance has been developed to assist land disturbers or plan-approving authorities that feel Anionic PAM may be beneficial to a specific site. Following further use and testing in Virginia, DCR may consider including an Anionic PAM specification in a future edition of the *Handbook*.

Background

“PAM” is a generic term for long-chain organic polymers that have been in use for many years as flocculating agents in wastewater treatment and food processing plants; furrow agriculture; mining separations; petroleum recovery; and personal care products. Extensive study has demonstrated that occupational exposure to *Anionic* PAM is **NON-TOXIC** when used as directed and is not a Federally listed hazardous compound; however, *Cationic* PAM is highly toxic to aquatic life and must **NEVER** be employed. Several states, NRCS, and EPA have recently completed guidance on the use of Anionic PAM for sediment control on agricultural and construction sites. Anionic PAM products reduce erosion and sedimentation by targeting the smallest soil particles, fine silts, clays and colloidal materials (5-10 microns in size), which are difficult or impossible to control using conventional ESC measures. These smaller particles are commonly maintained or introduced on site as fill because they are easily compacted. Silt fence and sediment basins, only trap particles as small as 125 microns (sands and coarse silts) and >20 microns (silts), respectively. Thus, once liberated, the smallest particles remain in the water column, and may necessitate complex and expensive solutions to prevent violations and remediate property and environmental damage that may result if this material is transported off site in stormwater. In a recent three-year efficacy study on construction sites, Anionic PAM provided up to 70% reduction in runoff-sediment, and even better results when combined with conventional mulching and seeding measures.

Anionic PAM uses two mechanisms to affect these difficult to address particles. It preferentially increases aggregation of these small particles to improve soil stability and prevent soil detachment in the first place, and decreases the settling time of particles that become suspended to aid in their deposition within the site, thus improving runoff water quality. Additionally, Anionic PAM can increase soil pore volume and permeability, thus increasing infiltration and reducing the runoff quantity.

Anionic PAM is applied on site via two “dosing methods” (direct, passive), and is available in four media types (powder, powder dissolved in water [wet], emulsion, gel block). The powder, wet, and emulsion media are applied directly to short, steep slopes, and other exposed soil surfaces for soil stabilization, while gel blocks are “passively” used within a ditch or conveyance system for in situ water treatment above pre-constructed sediment ponds. Further, to optimize performance, preliminary site-specific assessment (soil and water testing) by a qualified manufacturer must be conducted to select media, additives, dosing rate, dosing method, and maintenance procedure tailored to site-specific soil characteristics, topography, hydrology, and type of erosion targeted.

Application of Anionic PAM to sites with problem soils in accordance with manufacturers guidance, this bulletin, and other regulatory programs, shows great promise for improving compliance with NPS requirements, specifically Minimum

Standards 1 (soil stabilization) and 19 (stormwater management) of the Virginia Erosion & Sediment Control Regulations (4VAC50-30-40), and in turn, preventing degradation of off site property and water resources.

Applicability

Anionic PAM is intended for use on areas that contain **high amounts of fine silt, clay, or colloidal soils**. Anionic PAM is generally applicable where the timely establishment of vegetation may not be feasible, is absent or inadequate, or where topographic conditions, construction activities, or other forces limit the utility of conventional temporary sediment control practices alone. Anionic PAM may be beneficial to the following activities/areas:

- ❑ Staging areas
- ❑ Rough grading operations
- ❑ Balanced cut and fill earthwork
- ❑ Man-made or natural stormwater conveyances
- ❑ Haul roads
- ❑ Roadside ditches
- ❑ Soil stockpiles and borrow areas
- ❑ After final grade and before paving, final seeding, and planting
- ❑ Phased projects
- ❑ Sites having a winter shut down
- ❑ Other exposed areas that have not been adequately stabilized with vegetation or where other stabilization measures would interfere with construction activities or are otherwise ineffective/inefficient for the area or time of year.

*As further discussed in the **Application Restrictions** section, the proper type of Anionic PAM **must** only be applied in accordance with an approved plan/permit and on areas that ultimately drain to a pre-constructed sediment trap or basin prior to introduction to surface waters.*

Advantages & Limitations

Below is an inclusive list of common advantages and limitations that may apply to use of Anionic PAM. These issues should be carefully considered before applying Anionic PAM to a specific site.

Advantages

- ❑ Improves stability of problem soils to prevent soil detachment in the first place
- ❑ Provides quick stabilization where vegetation has yet to be established
- ❑ Promotes flocculation (reduces settling time) of smallest particles
- ❑ Increases soil pore volume and permeability, thus decreasing impervious cover
- ❑ Less obtrusive than some conventional measures - doesn't interfere with construction machinery/activity
- ❑ Convenient and easy to apply and store along with other soil amendments (fertilizer, mulch, etc.) with conventional seeding, mulching, or irrigation equipment
- ❑ Material is specifically designed for the soil, waters, and other on site characteristics
- ❑ May prevent costly repair and reshaping of rilling or failing slopes
- ❑ Re-application may not be necessary for several months if treated areas are mulched
- ❑ Reduces seed, pesticide, and fertilizer (phosphorus and nitrogen) losses that hinder vegetation establishment on site, increase costs, and promote nutrient and chemical loading offsite
- ❑ Non-toxic to aquatic biota
- ❑ Reduces windborne dust conditions
- ❑ May prevent water quality damages (TSS, turbidity), eutrophication, habitat destruction, stream channel erosion, sedimentation, and related remediation costs
- ❑ Reduces potential for violations of MS-1 and MS-19
- ❑ Less expensive in the long-term by requiring less mulch, seed, etc. and corrective actions/remediation

Disadvantages/Limitations

- ❑ Materials are “soil-specific,” so you can not reuse extra supply or bulk order for multiple sites
- ❑ Requires site-specific testing that may take several days to complete
- ❑ Energy intensive process (mechanical mixing) may be required for proper dissolution of viscous products
- ❑ May enhance precipitation of fine sediments in downstream structures, and therefore, increasing maintenance requirements (removal of sediment/PAM complex from basins)
- ❑ Misuse (over use) by inexperienced parties that clog soils, thereby decreasing infiltration
- ❑ Are not effective when applied to pure sand or gravel with no fines, and when applied over snow cover
- ❑ Qualified manufacturers and distributors may not be currently available throughout the entire state
- ❑ Improper over-reliance on Anionic PAM, in lieu of proper conventional ESC measures
- ❑ May require engineers to consider Anionic PAM’s impact on existing seeding/fertilizer, pond sizing, and other specifications
- ❑ Public concern over introduction of polymer products to the natural environment

Application Restrictions

To help ensure, safe, effective, and environmentally friendly application of Anionic PAM to construction sites, DCR has established four site restrictions to Anionic PAM application. Note a qualified manufacturer should be consulted to confirm a compliant and effective product is selected. It is suggested that applicants request references from manufacturers and/or contact appropriate public agencies to confirm qualifications before contracting service.

ALL ANIONIC PAM APPLICATIONS MUST COMPLY WITH THESE RESTRICTIONS.

(1) Material

Only Anionic PAM and Anionic PAM mixtures that comply with the following criteria may be used. The criteria listed below are generally included on the product label and/or Material Safety Data Sheet (MSDS).

- ❑ PAM copolymer formulation **must** be anionic (negatively charged), with a charge density of 8 to 35% by weight (15-18% is typical)
- ❑ Ultra high molecular weight of 6 to 24 mg/mole (preferably 12-15 mg/mole)
- ❑ Water-soluble, “linear,” or “non-crosslinked”
- ❑ Highest grade Anionic PAM (potable drinking water grad – PDWG), certified for compliance with ANSI/NSF Standard 60 and EPA and FDA residual acrylamide monomer (AMD) limits of 0.05% for drinking water/food treatment
- ❑ Non-combustible
- ❑ Does not change soil pH
- ❑ Expiration date included
- ❑ Must be accompanied by MSDS and toxicity information from the manufacturer that the Anionic PAM product and any required additives are non-toxic to aquatic biota (acute and chronic toxicity results using EPA protocols approved under the Clean Water Act at 40 CFR 136) **NOTE: Site-specific Anionic PAM product toxicity or efficacy testing is not required by DCR at this time. However, compliance with other regulatory programs/agencies may require this testing to ensure safe and compliant use on site.**
- ❑ **Must** be accompanied by manufacturers written instructions to ensure proper (1) Product and Site Preparation, (2) Application, (3) Maintenance/re-application, (4) Storage, and (5) Safety, in accordance with Occupational Health and Safety Administration (OSHA) and other applicable guidelines

NOTE: Cationic PAM (positively charged) shall **never** be used because of its toxicity to aquatic organisms at very low concentrations. When used properly, Anionic PAM has no measurable toxicity to humans, aquatic organisms, or plants. The high molecular weight Anionic PAM suggested herein present little concern for toxicity, as their molecules are so ultra large that they do not penetrate biological membranes. Additionally when Anionic PAM is introduced into waters containing sediments, humic acids, or other impurities, its effects are buffered to an even greater degree. Further, **acrylamide** (a known carcinogen) residuals found in very small amounts in PAM products is stringently regulated during manufacturing by EPA and FDA, so toxic concentrations do not reach the market.

(2) Site-Specific Testing and Instructions

Users **must** obtain site-specific soil and water testing and guidance from a qualified manufacturer to ensure that an (a) Anionic PAM product, (b) additives, and (c) application scheme are selected that is tailored to site-specific soil characteristics (type, aggregate size, organic content, ion content), topography, hydrology, and type of erosion targeted. Manufacturers generally provide this service at no cost. The final site-specific specifications, along with material specifications noted in item 1 above, should be provided to the plan-approving authority to be included with the ESC plan.

(3) Application Conditions

Anionic PAM **must always** be applied above a pre-constructed sediment trap or basin inflow structure and **never** be applied directly to:

- ❑ Slopes that flow directly into a wetland or state waters
- ❑ Sediment basins, traps, or other SWM ponds
- ❑ Wetlands or state waters

(4) Approvals and Permits

Anionic PAM use **must** conform to all federal, state, and local laws, rules, and regulations regarding use, discharge, and disposal of chemical materials.

- ❑ Site-specific specifications for Anionic PAM **must** always be consistent with this bulletin, included with the ESC plan, integrated with other conventional measures to maximize effectiveness, and approved by the appropriate plan-approving authority – **Anionic PAM should not be used IN LIEU of conventional measures!**
- ❑ Users **must** contact the appropriate local, regional, and/or state authority to confirm that Anionic PAM use will not conflict with any site-specific Virginia Discharge Elimination System Permits (VPDES), Virginia Water Protection Permits, or other discharge or wetlands permits

Application Considerations

As noted in the Materials subsection above, the manufacturer is required to provide written application instructions for Anionic PAM. The following are additional considerations and recommendations relating to the use of Anionic PAM that may enhance effectiveness or avoid problems.

EXCEPT FOR THE APPLICATION RESTRICTIONS IN THE PREVIOUS SECTION, MANUFACTURERS APPLICATION GUIDELINES MUST ALWAYS BE FOLLOWED AND TAKE PRECEDENCE OVER THESE ADDITIONAL CONSIDERATIONS.

General Considerations

- ❑ **DO NOT OVER APPLY ANIONIC PAM. Excessive application of Anionic PAM can lower infiltration rates or increase suspended solids in water. Note that application rates of Anionic PAM above those suggested by the manufacturer will not provide additional effectiveness. More is not better!**
- ❑ Published literature and guidance recommends that application of Anionic PAM in pure form (75%-90% active polymer) not exceed 10 lbs/acre per single application event, 200 lbs/batch, or 200 lbs/acre/year.
- ❑ Note that for Anionic PAM to work effectively there must be a source of “divalent cations.” Gypsum (CaCl₂) is a common source. The divalent cation source may be in the Anionic PAM mix, in the soil, or applied directly to the soil. Manufacturers soil tests should be used to determine whether additives are necessary.
- ❑ Care must be taken to prevent spills onto paved surfaces, as Anionic PAM may be very slippery. Skid protection should be employed in wet areas.
- ❑ Gloves should be worn whenever handling Anionic PAM and surfaces that contacted them.
- ❑ Consider all OSHA health and safety precautions and manufacturers instructions.

Direct Application Considerations

- ❑ Recent publications suggest that Anionic PAM application costs will range from \$107 - \$222/acre
- ❑ **Do not** add water to powdered Anionic PAM. Add Anionic PAM powder **slowly** to water to the desired concentration and mix for 3 to 5 minutes. If water is added to PAM, globs may form that can clog dispensers – this indicates incomplete dissolving of the Anionic PAM, and therefore, increases the risk of under-application.
- ❑ Including tackifiers, mulch, seed, and fertilizer in the final Anionic PAM mixture is recommended to improve performance and provide additional permanent protection beyond the useful life of the Anionic PAM. **However, Anionic PAM should always be the final additive to the mixture.**
- ❑ The Anionic PAM mixture should be prepared immediately prior to application as effectiveness decreases if too much time passes between mixing and application.
- ❑ Application to dry soil is preferred.
- ❑ May be sprayed on bare soil using standard irrigation equipment, hydroseeding/hydr mulching equipment, water trucks, or other spraying devices that have a mechanical agitator, mixing apparatus, or hydrologic recirculation.
- ❑ Marking with tracer or colorant to visually track application is recommended.
- ❑ Use a minimum 30 ft. setback when applying near wetlands or surface waters.
- ❑ Procedures for application should ensure uniform coverage to the target area and avoid drift to non-target areas.
- ❑ Inhaling powdered Anionic PAM in large quantities may cause choking or difficulty breathing. Persons handling and mixing Anionic PAM should use a dust mask of a type recommended by the manufacturer.
- ❑ If Anionic PAM powder gets on skin or clothing, wipe off with a towel rather than washing with water.
- ❑ Limit exposure of the powder Anionic PAM supply, as air and sunlight degrade effectiveness in 3 months.

Passive Application Considerations

- ❑ Gel block media size and shape should be regulated to deliver the appropriate dosage within a particular conveyance – applicants should work with the manufacturer to ensure sediment removal.
- ❑ Gel blocks should generally be placed in the center of the ditch as close as possible to the active land-disturbing activities and an appropriate distance above the inflow of the sediment trap or basin to ensure adequate turbulence and mixing energy for flocculation in the downstream sediment trap or basin.
- ❑ Stakes, nylon mesh bags, wire cages, and other equipment used to maintain/protect the block within the conveyance should be installed in accordance with manufacturers directions.

Maintenance and Disposal

Degradation of PAMs in soil systems can be expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt, and temperature effects at a rate that has been estimated to be approximately 10% per year. However, these effects are accelerated in highly exposed areas. Anionic PAM may be reapplied in accordance with manufacturers instructions to disturbed areas after a 48-hour period. Reapplication is not required unless Anionic PAM treated soil is disturbed or turbidity or water quality show the need for an additional application. If PAM treated soil is left undisturbed, a reapplication may be necessary after 6-8 weeks. Further Anionic PAM applications may be required for steep slopes, highly silty and clayey soils, long grades, and high traffic or precipitation areas. **Note that if Anionic PAM is first applied to bare soil and then covered with mulch, a reapplication may not be necessary for several months.** Continue to monitor areas to which Anionic PAM has been introduced after every precipitation event and until treated areas are permanently stabilized.

All equipment should be maintained to provide the application rates recommended by the manufacturer. Rinse all equipment used to mix and apply Anionic PAM thoroughly with water to avoid formation of residues.

Anionic PAM may enhance precipitation of fine sediments in downstream pipes, channels, and detention basins. Accordingly, these structures should be inspected periodically and sediment removed when it exceeds 10% of the structure's mean depth or in accordance with the clean out schedule recommended for the particular measure.

Recovered sediments containing Anionic PAM should be reused or disposed of in accordance with local, state, and Federal regulations. Anionic PAM is not listed in Federal hazardous waste regulations (Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Public Law 96-510, as amended by the Superfund Amendments and Reauthorization Act of 1986, Public Law 99-499), or in the Virginia Hazardous Waste Management Regulations (9VAC20-60-12 et seq.). Accordingly, recovered sediments may be dewatered appropriately and used as a fill material, or alternatively, may be land applied if the sediment does not have the structural stability to act as fill.

Further Information

Requests for further information or questions regarding the application of Anionic PAM to construction sites in Virginia should be directed to qualified manufacturers or DCR's Central Office in Richmond, VA.

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