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4.4.12.5 Flocculants and Polymers



Source: ALSWCC (2018)

Definition and Purpose

Flocculants and polymers are chemical treatments used on construction sites to promote the aggregation of fine suspended particles, such as clays and silts, into larger masses known as “flocs.” These flocs settle more rapidly than individual particles, improving the clarity of stormwater runoff before it leaves the site. These chemicals may be derived from natural or synthetic polymers and can also be applied to soil surfaces or erosion control materials to stabilize sediment and limit erosion (USEPA, 2021).

Appropriate Applications

Flocculants and polymers are most applicable on construction sites where conventional EPSC measures alone cannot effectively retain sediments onsite. Therefore, chemical treatment is to be used in conjunction with other EPSC practices. They are particularly suited for situations requiring stringent turbidity control when discharging to sensitive water bodies, such as lakes, ponds, and trout streams, or in areas where soil types produce particles too small and buoyant for settling or filtration (ALSWCC, 2018; TDOT).

Flocculants can be applied in granular powder or liquid form on graded or disturbed areas, causing soil particles to bind together and become more resistant to wind erosion and raindrop detachment. Further, they can be applied in solid form, as a floc log, or gel in areas of concentrated flow, such as swales or channels, or within structures such as sediment basins, traps, sediment filter bags, etc. When applied as the latter method, the chemical dissolves as water comes in contact with it, binds suspended sediments together, and increases the rate of sedimentation. Kazaz et al. (2023) observed agitation and mixing



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improvements up to 96% when flocculants were applied in concentrated flow scenarios. Selection of the appropriate chemical is site specific, requiring evaluation of soil characteristics and regulatory approval to ensure effectiveness and avoid aquatic toxicity.

Limitations and Maintenance

Flocculants and polymers require routine inspection and careful handling to ensure effectiveness and compliance with regulations. Dosing systems should be monitored daily, and solid flocculant products, such as floc logs, inspected at least twice weekly or after significant rainfall to confirm proper placement, moisture, and exposure. Only certain formulations, such as anionic, linear polyacrylamide (PAM) meeting EPA and FDA purity standards, are permitted in certain jurisdictions, and applications must avoid direct discharge to streams, wetlands, or other water resources, with minimum setback distances maintained to protect sensitive areas. Cationic forms of flocculants have a positive charge that is extremely toxic to aquatic species and are not permitted for use in Tennessee.

Planning and Design Considerations

Various products may be applicable for use as a flocculant; however, products such as with PAM or chitosan have been found to be the most effective (Kazaz, et al., 2023). The selection of a flocculant should be based on site-specific soil characteristics, often determined through testing methods such as a “jar test,” to ensure compatibility and maximize performance. Only products meeting regulatory purity and safety standards, such as anionic PAM with less than 0.05% free acrylamide, should be used, and they may require approval from localities. In areas where flocculants are permitted, applications must avoid direct discharge into sensitive water resources and maintain required buffer distances.



Source: TDEC

Proper mixing, distribution, and contact time are critical for effective flocculation, with passive mixing via channel turbulence often preferred. Flocculants dissolve slowly, requiring adequate agitation and time to become fully active, and must be reapplied after significant runoff events as they bind to sediment particles. Application rates should follow manufacturer guidelines and consider site conditions such as slope gradient (steeper slopes require higher rates but yield diminished benefits without strong vegetative cover). Certain soil types, such as sandy soils with low clay content, may see little to no improvement from flocculant use. Practical planning should also account for cost, material handling hazards, and ensure that all treated runoff passes through a downstream sediment control feature before leaving the site.



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When incorporating PAM as a sediment control measure, its application must be planned, implemented, and monitored in accordance with manufacturer specifications, regulatory requirements, and site-specific conditions. The following design considerations apply (ALSWCC, 2018; MPCA, 2023; NCDEQ, 2013; TDOT):

General Requirements

- Apply PAM only after all appropriate EPSC measures have been implemented.
- Use anionic PAM products only; cationic forms are prohibited due to aquatic toxicity.
- PAM products must meet EPA and FDA acrylamide monomer limits ($\geq 0.05\%$), have a density of 10–55% by weight, a molecular weight of 16–24 Mg/mole, be non-combustible, and contain only manufacturer-recommended additives.
- Application must comply with all OSHA safety requirements, Material Safety Data Sheet provisions, and federal, state, and local regulations.
- Vendors should supply, if requested, written toxicity reports verifying that the product meets state and federal water quality standards.

Application

- PAM shall not be applied directly to streams, wetlands, or other surface waters, nor within 30 feet of such resources.
- Treated areas should drain to a sediment basin, trap, etc., for final settling prior to discharge.
- PAM may not be applied downgradient from a sediment basin or trap.

Mixing and Dissolution

- Adequate mixing is essential for effectiveness. Introduce PAM at points of high velocity or turbulence (e.g., slope drains, storm drain junction boxes, or other high-energy flow areas) to maximize contact with suspended sediment.
- Ensure at least 60 seconds of mixing before water enters a sediment basin or trap.
- PAM is water-soluble but dissolves slowly; sufficient agitation and time are required.

Product Forms and Application Methods

- Liquid Emulsions: Apply only in accordance with laboratory-tested rates for the site; ensure uniform coverage and avoid over-application.
- Dry Powder: May be applied via hand or mechanical spreader; mixing with dry silica sand improves distribution. Pre-mixing with fertilizer, seed, or soil amendments is permissible.
- Solid Blocks/Logs: Install upgradient of sediment basins or traps in areas with constant flow. Placement should follow site-specific testing. Protect logs from dehydration by installing them in shaded or enclosed areas.

Limitations of Solid Forms

- PAM release rates from logs are not adjustable and may be inconsistent.



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- Wet PAM can collect sediment and debris, reducing effectiveness; dry PAM logs release less material until fully moistened again.
- To maintain performance, reduce upstream sediment loads, and ensure continuous water contact with the product.

Performance and Reapplication

- PAM effectiveness decreases after storm events; reapply after approximately two rainfall events.
- Soil testing is required to match the PAM formulation to the soil type of the site.
- Follow manufacturer application rates to avoid aquatic toxicity from over-application.

Post-Application Treatment

- After mixing, runoff should be detained in a sediment trap or basin (or other) to allow flocculated particles to settle.
- Stabilize basin inlets with geotextile or stone to prevent gully erosion.
- Consider installing baffles to improve settling efficiency and use surface skimmers for dewatering.

Application Suitability

- PAM is particularly effective in reducing turbidity from high suspended solid loads such as those from dewatering operations, borrow pits, excavation discharges, or stormwater from disturbed areas.
- An application system should be in place to minimize malfunction risk and prevent harm to sensitive water resources, especially those designated as ETWs.

Electrical flocculation, also known as electrocoagulation, is an advanced water treatment process that uses an applied electrical current to destabilize and aggregate suspended solids, colloids, and other contaminants without the need for conventional chemical coagulants. In this process, metal electrodes, typically aluminum or iron, release ions into the water under a direct current, which neutralize particle surface charges and promote floc formation through coagulation and flotation mechanisms. Compared to traditional polymer- or alum-based flocculation, electrical flocculation offers several advantages: it reduces or eliminates chemical dosing, produces less sludge, and





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allows for precise control over treatment intensity by adjusting electrical parameters. Studies, including Liu & Perez (2022), have demonstrated that when coupled with physical clarification devices such as lamella settlers, electrocoagulation significantly enhances turbidity removal efficiency, improves settling rates, and shortens treatment times. The technology also provides operational resilience under variable flow and contaminant loads, making it well-suited for construction site runoff treatment where sediment characteristics and flow volumes can fluctuate rapidly. However, considerations such as energy requirements, electrode maintenance, and cost must be evaluated before large-scale implementation.

Example Application

No formal design or quantities are required for this measure and therefore are not presented here.

References

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