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Soil in our Water

Why is Removal Important?

- September 2011 Minnesota impaired waters summary 303(d)

River, lake and wetland impairments:

2,575 total including 1,090 impaired by conventional pollutants (BOD, TSS, fecal coliform, pH, oil and grease).

Excessive Sediment

Impacts aquatic life and fisheries

Source waters for drinking water supplies

Recreational uses

Fine particulates also often carry other pollutants such as heavy metals.

Basic Terminology

- Sediment – Material in suspension in water or recently deposited from suspension.
- Flocculation – The process by which suspended colloidal or very fine particles combine into larger masses.
- Turbidity – The degree to which light is scattered or absorbed by a fluid. Turbidity is usually associated with suspended sediment.

Stormwater is full of suspended clays and particulates that *remain in suspension* due to small size and negative surface charge repulsion.

Untreated Particle Settling Time

1.0 mm coarse sand	10 seconds
0.1 mm fine sand	125 seconds
.01 silt	108 minutes
.0001 colloidals	755 days

Larger particles are mainly influenced by gravitational forces while suspended particles, in particular the clay sized particles, are subject to coagulation and flocculation.

Removal Mechanisms

Effective removal of sediment from runoff by stormwater BMPs is determined by:

The unit treatment process present in the BMP

The characteristics of sediments in the runoff

Dominant Removal Mechanisms

DRMs for sediment include sedimentation and filtration.

Both processes are enhanced by coagulation and flocculation.

Stormwater Characteristics and Environmental Conditions Influencing DRMs

- ***Temperature :***

  Settling velocity decreases as temperature decreases. Water viscosity more than doubles as temperatures decline from 80 degrees F to near freezing.

- ***Particle Size Distribution :***

  Generally larger are more easily removed than smaller particles.

- ***Charge :***

  Clay particles generally have negative surface charges.

  The negative charge and small mass cause the clay particles to repel each other in water and disperse, forming a colloid.

Clay colloids must be destabilized by coagulation/flocculation before they can be easily removed via sedimentation or filtration.

Destabilizing Repulsion Between Particles

Flocculation is used to describe the action of polymeric materials which form bridges between individual particles.

Flocculants absorb on particles and cause destabilization either by bridging or charge neutralization.

Counterbalance the Charge

- An anionic flocculant will usually react against a positively charged suspension (positive zeta potential)

- A cationic flocculant will usually react against a negatively charged suspension (negative zeta potential)

However, the rule is not general. For example, anionic flocculants agglomerate clays which are electronegative.

In this case, the destabilization mechanism is believed to be due to bridging.

Areas of Applications for Flocculants

E F G Y L B

V A C M Z S

W Q J U X K

D T H C T U

I Y S L J R

- Adhesives, aluminum anodization and surface treatment, aluminum smelters, aluminum sulphate, asbestos plate, borax production, brewing industry, brine clarification, centrifugation aid, ceramic industry, chemical industry, effluent, clay, china clay, production, coagulant, coagulant aid, coal washing, copper mining, cyanidation, dairy and milk industry, dicalcium phosphate, dredging and land reclamation, electroplating industry, drying beds, filter aid, food processing industry, flotation aid, hydraulic back-fill, industrial raw water treatment, iron ore, iron and steel industry, latex and synthetic rubber effluent treatment, leaching, magnesia from seawater, meat processing, motor/automotive, municipal sewage, oil production, petroleum refineries, pharmaceutical industry, phosphate ore, phosphoric acid wet process, potato industry, potable water, potash mining, pulp and paper, sand and gravel, settling aid, sugar processing, tailing disposal, tannery, textile industry, titanium dioxide manufacture, zinc electrolysis, stormwater erosion and sediment .

Natural Flocculants

- Chitosan
- Starch Derivitives
- Polysaccharides
- Alginates
- Guar Gums

Chitosan

- Chitosan (poly-D-glucosamine)
- Natural sediment flocculant.
- Second most common polymer in nature.
- Structurally related to cellulose.
- Found in the shells of crustaceans and certain other organisms such as fungi, algae, and yeast.

Source: US EPA

Chitosan

- Non-toxic, non-hazardous, commonly used by commercial aquariums to clean water.
- Binds sediment particles within 30 seconds by reducing the zeta potential (electrical charge resistance).
- Creates larger flocs enabling filtration or gravity settling to occur.
- Breaks down to carbon dioxide and water within approximately 19 days.
- No bio-accumulation concerns.

Synthetic Flocculants

- Polyacrylamides

Synthetic derivatives of the petroleum industry.

Based on polyacrylamide which is a nonionic polymer but can be given either a positive or negative charge.

Generally used on dry soil applications, ditch checks, and agricultural furrows.

Flocculation Visual

Why Is Flocculant Needed?

- The application of flocculant aids in the reduction of turbidity by more efficient removal of fine suspended sediment.
- Flocculant destabilizes colloids by neutralizing the forces (ionic charges) that keep the particles apart.
- Turbidity is difficult to control if fine particles are in suspension.

Flocculants

- When added in correct amounts, suspended colloidal particles combine resulting in an increased mass that is subject to accelerated settling by gravity.
- Selected BMP's become more efficient filtration devices.
- The proper use of flocculants assist in ensuring that waters from construction sites does not exceed the discharge requirements and permit conditions.
- Treated runoff with flocculants reduces toxicity by removing sediment and other pollutants.

Soil Specific

- Polyacrylamides are soil specific products.
- MnDOT currently working to identify the most effective PAM formulation for each soil type in the state.
- Chitosan is not soil specific.

Sprinkle 100 grams of PAM on the lower, center portion of the check where water is going to flow over.

Floc Bag Housing Unit

- Pump through mixing system.
- Allow 40-50 feet of mixing time prior to discharge.
- Y feature allows for easy bag replacement.

Liquid Injection

Precise metered dose rates using a high viscosity injection pump.

Clean Water Discharge

Biofiltration Discharge

Stormwater treated with Biostar, which cannot be treated with any methods due to insufficient capacity or for any other reason, can be discharged to the ground (overland flow) at a location which is at least 300 feet from the nearest surface water, in an area which is fully vegetated at the disposal location and over the entire pathway to a surface water.

- Allows for collection and bio-filtration of sediment flocs.

- Equipment: pump (2, 3, or 4”)
  suction hose (floating or skimmer)
  Biostar floc 500’s
  50’ discharge hose
  perforated dispersal pipe (1’ of pipe for each gpm of output)

Note: Connect the treatment assembly to the pressurized side of the pump (limit treatment flow rate to less than 300 gpm for best results)

Thank You!

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