FACTSHEET

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COAGULATION & FLOCCULATION

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Introduction

The processes of coagulation and flocculation target suspended solids to remove them from solution. They are used in conjunction with some methods of sedimentation.

Description

The terms 'coagulation' and 'flocculation' are often used interchangeably to refer to the wastewater treatment practice of adding a chemical that causes small particles to form larger clusters of particles. The binding together of the small particles increases settling and the potential for filtration. However, coagulation and flocculation are two different processes. Particles in washwater are negatively charged and repel each other unless the charges are neutralized. Coagulants added to water alter the molecular forces that keep particles separate by neutralizing particle charges. Coagulation is followed by flocculation in which the coagulated particles come together to form even larger clumps, known as 'flocs'. Flocculation brings the coagulated particles together through gentle mixing of the water and if necessary, additional chemicals, called flocculants, are added. Once the flocculation process is complete, the larger particles are allowed to settle. The sediment has to be removed periodically, the frequency of removal depends on the solid load of the wastewater and the size of the chamber.

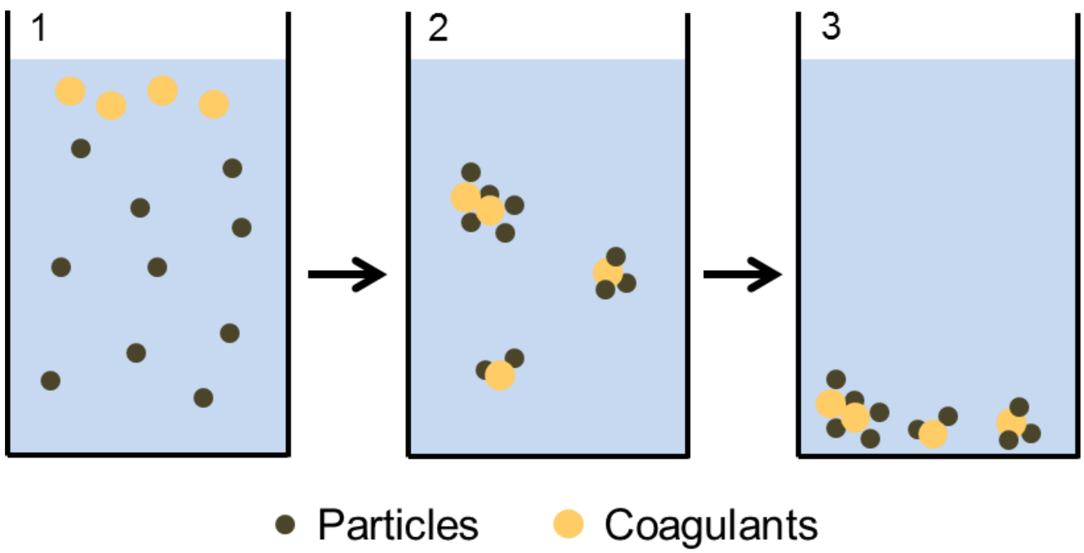

Figure 1: Demonstration of coagulation and flocculation: (1) Coagulants added to water with suspended particles which is followed by mixing to disperse the coagulants throughout the tank, (2) Flocculation process, and (3) Flocs settled to the bottom of the tank

Aluminum sulphate (alum) and ferric chloride are commonly used coagulants (Gebbie 2006; Mason et al. 2005). Flocculants are usually large organic polymers, such as polyacrylamide (PAM) (Gebbie 2006; Mason et al. 2005). Coagulants and flocculants are chosen based on the water chemistry of the wastewater and the concentration and size of the particles that need to be removed (Gebbie 2006; Pariseau et al. 2013). The pH of the water is important when determining which coagulant to use and the necessary dose. Common coagulants, such as alum, work better when the pH is slightly acidic, with alum's optimum pH ranging from 5.8-6.5 (Gebbie 2006). Therefore, unless pH adjustments will be made (at an added cost) it is essential to match the coagulant to the wastewater that will be treated. The rate at which the coagulants and flocculants are applied also depends on particle size and wastewater chemistry.

The fate of the water after treatment is important as well because if the water will be reused the coagulants and flocculants must be in line with food safety guidelines; and if the water is discharged then the chemicals cannot be harmful to the environment (Mason et al. 2005). Alum, for example, is available in food-grade form. If the removed solids are to be land applied, different regulations under the Nutrient Management Act will need to be followed depending on the wastewater and on what coagulants were used (Pariseau et al. 2013).

System Placement

This practice should be deployed early in the water treatment system as removing solids from the water can increase the efficiency of other treatment processes. The coagulants can be added into a sedimentation system such as settling tank or they can be utilized in their own specialized treatment unit. Coagulation can also increase the efficiency of filtration systems by creating larger particles that are less likely to pass through a filter instead of being trapped.

Considerations

When choosing coagulation and flocculation as a treatment method, several factors must be considered. The coagulant material is an ongoing cost as long as the system is running. The process requires a place in which the settling can occur; it can be in conjunction with a settling tank, pond, or in a separate unit. Each method has their own set of considerations including their size, cost to build, and cost to maintain. The sediment produced must be periodically removed from the system and be disposed of; its destination is dependent on the coagulant and removed solids.

Performance

Coagulants will vary in effectiveness. They can be easily tested by combining the targeted water and coagulants in the prescribed mixture in a bucket or jar. Water samples taken following flocculation will demonstrate the quality of the treated wastewater. Coagulants have specific parameters that they are able to treat, and some are more effective than others removing each factor. The performance of each coagulant is dependent on the individual water; thus, if coagulation and flocculation is chosen as a treatment option, on-site testing is crucial to determine the correct coagulant for the system.

Cost

The cost of a coagulation system is dependent on several factors. The chemistry and solid load of the wastewater determines the amount and type of coagulant needed. Vegetable washwater that contains muck soils have high concentrations of suspended and dissolved solids with very small particle sizes (<5 microns). As a result, if common coagulants, such as alum and FeCl, were used they would need to be applied at high rates. This can make coagulation an expensive treatment option, ranging from $0.96 to $2.64/1000L washwater (Gurvinder 2013).

There are other types of coagulants that are polymer based, and these could be more effective and lead to better water treatment, but they can also be expensive (Gurvinder 2013; Gebbie 2006).

Other costs can arise from the need of a system to periodically remove and dispose of the sediment. There also needs to be a system to add the coagulants to the wastewater. Systems that automatically dispense the required amount according to the profile of the wastewater are the most efficient but they come with an added capital cost. However, automatic-dosing systems are designed to deliver the ideal amount of coagulant and reduce overuse, which can mean lower usage costs in the long-term. Coagulation and flocculation may prove essential for the complete removal of the solid load from vegetable washwater, however, the ongoing and high cost may be a detriment for many producers.

Conclusion

Coagulation and flocculation can be an effective way to remove solids from washwater. The cost to run a system is one that is ongoing and is dependent on the quality of the water to be treated. This method is best used in conjunction with other treatment practices as it is targeted at one aspect of water quality.

References

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