News Release

Technology Investigation: Coagulation & Flocculation

Introduction

It was determined early on in the HMGA Water Project that coagulation and flocculation was a technology that must be investigated. Due to the nature of muck particles, conventional filtration methods were not sufficient to remove solids from vegetable washwater. The small size and density of muck soils make it almost immune to gravitational and centrifugal forces, eliminating settling and hydrocyclone technologies. The size also made filtration difficult as the pore size needed to be very small. Therefore, additional inputs would be required to create an effective and efficient solids removal system. Those inputs came in the form of coagulants, flocculants, and dosing systems. The testing of coagulants and flocculants was not completed in isolation; all tests and evaluations occurred in conjunction with another technology.

Coagulation is the act of neutralizing positive or negative charges contained in soil particles that allow them to repel each other (Figure 1). This usually has to be achieved by adding chemical aids when working with small particles. Flocculation happens when the neutralized particles are brought together to form larger compounds called 'flocs'. Factors affecting floc formation include the particles behaviour and desired speed formation. Once the particles have been formed into flocs, the separation from water can occur. There are three ways this can be achieved: sedimentation, creaming, or dewatering (Figures 1 & 2). Sedimentation involves allowing the flocs to settle. Creaming, or floatation, can happen two ways; the chosen flocculent may cause the flocs to float or they can be creamed by using aeration. Finally, the flocs can be dewatered by filtering them out of the water.

A dosing system controls the amount of chemicals added to the water. The dose depends on the chemistry of the water and the characteristics of the particles. Determining the required dose is best done by a professional as there is a vast array of products available.

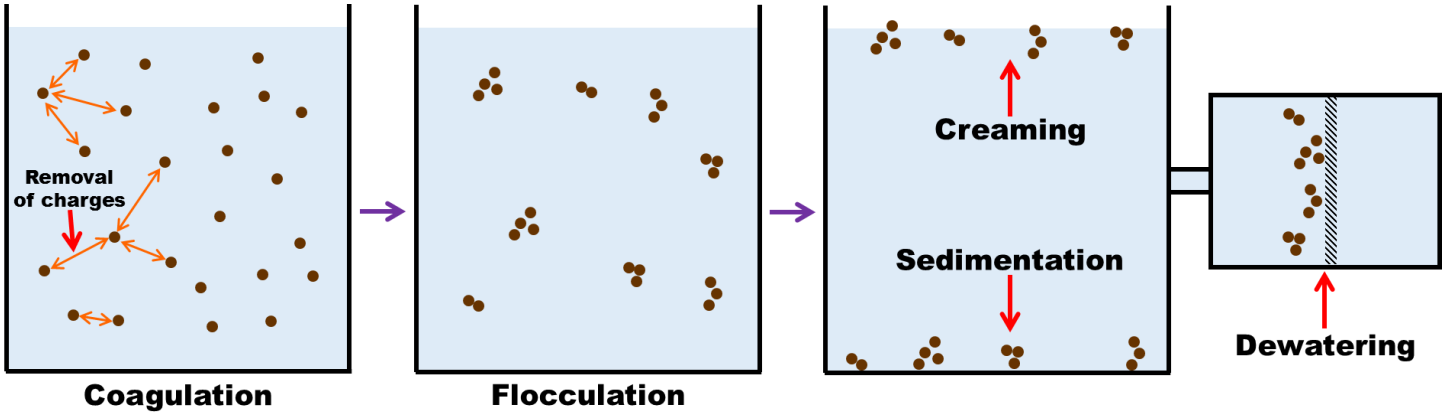

Figure 1: Coagulation and flocculation process followed by solid removal methods.

The HMGA Water Project evaluated coagulants and flocculants in three separate situations in partnership with two companies, Bishop Water Technologies and Prominent Fluid Controls, providing technical expertise. The chemicals were used in conjunction with two configurations of a woven filter bag "Geotube" (horizontal and hanging) and with a dissolved air filtration unit.

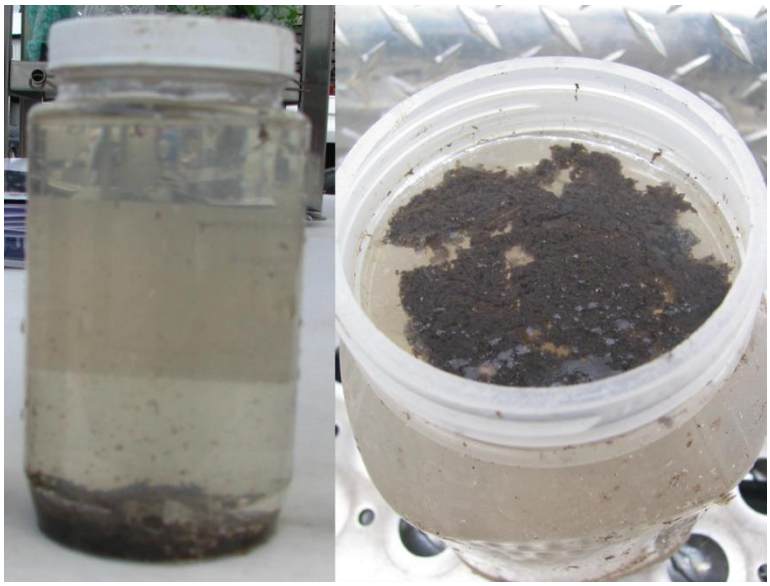

Figure 2: Examples of sedimentation (left) and creaming (right)

Horizontal Geotube

This demonstration site was previously reported on in "Technology Investigation: Filter Bags". Several samples were taken over the course of the day including three grab samples at the beginning, middle, and end as well as a composite sample covering the entire day. The composite sample showed the horizontal Geotube reduced the total suspended solids (TSS) concentration by 98% (Figure 3, Table 1). The grab samples showed a decrease range of 82 – 92%.

The existing solid removal technology at this site is a 2-cell settling tank system. The average decrease in TSS achieved by the tanks is 43% (27 samples), as shown in Figure 3 and Table 1.

Hanging Geotube

Two identical hanging Geotubes, referred to as 'filter bags', were installed a different vegetable washing operations. One was fitted with a chemical dosing system while the other operated with no added coagulants and flocculants. The TSS was decreased by 91% and 50% with and without chemical addition, respectively (Table 1).

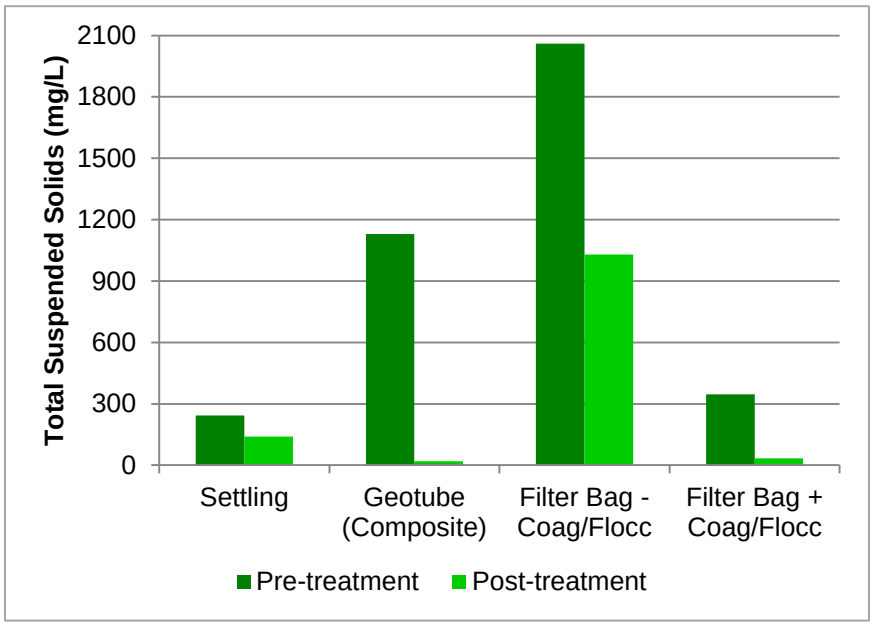

Figure 3: Reduction in total suspended solids (mg/L) by two treatments with no coagulant & flocculent addition (settling and filter bag) and two treatments with coagulant and flocculent addition (Geotube and filter bag). Date values are available in Table 1.

Dissolved Air Floatation Unit

A dissolved air floatation (DAF) unit works by injecting pressurized air into a water stream which is then mixed with incoming wastewater that carries solids. The dissolved air is no longer pressurized and comes out of solution in tiny bubble form. These bubbles attach to solids and cause them to cream. The solids can then be removed by skimming. If the solids need assistance floating, chemicals can be added to induce floc formation.

In this situation, a DAF unit was not functioning effectively due to improper flocculent addition. By manipulating the placement of the dosing and the product being used, solids were creamed and the unit began to perform properly.

Table 1: Results for total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorus (TP) and carbonaceous biological oxygen demand (CBOD) from four tests, two treatments with no coagulant & flocculent addition (settling and filter bag) and two treatments with coagulant and flocculent addition (Geotube and filter bag)

		Settling	Geotube (Composite)	Filter Bag	
				– Coag/Flocc	+ Coag/Flocc
TSS	Pre-treatment	243	1130	2060	347
	Post-treatment	139	19	1030	33
TKN	Pre-treatment	3.7	13.0	110	16.6
	Post-treatment	3.6	2.3	43	5.3
TP	Pre-treatment	1.1	2.6	8.6	2.7
	Post-treatment	0.8	1.0	5.7	0.7
CBOD	Pre-treatment	55	154	601	199
	Post-treatment	47	120	392	207

Conclusion

When trying to remove solids from water, one technology may not be sufficient. In the case of muck soils, additional effort is necessary to create flocs which can be successfully separated from water.

There are several factors to consider when installing a coagulation and flocculation system including placement of dosing, chemicals used, and solid separation strategy. A dosing system that is too close to the removal technology will not allow enough time for the coagulation and flocculation processes to occur which will result in wasted product and cause inefficiencies. The product used should match the solids removal strategy; for example, a skimming system must be used in conjunction with flocs that float. Due to the complex nature of coagulation and flocculation and the amount of different products available, it is best to involve an expert when considering this technology for water treatment.

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