Measurement of the Parameters Affecting the Formation and Breakage of Flocs

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ABSTRACT

Sediment in stormwater from construction site runoff consists of particles having a variety of sizes. Fine particles such as fine silt, clay, and colloidal particles remain in suspension and in many cases cannot be effectively removed by conventional sediment control practices. The US EPA is targeting fine silt, clay, and colloids in stormwater as primary pollutants. Some methods that can be employed for removal of the fine sediments from the runoff are gravitational settling, flocculation, filtration and/or a combination of these processes. The objective of the project is to estimate the coagulation factor and the breakage coefficient for three different soil-flocculant combinations, which are required to model the influence of flocculation on removal of sediment from stormwater runoff. An apparatus has been developed and tested to measure the variables required to estimate these parameters. A mathematical model based on the research work done by Krishnappan & Marsalek (2002) was used to estimate the flocculation parameters. The measured inputs to the model for estimating the parameters are: particle size class distribution, turbulent diffusion coefficient, sediment input mass flow rate (in l/min), flow rate of water (in l/min), suspended sediment concentration at various sampling stations (in g/L), mass of suspended sediment in reactors at the bottom of the sedimentation basin (in g), and mean square turbulent velocity (in cm/s). The experimental setup consists of a constant head tank, a rectangular flume with sampling ports, flocculant injection, soil separating flume, slurry tank, and oscillating grids. A constant head tank feeds water to a flume at constant flow rate of 170 l/min. The rectangular flume is 9.1 m long, 0.15 m wide and 0.46 m deep. The flow depth on the flume is set at 0.3 m. Sediment was injected in form of a slurry with sand-sized particles removed. The sediment slurry was stored in a tank and kept well mixed by pass-through circulation and a rotating mixer. Flocculant was injected using a peristaltic pump; the concentration of the flocculant in the flume was maintained at 0.05 g/L. This concentration was determined using jar tests to optimize flocculation. An oscillating grid assembly was used to induce turbulence with a known velocity gradient. Ten sampling ports were used to sample the suspended sediments in the flow. A known concentration of sediment flow was injected into the flume and mass balance equations were used to determine the rate of flocculation. The particle size class distribution of the input slurry was predicted separately using the pipette analysis. An acoustic Doppler velocimeter (ADV) was used to measure the turbulent velocities. The coagulation factor and the breakup coefficient, estimated from the mathematical model are expected to be constant. These can be used by storm water practitioners to model the sediment removal characteristics depending upon various types of soil and flocculants.

KEYWORDS. Flocculant, stormwater, coagulation factor, breakup coefficient.