# Bio-Based Coagulation and Flocculation Systems to Treat Contaminants in Concrete Washwater

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Worldwide, concrete is the most commonly used construction material. The United States Environmental Protection Agency prohibits the discharge of wastewater from washout of concrete, unless managed by an appropriate control.[1] Concrete washwater contains high levels of alkalinity, due to the dissolution of the limestone used in cement production.[2] Concrete washwater contains high levels of chlorides and heavy metals, derived from its cement, slag, and stone components, as well as its additives, which can include plasticizers, chloride accelerators, water reducers, and air entrainers. The Alabama Department of Environmental Management lists specific standards for discharge of effluents and includes specific regulations on pH (between 6.0-8.5) and Total Suspended Solids (TSS) (no greater than 50 mg/L).[3] Materials like bentonite and polymeric flocculants like polyaluminum chloride (PAC) and polyacrylamide (PAM) are used to flocculate undesirable particulates from the washwater mix, allowing for easier separation and disposal. While effective, these materials are derived from inherently unsustainable mining operations and energy-intensive refining methods.[4]

In a continuation of previous research on the composition of concrete washwater,[2] an analysis was performed on the potential for citrus-derived pectin to serve as a flocculant for concrete washwater. Pectin is a complex polysaccharide that can be found in the cell walls of plants, and commercially, is often derived from citrus plants like oranges. Citric acid is a weak acid that is naturally occurring in citrus fruits, especially lemons and limes, as well as oranges and grapefruits. A crucial aspect of this research was mimicking the construction job-site environment on a laboratory scale. A custom-built, scaled-down concrete hopper was used, along with an electric concrete mixer, and a pressurized water sprayer to wash down the hopper. Washwater was extracted using a vacuum pump and washwater characterization was carried out within 7 days of concrete batching. Measurements of pH, TSS and total dissolved solids (TDS) were conducted on samples. The flocculation ability of dry citrus pectin was compared with bentonite in powder form, and citric acid was utilized to neutralize solutions.

A variety of arrangements of citric acid and flocculant (bentonite or citrus pectin) additions were tested, in varying orders. It was found that both bentonite (BTo) and citrus pectin (CPo) did have a flocculating effect of the concrete washwater, though not to a sufficient extent to reduce TSS below the regulated maximum of 50 mg/L (Figure 1). Additionally, citric acid (CA+BT-seq) appeared to prevent settling of the concrete washwater suspension, countering the flocculant effectiveness and inhibiting the natural settling of the solution. Neither bentonite nor citrus pectin was found to have any significant effects on washwater pH. It was found that by utilizing a two-step additive process of flocculant addition, then sample extraction followed by citric acid addition (BT-sep-CA and CP-sep-CA), washwater could be both effectively flocculated and neutralized to TSS and pH values within the regulated standard ranges (Figure 1). A better understanding of the interactions between pectin, the many components of concrete washwater, and the washwater alkalinity may allow for a more finely tunable procedure for concrete washwater remediation.

## Statement of Research Advisor

During this project, Philip has investigated colloidal stability and bio-based flocculation strategies for concrete washwater in lab settings. This work really advances our understanding of the system so we can move forward with field trials that has great potential for alleviate environmental concerns related to the construction industry.

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## References

1.Office of Water, Office of Wastewater Management, & Water Permits Divison. (2010, April). MS4 Permit Improvement Guide (EPA 833-R-10-001). U.S. Environmental Protection Agency.

2. Street, P., & Holley, P. W. (2019). Alkalinity of Concrete Washout Water: A Pilot to Determine Jobsite Conditions for Potential Neutralization. In Creative Construction Conference 2019 (pp. 619-624). Budapest University of Technology and Economics.

3.Discharge and monitoring Requirements –Existing and Temporary Facilities (*Alabama Department of Environmental Management*, 2019)

4. Eisenhour, D. D., & Brown, R. K. (2009). Bentonite and its impact on modern life. Elements, 5(2), 83-88.

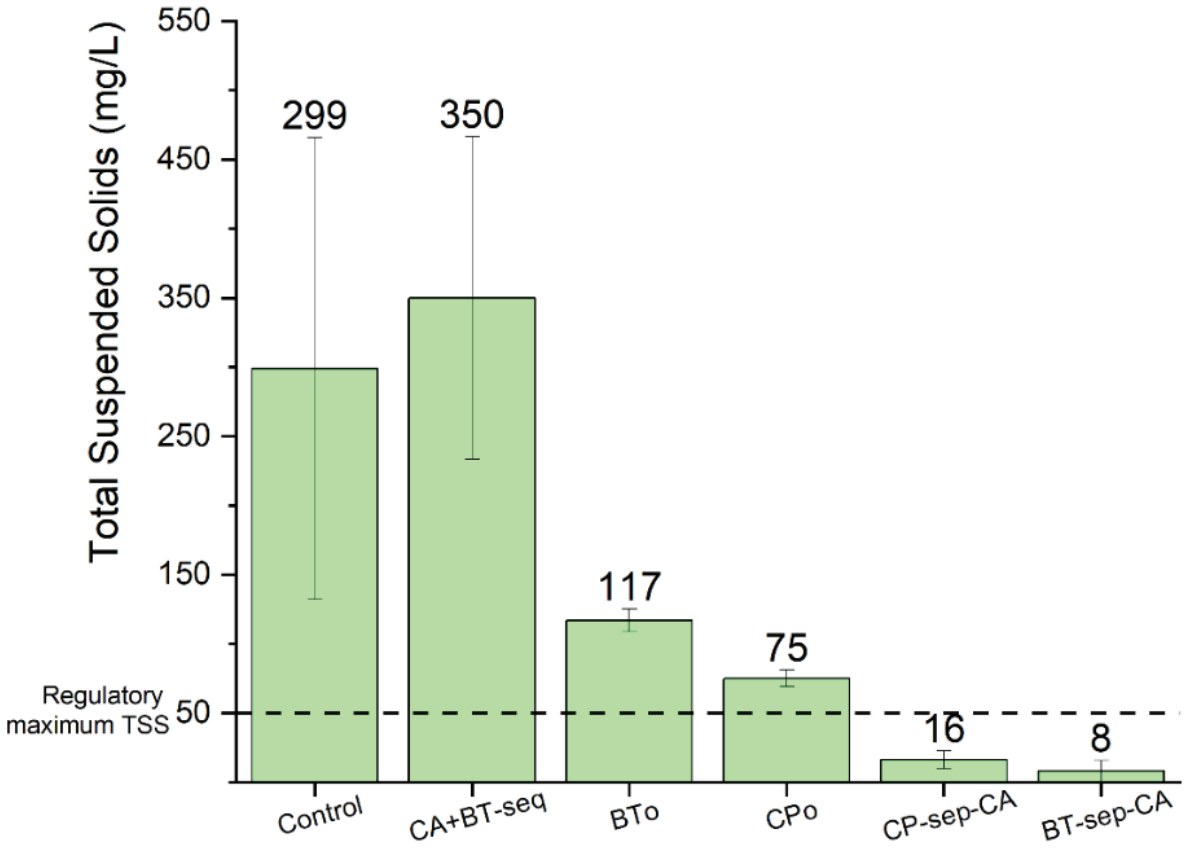


**Figure 1:** Total Suspended Solids of selected samples – (CP: citrus pectin, BT: bentonite, CA: citric acid).