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Efficient removal of nano-plastics from water through enhanced coagulation

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Motivation

Improvements in water treatment processes are required to tackle the upcoming challenges in water and wastewater due to the influx of emerging contaminants. One such emerging contaminants, nano plastics, are plastic materials within a size range of 1-100 nm, formed when larger plastics disintegrate due to mechanical wear, photo-oxidation, or fragmentation (see Figure 1). Due to their minute and variable sizes, these nano particles have high mobility, form stable colloids, and can serve as substrates for transporting disease-causing organisms in water[1-2]. Removal of nano-plastics from water poses a significant challenge to current water treatment plants. Conventional physico-chemical processes such as coagulation, flocculation, and settling are not able to effectively remove these plastics from water during treatment. This results in the adoption of costly additional treatment steps such as membrane and adsorption technologies.

Technological challenge

Coagulation involves the addition of chemicals to destabilize suspended particles in water. Once destabilized, suspended particles coalesce to form bigger aggregates that can settle. This happens under various conditions of pH, coagulant dosage, and mixing rates. Conventional coagulation/flocculation technologies have been optimized towards the removal of larger sized particles from water while smaller sized ones (1-100 nm), in most cases, escape the coagulation/flocculation stage.

To solve this problem an enhanced coagulation/flocculation approach will be developed. This process involves the improvement in conditions of coagulation/flocculation and/or the development of novel coagulation aids to improve the settleability of the nano-plastics[3].

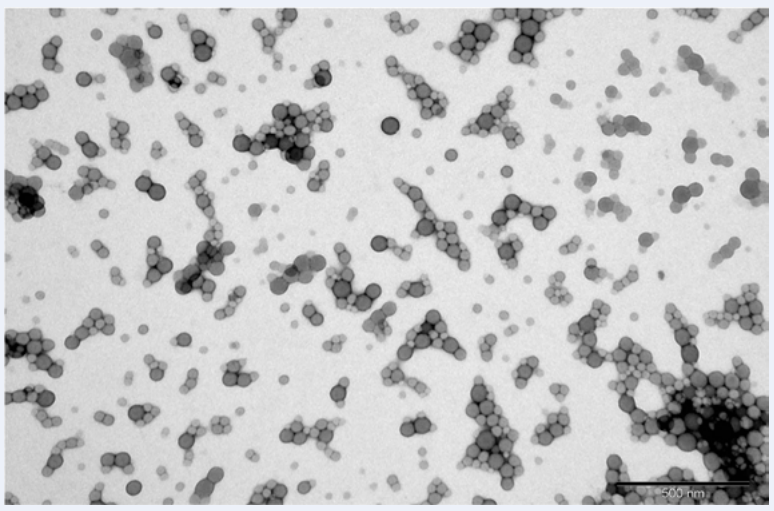

Figure 1. Image of nano-plastics. Source: https://www.wur.nl/en/Dossiers/file/Microplastics-and-Nanoplastics.htm

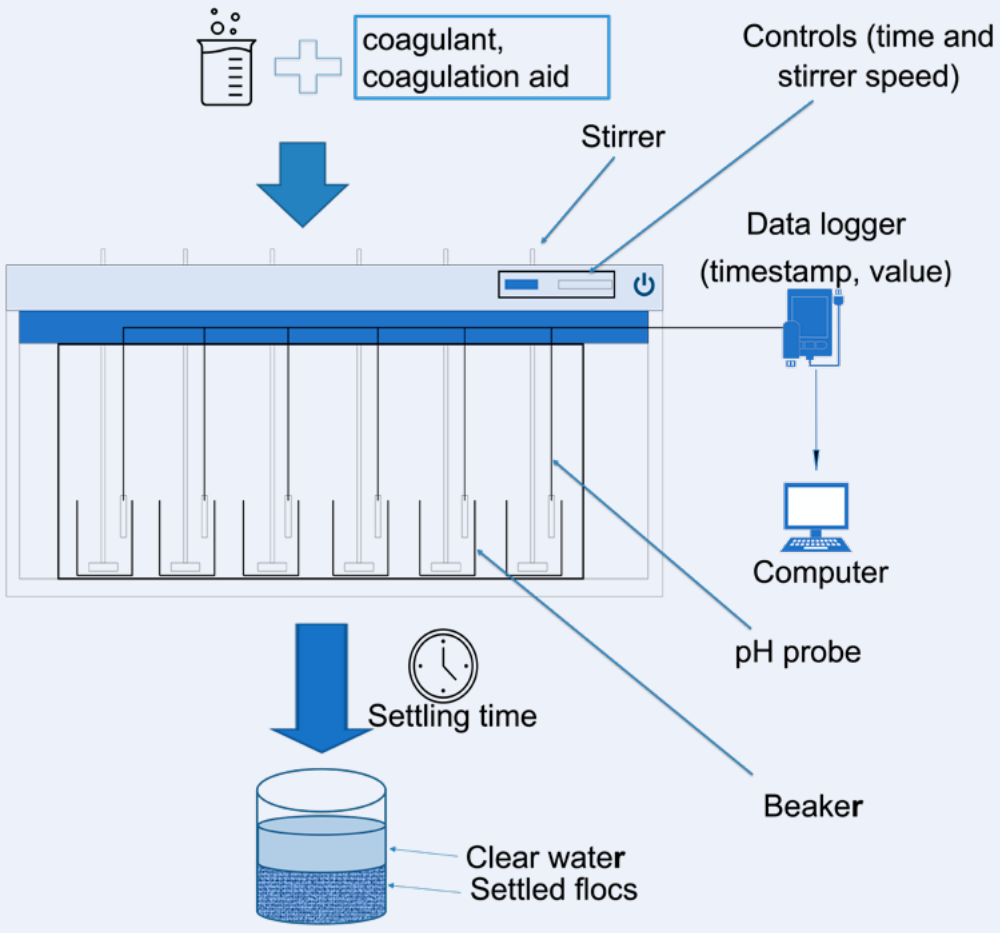

Figure 2. Set-up for enhanced coagulation experiment. Different coagulant and/or aid dosages are added to water samples spiked with nano-plastics under variable pH values and mixing rates.

Research goals

The project objectives are to

- Assess nano-plastic removal from water using conventional coagulation/flocculation processes to understand the gaps in the process (see Figure 2).
- Explore different types of coagulation aids, combining them with commercial coagulants and assessing their efficiency for nano-plastic removal.
- Explore the development of eco-friendly polyelectrolytes as coagulation aids aimed at nano-plastics.
- Larger-scale testing of the developed enhanced coagulation process.

References

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[2] Ma, B., et al. (2019). “Characteristics of microplastic removal via coagulation and ultrafiltration during drinking water treatment.” Chemical Engineering Journal 359: 159-167.
[3] Zhang, Y., et al. (2021). “Enhanced removal of polyethylene terephthalate microplastics through polyaluminum chloride coagulation with three typical coagulant aids.” Science of the Total Environment 800: 149589.

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