μSeize

Microplastic Capture in Municipal Wastewater Treatment

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WATERLOO | ENGINEERING

ENGINEER OF THE FUTURE FUND

PROBLEM

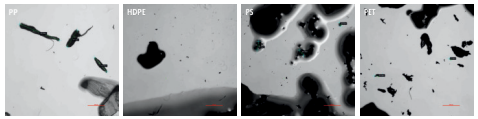
89% of plastics end up as litter or in landfills and break down into microplastics

Microplastics smaller than 20μm bypass standard filtration

Unknown health risks to prolonged microplastic exposure

How can we capture and remove microplastics that evade standard water filtration systems?

BACKGROUND



"...a multistage system, consisting of an electromagnet with on/off capabilities and a sonicator would be ideal for [...] binding, separation, and recycling of iron oxide NPs" - Leisha M. A. Martin et al, 2022

CLIENT SPECIFICATIONS

- Remove **98%** of microplastics
- Iron levels post filtration **<300μg/L**
- Filters common microplastics
- **3** reuse cycles of Iron NPs
- Maximum **15 minute** cycle
- **2%** iron NP to microplastic ratio

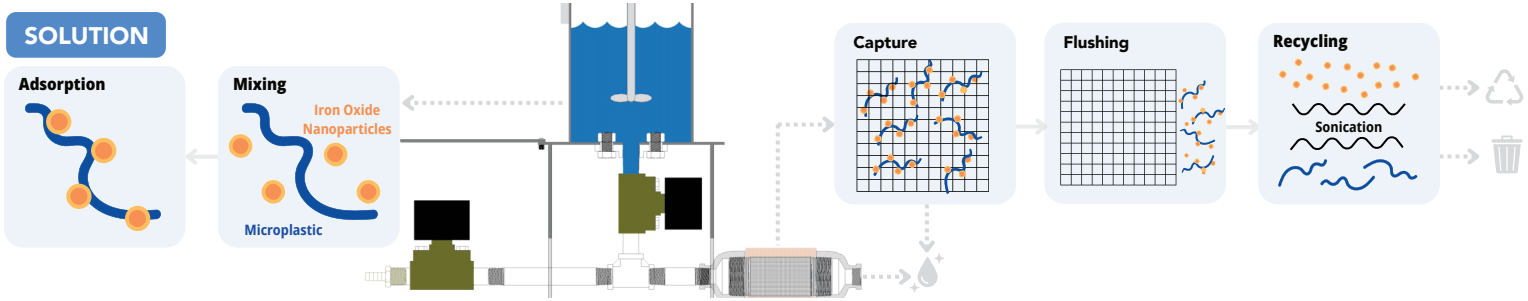
UNITED NATIONS SDGs

3 GOOD HEALTH AND WELL-BEING — Committed to decreasing health hazards linked to microplastics pollution

6 CLEAN WATER AND SANITATION — Dedicated to eliminating microplastic pollution in water sources

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE — Aims to create scalable technology to upgrade water treatment infrastructure

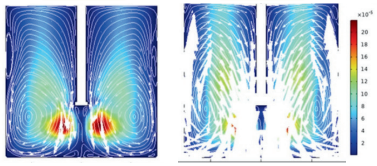
SOLUTION



DESIGN

PROPELLER PARAMETERS

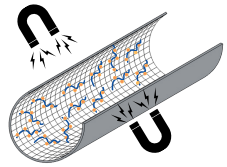
Eddy Diffusion (m^2/S)



Poor mixing below 240 RPM.
Microplastic shearing at 960 RPM.

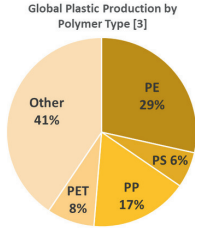
CAPTURE DESIGN

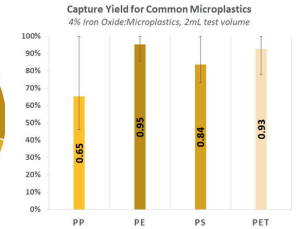
External Magnet Coupled with Ferromagnetic Mesh Lining

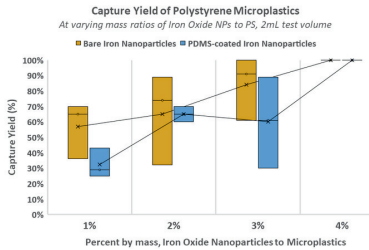


Mesh is magnetized, enhancing surface area and enabling capture of up to 98%.

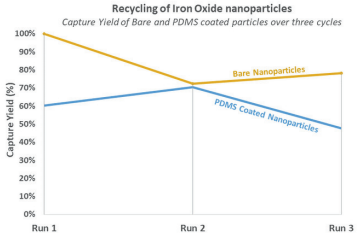
VERIFICATION







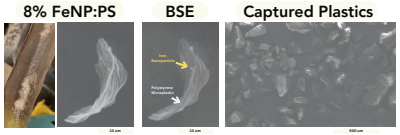
Highest capture efficiency at 4% FeNP:MP



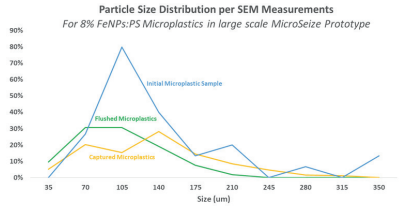
Iron oxide nanoparticles can be recycled

RESULTS

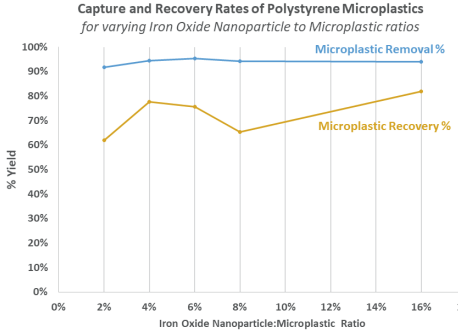
SCANNING ELECTRON MICROSCOPE



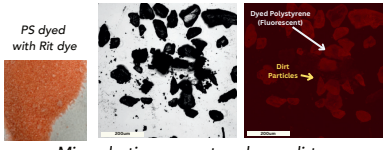
Particles smaller than 20 um are captured



LARGE SCALE TEST RESULTS



FLUORESCENCE MICROSCOPY



Microplastics are captured over dirt

POLYSTYRENE MAX CAPTURE YIELDS

2% FeNPs by mass, 50 mL test volume, 1 g/L PS microplastics

100% in MilliQ water with bare FeNPs
76% in MilliQ water with PDMS coated FeNPs
99% in hard tap water with bare FeNPs
87% with dyed microplastics and bare FeNPs

NEXT STEPS

1. Shift reactor design from lab-scale batch to continuous flow operation
2. Improve recyclability of iron oxide nanoparticles
3. Evaluate capture in alternate waste streams

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