Acoustic Filtration II: Scaling an Ultrasonic Microplastic Filtration Device and Exploring the Physical Phenomenon of Acoustic Blocking

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Microplastics have become a prevalent global environmental issue, with an estimated 75 trillion microplastics in the oceans today. MPs pose dangers to wildlife and cause serious health issues for humans. Existing microplastic removal methods are limited because of high expenses or potentially hazardous chemicals; consequently, a non-invasive, energy-efficient, and cost-effective solution is necessary. Previously, a novel ultrasound filtration system constructed with piezoelectric transducers was able to successfully filter microplastics at speeds of up to 40 mL/min with an acoustic blocking effect, where microplastics would be prevented from passing through the device and clean water would be able to flow through. In this year's study and new experimental setup, the device was upscaled, successfully filtering polyethylene and polystyrene microplastics of sizes 20-200 μm, with 20 μm being ten times smaller than any particle used last year. Tube diameters of 0.96, 2.1, and 3.8 cm were tested with polyethylene as both one-stage and two-stage designs. At flow rates of 40-200 mL/minute, the two-stage 0.96 cm device had filtration efficiencies of 82.5-96.2%. With the two-stage 2.1 cm tube, speeds of 40-300 mL/minute were tested and found to be effective, reaching efficiencies up to 96.5%. An automated microplastic retrieval and cleaning system was also implemented to facilitate a more streamlined filtration process. Furthermore, the acoustic phenomenon was further explored—the researchers believe that the ultrasonic waves create an increased pressure gradient within the device that blocks particles from passing. With its robust abilities of intercepting source pollution and cleaning contaminated waters, this device can be extended to remove other particle pollutants.

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