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Dynamics of microplastic fiber mobility in a periodic porous media: Experimental results and numerical simulations

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Microplastic fibers (MPFs) are the largest kind of microplastic in the environment by mass and their presence has been identified on every continent and ecosystem on the planet. MPFs are known to pose a threat to aquatic species and worms but impacts on larger animals and humans are largely speculative, in no small part to the difficulty in quantifying the dynamics of how these non-dissolved, colloidal masses move. The objective of this work was to advance our basic knowledge regarding how simple kinds of MPFs move through porous media using a combination of experimentation and numerical simulation. Pseudo-2d flow chambers, termed "meso-models,"were created as oversized analogs of micro-models that were big enough to inject fibers into a controlled flow field. High fluorescence MPFs were injected into the flow between an opaque backing and a clear polycarbonate top sheet, the flow was subjected to UV light, and the MPF paths through the periodic pore meso-model were captured directly using HD video. Image processing extracted the trajectories providing position and time from which both breakthrough curves and velocity statistics could be extracted. Numerical simulations of the experiments using the known pressure gradients and flow rates from the experiments were constructed and a bead-rod chain model of MPF migration [1] was tested against the experimental results. The numerical and experimental results showed strong similarities, differing mainly by variations that can likely be attributed stochastic fluctuations. These results are the first direct capture of MPF dynamics in any porous media and the encouraging agreement with the numerical results suggests that, despite their extraordinary complexity, predictive modeling of MPF dynamics is feasible, which will be essential for realistic risk assessment of any direct or indirect hazards posed by MPFs.

Participation

In-Person

References

[1] Engdahl, N.B. (2018) Simulating the mobility of micro-plastics and other fiber-like objects in saturated porous media using constrained random walks, Advances in Water Resources, 121, p.277-284, doi: 10.1016/j.advwatres.2018.08.011

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