MSc project
A new method for water purification

Introduction

Water purification is the removal of undesired substances from water; these include suspended particles, chemicals, gases, and biological matter such as parasites, bacteria, algae, or viruses. Especially the removal of (biological) particles from fluids is not straightforward, as it requires a physical mechanism that displaces the particles relative to the fluid. The main methods currently used are filtration, sedimentation, and flocculation.

An important drawback of these methods is that they rely on direct contact of the fluid with a solid material (i.e. the filter), which eventually leads to contamination or clogging. Contact-free separation methods would thus be highly desirable.

An alternative: Exclusion zone formation

In exclusion zone formation, particles suspended in water are repelled from an interface over long distances. This effect has been observed near various surfaces and in various research fields, but its physical origin has remained unclear. We have recently demonstrated [1] that Exclusion Zone (EZ) formation is caused by a combination of ion-exchange at the surface, diffusion of ions, and diffusiophoresis [2] of particles in the resultant ionic gradients. As a result of this new understanding, we should now be able to make use of the effect in separation technology and water purification.

Project

This project follows up on a currently running MSc project (student: Jorn Broers), where proof-of-principle water purification devices based on exclusion-zone formation are being built and tested. The developed fabrication methods and theoretical knowledge forms the basis for the current project. The main goals of your project are:

• Comparison of different microfabrication approaches to achieve solid device operation with simple and repeatable fabrication method.

• Optimization of devices for operation at higher throughput (by parallelization of devices, optimization of channel geometries).

• Testing of water purification devices on biological ‘particles’ (i.e. bacteria, virus capsules), in collaboration with the Wetsus water research center, Leeuwaarden.

Figure 1: Exclusion zone formation near a PVA hydrogel: Particles are expelled from the near-surface region.

Figure 2: Operation of water purification device. (A) Schematic: In channels with an active surface (Nafion) on one side, particles are pushed across the channel. At the outlet of each channel, purified and polluted streams are separated by a simple splitting of flows. (B) Microscope image from a device currently employed in our lab.


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