Nature Reviews Chemistry | Published online 24 May 2017; doi:10.1038/s41570-017-0049

WATER PURIFICATION

No-filter filtration

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Everyone needs an abundant supply of clean water, but not everyone has it. Constant efforts are being made to improve water purification processses to satisfy the growing global demand for clean water. One such effort, described by Howard Stone and co-workers in *Nature Communications*, has provided a technique that uses CO_2 — not a filter — to produce pure water.

Ordinarily, particles suspended in water are removed using filtration or sedimentation. Although filtration has proved promising for water purification, it is costly because the membranes must be periodically replaced and efficient pumps are required to generate the necessary pressure. Sedimentation does not require a membrane but instead uses an external force to induce the agglomeration. In a static suspension, this could be the force applied, for example, in a centrifuge. In flow, however, Stone and co-workers recognized that a chemical gradient could provide the necessary force.

Dissolving CO_2 in water gives H^+ and HCO_3^-, which can be used to produce a chemical gradient and a diffusion potential of about 92 mV — much larger than the potential generated by the dissolution of common salts, such as NaCl or KCl. "This high diffusion potential can control the motion of charged particles suspended in a liquid, so we realized that this approach would create opportunities for cleaning particulate materials from water in ways that did not involve traditional filtration," explains Stone.

The device that was designed and tested by Stone's group comprises a channel in which an aqueous suspension flows and is exposed to a transverse flow of CO_2. The ion concentration gradient thus generated induces a charge redistribution on the surface of the suspended particles, such that they move in a direction perpendicular to the water flow — so-called diffusiophoretic motion. The particles accumulate on one side of the pipe and can then be isolated by simply splitting the flow at the end of the channel. "Diffusiophoresis — the directed motion of particles exposed to a concentration gradient — is an out-of-equilibrium effect that is not well known to those outside of this specific field," notes Stone. "However, it appears to be an important process for controlling and manipulating colloidal materials."

"Our approach, which uses a transverse field in a continuous flow process to manipulate the position and transport of particles, is a modern variant of traditionally known field flow fractionation. As far as we are aware, no one has previously suggested using these controlled chemical gradients for removing particles in a continuous flow process, which is the key to thinking about particle removal without filtration," explains Stone. This proposed membrane-free purification technique would require significantly less energy than the filtration methods currently in use. The effective use of CO_2, an abundant pollutant, would prevent the use of more aggressive chemicals for the removal of bioparticles, such as viruses and bacteria, which are usually charged and therefore easily influenced by a diffusion potential. However, some unanswered questions still remain, and time will tell how scalable this method will be and how well it will perform for more complex solutions. One thing that is unquestionable is how attractive such a process would be as part of a sustainable and effective approach to purifying water.

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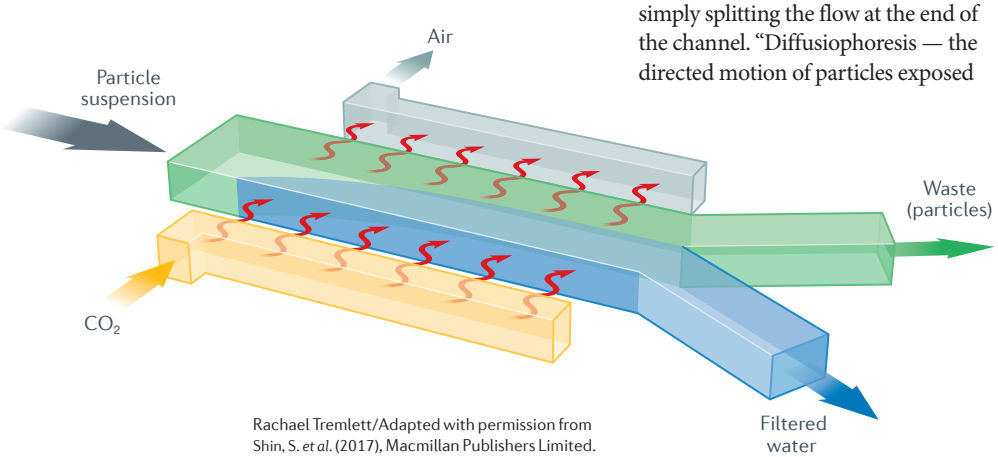

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ORIGINAL ARTICLE Shin, S. *et al.* Membraneless water filtration using CO_2. *Nat. Commun.* **8**, 15181 (2017)