Improved waste separation using super-stable magnetic fluid

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Two magnetic fluids with a magnet in the middle. Left: a non-stable magnetic fluid, where the magnetic particles in the fluid are drawn towards the magnet. Right: a fluid that does remain stable in a magnetic field. Credit: *Journal of Physical Chemistry Letters*. 2020 American Chemical Society

Magnetically separating waste particles makes it possible to reclaim a variety of raw materials from waste. Using a magnetic fluid, a waste flow can be separated into multiple segments in a single step.

Researchers from Utrecht and Nijmegen have now succeeded in creating a magnetic fluid that remains stable in extremely strong magnetic fields, which makes it possible to separate materials with a high density, such as electronic components. The results have recently been published in *The Journal of Physical Chemistry Letters*.

Magnetic density separation

When you drop a stone and a wooden ball into a basin of water, the stone will sink while the ball floats on the surface. This is because the two objects have different densities: the stone is more dense than the water, while the wood is less dense. That principle is also used in magnetic density separation (MDS), except that instead of using water—which has a fixed density—it uses a magnetic fluid with an effective density that can change in relation to its distance from a magnet: it has a higher apparent density at less distance to the magnet. As a result, waste particles of different densities float at different depths in the fluid.

Current application in plastics.

The MDS technology, which was developed in the Netherlands, has been used in Amsterdam to sort a variety of plastics since late 2019. Before, the plastics had to be separated by hand or by spreading small pieces of plastic in a normal fluid, where some pieces would float and others would sink. This is a relatively expensive method, due to the manual labour involved or the coarse separation into only two densities. MDS separates the waste into multiple sections in a single step, and has a relatively high degree of accuracy, so the various types of waste plastic can be re-used to produce new, high-quality plastic products. This makes the technology more economically viable.

Super-stable magnetic fluid

In order to make MDS applicable to materials heavier than plastic, such as electronic components, much stronger magnets are needed, together with new magnetic fluids that do not disintegrate in such a strong magnetic field. The researchers have now proven that it is indeed possible to create such super-stable magnetic fluids. These fluids consist of water with minuscule nano-particles of iron oxide. The proper preparation of the magnetic fluid makes it behave like a fluid magnet, while the magnetic particles in the fluid are not pulled out by the magnet itself.

More information: Alex M. van Silfhout et al. Colloidal Stability of Aqueous Ferrofluids at 10 T, *The Journal of Physical Chemistry Letters* (2020). DOI: 10.1021/acs.jpclett.0c01804

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