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The magnetic attraction of recycling plastics

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Plastic ready to be recycled. © Moreno Soppelsa/Shutterstock

Magnets and nano-sized magnetic particles could help to change the way plastics are sorted for recycling, saving billions of euros in raw material imports, and providing new tools to erode Europe's mountains of discarded plastic.

Improving the automated sorting of plastic thrown out by consumers could ensure a lot more is recovered and recycled, reducing the amount that ends up in incinerators or simply in landfill.

Magnetic density separator technology holds out the prospect of sharply reducing the cost of sorting plastic packaging, particularly in household waste such as drinks bottles, yoghurt pots, and soap dispensers.

The breakthrough technology works by mixing confetti-like flakes of shredded plastic waste into a magnetic liquid and running the fluid past a magnet to sort it into polymers of different densities. These can then all be recovered separately.

'This process is so special because you throw in the mix, and in one go it is separated into five different materials,' said Prof. Peter Rem of the Technical University of Delft in the Netherlands.

Prof. Rem is the scientific coordinator of the W2Plastics project, a 12-member EU-funded consortium of research institutes and industry partners set up to find a commercially viable technology for separating polyolefins. Also known as polyalkenes, these are the waxy or oily-feeling plastics often used in packaging and represent nearly half of the plastics made in Europe. They are not biodegradable and must be pure to be recycled.

While industrial leftovers from plastics manufacturing has been recycled for decades, the goal of W2Plastics is to unlock post-consumer waste – a source of recyclable material that is up to 10 times bigger and includes household rubbish, scrapped cars, and electronic goods such as old mobile phones and computers.

New plastic from old

In mixed form, the waste has little use. However, once it is separated, it can be reused as a cost-effective raw material for new plastics, potentially saving billions of euros spent each year on the oil imports used to make about 50 million tonnes of synthetic polymers in Europe. Some two kilograms of oil is needed to make each one kilogram of plastic.

But there are many different kinds of synthetic polymers, some differing only very slightly, and most methods used for recycling them are slow, complicated, and costly.

W2Plastics has shown the viability of magnetic density separation, where flakes of shredded plastic such as polyethylene or polypropylene are mixed into a magnetic fluid made by adding iron oxide to water.

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The iron oxide particles are so small – about five nanometres across – that they are suspended in the liquid and do not simply fall to the bottom of the container.

To separate plastics denser than water, the mixture of flakes and fluid is then passed over a magnet, which gently attracts the iron oxide, increasing the weight of the nearby liquid. The flakes passing through the container flow into distinct layers that match the densities of the different types of polymer. They can then be sucked away with pumps at different heights. The process is similar for plastics less dense than water, but the magnet is placed on top, reducing the weight of the nearby liquid.

'In a magnetic field and a magnetic liquid, the plastic particle will get to a certain equilibrium distance from the magnet – precisely that distance where the combination of gravity and the magnetic force on the liquid just balance the weight of the particle,' Prof. Rem said. 'It's strange to see, actually.'

800 euros per tonne

The W2Plastics consortium has demonstrated the profitability of the scheme. It costs about EUR 2 million for the sorting unit, while the cost of the separation process is less than EUR 100 per tonne, way below the market price for a tonne of recovered polymer of about EUR 800.

One of the partners, Urban SA, is implementing the technology in Romania, while other potential users are assessing its efficiency and economic viability.

Research is also under way into using magnetic density sorting for heavy plastics, such as polystyrene and PET mixtures, and even for shredded metals from electronic waste.

The W2Plastics consortium is awaiting an assessment by the European plastics recyclers' industry later this year under the separate EU-supported REMIX project to evaluate various available polymer treatment technologies.

Prof. Peter Rem of the Technical University of Delft in the Netherlands. Image courtesy of W2Plastics.

Other research has been done to reduce the cost of cleaning plastic waste before sorting, to remove dairy slime, or old shampoo or paper labels, using a minimum of water and energy. Processes to convert sorted flakes into useful polymer beads have also made good progress.

But post-consumer plastic processing still faces major logistical challenges in ensuring waste is collected efficiently and recycling facilities are in the right places.

At present, Europe only makes about EUR 2 billion of recycled polymer each year, compared to its total plastic production turnover of about EUR 100 billion.

Prof. Rem is optimistic that magnetic density sorting will help to improve the situation. 'Slowly, primary polymers will receive a smaller share of the market, I think that is inevitable. That is what we want in Europe and that is what is going to happen,' he said. 'In reality, it will not happen in a day, it will take a large number of years, but the basics are there now.'

More info

W2Plastics

Urban SA