SUSTAINABILITY

Chemical recycling: the formula for plastic waste?

As the agendas of the circular economy and climate action converge, some experts think chemical recycling could help the plastics sector adjust to a sustainable future

Jim McClelland

Chemical recycling offers a tantalising prospect: the ability to break down plastic into its constituent parts. Could it be the answer to plastic waste?

Also known as advanced, feedstock or tertiary recycling, the process creates new chemicals and plastics, with the same high quality and performance characteristics as virgin raw materials. It can tackle problematic packaging materials such as films, laminates and polystyrene, which do not currently meet the criteria for kerbside recycling and go straight in the bin.

Chemical recycling is a more sustainable option than last-resort incineration or landfill, says Yoni Shiran, partner at systems change company Systemiq. These pyrolysis-based chemical recycling technologies – which typically use thermal degradation in the absence of oxygen to convert plastic waste back into a gas or liquid oil – are suitable for common types of packaging made from polyethylene or polypropylene, he says.

"Studies show that scaling these up as a solution for hard-to-recycle plastic waste would lead to lower greenhouse gas emissions than relying on waste-to-energy incineration."

A key investment driver for all players with net-zero targets in the plastics industry is this potential for carbon reduction compared to other waste disposal options, says Marc van den Biggelaar, director of advanced recycling EMEA and APAC at materials-science giant Dow.

"Advanced recycling processes are expected to save approximately 1.5 tonnes of carbon dioxide per tonne of plastic recycled, compared to incineration," he explains. "The CO_2 emissions inherent in advanced recycling will definitely come down as we see greater investment and adoption of the technologies, which are evolving at pace."

Can chemical recycling really solve packaging's problem with plastic waste? It already has the backing of big brands such as Colgate Palmolive, PepsiCo and Mars, which are among the signatories of an open letter from the Consumer Goods Forum that expresses support for the development of sustainable solutions to chemical recycling.

The letter, issued to suppliers, regulators and investors by the Coalition of Action on Plastic Waste, calls for 800,000 tonnes of chemically recycled plastics a year by 2030.

PlasticsEurope, the trade association representing manufacturers, forecasts that planned chemical recycling investment will almost triple in the back half of this decade, from €2.6bn (about £2.2bn) in 2025 to €7.2bn in 2030.

According to recent analysis by BloombergNEF, the US has become a net importer of plastic waste for the first time. This is primarily because of the combination of rising domestic demand linked to the programme to build new chemical recycling plants in the company.

It's not surprising that big names in plastics and packaging have started making their moves.

In France, US chemical company Eastman has identified a site in Normandy as the preferred location for its planned $1bn (around £800m) investment in a molecular recycling plant. The project is set to create employment for approximately 350 people and lead to an additional 1,500 indirect jobs in recycling, energy and infrastructure.

Across Europe and the US, Dow is working with technology partner Mura to add as much as 600 kilotonnes of advanced recycling capacity by 2030. Their initial project, in Teesside, UK, is expected to be operational by 2023. This plant will be the first in the world to use Mura's supercritical steam process to convert materials such as flexible and multi-layer plastics, previously deemed unrecyclable.

In 2025, a much larger new Mura facility in Germany will deliver approximately 120 kilotonnes of capacity per annum, co-located on an existing Dow site in Böhlen.

Not everyone is convinced that chemical recycling is the answer. Zero Waste Scotland argues the process should not be classified as recycling at all, labelling much of it as forms of thermal and material recovery, instead.

Broad concerns remain about the levels of emissions involved, as well as market viability, especially given some of the negative perceptions resulting from initial bad press. The news that one of the early UK proponents, Swindon-based Recycling Technologies, was forced to call in the administrators in September has only fuelled the fires of doubt.

We should start by putting chemical recycling back in its place within the packaging waste hierarchy, suggests Shiran.

"The first step is to make it abundantly clear that chemical recycling is not a 'silver bullet' solution to enable ever-growing production of single-use plastics," he insists.

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"Efforts to reduce avoidable uses of packaging, design packaging for recycling, and (where appropriate) move from single-use to reusable or refillable packaging must come first," he adds.

As with any emerging technology, there are also calls for better transparency and data, to provide robust evidence of performance benefits as well as to allay market fears, comments Jack Payne, a PhD researcher at the University of Bath Institute for Sustainability.

"Traditionally, chemical recycling methods have been limited by their cost, energy intensity and emissions, or waste," he says. "Moving forward, it's imperative that life-cycle analysis and techno-economic analysis are included at the outset, to ensure any chemical recycling processes we do develop are actually economic and truly sustainable."

But if market demand stays strong, then investment in R&D will likely follow. Ongoing innovation holds a potential fix for some of the early issues, adds Payne.

"There are a number of ways to improve the sustainability credentials of chemical recycling, for example through sophisticated equipment engineering, such as reactor design," he says. "Another way is through the use of a catalyst, which can help make processes more efficient, cost-effective, less energy-intensive and reduce waste."

In fact, researchers at the Centre for Sustainable and Circular Technologies at the University of Bath have recently developed a new and simple method for the chemical upcycling of polycarbonate waste at room temperature, in the presence of a zinc-based catalyst. Polycarbonates are a robust class of plastics which are commonly used in construction and engineering, so the ability to convert them back into their chemical constituents makes them valuable to recycle.

The bigger question for the packaging sector moving forward arguably does not concern either the technology or the process but its commercial application. There is a risk of unintended consequences, plus the possibility that the plastics recycling industry will knowingly cannibalise itself by using chemical recycling for materials that would have been subjected to more traditional forms of recycling, effectively stealing from one waste stream to feed another.

The challenge is not just to make a business case for chemical recycling, but to make one that is responsible and sustainable in the wider waste context, says Shiran.

"The industry must demonstrate the benefits of chemical recycling and ensure that it fulfils its promise of producing high-quality, contact-sensitive plastics from hard-to-recycle plastic waste, and is not simply competing with mechanical recyclers for supplies." Mechanical recycling essentially means collecting plastic waste and processing it for secondary use without significantly changing the material's chemical structure — and so it can result in lower quality.

There are, though, trade-offs. Chemical recycling processes generally require much higher energy consumption and generate more greenhouse gas emissions than mechanical recycling.

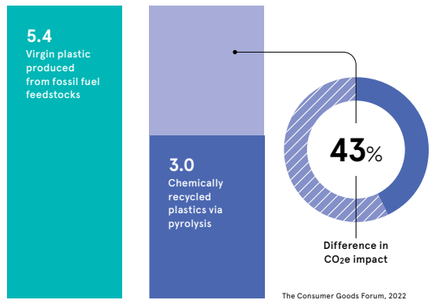
On the other hand, chemical recycling can claim some advantages over mechanical, notably in its ability to repeatedly create recyclate that can compete like-for-like with virgin material, eliminating downcycling – when the secondary material is of lower quality or functionality than the original – and transforming plastic waste into value-added products.

The two recycling methods boast different merits and suit different uses. The hope is that the market can make informed and sustainable choices, concludes van den Biggelaar. "Advanced recycling is critical to getting to net zero. Understanding the complementarity of mechanical recycling and advanced recycling is key – because one should not be at the expense of the other – and enhanced waste sorting will help both types of recycling grow."

Chemical recycling represents a global growth market, for right now and for the future. It might not be the only answer to packaging's problem with plastics but it is undeniably part of the solution. ●

CHEMICAL RECYCLING COULD REDUCE CARBON IN THE PRODUCTION PROCESS

Climate impact of plastics production by method (million tonnes of CO_2e)



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