

Editorial corner – a personal view

Chemical recycling: The silver bullet for plastic waste?

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What science and economy could not achieve is now achieved by political pressure: Polymer recycling has become a core issue of the industry. Negative public perception of plastic waste and the need for circularity with respect to climate change have altered the view of authorities in polymer science on the subject. Still, a too high fraction of polymers produced goes down a one-way street starting at the oil or gas well and ending up in landfills or the environment.

At the same time, the limitations of presently dominant mechanical recycling technologies are obvious, as processing and sorting of post-consumer plastic waste may still generate fractions too contaminated or mixed for virgin-like performance (<https://doi.org/10.1016/j.wasman.2017.07.044>). Chemical recycling, the breakdown of polymers to their building blocks or general raw material, is commonly seen as the escape route from this problem. Numerous projects have been announced recently by major players in the polymer and petrochemical industry: BASF partners up with Quantafuel and Remondis in Europe for 250 kilotons per year [kt/a] of polymer-based chemicals by 2025 ([link](#)), but also with Mitsui in Japan. ExxonMobil has announced a plant with 30 kt/a in the US for 2023. Borealis is planning a ‘ReOil’ plant of 16 kt/a in Austria with OMV by 2023 ([link](#)), but also another unit with Renasci in Sweden.

Various pyrolysis routes to generate fuel or heating gas have been around since Kaminski’s pioneering work in the 1970s (<https://doi.org/10.1002/0470021543.ch17>). The present target, however, is clearly monomers, far less easily to produce in single processes. For economic viability, selectivity and high monomer yield are needed, while limiting energy demand. This is rather easy for some conventional polymers like poly (oxymethylene) and poly(methyl methacrylate),

but rather difficult for poly(vinyl chloride), polyolefins or nylons (<https://doi.org/10.1038/s41578-020-0190-4>). Some authors therefore ask, if we should develop monomer-oriented recycling technologies for the existing commodity polymers, or replace them by easier to recycle polymers. A second question is whether we should forget about mechanical recycling altogether, but focus on chemical recycling alone.

The answer to both questions lies in adding life-cycle and performance aspects to the chemical and engineering considerations (<https://doi.org/10.1002/anie.201915651>). Total energy demand and carbon footprint necessary for societal needs should dominate our considerations, just like the degree to which materials can actually fulfil it.

Re-use and recycling of polymers will in the end need multiple ways in order to approach circularity, starting at system design and material selection, maybe including new polymers. Efficient collection is generally required, but even for chemical recycling some sorting and cleaning is indispensable. Defining input quality for a stable and productive progress is one of the major knowledge gaps in chemical recycling. Finally, a balance between mechanical and chemical routes should assure a minimum energy demand for the overall system (<https://doi.org/10.1002/jctb.5778>).



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