Deep Dive

Breaking Down Chemical Recycling

Ocean Conservancy®

What is chemical recycling?

Chemical recycling (sometimes known as **advanced recycling** or **molecular recycling**) is an umbrella term that encompasses a suite of technologies that use non-mechanical processes to break down plastics. Chemical recycling technologies can be roughly broken down into three categories:

- **Conversion technologies** – These technologies, like **pyrolysis** and **gasification**, use heat and pressure to break the chemical bonds in plastic to produce hydrocarbons such as synthesis gas ("syngas") and crude oils, which are then used as fuel for energy. These technologies have been available at scale for decades and are largely another form of **plastic-to-fuel**.
- **Depolymerization technologies** – These technologies, like **solvolysis** or **methanolysis**, use chemicals break the bonds in plastics to produce monomers (the building blocks for new plastics) or other feedstocks. These technologies are recent innovations and are limited in their use to specific plastics.
- **Purification technologies** – These technologies use chemicals to dissolve and extract out plastic polymers without breaking the chemical bonds. These technologies are recent innovations and are largely not available at scale.

Chemical recycling technologies, specifically pyrolysis and gasification, are being pushed as the solution to our plastic pollution crisis and our low and stagnant recycling rate for plastics. However, these conversion technologies do not recover plastics and therefore do not improve our plastic recycling or help us reach a circular economy.

What's the problem?

The petrochemical industry is pushing chemical recycling technologies as the solution to our plastic pollution crisis. But many of these technologies **aren't really recycling** – they're turning plastics **back into fossil fuels** like oil and synthetic gas to be used for energy. In practice, this means turning plastic waste into fuel and using virgin plastic to make new products. As the world shifts away from fossil fuels for energy and transportation, the fossil fuel industry is relying on an increase in plastic production to make up the difference.

- Petrochemicals, driven by plastic production, are projected to be the largest source of oil demand growth through 2030 and plastics are estimated to make up 20% of oil consumption by 2050.

Industry is working to redefine what is considered recycling to count these plastic-to-fuel systems as states throughout the country are working to pass comprehensive plastics legislation to transition to a circular economy. Industry is also working to change how these systems are regulated to reduce their emissions standards and reporting, reducing protections for the surrounding communities. If successful, these efforts would enable the growth of plastic-to-fuel technologies that **perpetuate the need for virgin plastic production to replace the plastics being turned into oil.**

- To date, over 20 states have passed legislation reclassifying chemical recycling as manufacturing, subjecting them to less rigorous air and water emission requirements.

Many of these technologies face the same challenges as mechanical recycling (e.g., limited collection of recyclables, need for improved sorting) and investments in these expensive and harmful technologies can delay the needed action to addressing plastic pollution like reducing single-use plastics and investing in existing reuse and recycling systems.

What's the truth?

Chemical recycling technologies do not recover plastics, rather they break the polymer chain into various hydrocarbons like oil and syngas.

- Typical yield of usable plastic material from conversion technologies, which requires several additional steps, range from 0.1-5.7% for pyrolysis to 2-14% for gasification. Typical yields for mechanical recycling range from 73-84%.

Chemical recycling technologies face the same challenges as our current mechanical recycling systems: poor product design, limited collection and difficulties sorting.

- While pyrolysis and gasification can accept a broader range of plastics, they require sortation to remove plastics with chemicals that contribute to their harmful emissions.
- Potential plastics-to-plastics chemical recycling technologies would require careful sortation.

These technologies are known to release harmful emissions including polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), carbon monoxide, nitrous oxides.

- Toxics from plastics have been found in the products (e.g., oil), byproducts (e.g., char), and air emissions from chemical recycling like pyrolysis.

Of the limited number of facilities currently operating, the majority are sited in low income communities (5 out of 8) and/or minority communities (6 out of 8) according to a recent investigation.

Chemical recycling technologies like pyrolysis and gasification are energy-intensive processes that contribute to our climate crisis. They perpetuate our need for new virgin plastic, 99% of which are made from fossil fuels.

- It is estimated that pyrolysis emits nearly twice as much CO_2-equivalent emissions as mechanical recycling.

Chemical recycling technologies are costly, requiring significant investments that could otherwise be directed towards improving our existing recycling system.

- Recent reporting on chemical recycling projects found that most of the facilities were operating at a limited scale (only 20% are currently operating) and more than half were years behind schedule.

We have all the tools we need to address this crisis

Focusing on chemical recycling or any other single solution as a "quick fix" to the plastic pollution crisis risks delaying the systemic changes needed to address this crisis. While it won't be easy, we know what we need to do to address this problem, and we already have the policy tools to do it.

- We need a comprehensive approach focused on **making less plastic in the first place.**
- Policies like extended producer responsibility, which shift the onus from consumers to producers to pay for the cost of collecting and managing the waste their products create, can help fund the transition to a circular economy built on reuse and real recycling.

Ocean Conservancy's position on chemical recycling

Ocean Conservancy does not presently support any form of chemical recycling. In its current form, chemical recycling does not contribute to a circular plastics economy and creates environmental and social harm.