

Whole Cycle Tuesday

Takeaway

As PFAS regulations continue to evolve, pyrolysis represents an exciting advancement in the toolbox available to environmental professionals. When properly designed and operated, thermal treatment technologies have the potential to reduce the environmental liability associated with PFAS-contaminated residuals while recovering energy and reducing landfill dependence.

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*"Nature does not hurry,
yet everything is
accomplished."*

— Lao Tzu

Pyrolysis: a part of the Future of PFAS Destruction

As regulators continue to tighten standards for PFAS in water, soil, and residuals, new treatment technologies are receiving increased attention. Among them, pyrolysis has emerged as one of the most promising methods for reducing and potentially destroying PFAS contained in concentrated waste streams, but it doesn't come without its' challenges.

Pyrolysis is a thermal treatment process that heats organic materials to temperatures typically ranging from 700°F to over 1,800°F (375–1,000°C) in the absence of oxygen. Unlike incineration, which relies on combustion, pyrolysis breaks down complex organic molecules through heat alone. The process converts feedstocks into three primary products: a solid carbon-rich material (biochar), condensable oils, and combustible gases known as syngas. Because oxygen is excluded, fewer combustion byproducts are produced, and the energy contained within the gases can often be recovered to help fuel the process itself.

Researchers are evaluating pyrolysis as a treatment option for PFAS-contaminated materials such as biosolids, sewage sludge, spent filtration media, soils, and industrial residuals. Under sufficiently high temperatures and appropriate residence times, many PFAS compounds begin to

break apart as the strong carbon-fluorine bonds are disrupted. However, successful PFAS destruction depends on much more than simply heating the material. Reactor temperature, residence time, feedstock composition, gas management, and post-treatment controls all play roles in determining if PFAS are fully mineralized or transformed into intermediate compounds.

Depending on operating conditions, some PFAS byproducts may remain in the char if treatment temperatures are insufficient. Likewise, gases generated during pyrolysis must often pass through secondary thermal oxidation or advanced air pollution control systems to ensure complete destruction of any remaining fluorinated compounds before atmospheric release.

While laboratory and pilot-scale studies have demonstrated encouraging results, pyrolysis should not yet be viewed as a universal solution. Different PFAS compounds respond differently to thermal treatment, and researchers continue to study the operating conditions necessary to consistently achieve high destruction efficiencies across the broad family of PFAS chemicals. Regulators are also working to establish standardized testing methods that can verify destruction performance rather than measuring reductions in individual PFAS concentrations.

