Non-Combustion Technologies for PFAS Destruction

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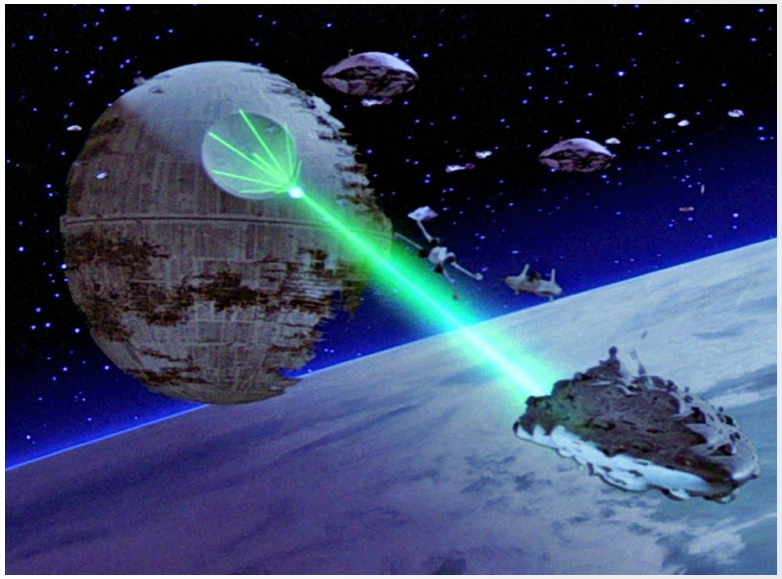
Executive Meeting | Board of Scientific Counselors
September 29-30, 2021

Goals

- PFAS are persistent in the environment
- Presence, fate, and transport through wastewater systems and landfills
  - Circular nature of biosolids disposal in landfills and leachate sent to WWTPs
- May pass through traditional treatment systems
- Goal: Identify and assess technologies that can destroy PFAS
  - Also check for by-products, intermediates, etc.

Approach for Evaluation of Technologies

- Need to supply enough energy to break carbon-fluorine bond
- Combustion may be able to do this BUT very energy intensive
- Are there more efficient ways to focus energy?
- Waters/wastewaters
  - Biological processes
  - Electrochemical oxidation
  - Hydrothermal processes
    - Supercritical water oxidation (SCWO)
    - Hydrothermal liquefaction
    - Hydrothermal oxidation
    - Sub-critical water oxidation
  - Electron beam irradiation (E-beam)



Source: www.starwars.com

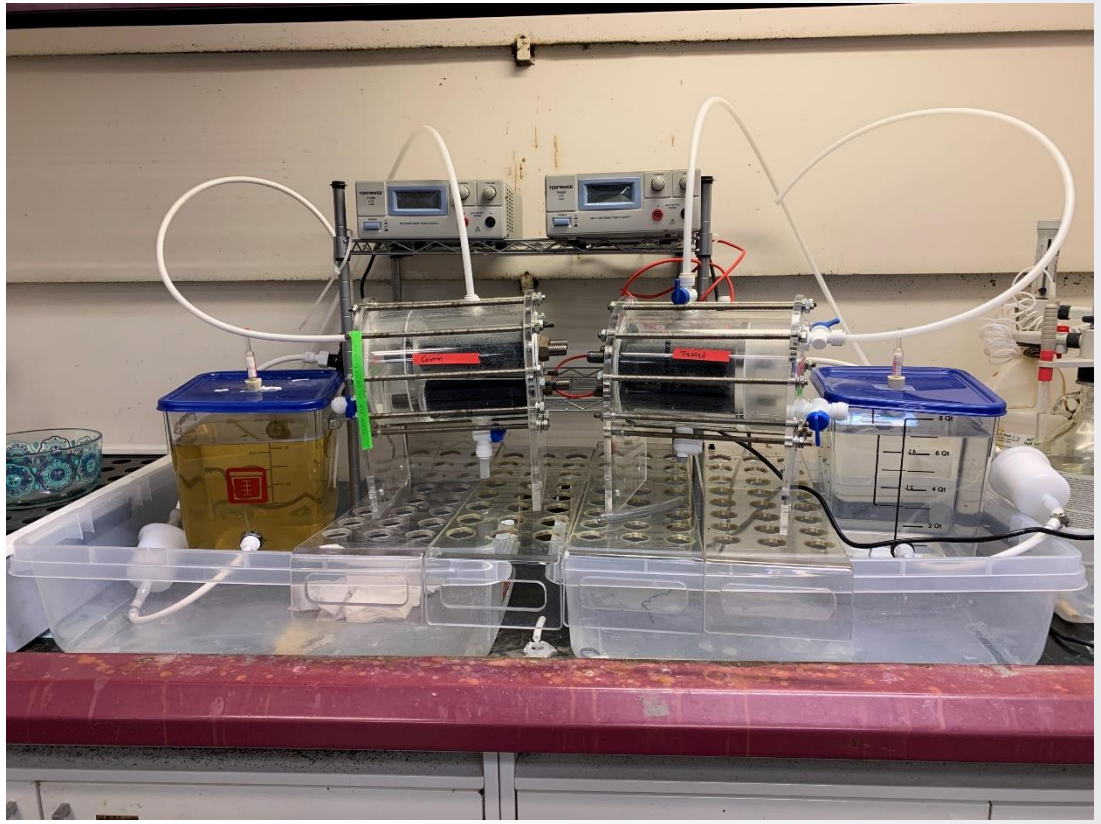
Approach for Evaluation of Technologies

- Need to supply enough energy to break carbon-fluorine bond
- Combustion may be able to do this BUT very energy intensive
- Are there more efficient ways to focus energy?
- Waters/wastewaters
  - Biological processes
  - **Electrochemical oxidation** – electrical current applied
  - **Hydrothermal processes** – heat and pressure
    - Supercritical water oxidation (SCWO)
    - Hydrothermal liquefaction
    - Hydrothermal oxidation
    - Sub-critical water oxidation
  - Electron beam irradiation (E-beam)

Source: General Atomics, https://www.ga.com/hazardous-waste-destruction

Electrochemical Oxidation (EO)

- MCRADA with AECOM
- Site visit and lab-scale experiment in January 2021
- Tested EO on high-PFAS wastewater (AFFF)
- Analyzed for 24 PFAS, Total organofluorine (TOF), fluoride, and chemical oxygen demand (COD)
- Data received
- Publication 2022

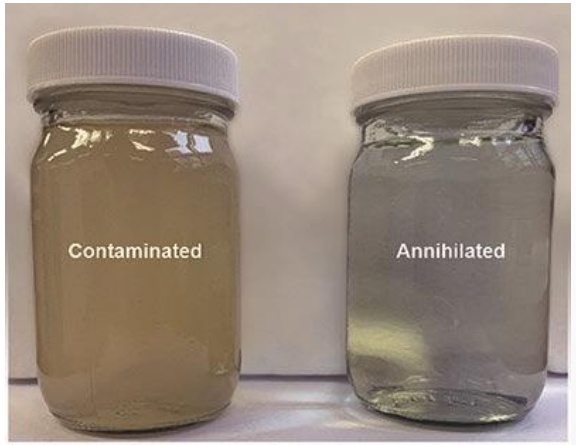


Source: Max Krause (2020)

Supercritical Water Oxidation (SCWO)

- Case studies performed with four separate SCWO operators
  - Aquarden (Denmark)
  - 374Water (Durham, NC)
  - Battelle (Columbus, OH)
  - General Atomics (San Jose, CA)
- Tested SCWO on dilute AFFF
- Analyzed for PFAS, TOF, fluoride, and COD
  - Some gas-phase PFAS sampled w/General Atomics

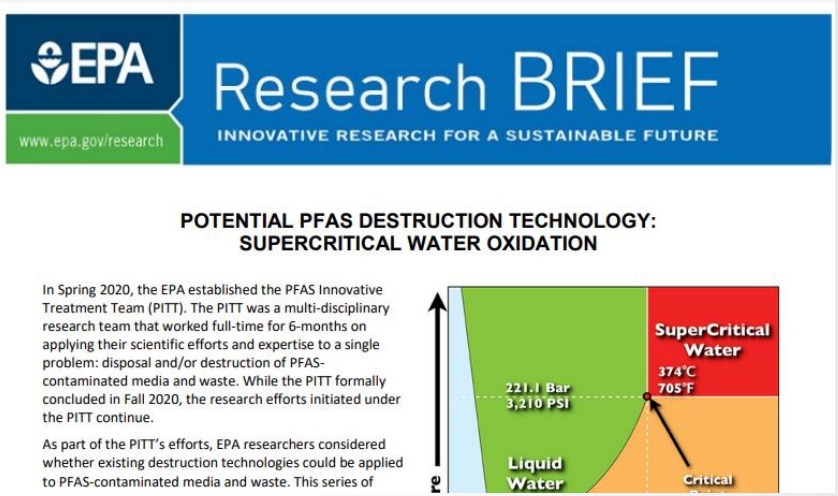
Source: https://aquarden.com/



Source: https://www.battelle.org/government-offerings/energy-environment/environmental-services/pfas-assessment-mitigation/pfas-annihilator-destruction-technology

Current Status

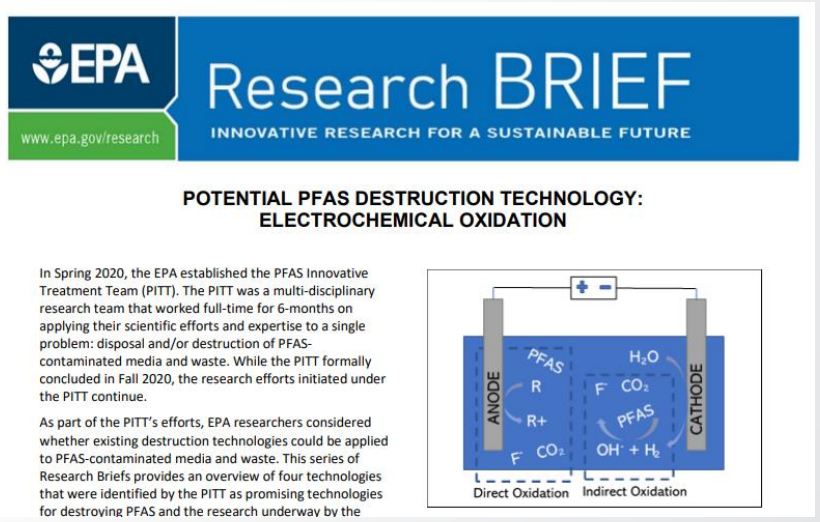
- Experiments completed
  - SCWO
    - Four case studies undertaken on high-level PFAS wastewater (AFFF)
    - Manuscript accepted at ASCE Journal of Environmental Engineering
  - Electrochemical oxidation with AECOM
    - Experiment on high-level PFAS wastewater (AFFF)
    - Report being prepared
- Two Research Briefs
  - https://www.epa.gov/chemical-research/pfas-innovative-treatment-team-pitt


EPA www.epa.gov/research
Research BRIEF
INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

POTENTIAL PFAS DESTRUCTION TECHNOLOGY: SUPERCRITICAL WATER OXIDATION

In Spring 2020, the EPA established the PFAS Innovative Treatment Team (PITT). The PITT was a multi-disciplinary research team that worked full-time for 6-months on applying their scientific efforts and expertise to a single problem: disposal and/or destruction of PFAS-contaminated media and waste. While the PITT formally concluded in Fall 2020, the research efforts initiated under the PITT continue.

As part of the PITT's efforts, EPA researchers considered whether existing destruction technologies could be applied to PFAS-contaminated media and waste. This series of


EPA www.epa.gov/research
Research BRIEF
INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

POTENTIAL PFAS DESTRUCTION TECHNOLOGY: ELECTROCHEMICAL OXIDATION

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As part of the PITT's efforts, EPA researchers considered whether existing destruction technologies could be applied to PFAS-contaminated media and waste. This series of Research Briefs provides an overview of four technologies that were identified by the PITT as promising technologies for destroying PFAS and the research underway by the

Contributors

Funding for PFAS Innovative Treatment Team (PITT) was provided by SHC

ORD (CESER and CEMM) personnel in coordination with:

SCWO: Aquarden, Battelle, 374Water, General Atomics

Electrochemical oxidation: AECOM

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