PFAS, An Emerging Threat To Environment and Human Health

Emerging Threat: Per- and poly-fluoroalkyl substances (PFAS) are associated with adverse health outcomes, including cancer, reduced fetal growth, and liver injury. Human exposures occur through contaminated water, soil, air, and food. Remediation strategies will be critical to reducing PFAS exposures in people and the environment.

Figure 1. Over 1,930 confirmed U.S. PFAS contaminated sites identified by PFAS Project Lab

Figure 2. History of PFAS production and use according to ITRC

Figure 3. Molecular structures of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS)

Objectives: To understand which remediation strategies (techniques) are most viable for remediating PFAS contaminated soil and water. Also: What critical barriers exist for translation from bench scale/pilot research to real-world applications?

Methods: Literature review, with comparative analysis, of 329 remediation studies (10 soil, 157 aqueous (laboratory-made), 162 water), of varying scales (bench, pilot, and industrial), from the PFAS-Tox Database (https://pfastoxdatabase.org/), a publicly available systematic evidence map of over 1,000 PFAS health and toxicology studies.

PFAS Chemistry

- Large class of human-made chemicals with hydrophobic tail and hydrophilic head
- Persistence from tail’s strong carbon-fluorine (C-F) bonds; desirable remediation traits from functional group head
- Ex. Dissociation (hydrogens from head break away) in water leads to anionic chemical (easier to remove than neutrally charged acid)

Common Challenges

- PFAS precursor transformations often result in toxic PFOA and PFOS as terminal degradants
- Different chemical structures may require unique remediation strategies

References

1. PFAS Project Lab and PFAS Exchange: https://pfas-exchange.org/connecting-communities/
2. Interstate Technology and Regulatory Council (ITRC): https://itrcweb.org
5. Environmental Protection Agency (EPA): https://www.epa.gov/pfas

Future Directions

- What remediation techniques are best for:
  - Long versus Short Chain PFAS | Branched versus Linear
  - Carrying out Defluorination versus Mineralization
  - Destroying the PFAS head versus tail
- What are the specific technique/technology treatment train sequences to achieve high removal/destruction efficiencies (>90%)
- What are the main environmental health and engineering implications

Figure 4. Summary of advantages, challenges, and product degradants of different PFAS remediation techniques