EPA Tools & Resources Webinar: PITT Findings on PFAS Destruction Technologies
February 17, 2021 | Responses to Questions Asked During the Webinar
Note: Responses are limited to the scope of the PITT effort. Links to EPA resources are provided where appropriate.

General PFAS Questions

1. **Can you elaborate on your remarks regarding the extent of the PFAS problem as an environmental risk?**

   Please see the EPA website for basic information about PFAS.

2. **Are you conducting research to eliminate the use of PFAS in the first place?**

   We are not currently conducting research of this kind.

3. **Has there been any efforts to restrict, reduce, or ban the production of PFAS?**

   With regards to EPA activities, please see the EPA PFAS website for more information.

Combustion Technology Questions

4. **With respect to combustion technologies that achieve 99% reduction, does the surviving 1% represent a threat?**

   The byproducts from treatment have not been characterized. The PITT did not determine environmental or human health risk.

5. **Do you know how much energy is needed to break the C-F bond at standard temperature and pressure (STP)?**

   130 kcal/mol or less, depending on the structure of the molecule.

6. **Can you speak to the differences in ECO anode materials and their pros/cons to effective C-F bond destruction?**

   This was outside of the PITT Scope.

7. **What are your plans for incineration field trials?**

   EPA is seeking opportunities for field work in partnership with commercial/industrial sites and with the state(s) in which those sites may be located.

8. **Are you planning on field testing municipal waste combustors (MWCs)? If so, will you include facilities that combust medical waste?**

   EPA would welcome the opportunity to test at a MWC if a suitable partnership could be found.

9. **Have you ever looked into Brown's gas ("HHO" - a gas-plasma form of water with high expansion and flammable characteristics)?**

   No, this was not considered.

10. **Was any analysis done on the Eielson Air Force Base's PFAS project involving thermal treatment?**

    No. The PITT did not do analysis on the Eielson Air Force Base.

11. **Can you clarify whether the incineration technologies you studied included RCRA Subtitle C hazardous waste combusted?**

    The PITT did not find any available data on PFAS performance and byproducts from full scale incineration technologies, including RCRA Subtitle C facilities, and so these were not assessed by the PITT.

12. **Are you aware of work on defining relative PFAS bond strength among the series of C-F bonds to assist in evaluating products of incomplete combustion (PICs) or byproducts from precursors and transformation issues?**

    No. The PICs from different processes may or may not be based on C-F bonds, as many of the technologies are based on other mechanisms (e.g., radical generation, radical stability, electron affinity, etc.). Even with thermal processes, PICs likely won't be determined purely by thermodynamics.

13. **Were there any differences in the efficacy of the various methods with respect to branched versus straight chain PFAS? Or were only straight chain PFASs tested?**

    The PITT's work only looked at straight chain PFAS.

14. **Given that thermal destruction is currently one of the most common control technologies in use, what industries are you planning to field test?**

    EPA is seeking to field test at a variety of industrial locations including municipal waste incinerators, hazardous waste incinerators, rotary kiln and cement kilns, and sewage sludge incinerators.

15. **The processes evaluated (in general) require high energy. Was the global warming potential of each technique taken into account in the analysis?**

    No.

Biosolids Pyrolysis/Gasification Questions

16. **The temperatures required to destroy PFAS in municipal biosolids are very high - so high, that clay-like substances are likely to co-occur causing irreversible burner fouling. Are you doing any investigations of side-effects of super high temperature burning of municipal biosolids?** *No. However, it can be pointed out that soil contaminated with PFAS could proceed through a lower temperature, evaporative process, removing the soil from the subsequent higher temperature, gas phase destruction zone. Our initial field-scale investigations are planned using the normal operating conditions that the various facilities operate under. Any burner fouling that occurs should be representative of what the operators see under normal operation.*

17. **Are there any plans for EPA to test PFAS destruction in existing sewage sludge incinerators?**

    Yes, EPA is pursuing possibilities to sample in sewage sludge incinerators.

18. **Did any of the treatment experiments use industrial wastewater as an influent?**

    No.

19. **How was "spent" aqueous film forming foam (AFFF) recovered?**

    We didn't use recovered AFFF but simulated spent AFFF by diluting the concentrate. We did not collect real-world "spent" samples.

20. **The Department of Defense (DoD) has contracted with hazardous waste combustors to destroy their AFFF waste. Is there potential to work with DoD to gain access to these incinerators for your research?**

    ORD maintains research contacts with DoD on PFAS disposal, but regarding DoD contracts with hazardous waste combustors we do not have collaborative work at this time.

21. **Biosolids are mostly land applied. How will the biosolid incineration effort of PITT change this?**

    EPA is seeking opportunities to sample at a sewage sludge incineration facility to understand the fate of PFAS in a commonly used treatment practice. It is speculative to predict how these results could affect biosolids use. Biosolids can also be pyrolyzed or gasified for landfill disposal or to potentially provide a useful soil amendment.

Non-combustion technologies - General

22. **Which of these technologies has the most potential for large scale/municipal application?**

    The PITT didn't determine relative potential of the non-combustion technologies although we did consider applicability and technology readiness.

23. **Are any in-situ treatments being developed?**

    Yes, but the PITT did not investigate these.

24. **As potential solutions gain traction, what kind of precautions are being taken to protect workers at various stages of the processes?**

    An answer to this question would be technology specific. For example, during our tests on Super Critical Water Oxidation we employed area HF monitors to ensure inhalation safety.

25. **Some toxicological assessments indicate risk at parts per trillion (e.g. 10 to 100). Would 99% reduction leave residual risk for subsequent contamination? Is this true for many compounds used today, including short chained replacement compounds like Gen-X and others? Handling an ounce of some of these substances presents a considerable risk to media for release or worker cross contamination of processes and plant processes. Can technologies be ranked for difficulty in application and cost per gram of contaminant destroyed?**

    The residual risk from 99% reduction would depend on the toxicity/hazard of the specific PFAS compound and the level of exposure. EPA has published standard human health toxicity reference values for some PFAS and is working to develop risk assessment values for several other PFAS compounds (see more information on EPA's Actions to Address PFAS website). In addition, these questions can only be answered when full scale performance and cost data are available. It should also be recognized that (1) different technologies work on different waste streams/media types (solid versus liquid versus gas) and (2) different technologies are better for different concentration ranges. Also, most media (except concentrated AFFF or pure PFAS) is not 100% PFAS but generally only contains ppb levels or less of PFAS to begin with.

26. **What's the minimum concentration of PFAS that the super critical water oxidation (SCWO) can treat?**

    We do not yet know the answer to this question. SCWO is very cost and energy intensive, so we have focused our work on higher PFAS concentration media (e.g., AFFF), where the destruction would be more cost-effective. SCWO treatment of less concentrated media (e.g., landfill leachate) is less likely to be economical or efficient. The lower limit of concentration is more likely a cost question than a treatment efficacy limitation.

Landfill and Land Application Questions

27. Are you looking at filtration, encapsulation, and sequestration in a lined landfill? TCLP testing etc.

The PITT did not look at landfills as a treatment technology but, in passing, as a sequestration tool and as the impetus for the System Analysis Tool which is now publicly available.

28. Have you looked into treatment of PFAS in landfill leachate directly, or just after separating PFAS from the leachate?

Yes, the former.

29. Have you seen different patterns of PFAS types and concentrations for AFFF impacted soil vs leachates/biosolids? if so, will they be published?

The PITT did not examine the literature for these data.

30. Several canisters of AFFF was applied to my house by the fire department in 2017. We were never told until Jan. 2020. It has spread into our community. Small town, and no plan to remediate or control areas of contamination. What would remediation of both soil and contaminated building products of a residential site look like?

Remediation options would depend on many factors, and we cannot speak definitively to what remediation of a specific site would look like.

Biological Applications Questions

31. What is the state of the industry on any biological destruction of PFAS?

The PITT did not investigate these in depth. When we proposed it initially as a technology to consider further, we determined that biological destruction of PFAS remained in the theoretical / laboratory experimental stages. Most successful demonstrations of biological PFAS destruction either (1) produce PFAS byproducts (i.e., does not completely destroy all C-F bonds) and/or (2) involved microorganisms fed diets that made PFAS metabolism energetically feasible. In many cases, the addition of other carbon/energy sources would be preferable to destroying PFAS, making application to real environmental media challenging. In addition, there was little information available on rates or viability for biological PFAS destruction in real media. The questioner is referred to potential work in the program www.serdp.org.

Byproduct Formation Questions

32. Do you have any preliminary information on the nature/type of remediation by-products?

There is limited information published on byproducts. The sampling and analytical methods are being developed in parallel to treatment technologies, limiting current knowledge of by-products.

33. Is there a way to capture fluoride at the end of the process?

The most common by product is hydrogen fluoride (HF) which can be caught in a caustic scrubber, much like hydrogen chloride (HCl). Silicon and calcium effectively trap fluoride ions. We see this especially in the mechanochemical (e.g., Si-F bond formation) treatment and the thermal treatment (HF loss to silica reactors / tubing).

34. When assessing byproducts using mass spectrometry, were assays limited to negative mode, or were other detection methods (e.g., chemical ionization, positive mode, etc.) used?
We conducted a variety of mass spectrometry assays. For liquid chromatography with tandem mass spectrometry (LC/MS/MS), we used modifications of EPA Method 533 and Method 537. For gas chromatography with mass spectrometry (GC-MS) analysis, we used electron ionization (EI). For real time experiments we used I- adduct chemical ionization (I- CIMS) with negative ion detection. We have not performed non-target analyses on any byproducts yet, although this is planned.

35. Are you confident that the HF being produced in a combustion/incineration treatment is adequately being fully neutralized?

We have seen no data on HF scrubbing although other halogenated acids such as HCl are scrubbed by common practice.

PITT's Scope, Methodology, and Next Steps Questions

36. Which PFAS chemicals have been tested? Only perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS)?

We tested AFFF as well as a range of C1 to C8 PFAS.

37. What kind of PFAS levels did you study?

In-house combustion studies injected C1-C2 PFAS in levels at approximately 25 parts per million (ppm) in the gas-phase of the combustor. This was based on balancing detection limits of measurement techniques with minimizing potential equipment damage due to HF attack.

***38.* Why was it difficult to find volunteers/sources for your pilot studies?**

Challenges in finding sources included concerns from both industrial partners and communities regarding the uncertainty of the effectiveness of PFAS treatment as well as concerns from industrial partners relating to impacts on equipment and operations.

39. **What instrumentation was used for the analysis? Same across the board?**

    Generally, the targeted analysis was done by a Modified EPA Method 537 (LC/MS/MS), usually with isotope dilution following the DoD / Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories Version 5.3, Appendix B, Table B-15. We used qualified PFAS analytical laboratories for targeted PFAS analysis, although may have used different laboratories for different projects.

40. **Are relevant EPA buildings or labs or both still facing closures (i.e., reopened and closed again)? PFAS is a high priority for the Agency.**

    Special measures have been taken to ensure that research on PFAS continues at a pace commensurate with safety and availability of personnel.

41. **Even though the PITT's work ended in September 2020, is EPA contemplating or conducting any field work or sampling as next steps?**
    Yes, EPA is continuing to pursue field sampling possibilities.

42. **Given there is still a lot of information needed to make decisions on the technologies with greatest application potential, will EPA continue the PITT work?**

    PFAS is one of the Agency's highest priority research areas. Work is continuing on thermal and non-thermal treatment technologies.

43. **Any innovative ideas from the competition that catches your interest?**

    Yes. The Challenge solvers will be selected and announced in April 2021. For more information on the Challenge, please see https://www.epa.gov/innovation/innovative-ways-destroy-pfas-challenge

44. **Thank you for posting Dr. Linda Birnbaum's slides of the presentation, "The Perils of PFAS." Is there a link to the recording of the talk?**

    Dr. Birnbaum's presentation is available on YouTube. Please see: Linda S. Birnbaum - The Perils of PFAS: https://youtu.be/JKLGzAo47NQ. Note that Dr. Birnbaum is not an EPA employee, and this is not an EPA presentation.

45. **I am a sole owner of the Innovative Science Applications - ISA, working with Caltech and other academic institutions, nationally and internationally. One of my projects is the water purification system. Could we collaborate through the EPA SBIR?**

    EPA is one of 11 federal agencies that participate in the SBIR Program established by the Small Business Innovation Development Act of 1982. EPA issues annual solicitations for Phase I and Phase II research proposals from science and technology-based firms. Phase II contracts are limited to small businesses that have successfully completed their Phase I projects. The next SBIR solicitation is scheduled to open in June 2021. Please see https://www.epa.gov/sbir/sbir-funding-opportunities.

Air & Water Analytical Methods, Sampling, Etc.

46. Is there any concern with PFAS release into the air during wildfires that consume homes or industrial facilities?

To our knowledge this issue has not be investigated to date.

47. How would you best scrub an air emission source to at least capture PFAS?

The PITT did not examine emission scrubbing technologies.

48. Is anyone looking into PFAS in drinking water and technologies to remove it?

Yes, more information can be found at https://www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas#3 and in the EPA Drinking Water Treatability Database.

49. We use fluorine ion detectors in liquid media to indicate how well we are doing as LS-MS is expensive. Does PITT use this method?

We did use a fluoride sensitive electrode (FSE) for some work. FSE is generally comparable to ion chromatography (IC) at higher concentrations (above the detection limit). It may also be important to note that using F- ions as an indicator for PFAS destruction / defluorination may or may not be representative, depending upon the chemistry of the system. For example, activity corrections, ion pairing, precipitation, or HF formation (and subsequent reaction) may lead to false conclusions if basing results on F- ion concentrations.

50. Water PFAS standards are at low parts per trillion levels: is the 99% destruction good enough for that?

This depends on the source strength and the technology.

51. Is the team taking in consideration of treating the saturated zone in groundwater contamination?

No, the PITT did not consider in situ treatments.