PFAS Quantification in Leachate and Treatment Technologies

1. Groundwater contamination, regulatory concentrations, and human health

Two classes of anionic degradation products of PFAS compounds, PFOA and PFOS, are soluble in water and present the greatest risk to groundwater. In 2016, the US EPA defined Health Advisory Levels (HAL) of 70 parts-per-trillion (ppt) for PFOA and PFOS (EPA, 2016); however, these were not deemed to be protective of human heath given projections of 5-8 fold accumulation in the human bloodstream. For these reasons, New Jersey in 2018 was the first jurisdiction in North America to adopt lower limits for PFOA (14 ppt), PFOS (13 ppt) and PFNA (0.013 ppt) (NJDEP, 2018), the latter a particularly toxic PFAS compound (Jantzen et al., 2016). Most recently, in February 2020, the EPA declared its intent to regulate PFAS compounds and is gathering information to define regulatory Maximum Contaminant Levels (MCLs). The interim plan is to screen sites for concentrations in water of 40 ppt or greater for either PFOS or PFOA, while maintaining the 70 ppt Drinking Water Health Advisory concentrations as the preliminary remediation goal (EPA, 2020).

In parallel, Health Canada first proposed in June 2016 Maximum Acceptable Concentration (MAC) guidelines for drinking water of 0.2 ppt for PFOA and 0.6 ppt for PFOS (Health Canada, 2016). After a period of public consultation, these levels were confirmed by the government in two documents dated December 2018 (Health Canada 2018a, b). There are presently calls for MACs and remediation targets below detection limits (cited at 0.05 ppt) or quantification limits (cited at 0.2 ppt).

<u>Take away points and recommendations:</u>

- Regulatory limits/recommendations are currently in the ppt to sub-ppt levels and are still under development and consideration in both Canada and North America; our study should have the capacity to identify sub-ppt concentrations.
- Selection of a high quality, dependable commercial laboratory to run PFAS samples will be critical to the success of this project. At minimum they should be able to routinely get to 0.2 ppt PFOA / 0.6 ppt PFOS. Recommendation that we discuss this with an analytical chemist with expertise in PFAS
- The US EPA methods 533 (Nov 2018) and 537.1 (Dec 2019) are the state of the art for identifying PFAS in drinking water. Ensuring the selected analytical laboratory is using the latest methods will add credibility to the results.

2. Treatment Technologies

There are several technologies to treat PFAS in water; for example, PFAS-selective sorbents, reverse osmosis, (electro)chemical oxidation, membrane filtration, and thermal degradation. Among these the most promising are sorbent technologies, with granular activated carbon (GAC) and biosolids-derived biochar able to remove many PFAS compounds to below detection limits, albeit at varying rates of sorption (Xiao et al., 2017; Liu et al., 2019). These technologies are attractive because they are low-cost. However, caution is warranted as the efficiency of PFAS removal depends on the solution (in our case leachate) chemistry. Factors such as pH, ionic strength, competing organic compounds, the need for sorbent regeneration or replacement, and cations that can bridge acidic PFAS compounds to solid surfaces or to each other directly impact removal efficiency. Systematic testing of these parameters in the laboratory would be needed to optimize a sorbent technology. Other technologies, such as reverse osmosis and (electro)chemical oxidation, are far less dependent on water chemistry and can efficiently remediate PFAS in leachate, but at a higher cost.

Take away points and recommendations:

- The selection of remediation technology is dependent on cost and efficiency. The first step of the project should be to fully characterize the leachates of interest (part #1 above) to better inform technology selection.
- We should test a wide range of treatment technologies within the first months of a research collaboration in order to identify those that are most promising, and then focus efforts on optimizing the selected processes.

3. References

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