

PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES IN THE ENVIRONMENT: ORIGINS AND FEASIBILITY IN THERMAL DESORPTION

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Per- and polyfluoroalkyl substances (PFAS) came into use in 1950's and since then have been used in numerous industrial and commercial applications. PFAS comprises a large group of compounds (> 6.000) consisting of at least a hydrophobic alkyl chain of varying length C_nF_{2n+1} . This hydrophobic variety can be completely fluorinated (perfluorinated alkyl substances) or partly fluorinated with at least two fully fluorinated carbons (polyfluorinated alkyl substances).

Compared to the binding energy of C-C bond (347 kJ/mol), the C-F bond (439 kJ/mol) is extremely strong and stable, the strongest in organic chemistry. The chemical and thermal stability of PFAS, in addition to its hydrophobic and lipophobic nature leads to highly useful properties in surfactants (fluoropolymer, coatings, aqueous film-forming foams, etc...) and polymers (textile stain, soil repellents, grease-proof, food contact paper, etc...). However, due to its stability, PFAS are resistant to biodegradation, direct photolysis, atmospheric photooxidation, hydrolysis and so forth. Moreover, these compounds are water soluble, so highly mobile.

For a better comprehension of the environmental occurrence and behavior of PFAS and to decrease the long-term impact, it is essential to look at the two main manufacturing processes used to produce PFAS compounds: (1) Electrochemical Fluorination (ECF) – generally results in even- and odd-numbered, branched and linear chains of perfluoroalkyl compounds; (2) telomerization – produces even-numbered, linear chains. ECF lead to a mixture of a linear and ramified compound compared to the telomerization. For this reason, most production today is via the telomerization.

To date, there are hundreds of research studies about PFAS. However, the number and complexity of environmentally-relevant PFAs and the exponential increase in related scientific publications have led to confusion in the environmental community and public. It is essential to use the same language through researches to keep clarity of investigative results and will reduce confusion and support clearer communication.

However, due to the energy required to break the C-C and the C-F bonds, thermal decomposition of these compounds is possible in soil. The use of thermal desorption technologies to recover these products is quite feasible. The article covers the thermal behavior of PFAS-impacted soil when heated at increasing temperatures. Efficiency of thermal desorption for PFAS is presented in function of temperatures, residual time and residual concentration.