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A survey of analytical methods employed for monitoring of Advanced Oxidation/Reduction Processes for decomposition of selected perfluorinated environmental pollutants☆

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Abstract

The monitoring of Advanced Oxidation/Reduction Processes (AO/RPs) for the evaluation of the yield and mechanisms of decomposition of perfluorinated compounds (PFCs) is often a more difficult task than their determination in the environmental, biological or food samples with complex matrices. This is mostly due to the formation of hundreds, or even thousands, of both intermediate and final products. The considered AO/RPs, involving free radical reactions, include photolytic and photocatalytic processes, Fenton reactions, sonolysis, ozonation, application of ionizing radiation and several wet oxidation processes. The main attention is paid to the most commonly occurring PFCs in the environment, namely PFOA and PFOS. The most powerful and widely exploited method for this purpose is without a doubt LC/MS/MS, which allows the identification and trace quantitation of all species with detectability and resolution power depending on the particular instrumental configurations. The GC/MS is often employed for the monitoring of volatile fluorocarbons, confirming the formation of radicals in the processes of C-C and C-S bonds cleavage. For the direct monitoring of radicals participating in the reactions of PFCs decomposition, the molecular spectrophotometry is employed, especially electron paramagnetic resonance (EPR). The UV/Vis spectrophotometry as a detection method is of special importance in the evaluation of kinetics of radical reactions with the use of pulse radiolysis methods. The most commonly employed for the determination of the yield of mineralization of PFCs is ion-chromatography, but there is also potentiometry with ion-selective electrode and the measurements of general parameters such as Total Organic Carbon and Total Organic Fluoride. The presented review is based on about 100 original papers published in both analytical and environmental journals.

Graphical abstract

☆ Dedicated to Professor Gary D. Christian on his 80th birthday anniversary