Potential and pitfalls of XRF-CS analysis of ion-exchange resins in environmental studies

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Detecting clandestine, intermittent release of heavy metal pollution into natural and man-made water ways is challenging. Conventional chemical methods are both labor intensive and expensive. The recent approach combining ion-exchange resins with the capabilities of X-ray fluorescence core scanners (XRF-CS) therefore is of great interest. In short, ion-exchange resin is deployed in the water using small sachets, the resin is then collected, dried, filled into sample holders and scanned using XRF-CS.
Ion-exchange resins take up heavy metals in proportion to the concentration in the ambient water, with a correlation coefficient (R^2) between concentration and XRF-CS counts better than 0.96 for most elements. However, a number of parameters influence the measurements. Different drying methods introduce differences in the XRF counts because of lattice bound water, resin shrinkage, and disaggregation of the resin particles. Furthermore, the newly developed sample carrier, which was constructed using 3D printed polymers, contains trace amounts of elements that may influence the sample measurements through edge effects and secondary fluorescence. In the tested sample carrier materials, substantial levels of Cr, Fe, Co, and Zn were detected, while Ca, Ti, Ni, Cu, Ga showed variable levels. Ba, Tl and Bi show very low levels, and Pb is only of importance in the PLA carrier. It is therefore necessary to streamline the analysis-process to ensure that the variations in sample treatment and drying and filling methods are minimized. It is also recommended that only spectra from the center of the compartments are used for the evaluation to avoid edge effects caused by secondary fluorescence of metals in the compartment walls.
Although the technique of using ion-exchange resin sachets and XRF-CS analysis is only semi-quantitative, it is a cost effective and fast way to monitor large areas for environmental pollution, and the new sample carrier greatly contributes to make the process faster and less error prone. This study was published in Scientific Reports: doi.org/10.1038/s41598-021-00446-9

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