AUTOMATION OF SOLID-PHASE EXTRACTION AND LIQUID-LIQUID EXTRACTION IN RADIOCHEMICAL ANALYSIS

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Radiochemical analyses are increasingly demanded in routine laboratories for monitoring purposes due to radionuclides widespread use: nuclear power plants, nuclear medicine services and industrial uses, among others. Since radionuclides activity concentrations in environmental and biological samples are usually very low, extraction and preconcentration steps are required prior detection. Within pretreatment techniques in radiochemical analysis, solid phase extraction and liquid-liquid extraction are the most common analytical procedures, providing not only sample clean-up but also high enrichment factors. These protocols are usually long and tedious, involving a large consume of reagents and of waste generation, what difficult their application in monitoring plans. Flow analysis techniques have proved to be suitable platforms to develop automated radiochemical analyzers, offering advantages such as fast and low-cost methods with low reagents consumption and so waste generation and low manipulation by the analyst. Thus, automation in radiochemical analysis exploiting most commonly used pretreatment procedures by multicommuted flow analysis techniques, is presented.

1988 FIA-LLE system for U determination

1994 FIA-SPE for Tc, Th, and U determination

1999 Sensor-SPE for Tc determination

2010 LOV-SPE system for U determination

2015 In syringe-LLE for U determination

2015 In syringe-DLLME for Tc determination

Figure 1. Milestones of radiochemical analysis automation based on flow techniques.

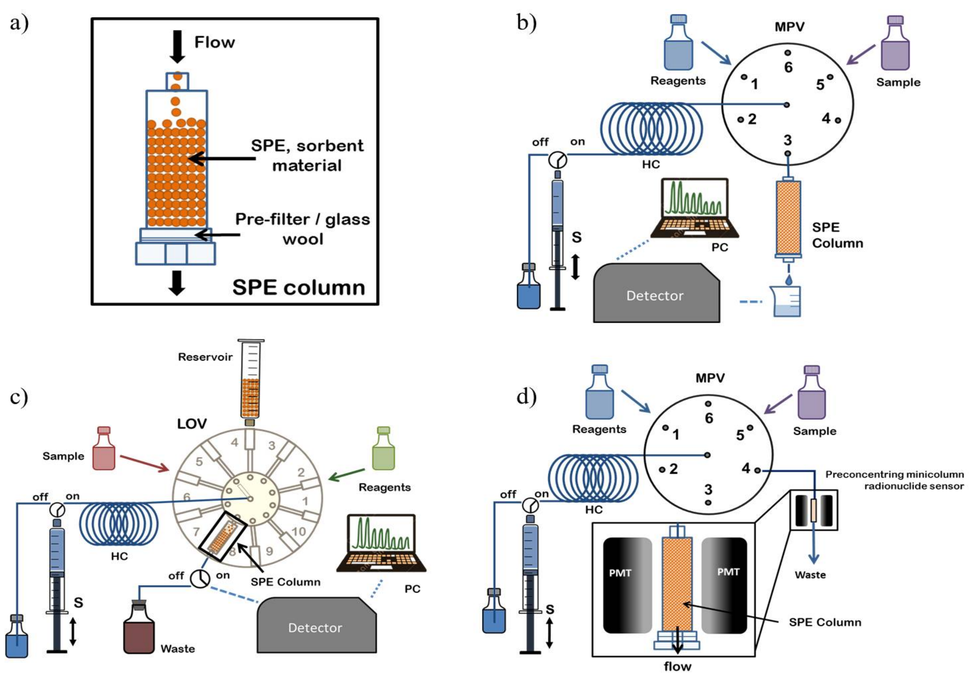

Figure 2. Automation of radionuclides solid phase extraction. a) Schematic depiction of SPE column. b) Typical sequential injection (SIA) system exploiting solid phase extraction (SPE) in column; c) Lab on valve (LOV) system with integrated column; d) SIA system exploiting a radionuclide sensor. HC: holding coil, MPV: multiposition valve, PC: personal computer, PMT: Photomultiplier tube, S: syringe.

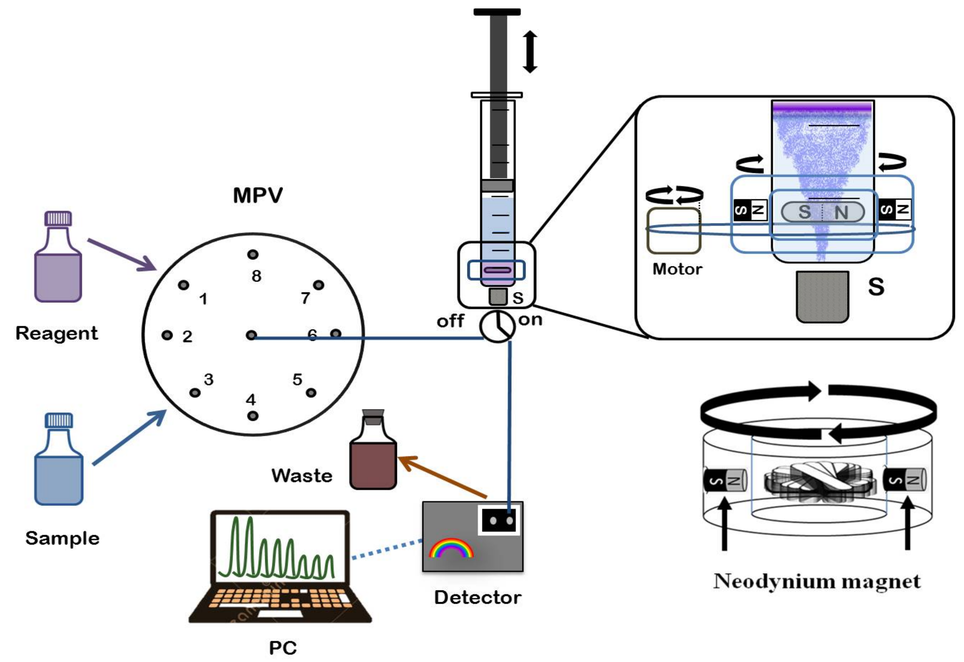

Figure 3. Schematic depiction of an in-syringe magnetic stirring assisted liquid-liquid extraction system for radionuclides determination. MPV: multiposition valve, PC: personal computer, S: syringe.

Table 1. Characteristics of automated solid-phase extraction and liquid-liquid extraction for radionuclides determination in environmental and biological samples.

Automated solid-phase extraction	Automated liquid-liquid extraction
High sample volume	Limited sample volume
Very high enrichment factors	High enrichment factors
Minimal or avoidance of organic solvents use	Low organic solvents use
Reusable (long durability)	Single-use or low reusability
Reproducible	Reproducible
Low reagents consumption	Low reagents consumption
Minimization of waste generation	Minimization of waste generation
Expensive SPE materials	More affordable and common
Backpressure problems	No backpressure problems

Conclusions

Automation of radiochemical analysis by flow techniques provides several advantages in terms of cost, time and environmental efficiency, such as lower reagent consumptions and so less radioactive waste production, faster methods and lower manipulation what improves method accuracy and the analyst safety. New trends tend towards miniaturization and the use of multicommutated flow techniques, such as LOV and LIS. SPE and LLE are the most common techniques used for radionuclides extraction and preconcentration in automated approaches. These have been successfully automated by flow techniques. SPE provides better sensitivity due to larger sample volumes can be preconcentrated what is of great relevance in radionuclides environmental monitoring. However, automated LLE provides simple and efficient radionuclide determination methods. Thus, flow techniques have proved to be efficient tools to automate radiochemical analysis. Even when just partially automation is possible due to the long counting times required, automation of the sample pretreatment is worth.

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