

### **63-Optimization and Study of Parameters Affecting Liquid Scintillation Counting for Gross Alpha and Beta Activities in Water Samples**

M.Palomo<sup>1</sup>, M.Villa<sup>2</sup>, A.Peñalver<sup>1</sup>, C.Aguilar<sup>1\*</sup>, F.Borrull<sup>1</sup>, J.M.Bruach<sup>3</sup>, N.Casacuberta<sup>3</sup>, P.Masqué<sup>3</sup>

<sup>1</sup>Unitat de Radioquímica Ambiental i Sanitària, Universitat Rovira i Virgili, Tarragona, Spain.

<sup>2</sup>Centro de Investigación, Tecnología e Innovación. Servicio Radioisótopos. Universidad de Sevilla, Spain

<sup>3</sup>Institut de Ciència i Tecnologia Ambientals - Departament de Física, Universitat Autònoma de Barcelona. Spain

\*Corresponding author: carme.aguilar@urv.cat

Ultra-low level liquid scintillation counting (LSC) with alpha–beta discrimination allows rapid and simple determination of gross alpha and beta activities in water samples, which are simultaneously differentiated and measured. Particularly, the Quantulus 1220 (Perkin Elmer) liquid scintillation detector uses a pulse shape analysis circuit (PSA) to differentiate between alpha and beta disintegrations; therefore, it is necessary to optimize the PSA parameter prior to gross alpha and beta measurements [1,5].

The main aim of this study has been to carry out an exhaustive study and evaluation of all the parameters which have some influence either in the sample preparation or in the measurement step by LSC. This implies the optimization of the PSA value, the evaluation of the quench effect over the measurement and the sample pre-treatment. This study also included the collaboration between three Spanish laboratories which in an independent way evaluated the different parameters that affect the measurement of gross alpha and beta activities.

For PSA optimization, an alpha (<sup>241</sup>Am) and a beta (<sup>40</sup>K) emitters were separately measured and the interference between both spectra was determined for different PSA values. The optimum PSA parameter was selected according to the criteria of obtaining a minimum value for the sum of the alpha and beta interferences. Unfortunately, as this separation is not ideal, the classification of the radiation is strongly dependent on quenching agents. Quench can be described as any interference in the sample that causes a spectrum shift and also a reduction in the signal being measured, which causes a decrease in counting efficiency as well as changes in the alpha-beta discrimination parameters. For this reason we evaluated the influence in these parameters by adding small quantities of quenching agents to the samples, such as HNO<sub>3</sub> and Na<sub>2</sub>CrO<sub>4</sub>.

Concentrations of radioisotopes in the environment are typically low, thus the optimized method of analysis requires preconcentration of samples. Evaporation was the procedure selected in this study. Different concentrations of acids, HCl and HNO<sub>3</sub>, and different

combinations of sample and acid volumes during evaporation have been studied, in particular for the re-dissolution of the whole dry residue and to obtain a homogeneous mixture with the scintillation cocktail. Finally, the applicability of the optimised method was demonstrated through the analysis of different types of samples, of high and low salinity content, from the Tinto, Odiel, Ebro and Llobregat rivers.

The overall comparison between laboratories showed that no significant differences were obtained within the uncertainties provided, neither in the optimization process nor in the determination of gross alpha and beta activity in the different samples analysed. Also with the developed method we observed that both sample preparation and counting times are reduced in comparison with more conventional methods that use ZnS scintillation counters and/or an alpha/beta counter of low background multiple detector type. For these reasons, LSC can be used as an attractive and alternative technique to the above mentioned techniques.

#### Literature:

- [1] L.Salonen. 2006. Alpha/Beta liquid Scintillation Spectrometry in Surveying Finnish Groundwater Samples. *Radiochemistry* 48, 6, 606-612.
- [2] L. Kaihola. 2000. Radionuclides identification in liquid scintillation alpha-spectroscopy. *Journal of Radioanalytical and Nuclear Chemistry* 243, 2, 313-317.
- [3] J.M. Pates, G.T.Cook, A.B.MacKenzie and C.J.Passo. 1998. Implications of beta energy and quench level for alpha/beta liquid scintillation spectrometry calibration. *Analyst* 23, 2201-2207.
- [4] T.A. DeVol, C.D.Theishen and D.P.DiPrete. 2007. Effects of Quench on Alpha/Beta Pulse Shape Discrimination of liquid Scintillation Cocktails. *Health Physics* 92, 105-111.
- [5] R. Rusconi, M. Forte, M. Caresana, S. Bellinzona, M.T. Cazzaniga, G. Sgorbati. 2006. The evaluation of uncertainty in low-level LSC measurements of water samples. *Applied Radiation and Isotopes* Volume 64, 10-11, 1124-1129.