SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Analytical, Environmental & Geo-Chemistry

has the honor to invite you to the public defence of the PhD thesis of

Inés Llopart Babot

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Development of novel assays for 'difficult-to-measure' radionuclides in materials produced during nuclear decommissioning activities

Promotors:
Prof. dr. Martine Leermakers (VUB)
Dr. Jixin Qiao (Denmark Technical University)
Dr. Mirela Vasile (SCK CEN)
Dr. Andrew Dobney (SCK CEN)
Mr. Sven Boden (SCK CEN)

The defence will take place on

Friday, February 2, 2024 at 16 h in Room D2.01

The defence can also be followed through a live stream: Click here to join the meeting

Members of the jury
Prof. dr. Frederik Tielens (VUB, chair)
Prof. dr. Steven Goderis (VUB, secretary)
Prof. dr. Yue Gao (VUB)
Prof. dr. Joske Ruytinx (VUB)
Dr. Hildegarde Vandenhove (International Atomic Energy Agency, Austria)
Prof. dr. Xiaolin Hou (Denmark Technical University)

Curriculum vitae

Inés Llopart Babot completed her Bachelor's degree in Chemistry at the University of Barcelona, Spain. In 2017, she began her Master's in Analytical Chemistry at the same university. Her Master's thesis was conducted in the same university and was primarily focused on optimizing a radiochemical separation procedure to determine ^{89}Sr and ^{90}Sr using radiometric measurements.
Inés initiated her PhD thesis in Belgium, collaborating between VUB and the Belgian Nuclear Research Centre (SCK CEN) in Mol. Her PhD research concentrated on developing procedures to quantify 'difficult-to-measure' radionuclides. Her findings have been published in four manuscripts, and she has actively participated in various international conferences.

Abstract of the PhD research

During the nuclear reactor operational life and when it enters the decommissioning phase, large amounts of nuclear wastes are generated. All waste streams have to be characterized for their radioactive content to prove conformity with regulations related to unconditional or conditional release and final disposal. Gamma emitters such as ^{60}Co or ^{137}Cs, easy to measure radionuclides (ETM), can be quantified by a non-destructive analysis such as gamma-ray spectrometry. However, in the case of pure beta- and alpha-particle emitters, called difficult to measure radionuclides (DTM), a radiochemical separation is needed to obtain the required selectivity of the analysis method. Moreover, the radiotoxicity, mobility and half-lives of the radionuclides are important factors to consider in the waste disposal repositories from the safety point of view. Scaling factors are commonly applied to estimate the activity of DTM radionuclides based on the measurement of ETM radionuclides, but the disadvantage of this method is the large uncertainty on the estimated results.

This research focuses on analytical method development for several relevant DTM radionuclides, including ^{36}Cl, ^{129}I, ^{79}Se, ^{151}Sm, ^{147}Pm and ^{41}Ca. All these radionuclides are beta-particle emitting radionuclides or decay by electron capture (^{41}Ca) and are considered in radiological safety assessments for waste management. ^{36}Cl and ^{41}Ca are neutron activation products in graphite and concrete respectively, while ^{79}Se, ^{129}I, ^{151}Sm and ^{147}Pm are fission products which can be present in exchange resins or in waters from the cooling system of the reactor.

The objectives of the project are: (1) development and optimization of sample decomposition techniques, (2) development of individual or sequential radiochemical separation and measurement methods and (3) application of automated radiochemical separation systems. Different type of samples such as graphite and concrete are considered in this project. For the sample decomposition, pyrolysis (RADDEC pyrolyser) and fusion (Katanax K3 automated fusion fluxer) techniques are investigated. Liquid scintillation counting (LSC) will be used to determine the activity concentration levels of all the selected radionuclides (considering beta interferences), inductively coupled plasma mass spectrometry (ICP-MS) will be used for chemical recovery quantification and tandem ICP-MS (ICP-MS/MS) will be investigated for quantifying the activity concentration of ^{36}Cl and ^{151}Sm.

The newly developed methodologies will reduce the uncertainties with respect to the inventory estimation for these DTM radionuclides, and thereby facilitate more accurate waste characterization and cost-effective waste management in nuclear decommissioning.