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A Review of Flow Analysis Methods for Determination of Radionuclides in Nuclear Wastes and Nuclear Reactor Coolants☆

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Abstract

The safety and security of nuclear power plant operations depend on the application of the most appropriate techniques and methods of chemical analysis, where modern flow analysis methods prevail. Nevertheless, the current status of the development of these methods is more limited than it might be expected based on their genuine advantages.

The main aim of this paper is to review the automated flow analysis procedures developed with various detection methods for the nuclear energy industry. The flow analysis methods for the determination of radionuclides, that have been reported to date, are primarily focused on their environmental applications. The benefits of the application of flow methods in both monitoring of the nuclear wastes and process analysis of the primary circuit coolants of light water nuclear reactors will also be discussed.

The application of either continuous flow methods (CFA) or injection methods (FIA, SIA) of the flow analysis with the β−radiometric detection shortens the analysis time and improves the precision of determination due to mechanization of certain time-consuming operations of the sample processing. Compared to the radiometric detection, the mass spectrometry (MS) detection enables one to perform multicomponent analyses as well as the determination of transuranic isotopes with much better limits of detection.

Keywords:
Flow analysis, radionuclides, radiometric detections, ICP-MS, spent reactor fuel, reactor coolan

1. Introduction

In the middle of 1950s, less than 20 years from the breakthrough discovery of the nuclear fission by neutron irradiation of uranium (Hahn and Strassmann), the first nuclear power reactors for the production of electricity were placed in operation in Soviet Union, United Kingdom and USA. They were a crucial technological alternative to power plants based on fossil fuels or hydroelectric plants and, at that time, they were also a part of a politically significant movement for the peaceful use of nuclear energy. In the following decades, they were increasingly valued due to the prospect of future shortages of fossil fuels and also the necessity to protect the natural environment, strongly polluted by conventional power plants employing fossil fuels. With currently 448 nuclear power reactors operating

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