Development Of A Diffusive Gradient Thin Film Instrument For Cesium Monitoring

by

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Submitted to the Department of Nuclear Engineering and Engineering Physics
Faculty of Engineering Universitas Gadjah Mada on January , 2019
as partial fulfillment of the requirements for the Master's Degree in Engineering Physics

ABSTRACT

Nuclear power plants, nuclear reprocessing facilities, and nuclear weapons are sources of anthropogenic radionuclides that may be released to the environment during nuclear weapon testing, nuclear accidents, or in spent fuel disposals. In particular cesium (^{137}Cs) is one of the most important radionuclide to consider due to its high affinity with clay minerals in soil. Moreover, cesium is highly mobile and can travel long distances when suspended in the air onto aerosols or dissolved in water. In aquatic environments, the concentration of natural cesium varies from 0.004 to 2 $\mu g \cdot L^{-1}$ with an average of 0.05 $\mu g \cdot L^{-1}$ which is below 1 $nmol \cdot L^{-1}$. Furthermore, after the Fukushima nuclear accident, radioactive Cs activity in certain water samples is less than 0.01 $Bq \cdot L^{-1}$ or below 0.02 $fmol \cdot L^{-1}$. As a comparison, germanium semiconductor detectors show a limit of detection of 0.3 $Bq \cdot L^{-1}$, for 12-hour measurement. Therefore, direct determination of radioactive Cs is therefore impossible. Diffusive gradients in thin films (DGT) technique allows for in-situ preconcentration of trace and ultra-trace labile compounds. Whereas this technique has been widely used to probe heavy metals and, more recently, the persistent organic pollutants or radionuclides, it is not customarily applied to Cs. This is because commercially available DGT devices are not fitted to the physicochemical properties of Cs. To tackle this limitation, a novel Cs-specific DGT device has been developed. This includes an agarose gel that serves as a diffusion layer and uses potassium copper ferrocyanide (KCuFC) resin as a binding agent. To allow simultaneous measurement of both the stable and the radioactive Cs, a preliminary cleaning of the diffusion gel was required. The proposed cleaning process involves HCl and KCuFC treatments. This resulted in the removal of > 99% of the diffusion gel layer impurities.

Keywords: *Diffusion Gradient in Thin Film, Cesium, Potassium Copper Ferrocyanide, Agarose*

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