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Determination of plutonium in water fluids of naval nuclear reactor plants

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A rapid method to determine plutonium in water is to separate it on microfiltration polymer membranes impregnated with antimony, zirconium, and manganese oxides or zirconium, titanium and other phosphates, having the highest efficiency for adsorption of plutonium. In addition, ballast salts are removed. A method was developed for determining the total activity of alpha emitters with preliminary concentration of transuranic elements (TRU) by filtering a sample through the cellulose acetate membrane impregnated with hydrated manganese dioxide. However, this method had a problem with identification of spectra in measurements of TRU activity by alpha spectrometry. Preliminary evaporation of a water sample and consequent adsorption of plutonium onto an ion exchange resin is a preferable choice for separation of TRU and identification of plutonium. The method is to add nitric acid in a water sample, evaporate the sample to almost dryness, dissolve it again, adjust all forms of plutonium to Pu(IV), and filter the sample through a strong-base anion exchanger. The anion exchange resin adsorbs only plutonium, while all other TRU including americium remain in the solution. Plutonium is then eluted from the resin using ammonium iodide dissolved in hydrochloric acid. A sample for counting is prepared by filtering the plutonium sample through the cellulose acetate membrane impregnated with hydrated manganese dioxide. The activity of plutonium precipitated on the membrane is determined by alpha radiometry or alpha spectrometry. Comparison of spectral characteristics shows that electrolytic and membrane methods of preparing samples for alpha counting have a relatively similar efficiency. However, the electrolytic separation takes at least 2 hours, while the membrane filtration time is 0.5 hours. The method for determining the volumetric activity of plutonium nuclides in plant water measures the activity in the range of 5-5·103 Bq/l, the efficiency of removing artificial and natural impurities being higher than 103. The degree of plutonium adsorption can reach 90%.

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