

limit law concerning the relative variation of the self diffusion coefficient with the ionic strength. Comparison of the behaviour of the europium ion $^{152}\text{Eu}^{3+}$ with that of the americium ion $^{241}\text{Am}^{3+}$ from the point of view of ionic transport. This work would be useful in elucidating the electrolytic behaviour of actinide and lanthanide ions, especially with respect to ion-ion and ion-solvent interactions under equilibrium and non-equilibrium conditions.

The data show that there is a similarity in the ionic transport processes of the $^{152}\text{Eu}^{3+}$ and $^{241}\text{Am}^{3+}$ ions.

Diffusion coefficient of lanthanide ion at infinite dilution: $D_1^\circ \times 10^6 \text{ cm}^2 \text{ s}^{-1}$: 6.10 ($^{152}\text{Eu}^{3+}$) [1].

Diffusion coefficient of actinide ion at infinite dilution: $D_1^\circ \times 10^6 \text{ cm}^2 \text{ s}^{-1}$: 6.19 ($^{241}\text{Am}^{3+}$) [1].

The present work shows that the electrostatic relaxation effect for $^{152}\text{Eu}^{3+}$ in an aqueous solution of $\text{Eu}(\text{NO}_3)_3$ is responsible for a relatively important variation (20%) in the concentration range 0 to 10^{-3} M for the self-diffusion of these ions.

On the other hand, our results show that the ionic transport process for $^{152}\text{Eu}^{3+}$ is similar to that for $^{241}\text{Am}^{3+}$ at pH 2.5. Moreover, it may be provisionally argued that the Eu^{3+} ion in solution at $\text{pH} \geq 6$ has essentially the same structure as a tripositive 5f ion.

- 1 H. Latrous and J. M'Halla, *Radiochem. Radioanal. Letters*, 53 (1) 33–44 (1982); B. Fourest, J. Duplessis and F. David, *J. Less-Common Met.*, 92, No. 1, 17 (1983).

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Removal of Thorium and Uranium from Surfaces by Attapulugus Clay Suspensions

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In the operations connected to the nuclear fuel cycle, equipments and surfaces can undergo radiological contamination for accidental causes or consequently to their use; among radionuclides, Uranium and Thorium are often present and in a large amount.

Protection of the operators requires the removal of radioactive substances from the materials involved in the working especially in the case of alpha emitters, whose effects on man are very dangerous. Severe limits to the contamination levels are imposed in the various countries: generally, alpha activity on the working surfaces must be below 1.85 Bq cm^{-2} .

Radioactivity elimination current techniques involve the use of physical and chemical methods. The

physical or abrasive methods can change in some degree treated materials and are not suited for a lot of instruments; chemical methods produce large quantities of radioactive wastes which often show some difficulties in handling. Both decontamination techniques can introduce some irradiation and contamination hazards for the operators.

In order to reduce these disadvantages, there is arising a certain interest in the use of solid decontaminating agents as easily applicable pastes or gels. At C.A.M.E.N. we have used a suspension of a particular clay. The basic constituent of these decontaminating media is attapulugite, a widely used material utilized to remove resisting dirt present on artworks; its aqueous suspensions show high chemical inertness and thixotropic and non-newtonian properties.

The present work describes some decontamination experiments of materials frequently used in the actinides technology, previously contaminated with uranyl nitrate and thorium nitrate. This decontamination is carried out by attapulugus clay aqueous suspensions. Samples, cured by B.S. 4247 specification, of the following materials, stainless steel AISI 304, mild steel UNI Aq 42, aluminium alloy UNI P-Al-Mg 3.5, lead, polymethylmetacrylate, polyvinylchloride, polytetrafluoroethylene, polypropylene, have been contaminated with 0.2 ml of 2% solutions of uranyl nitrate and thorium nitrate ($\text{pH} = 3.0$) respectively. The suspension, obtained on mixing attapulugitic clay and water in predetermined proportions, was laid by a spatula with a 10–12 mm thickness, corresponding to $1.0\text{--}1.2 \text{ g cm}^{-2}$. The samples were kept for 48 hours at room temperature; the suspension dries up and severs spontaneously. A light halo eventually remained on the samples and can be removed by wiping delicately surfaces with a lightly wet flock of cotton. The samples have been measured by an alpha scintillator, with ZnS(Ag) detector, after contamination and after each decontamination process; the efficiency of the instrument was determined with uranyl nitrate and thorium nitrate standard.

Results obtained in experiments are reported as decontamination factor D_F (logarithm), where D_F :

$$D_F = \frac{\text{activity before decontamination}}{\text{activity after decontamination}}$$

In Tables I–II values of logarithm of D_F found for uranyl nitrate and thorium nitrate for repeated applications of attapulugus clay aqueous suspensions are reported.

From the data it appears that:

– For most of the examined materials a high removal has been obtained: more than 95% of the initial activity, except for mild steel, where removal

TABLE I. Values of $\log D_F$ Found for Thorium Nitrate After Decontamination by Applications of Attapulgus Clay Aqueous Suspensions.

Materials	Number of Applications			
	1	2	3	4
Mild steel	0.62	0.77	0.80	0.80
Stainless steel	2.22	2.51	2.53	2.53
Lead	1.38	1.73	1.80	1.80
Aluminium alloy	1.80	1.95	1.97	1.98
Polytetrafluoroethylene	1.57	2.22	2.24	2.25
Polyvinylchloride	2.00	2.82	2.82	2.83
Polypropylene	1.70	2.39	2.41	2.41
Polyethylmetacrylate	2.12	2.89	2.90	2.90

TABLE II. Values of $\log D_F$ Found for Uranyl Nitrate after Decontamination by Application of Attapulgus Clay Aqueous Suspensions.

Materials	Number of Applications			
	1	2	3	4
Mild steel	0.58	0.72	0.75	0.76
Stainless steel	1.63	1.75	1.76	1.78
Lead	1.01	1.26	1.31	1.32
Aluminium alloy	1.33	1.66	1.72	1.73
Polytetrafluoroethylene	1.41	1.54	1.63	1.64
Polyvinylchloride	2.20	2.41	2.43	2.43
Polypropylene	1.98	2.30	2.32	2.32
Polyethylmetacrylate	2.32	2.49	2.50	2.50

is about 78% for Uranium and 80% for Thorium respectively.

— Decontaminated surfaces do not show visible damages except for the mild steel.

— Total removed activity increases with the number of applications, to reach a level at which no further improvement is obtainable.

— For investigated materials, whose $\log D_F$ are lower than 1.40 after first attapulgus clay application, it is possible to foresee decontamination factors obtainable in the successive treatment by the following relation which we suggest:

$$\log(D_F)_n = 1.31 \log(D_F)_1 \text{ thn}$$

where $(D_F)_n$ = decontamination factor obtained after the first application; $(D_F)_1$ = decontamination factor obtained after the nth application; n = number of applications.

— For all the investigated materials, except the mild steel, the residual activity found after four applications is below 1.85 Bq cm^{-2} .

The decontaminating method, in our experimental conditions and with the above mentioned exception, allows to reuse uranium and thorium nitrate contaminated materials.

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Uranium Optogalvanic Laser Spectroscopy

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When laser radiation is sent into a hollow cathode lamp and the radiation wavelength is tuned on an absorption line of a species which is present in the lamp, the discharge impedance does change. This optogalvanic effect can be used to obtain spectroscopic information about the cathode elements and/or the buffer gas.

This technique is particularly powerful for refractory elements since it associates the efficiency of sputtering evaporation to a straightforward and very sensitive detection means.

We use this technique in order to study the uranium spectrum, detect new atomic energy levels and measure physical parameters useful for a laser isotope separation process.

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Spallation-produced Radiolanthanides via Tantalum; Coprecipitation with Fluorides and Separation in Short Columns with Cation-exchange Resin

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Nuclear reactions of tantalum spallation by high energy protons is an effective way to get neutron deficient radiolanthanides of the yttrium subgroup of rare-earth elements. Lanthanides were separated from tantalum dissolved in HF-HNO_3 by coprecipitation with LaF_3 adsorbed in cation-exchange resin. This excluded completely their loss at the stage of preparation for chromatographic separation.

The combined sample of lanthanides was separated to individual elements in the short columns $70 \times 3 \text{ mm}$ Aminex A-5 $13 \pm 2 \text{ m}$ by the buffer solution of alpha-hydroxyisobutyric acid with $\text{pH} = 4.5$. The target treatment and chromatographic separation lasted for about an hour. The chemical yield of elements was about 90%, contamination with neighbouring lanthanides being not more than 1%. The technique was developed with a glance to using it behind the biological shield with the help of remote-control devices. It has been successfully employed to get relatively short-lived ($T_{1/2} \approx 10 \text{ min}$) nuclides for nuclear spectroscopic investigations and to prepare samples of ^{167}Tm ($T_{1/2} = 9.25 \text{ days}$) for the purposes of nuclear medicine.