

# «GREEN EXTRACTION» OF RADIONUCLIDES FROM AQUEOUS SOLUTIONS USING THE SULFONAPHTHALENE OXAZOLE DERIVATIVE OF 2,6-PYRIDINE-DICARBOXYLIC ACID

*Krasnopyorova A.P., Yukhno G.D., Efimova N.V., Ilyashenko R.Yu.*

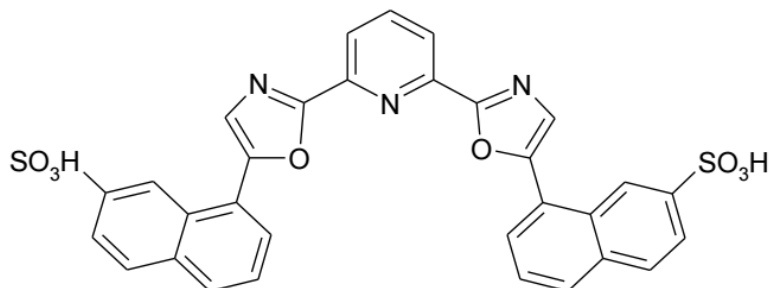
V.N. Karazin Kharkiv National University, [alla.p.krasnopyorova@karazin.ua](mailto:alla.p.krasnopyorova@karazin.ua)

Liquid extraction is a prospective field of research in the creation of processes for the extraction and separation of metals and radionuclides. The development of this area is associated with the use of fundamentally new extraction systems, which must be environmentally friendly, do not contain toxic extractants and solvents («green extraction»), and used or wasted solutions must be easily recycled or destroyed.

These requirements most completely correspond by two-phase aqueous systems based on water-soluble polymers, which are polyethylene glycols (PEG), and an inorganic salt-salting agent.

The possibilities of extraction methods are significantly expanded when water-soluble reagents are used, which have a high complexing ability and selectivity for metal ions. The group of the most effective complexing agents includes heterocyclic nitrogen- and sulfur-containing compounds, in the molecules of which chelate cavities are formed, the size and spatial geometry of which are favorable for the coordination of metal ions.

Previously, we synthesized a sulfonaphthalene oxazole derivative of 2,6-pyridine-dicarboxylic acid — 5,5'-[pyridine-2,6-diylbis(1,3-oxazol-2,5-diyl)]dinaphthalene-1-sulphonic acid (SNPO 2,6-PDA), and its complex formation with metal ions was studied [1, 2].



In the present work, we studied the extraction ability of the PEG-3000 —  $(\text{NH}_4)_2\text{SO}_4$  —  $\text{H}_2\text{O}$  two-phase system using SNPO 2,6-PDA as a complexing agent in relation to  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$ ,  $^{90}\text{Y}$ ,  $^{144}\text{Ce}$ , and  $^{238}\text{U}$  radionuclides.

For this, model solutions were used: a  $^{137}\text{Cs}$  solution with a specific activity of  $8.6 \cdot 10^7 \text{ Bq/dm}^3$ , a  $^{90}\text{Sr}$  solution with a specific activity of  $1.8 \cdot 10^8 \text{ Bq/dm}^3$ , as well as solutions of yttrium (III) chloride with a cerium (IV) with a metal ion concentration of  $2.77 \text{ mg/dm}^3$  and uranyl nitrate U(VI) with a metal ion concentration of  $1.52 \text{ mg/dm}^3$ . The ratio of aqueous and organic phases was 5:1. The time to reach equilibrium was determined experimentally and was 15-20 minutes. The equilibrium aqueous and organic phases were separated by centrifugation, after which samples were taken from the aqueous phase for analysis.

Determination of the radioactivity of dry residues of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  solutions on the  $\alpha$ - $\beta$ -automatic machine NRR-610 «Tesla». The concentration of Y(III), Ce(IV), U(VI) ions was determined by atomic emission spectroscopy on a Varian 725-ES optical emission spectrometer. The concentration in the organic phase was determined from the difference between the total concentration and the concentration in the aqueous phase.

The extraction capacity of SNPO 2,6-PDA with respect to  $\text{Cs}^+$ ,  $\text{Sr}^{2+}$ ,  $\text{UO}_2^{2+}$ ,  $\text{Y}^{3+}$ ,  $\text{Ce}^{4+}$  radionuclides is characterized by distribution coefficients (D) and extraction coefficients (R), which were calculated by the formulas:

$$D = ((C_0 - C_p) / C_0) (V_{\text{org}} / V_{\text{aq}}), \quad (1)$$

$$R = D \cdot 100 / [D + V_{\text{aq}} / V_{\text{org}}] (\%), \quad (2)$$

where  $C_0$  and  $C_p$  are the initial and equilibrium concentrations (activity) of the radionuclide in the aqueous phase,  $\text{mg/dm}^3$  (imp/s);

$V_{\text{org}}$ ,  $V_{\text{aq}}$  are volumes of organic and aqueous phases,  $\text{cm}^3$ .

The results are shown in the table.

**Table**

Distribution coefficients (D) and extraction coefficients (R, %) of radionuclides in the two-phase system PEG-3000 —  $(\text{NH}_4)_2\text{SO}_4$  —  $\text{H}_2\text{O}$

Radionuclide	$^{137}\text{Cs}$	$^{90}\text{Sr}$	$^{238}\text{U}$	$^{90}\text{Y}$	$^{144}\text{Ce}$
<b>D</b>	0.26	0.48	0.85	1.34	11.91
<b>R, %</b>	4.9	8.8	14.5	21.1	70.4

The obtained results of the studied systems show that in the series  $\text{Cs}^+$ ,  $\text{Sr}^{2+}$ ,  $\text{UO}_2^{2+}$ ,  $\text{Y}^{3+}$ ,  $\text{Ce}^{4+}$ , the extraction ability increases, which correlates with the previously determined instability constants of the complexes of SNPO 2,6-PDA with the corresponding ions [2].

This indicates that the determining role in the distribution of metal ions between the phases of the extraction system is played by their complex formation with SNPO 2,6-PDA.

Thus, two-phase aqueous systems based on PEG with additions of the complexing agent SNPO 2,6-PDA can be used for the selective extraction of the  $^{144}\text{Ce}$  radionuclide from aqueous solutions.

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## PHOTOCHEMICALLY ACTIVE BIODEGRADABLE POLYMER HYBRIDS AND THEIR USE FOR DECONTAMINATION OF WASTEWATER

*Zinchenko O.V., Ezhova V.D., Tolstov O.L.*

Institute of Macromolecular Chemistry NASU, [a.tolstov@ukr.net](mailto:a.tolstov@ukr.net)

Growing industrial activities in most countries initiates producing large volumes of wastewater [1]. Utilization of soluble wastes and wastewater recycling requires the elaboration of novel green, fast and efficient technologies for the decontamination of wastewater. Today a one of the leading research activities of scientific society is directed at using renewable energy sources for degrading inorganic and organic pollutants in the water before reuse. Great potential in this direction has inorganic photocatalysts whose oxidation/reduction activity initiate by UV or visible light irradiation [2]. Recent advances demonstrate the development of a variety of photocatalysts with different photochemical activity, chemical and atmosphere stability, wavelength working range, etc [3]. Despite many achievements in studying photocatalysis and photocatalysts, nanocrystalline titanium (IV) oxide still attracts great attention due to exhaustive photochemical activity, chemical and photochemical stability, economic and technological reasons [4]. Our previous works provided exhaustive data on the effect of the structure-dependent photochemical activity of nanocrystalline  $\text{TiO}_2$  [5].