

INAA STUDY OF U SORPTION FROM TECHNOLOGICAL SOLUTION BY DIFFERENT MICROORGANISMS

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Introduction

Extraction of U from technological solution excludes a loss of valuable metal and pollution of the environment by heavy and radioactive element. For the purpose, nontraditional method of extraction using capacity of the microorganism sells to accumulate metal ions (cation) has been applied¹⁻³.

Aim of this work is to study of U sorption from technological solutions by different microorganisms and to search more effective biosorbents among microorganisms- actinomycetes, fungal culture (*Acremonium*, *Aspergillus*) by using INAA.

INAA is more available and cheap method for us also it has high enough sensitivity and allows to avoid exposing the bacteria to radioactive metals. Atomic absorptive analyzer is more suitable for the determination of impurities in solutions, but it is expensive and not available for us.

Actinomycetes were reproduced on starch-ammoniac agar medium: NaNO₃ – 1g, actinomycetes MgSO₄ – 1g, K₂HPO₄–1g, starch –10g, agar –20g, distilled water – 1000ml, pH = 6.8 - 7.0 on horizontal shaker (180rpm) at temperature 28-30°C for 1-3 days.

Fungi were reproduced in liquid medium: NaNO₃ – 2g, K₂HPO₄–1g, KCl – 0.5g, MgSO₄ – 0.5g, FeSO₄ – 0.01g, saccharose –20.0g, tap water –1000ml, pH = 7.0-7.2 on horizontal shaker (180rpm) at temperature 28-30°C for 1-3 days. After reproduction strains actinomycetes and fungi were separated by centrifuging (6000rpm) and washed many times by distilled water.

Strains of actinomycetes and fungi (1g of each) were placed in 1 litre of the U technological solution (70.0 mg/l) and mixed on horizontal shaker (180rpm). Interaction between strains and solution lasted 5, 10, 15, 30 and 60 min. After interaction the content of U not sorbed by strains (residual content) was measured from the over-sedimentary solution (decantate).

1ml solution (decantate) was dropped on strip of ash free filter paper. The strips (samples) were dried, wrapped in the aluminum packets and placed in a container for irradiation in nuclear reactor.

The U samples were irradiated for 5 at the fission neutron flux density of $5.3 \cdot 10^{13} \text{ cm}^{-2} \text{ s}^{-1}$. After irradiation and cooling (2-3 days) spectra of samples were measured with using HPGE coaxial gamma ray detector (the resolution 1.8 keV at 1332.5 keV ⁶⁰Co), charge sensitive preamplifier, multichannel analyser DSA 1000 with software Genie 2000. The U content was calculated from the gamma-line (228.2 keV, 277.8 keV) intensities of radionuclide ²³⁹Np⁴⁻⁶. The values of U sorption from the solution by different strains of actinomycetes are shown in Table 1. It is seen from Table 1 that all the strains absorb U from solutions to different extent. There are two of 9 strains which absorbed more effectively.

Table 1. U sorption by different strains of actinomycetes from species *Streptomyces*.

№	Number of strain	Biosorption, %	№	Number of strain	Biosorption, %
1	67	98.9	6	4-9	48.2
2	82	27.8	7	4-14	26.6
3	140	99.5	8	4-15	51.0
4	3-6	38.8	9	4-16	46.8
5	4-11	52.2			

The values of U sorption from the solution by different strains microscopical fungi from species *Acpergillus niger* are shown in Table 2. It is seen from Table 2 that all the strains very poorly absorb U from solutions.

Table 2. U sorption from technological solution by microscopical fungi from species *Acpergillus niger*

№	Strain	Residual content, mg/l	Sorption, %
1	2	58.5 ± 0.5	16.4
2	40	48.9 ± 0.7	30.1
3	7	48.8 ± 0.7	30.3
4	14	44.8 ± 0.7	36.0
5	9	46.2 ± 0.7	34.0
6	138	37.2 ± 0.5	46.8
7	110	47.1 ± 0.7	32.7

The values of U sorption from the solution by different strains microscopical fungi from species *Acremonium* are shown in Table 3. It follows from Table 3 there is one of 15 strains, which absorbed effectively.

Table 3. U sorption from technological solution by microscopical fungi from species *Acremonium*

№	Strain	Residual content, mg/l	Sorption, %	№	Strain	Residual content, mg/l	Sorption, %
1	201	48.5 ± 0.7	30.7	9	211	34.3 ± 0.6	51.0
2	196	40.2 ± 0.5	42.6	10	219	46.1 ± 0.7	34.1
3	200	53.0 ± 0.8	24.3	11	215	13.0 ± 0.3	81.4
4	199	54.5 ± 0.8	22.1	12	203	39.4 ± 0.8	43.7
5	193	38.1 ± 0.5	45.6	13	205	62.8 ± 0.9	10.3
6	212	46.6 ± 0.7	33.4	14	219	61.7 ± 0.4	11.8
7	194	58.8 ± 0.5	16.0	15	197	61.0 ± 0.6	12.8
8	210	52.0 ± 0.6	25.7				

Additional studies were carried out with strain of actinomycetes labeled 140 and strain *Acremonium* labeled sp 215. Dependence of U sorption by strain *Acremonium* sp 215 on the reproduction period is shown in Table 4. There is no direct relation between these values. There may be such dependence for a reproduction time less than 1 day, but such study was not carried out.

Table 4. Dependence U sorption on the age of culture for *Acremonium* sp 215

№	Age of culture, hour	Sorption, %
1	24	97.6 ± 0.4
2	48	97.9 ± 1.0
3	72	97.7 ± 1.4

The interaction between biomass and solution lasted for 5, 10, 15, 30, 60 min. Dependence U sorption on the interaction time for strains is shown in Figure 1. It is obvious, that full saturation of the biomass with U from the solution took place in 15 min.

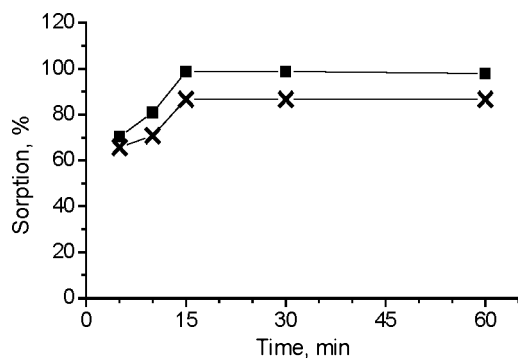


Fig 1. Dependence U sorption on the interaction time for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

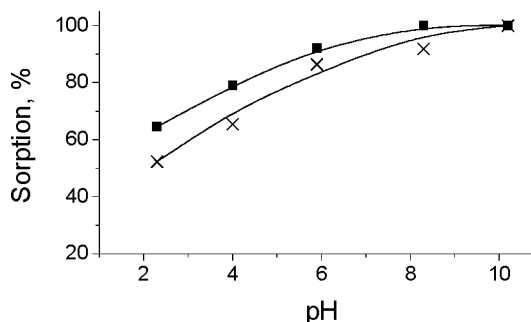


Fig 2. Dependence of U sorption on pH for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

The process of U biosorption was studied in a wide range of pH from 2.3 to 10.2. Dependence of U sorption on pH for strains is shown in figure 2. Sorption of U achieves 90-100 % for pH from 5.9 to 10.2. Dependence of U sorption by strains Actinomycetes sp 140 and Acremonium sp 215 on the solution temperature is shown in Figure 3. It is obvious, the U sorption at temperature from of 20 °C to 65 °C

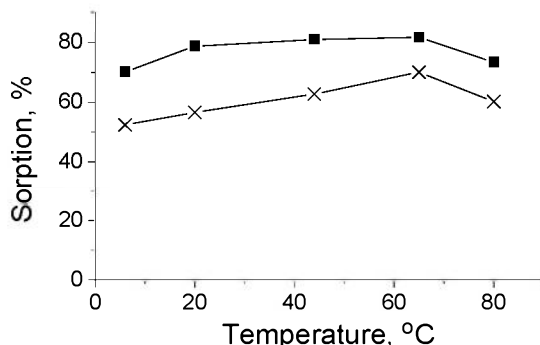


Fig 3. Dependence of U sorption on the solution temperature for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

achieve maximal value and decrease at temperature higher 65 °C and lower 20 °C.

Uncertainty the U determining (relative standard deviation) was 2-3 %. Is shown, that the most effective sorbents of U from technological solutions are some strains of actinomycetes (98,0%) and microscopical fungi Acremonium sp10 (98,3%).

The optimal temperature solution was from of 23.5° to 42.0 ° and optimal pH was 8,3. After the full study, these microorganisms can be applied for extraction of U from technological solutions and for water purification from heavy and radioactive U.

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