INAA STUDY OF U SORPTION FROM TECHNOLOGICAL SOLUTION BY DIFFERENT MICROORGANISMS

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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 cells to accumulate metal ions (cation) has been applied[1-3].

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 one 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 temperatures of 28-30°C for 1-3 days.

Fungi were reproduced on 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 temperatures of 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).

1-ml 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 $5.3 \cdot 10^{13}$ $cm^{-2}s^{-1}$. After irradiation and cooling (2-3 days) spectra of samples were measured with using HPGE coaxial gamma ray detector (with resolution of 1.8 keV at 1332.5 keV ^{60}Co), charge sensitive preamplifier, multichannel analyser DSA 1000 with Genie 2000software.

The U content was calculated from the gamma-line (228.2 keV, 277.8 keV) intensities of radionuclide ^{239}Np[4-6].

The values of U sorption from the solution by different strains of actinomycetes are shown in Table 1. It follows 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 follows 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. U sorption dependence 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 and 60 min. U sorption dependence 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.

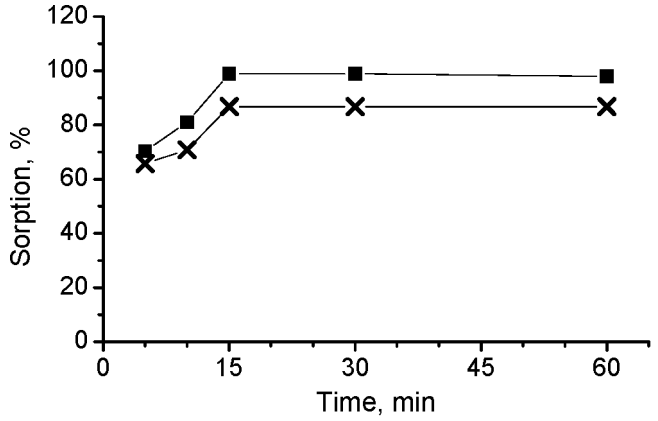


Fig. 1. Dependence U sorption on the interaction time for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

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.

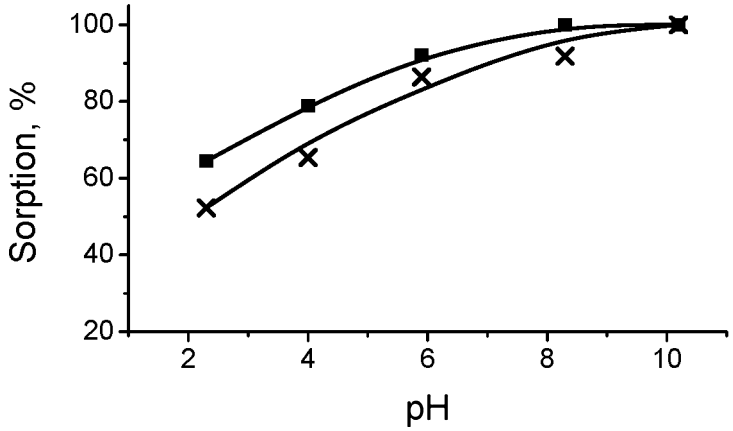


Fig.2. Dependence of U sorption on pH for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

Dependence of U sorption by strains Actinomycetes sp 140 and Acremonium sp 215 on the solution temperature is shown in figure 3. Obviously, the U sorption at temperatures from 20 ^{0} C to 65 ^{0} C achieves its maximal value and decreases at temperatures higher than 65 ^{0} C and lower than 20 ^{0} C.

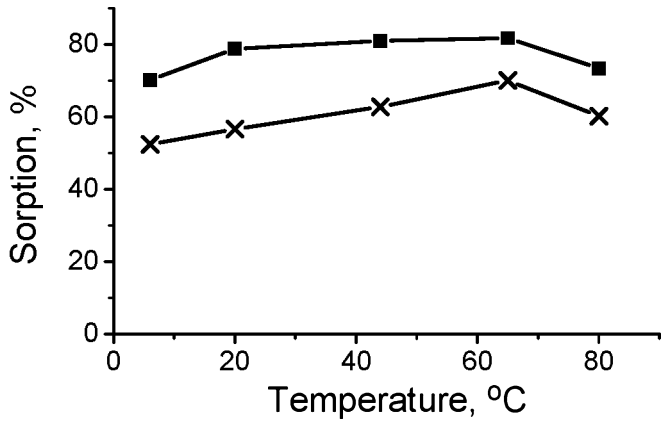


Fig. 3. Dependence of U sorption on the solution temperature for Actinomycetes sp 140 (■) and Acremonium sp 215 (×)

Uncertainty in the U determination (relative standard deviation) was 2-3 %.

It 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 of the solution was from 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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