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EXPRESS DETERMINATION OF SR-90 CONTENT IN DIFFERENT OBJECTS WITH DICYCLOHEXYL-18-CROWN-6 (DCH18C6)

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The present method is worked out for ^{90}Sr determination in objects of different origin, especially in agricultural production, cattle production, and food. The method may be applied to determine the ^{90}Sr contamination of objects and territories, which were exposed to accidents at nuclear energy objects, buffer areas of NPP, and possible use of so called "dirty" bombs. The principle of the method is based on chromatographic extraction of strontium from nitrate solutions followed by radiometric determination of ^{90}Sr activity. A highly porous matrix of styrene-divinyl benzene in the form of beads ~1 mm in diameter is used as a substrate to support the extractant, dicyclohexyl-18-crown-6 (DCH18C6) in tetrachloroethane, which is in the liquid state deep in the pores of the matrix. Dicyclohexyl-18-crown-6 belongs to synthetic macrocyclic polyethers (so-called crown ethers) and has the ability to bind ^{90}Sr with high selectivity so that ^{90}Sr is extracted with 90 – 95 % efficiency. Fig. 1 depicts the structural formula of dicyclohexyl-18-crown-6. The first number in names of crown ethers indicates the size of a ring, and the second number defines the quantity of oxygen atoms in a ring. The properties of crown ethers are described in detail in [1].

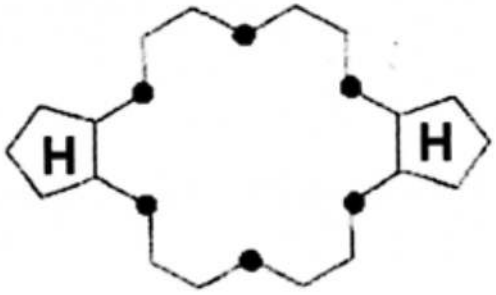

Fig. 1. Dicyclohexyl-18-crown-6

The scientific base of the most exact and express method of definition of the Sr-90 contents in the environmental objects of environment was developed in GEOHI of the Russian Academy of Sciences (Moscow) under the direction of academician B.F. Mjasoedov soon after the accident at the Chernobyl NPP [2]. This method was later adapted at the Institute of Physics of NAS of Belarus. It is meant for ^{90}Sr determination in soil, water, and milk. It is described in detail in [3].

Now at the Institute of Physics of NAS of Belarus the method of determination of ^{90}Sr in objects of organic origin (cereals, leguminous plants, meat and milk production, food, etc.) has been developed.

The main stages of the modernized version are:
1. Sample preparation. The method of wet combustion of the samples by aquafortis, filtering, evaporation, and final correction of the nitric acid concentration to 1.5 M of obtained solutions are used. Method «wet combustion» is based on combustion of dry sample by

concentrated nitric acid in the presence of perchloric or sulfuric acid. Reacting with organic substance, nitric acid decays to water, nitrogen dioxide and oxygen. Oxygen in free state has huge reactivity and oxidizes hydrogen of organic substance up to water. The presence of sulfuric or perchloric acid considerably accelerates combustion.

2. Preparation of selective sorbent, extract elution through a chromatographic column. To prepare the selective sorbent, solid extragent (solex) balls are placed in the chromatographic column and a 5% or 10 % solution of the sorbent dicyclohexyl – 18 – crown – 6 (DCH18C6) in tetrachlorethane is poured. The nitrate extract of the sample is passed through the chromatographic column (the time of completion of the sample passage is taken for the moment of separation of ^{90}Y and ^{90}Sr). Then the chromatographic column is washed with 1.5 M nitric acid. Next the column is heated to 80 ^0C by a thermostat, hot water is poured, and strontium desorption from the chromatographic column is carried out. The efficiency of strontium-90 desorption from the chromatographic column depends on the temperature of water and the crown ether concentration. Results of experiment are represented in Table1.

Table1. Desorption of strontium from the chromatographic column

Desorption temperature ^0C	60	70	80	90	60	70	80	90
Crown ether conc. %	5	5	5	5	10	10	10	10
Yield %	75	80	91	90	80	90	92	90

Consistent recovery of 92 % can be obtained at a water temperature of 80 ^0C. The process of elution is shown in Fig.2

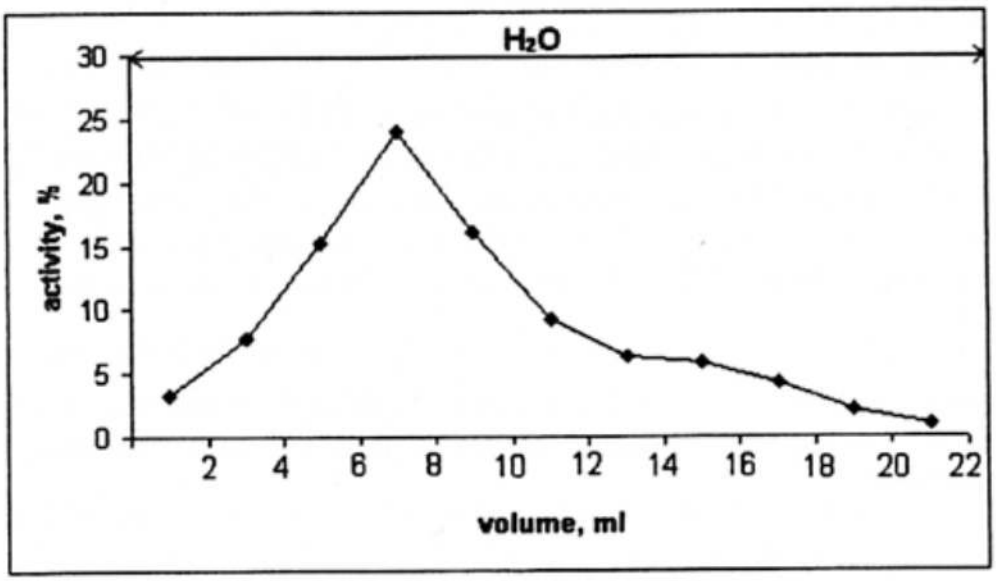

Fig. 2. Elution curve

With one cycle strontium is almost completely washed from the chromatographic column.

3. Radiometric measurement is performed in the liquid phase by beta-radiometer "Beta-2" using liquid scintillators. The ^{90}Sr activity is determined with allowance for the scintillating cell background, the conversion factor depending on the ^{90}Y accumulation time and the ^{90}Sr and ^{90}Y detection efficiency. For registration Sr-90 in the given methods scintillator cocktail Ready Safe was used.
The basic technical parameters of the method are represented in Table 2.

Table 2. Technical Parameters

Parameter		Value
Lower-range value, Bq		1
Upper-range value, Bq		1000
Time of realization of one analysis, h		4-5
Measurement error, %	1-3 Bq	30
	3-10 Bq	20
	10-1000 Bq	15

The present method provides considerable reduction of time needed for measurement of a sample (4-5 hours) in comparison to traditional radiochemical method (up to 2 weeks). Use of ultrasonic radiation and microwave radiation allows to reduce time of sample preparation.
Now the method is being tested in the Institute of Environmental Physics, University of Bremen. During this work optimum parameters for the given method will be determined. Also the procedure will be tested for low activities (less than 1 Bq).

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