

TITLE

Development of rapid universal method for determination of Cs-137 in different environmental samples by means of inorganic ion exchangers (part of a coordinated programme on radiological and environmental protection studies in the Danube river catchment area)

FINAL REPORT FOR THE PERIOD

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FINAL REPORT

IAEA RESEARCH CONTRACT 2414/RB

TITLE: DEVELOPMENT OF RAPID UNIVERSAL METHOD FOR DETERMINATION
OF Cs-137 IN DIFFERENT ENVIRONMENTAL SAMPLES BY MEANS OF
INORGANIC ION EXCHANGERS

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S.M. Levi

DEVELOPMENT OF RAPID AND SIMPLE METHOD FOR DETERMINATION OF
CS-137 IN DIFFERENT ENVIRONMENTAL SAMPLES BY MEANS OF
INORGANIC ION EXCHANGERS

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Marked
Using three synthetic inorganic ion exchangers of the same type - $X_2 [YFe(CN)_6]$ (when X = alkali metal, Y = transition metal) one simple and universal rapid method for determination of Cs-137 in environmental samples was developed.

The investigations carried out on synthesis, next preparation and practical use in routine analysis showed that $K_2[CoFe(CN)_6]$ (abbr.KCFC-II) is the most suitable for analysis of low level activities of Cs-137 in different environmental samples. The optimum conditions for routine use of KCFC-II in different separation schemes were found. Repeated analysis of Cs-137 in different environmental samples as well as analysis of IAEA-Reference Materials using our rapid and one classical method showed good agreement of the results. The proposed rapid method can be used in emergency situations and in routine radiation control.

I. Scope and scientific background of the research project.

During the last 20 years a great attention was paid to environmental radiation control and development of rapid and enough accurate instrumental and radiochemical methods. It is well known that almost all recommended classical radiochemical methods for determination of Cs-137, Sr-90 etc. are very time consuming, expensive and not suitable for routine work or emergency situations especially with large number of samples /1,2/.

Ion exchange chromatography using inorganic ion exchangers is one modern method. One of these exchangers very often used in environmental radiation control is AMP (ammonium molybdophosphate). Unfortunately AMP has not strongly determined stoichiometric substance and can't be used for preparation of planchettes and direct measurements of Cs-137 /3/.

The inorganic ion exchanger $K_2[CoFe(CN)_6]$ (abbr.KCFC), which is one of the objects of our investigations, was reported by Prout and coauthors /4/. In the first paper Prout reports some preliminary observations on physical, chemical and ion exchange characteristics of KCFC. Petrow and Levine /5/ reported another ion

exchanger $(\text{NH}_4)_2\sqrt{\text{CoFe}(\text{CN})_6}$ (abbr. NCFC) and reported that NCFC is identical to KCFC in its ability to adsorb selective Cs-137. Shvidko and coauthors recommended method of selective adsorption of Cs-137 on KCFC, as a most promising of the rapid methods /6/.

Following these recommendations some years ago we began to use KCFC in routine environmental radiation control around our nuclear reactor IRT-2000 Sofia. First of all we used $\text{K}_2\sqrt{\text{CoFe}(\text{CN})_6}$ (called by us KCFC-II) after dry ashing /7/. Recently according ^{to} the programme of our Res. contract with IAEA, Vienna/ 8 / we began to investigate two other ion exchangers of the same type: NCFC. - $(\text{NH}_4)_2\sqrt{\text{CoFe}(\text{CN})_6}$ and $\text{K}\sqrt{\text{CoFe}(\text{CN})_6}$ proposed by Bobovnikova and coauthors /9/ and called by us KCFC-II.

The object of our research contract was to develop simple and rapid method for determination of Cs-137 in environmental samples using inorganic ion exchangers. Our experiments were on the next problems:

1. Synthesis of these three ion exchangers; investigations and comparing their properties in order to choose one of them - the most suitable in developing one rapid and universal method.
2. To find optimal experimental conditions when using these three ion exchangers.
3. To develop a rapid separation schemes for Cs-137 suitable for different environmental samples-to make the method universal. Interference factors.
4. To study the reproducibility and accuracy of the results by means of:
 - repeated analysis of Cs-137 in one and the same sample.
 - analysis of Cs-137 in one and the same sample using our rapid method and one classical method.
 - analysis of reference materials from IAEA.

II. Description of methods used

II.1. Experimental

II.1.1. Reagents, radionuclides and other materials. All reagents used in this study are of analytical grade, from Bulgaria, CSSR, USSR, FRG, England. The radionuclides are from "Amersham"-England, CEN-France, Institute of Isotopes of Hungarian Academy of Sciences and "Metronex"-Poland. Ion exchangers, model solutions and different

solutions after dry or wet ashing were obtained by us.

II.1.2. Apparatus and other facilities: beta-counting device UMF-1500M with SBT-6M counter/background 4-5 c/min (USSR); universal shaker-327 (Poland); thermostat TB-25, DDR; magnetic stirrer MA-2A (CSSR); planchettes $\phi = 30$ mm; planchettes containing pure KCFC-II 100/125 mg/for background measurements/, planchettes with 100/125 mg of pure KCFC-II+standard solution of Cs-137, for determination of η .

II.2. Procedures

II.2.1. Preparation of the ion exchangers. KCFC, called by us KCFC-II was prepared by the method of Prout with some modifications. NCFC we obtained using Petrow/Levine's method. KCFC-II we prepared using the method of Prout in our modification: One volume of 0.5N $K_3/Fe(CN)_6$ was added to 2.4 volumes of 0.3N $Co(NO_3)_2 \cdot 6H_2O$ over period of 30 min. The dark brown slurry was allowed to stay overnight or 3-4 h. After very good washing with dist. water/in centrifuge tube /the residue was dried, 3h at 115°C. The resulting granules were crushed, sieved through 0.4mm sieve and washed again. After 5-6 min the smallest particles were poured down. The residue was then redried and sieved and particles of different size were collected.

II.2.2. Ion exchange of Cs-137. Almost all investigations were carried out in bath equilibrium tests, using magnetic stirrer, different model solutions, after dry or wet ashing of the samples. Only for water samples we used ion exchange in dynamic conditions.

III. Results obtained

According to our research programme we found optimum experimental conditions on synthesis, next preparation and practical use of the three synthetic inorganic ion exchangers mentioned above. Comparing their properties and ion exchange characteristics, we found that all of them can be used for selective adsorption of Cs-137, but KCFC-II was considered to be the most suitable for determination of low level activities of this radionuclide in environmental samples.

Using KCFC-II, we developed different separation schemes for plants, dust from collectors, aerosols, soils and bottom sediments /Table I, A, B, C, / and for water samples /Table 2, A, B /. In Table-3/A, B/ we show the results for Cs-137 obtained by us analyzing IAEA-Reference Materials and different environmental samples

using our rapid method and one classical method. In Table-4 we give one rapid separation scheme/10 / for determination of Sr-90 (and Ce-144) and its possible combination with our rapid scheme for Cs-137/only for plant solutions /. Table-5 shows our preliminary separation scheme for simultaneous determination of Cs-137, Sr-90, Ce-144 and Pu-239 in one and the same sample.

a. Discussions and interpretation of the results

Investigating the problems of synthesis and next preparation of the adsorbents we found that the washing procedure is very important, especially for KCFC-I and KCFC-II, containing potassium (resp. ^{40}K). /8, 11, /. After good washing (see II.2.1) the adsorbents have lower background and more stable granules. From all three adsorbents we used KCFC-II because of its better physical and chemical properties and enough ion exchange capacity for Cs-137 (0,35 meq/g) and lower potassium-content/background for 100 mg of adsorbent. 1-2 c/min). The ion exchange capacity of KCFC-I under the same experimental conditions (acid solution of 2N HCL and one hour of stirring) is $\sim 0,55$ meq/g, but the background is higher -4-5 c/min for 100 mg.

Developing our rapid procedure, we investigated the influence of different experimental conditions (pH, concentration of salts, method of stirring, the volume of the solution etc.) /8, 10 / on E% (percent adsorption) and on K_d (distribution coefficient). E% in our rapid schemes corresponds to radiochemical yield (\mathcal{E}). We do not determine \mathcal{E} (E%) for every sample, but for groups of samples of the same type. That's why it is very important to know the interfering factors. /7, 8, 11 /.

Extending our rapid separation scheme to different environmental samples we had no problems with plants, dust from collectors and aerosols /Table-I, A, B, C, / except of their extremely low Cs-concentration (Cs-137), very often below the detection limit of the method. In such cases we need higher amounts of ash for analysis. Interference of higher Ca and Mg concentrations in some samples (plants, milk) is possible. To avoid the precipitation of CaF_2 , after adding of HF (see Table-I) we recommend dissolving the ash in 4N instead of 2N HCL (see sep. scheme -1). The interference from rubidium/resp. Rb-87/ is possible in fish and soil samples. This interference is lowest for KCFC-II. The higher the concentration of Cs-carrier, the lower the interference of Rb-87. Our opinion is that scheme -8/ Table 1/ is more

suitable for water samples, avoiding the time consuming step of evaporation. The radiochemical yield for plants is 85 %, for soils 75 % and for water samples for scheme B ~ 70 %. The results from parallel analysis of Cs-137 using our rapid method and one classical, method are very good. Repeated analysis of Cs-137 in different environmental samples as well as analysis of different IAEA's Reference Materials/ Table -3A, 3B / using our rapid and one classical method showed good agreement of the results and stable experimental conditions for a long period of time.

b. Final conclusions of the entire project

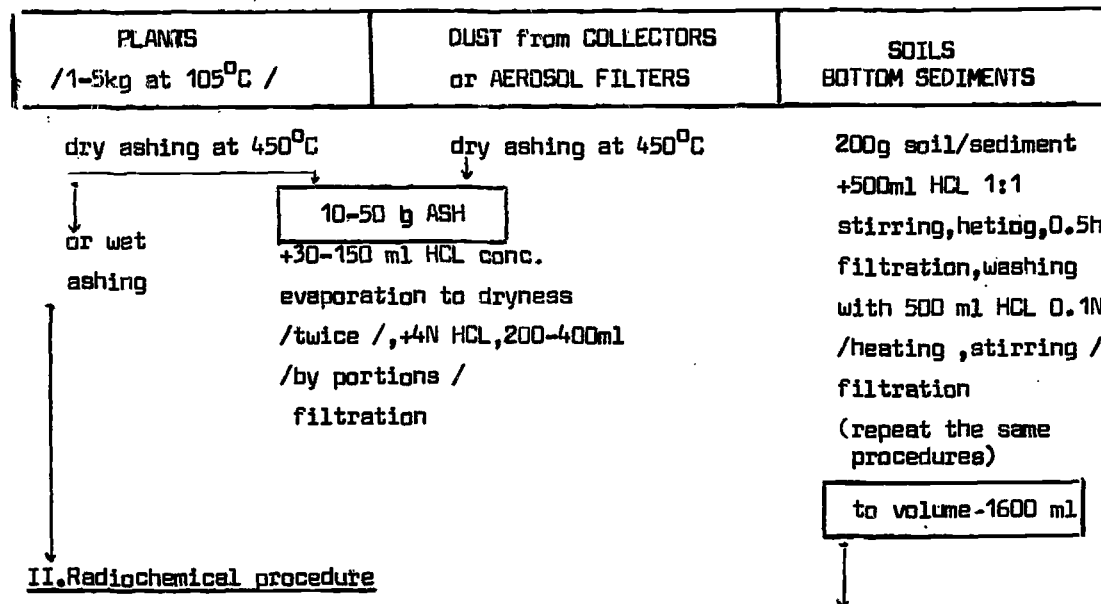
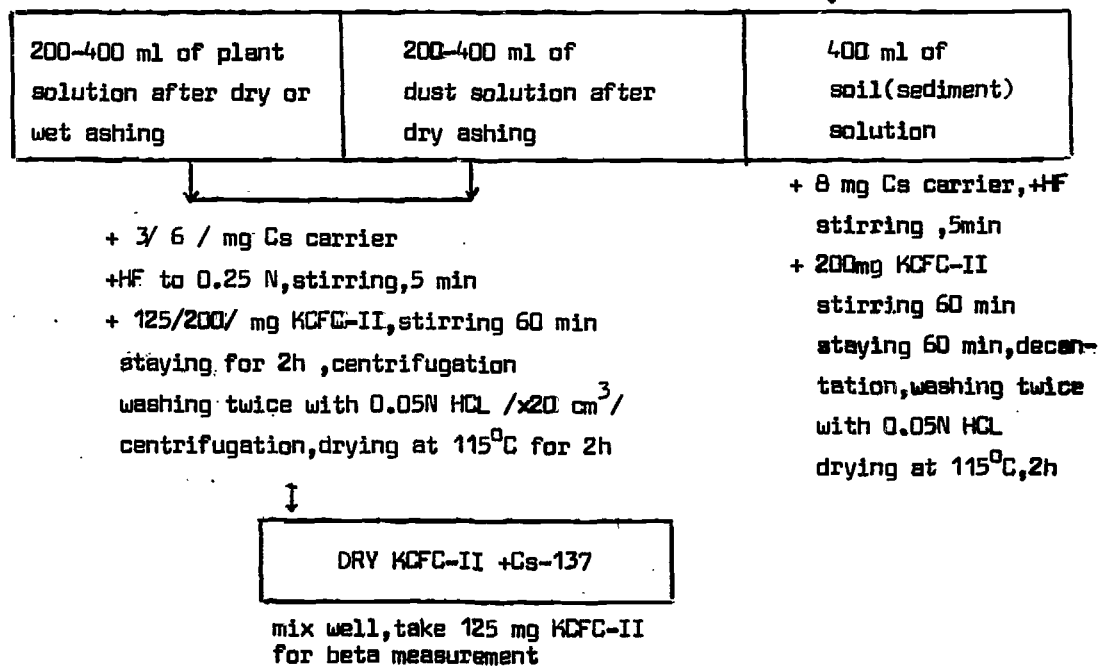
One rapid and universal radiochemical method for determination of Cs-137 in environmental samples is developed. The most suitable for determination of low level activities of Cs-137 is ion exchanger KCFC-II. All procedure (without preliminary preparation) takes only one day. The method is simple, rapid and enough accurate, suitable for environmental radiation control - in routine work and for emergency situations.

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TABLE-I

SEPARATION SCHEMES FOR DIFFERENT ENVIRONMENTAL SAMPLES

I. Preliminary concentrationII. Radiochemical procedure

Sample -planchettes KCFC-II +Cs -137 from the sample /125 mg/	Background-planchettes 125 mg of pure KCFC-II	Standard-planchettes 125 mg of pure KCFC- +standard solution of Cs -137
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III. Calculations for determination of Cs-137 in Bq/kg

TABLE-2

SEPARATION SCHEME FOR WATER SAMPLES

SCHEME-A

50l of water

- + 10mg Cs carrier
- + HCL conc. 250 ml
- evaporation to 200ml
- transfer to porcelain dish
- evaporating to dryness
- heating at 450°C 1h

Ash-I

- +HCL conc.
- evaporation to dryness
- /3 times /

Dry residue-II

- dissolution in
- 400ml 2N HCL/by portions/

Solution of salts
/400ml /

- +HF 2ml/slowly, by drops /
- stirring 5 min
- +200 mg of KCFC-II/I /
- stirring 1h

Beta measurement
/100/125 /mg of
adsorbent

Note: This formula is
for beta measurement
after sep./schemes A and B.
Only $\epsilon = \%$ is different:
For scheme B $\epsilon = 70\%$,
for scheme A $\epsilon = 85\%$.

SCHEME-B

50l of water

- + Cs carrier/not more than 4mg/g of
adsorbent
- +HCL conc. to 0.5 N
- +HF conc. to 0.5N, mix well

Ion exchange of ¹³⁷Cs on KCFC-II
/4g of adsorbent (size 0.3-0.1mm)
in ion exchange column /

Flow -rate 50ml/min

Effluent

- Washing the column with 1L 0.02NHCL
- / 10 ml /min
- drying KCFC-II/I/ at 115°C, 2h

Dry KCFC-II + ¹³⁷CsGamma measurement of 4g KCFC-II
/or gamma spectrometry /

or

Beta measurement of 100(125)mg of
KCFC-II, planchettes $\phi = 30\text{mm}$ Calculations for scheme-B and A:

$$A_{\text{Bq/50L}} = \frac{N \pm \Delta N}{n \cdot \epsilon \cdot \eta \cdot 0.037}$$

- / $N \pm \Delta N$ = c/min for n mg of KCFC-II
- m - total amount of KCFC-II used in a column
- ϵ - E% = radiochemical yield
- η - Efficiency of the counting device
- x 0.037 - transfer from pCi to Bq

TABLE-3 / A AND B /

A/ ANALYSIS OF REFERENCE MATERIALS FOR Cs-137 (1. A-7 Milk powder from Seberedorf IAEA Laboratory, Vienna 2. MA-8-1 Anadora Granosa, from IAEA Laboratory, Monaco)

Reference material	Recommended values Bq/kg /date /		Results obtained Bq/kg			
			classical method*	rapid method**		
A-7	1.11.1980	1.11.81	1.11.80	1.11.80	1.11.81	1.VI.82
	5.9 ±0.9	5.1±0.8	5.6±0.5	<u>5.2±0.5</u> 4.1 5.3 6.1	<u>5.0±0.3</u> 4.7 5.2	<u>5.2±0.5</u> 4.8 5.6
MA-8-I	1.II.1980	1.11.81	1.11.80	1.11.80	X.81	1.VI.82
	518±15	495±12	703±18	<u>467±19</u> 510 466 426	<u>506±30</u> 444 555 518	<u>450±30</u> 407 481 463

B/ ANALYSIS OF DIFFERENT ENVIRONMENTAL SAMPLES

N Sample	A Bq/kg		N sample	A Bq/kg	
	classical method	rapid method		classical method	rapid method
1 plant	4.5	4.6	6 soil	11.4	9.3
	3.2	2.5		11.0	13.8
	<u>2.8</u>	<u>—</u>		<u>12.4</u>	<u>13.0</u>
	3.5±0.6	3.6±1.0		11.6±0.4	11.7±1.3
2 plant	5.6	4.8	7 soil	25.0	24.7
	<u>6.4</u>	<u>4.1</u>		20.1	21.8
	6.0±0.4	4.5±1.0		<u>22.5±2.2</u>	21.6
				18.4	<u>24.6</u>
3 algae	9.7±2.6	9.1±3.7			<u>22.2±0.44</u>
4 bottom sediment	9.9±1.5	7.8±2.6			
5 -"-	3.2±0.9	not detectable			

* -classical method with final precipitation of Cs-137 as Ca_2PtCl_6

** -adsorption on KCFC-II

SCHEME FOR DETERMINATION OF LOW LEVEL ACTIVITIES OF STRONTIUM-90
IN FOOD AND OTHER BIOLOGICAL SAMPLES

(W. Kracke, Y. M. LIN, M. RADICHEVA, B. SANSONI, 1976, NEUHERBERG, GSF, MÜNCHEN)

SAMPLE: 100-1000g of foodstuff or other biological or organic environmental samples, reduced to small pieces

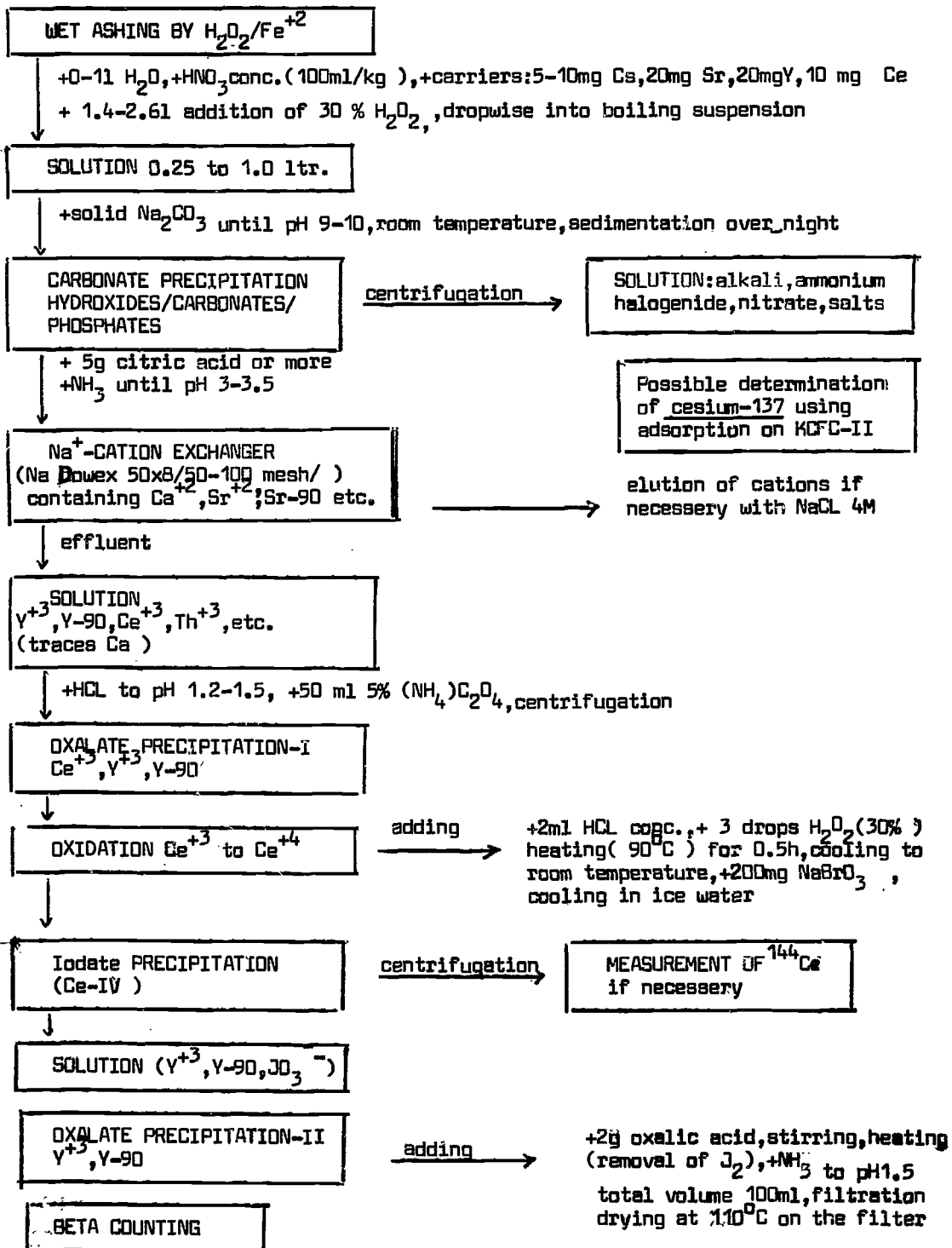
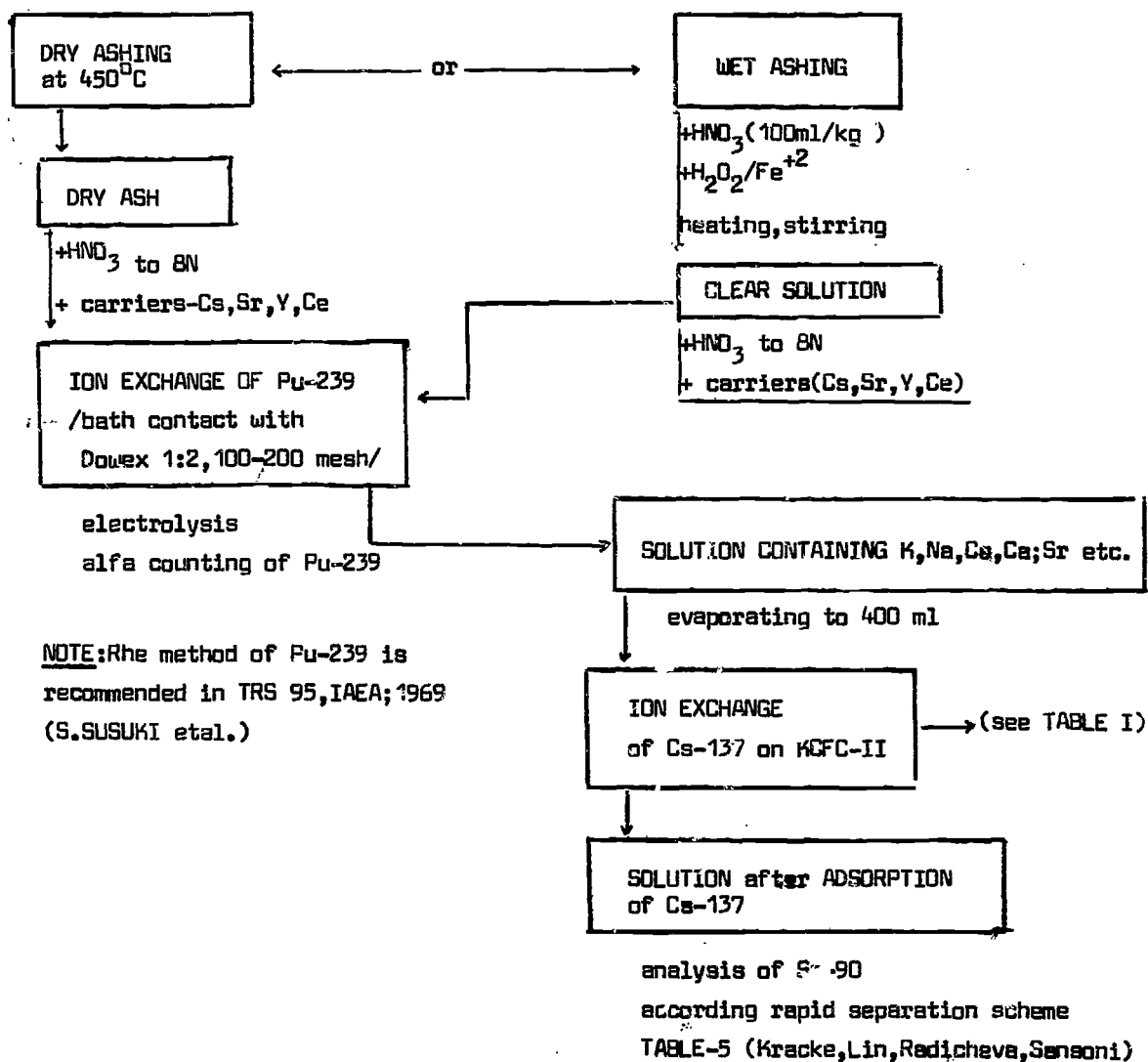


TABLE-5

PRELIMINARY SEPARATION SCHEME FOR SIMULTANEOUS DETERMINATION OF Cs-137, Pu-239, Sr-90, Ce-144/in one and the same sample / .PLANTS AND BIOLOGICAL MATERIALS



FINAL REPORT

IAEA RESEARCH CONTRACT 2414/R2./RB

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CHIEF INVESTIGATOR:MARINA A.RADICHEVA

TIME PERIOD COVERED:01.12.1981-01.10.1982

INVESTIGATORS:L.A.BOGDEVA,M.D.APOSTOLOVA,S.M.LEVI

INTRODUCTION. During the last 20 years, a great attention was paid to environmental radiation control and development of rapid and enough accurate instrumental and radiochemical methods. It is well known that almost all recommended classical radiochemical methods for determination of ^{137}Cs , ^{90}Sr etc. are very time consuming, expensive and not suitable for routine work or emergency situations especially with large number of samples. /1, 2 /

Ion exchange chromatography using inorganic ion exchangers is one modern method. One of these exchangers very often used in environmental radiation control is AMP/ammonium molybdophosphate. Unfortunately AMP has not strongly determined stoichiometric substance and can't be used for preparation of planchets and direct measurements of ^{137}Cs . /3 /

The inorganic ion exchanger $\text{K}_2[\text{CoFe}(\text{CN})_6]$ (abbr. KCFC), which is one of the objects of our investigations, was reported by Prout and coauthors /4 /. In the first paper Prout reports some preliminary observations on physical, chemical and ion exchange characteristics of KCFC. [5] Petrov and Lavine reported another ion exchanger $(\text{NH}_4)_2[\text{CoFe}(\text{CN})_6]$ -abbr. NCFC and reported that NCFC is identical in its ability to adsorb selective ^{137}Cs to KCFC. Shvidka and coauthors recommended method of selective adsorption of ^{137}Cs on KCFC, as a most promising of the rapid methods. /5 /

Following these recommendations we began to use KCFC, prepared by us in environmental radiation control around Nuclear Reactor IRI-2000, Sofia (at first only for plants) / 7 / . Under the res. programme of our contract with IAEA 2414/RB 1979-1982 we developed one rapid and universal radiochemical method using three inorganic ion exchangers of the same type: KCFC, NCFC and KCFC-II, proposed by Bobovnicova et al. [8] We called KCFC from Prout KCFC-I / and synthesized all this ion exchangers using given methods in our modification. We investigated some of their characteristics and chose KCFC-II for developing our rapid Schemes for plants, soils and bottom sediments etc. /see REPORTS RES.CONTRACT 2414/RB /1979-1981 / . We studied the reproducibility of the results using our separation schemes in repeated analysis in one and the same sample, comparing the results for ^{137}Cs using our method and classical method, and analysis of REFERENCE MATERIALS from IAEA-Vienna. / 9 / . The reproducibility of the results were considered to be very good.

II. EXPERIMENTAL

All reagents used in this study are of analytical grade, from Bulgaria, USSR, USSR, FRG, England. The radionuclides are from "Amersham"-England, DEN-France, Institute of Isotopes of Hungarian Academy of Sciences and "Metronax"-Poland.

Other materials: Ion exchangers KCFC-I, NCFC, KCFC-II synthesized by us.

Different solutions from environmental samples after dry or wet ashing, and different model solutions.

Apparatus and other facilities

-beta counting device UMF-1500M, 3T-GM counter, 4-5 c/min (USSR)

-universal shaker type 327 (Poland)

thermostat TB-25, ODR; Magnetic stirrers MA-2A (USSR); aluminium, quartz and other
planchets: ϕ -24-30 mm;

Procedures

Preparation of the ion exchangers: 1. KCFC called by us KCFC-I was prepared by the method of Prout / 4 / with some modifications. 2. NCFC we obtained using Petrov / Levine's method. / 5 /. 3. KCFC-II, proposed by Bobovnicova and coauthors / 8 / we prepared using the method of Prout in our modification.

Ion exchange of ^{137}Cs

Almost all investigations were carried out in bath equilibrium tests, using magnetic stirrer, different model solutions after dry or wet ashing of the sample. Adsorbents -100-200mg, Cs-carrier not more than 4 mg per g KCFC-II. Only for water samples we used ion exchange in dynamic conditions: 50l of water (model solutions of tap water + Cs-carrier + HCL to 0.5N + ^{137}Cs) were percolated through the column, ϕ -20mm, l=100mm/filled with KCFC-II, 4g, (0.2-0.1 mm) at a rate 50 ml/min.

The percent adsorption -E% was determined by us for different experimental conditions in bath equilibrium tests and only for water samples in dynamic condition.

All results received by us for the period of 1960-II.12.1961 were given in our previous reports and other publications. In this report we give again the separation scheme I (for plant solutions) and some of the results obtained according

the research programme for the period of 01.12.1981-01.10.1982.

During the last period of the contract we investigated the possibility to extend our rapid scheme for water samples. We investigated three separation schemes (two of them are in table 2). The results obtained using model solutions /table 3 / are interesting and will be published after some other experiments. Our opinion is that separation scheme B can be more suitable for determination of low level ^{137}Cs concentrations in different water samples. In table 3 we give one example of model experiment with water samples and some calculations. The reproducibility of the results is very good and $\pm 5\%$ or more 70% for given experimental conditions. We believe to improve the separation scheme after some more experiments. In all cases this separation scheme is simpler than scheme A avoiding the time consuming evaporation step.

Now we continued our experiments with water samples and some of the results will be published.

The other problem investigated during this time was to find optimal conditions to combine our rapid separation scheme for ^{137}Cs with other rapid schemes /TABLE 4/ for ^{90}Sr (see scheme 4). The rapid scheme for ^{90}Sr was developed under research programme of IAEA fellowship SC/202/DUL/7503 in 1980 together with prof. dr. J. Sansoni in Neuherberg-Munich, GFR. The rapid separation scheme for ^{90}Sr /TABLE 4/ is developed for plant and other biological samples. The method is based on low level beta counting of $^{90}\text{Y}/\text{yttrium}$ /instead of ^{90}Sr after separation of anionic yttrium-90 in citric acid solution by cation exchange, followed by two oxalate and one iodate separation. The method is very simple compared with the classical fuming nitric acid method, suitable for low level determination in routine work with large samples, even in not so well equipped environmental laboratories. There is no interference from $^{141/144}\text{Ce}$ and interference from ^{210}Pb is 0.25%, from ^{226}Ra 0.1%, from $^{228/324}\text{Th}$ 1.5%. This scheme gives possibility to determine in one and the same sample ^{90}Sr , ^{144}Ce and ^{137}Cs .

^{144}Ce can be determined after iodate precipitation (Ce-IV). Cesium-137 can be determined using the solution after carbonate precipitation of the Highp /see sep. Scheme 4/. The second possibility to combine these two rapid

methods in the next, investigated by us :

WET ASHING BY H_2O_2 / Fe^{+2} -100 to 1000g of material
+Cs carrier

adsorption of ^{137}Cs on KCFC-II/200-400 g /
washing, drying and measurement of β -activity
/see other separation schemes/

Solution after ^{137}Cs adsorption on KCFC-II

The next steps for determination of ^{90}Sr

and ^{144}Ce are the same as in the scheme 4 , table 4 .

The radiochemical yield for ^{137}Cs in the first case (adsorption from alkaline solutions) is $\sim 60-65\%$ and strongly depends on the volume and concentration of the solution. The Yeld /% for ^{137}Cs / for the second scheme given above is 70-80%. Our believe is that the second scheme is more suitable for simultaneous determination of these three radionuclides from one and the same sample.

One possible scheme for determination of ^{137}Cs (using our rapid method) and ^{239}Pu is given in table 5 . If the method ^{239}Pu determination is extraction of ^{239}Pu as cupferonates , ^{137}Cs can be determined in the residual solution. The other possibility is to adsorb ^{239}Pu on DOWEX1x2 resin and to determine ^{137}Cs in the solution /see scheme 5 /. At the moment we are interested only in the possibility to combine our rapid scheme in optimal conditions with other methods and we have already good preliminary results. The % for ^{137}Cs in the two cases is 70-80%. The problems connected with ^{239}Pu will be the object of our future work.

In conclusion we can say that our rapid and universal method for ^{137}Cs determination is very useful for routine work and for emergency situations.

We would like to express our gratitude to Dr. A. Bianco , Mr. P. Date and all colleagues from IAEA for the rendered assistance, both financial and scientific, during the period covered by the contract.

10.01.1963
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Chief investigator:

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/Marina Radicheva /

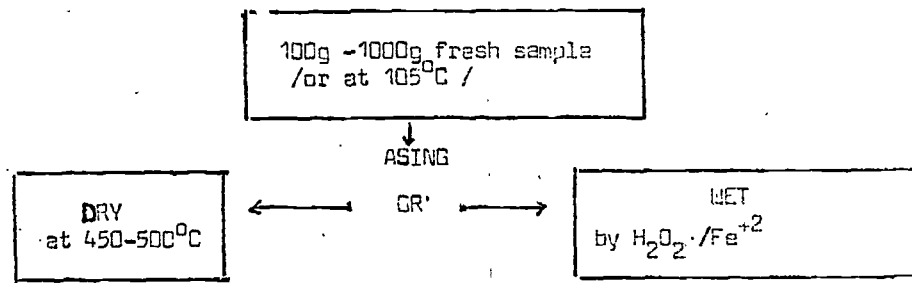
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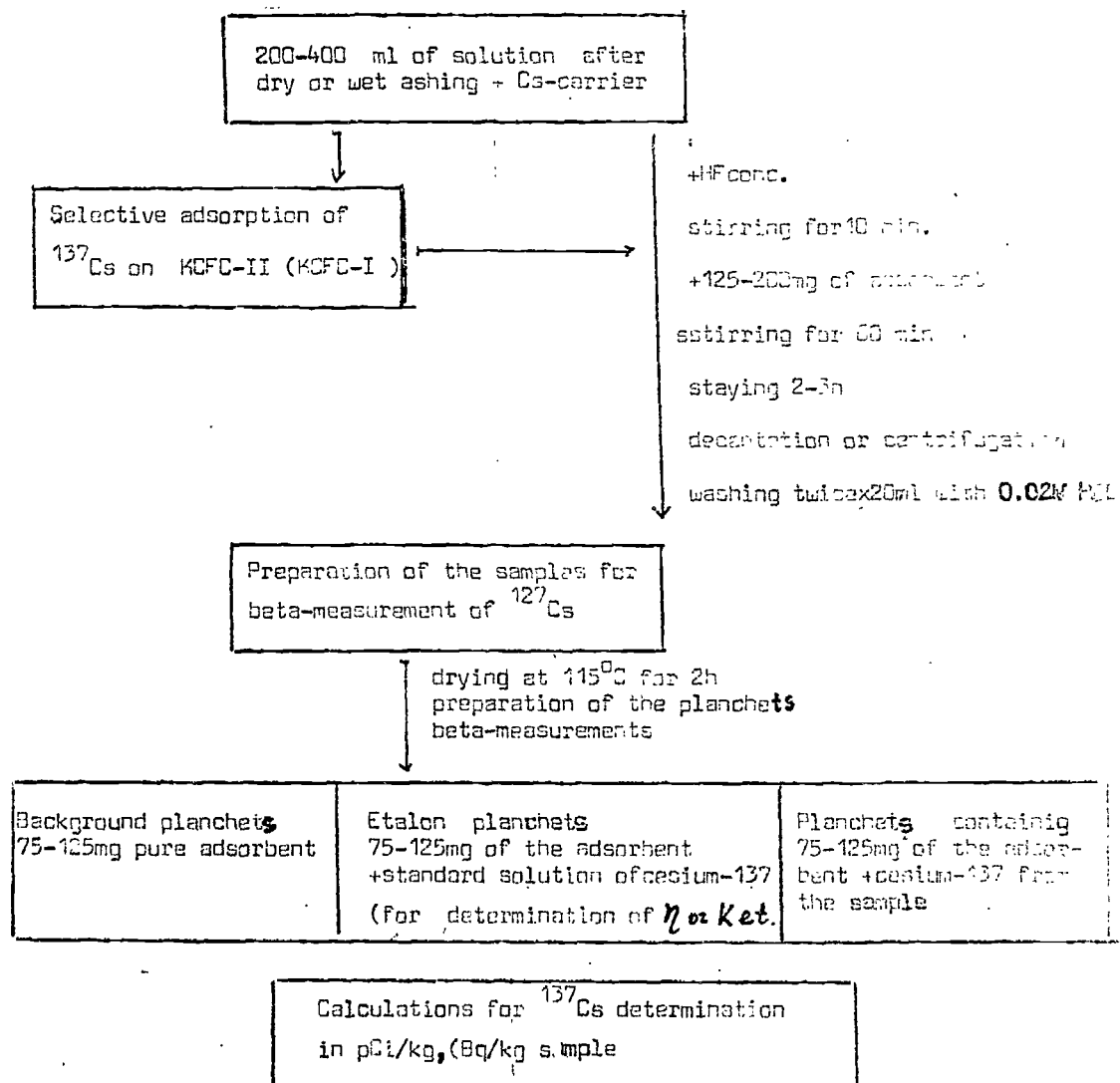
TABLE-4

SEPARATION SCHEME -I(Plants and other biological Samples)

Part -I.Preliminary concentration



Part-2.Rapid radiochemical separation



Remarks: E_{β} is around 85 % for biological samples

$$A_{pCi/kg} = \frac{N + \Delta N / a.Ket}{b.K_1.K_2}$$

$N + \Delta N / -C/min$
 a-ash in 1kg of plant
 b-ash for analysis
 Ket-transfer factor in %
 $K_1 = E_{\beta}$; $K_2 = e^{-\lambda t}$

TABLE -2

SEPARATION SCHEMES FOR WATER SAMPLES

SCHEME-A

50 l OF WATER

+Cs CARRIER

+HCL conc. 500ml

evaporating to 400ml

transfer to porcelain dish

evaporating to dryness

heat to 450°C 1h

ASH-I

evaporating to

dryness 3 times

with conc.HCL

DRY RESIDUE-II

dissolution in

400 ml 2N HCL by

portions

SOLUTION OF SALTS
IN 2N HCL

+ HF conc.

+200mg of KCFC-II
stirring 1hwashing ,drying KCFC-II
at 115°C

BETA MEASUREMENT

SCHEME-B

50 l OF WATER

+Cs carrier/not more than 4.0g
KCFC-II

+conc.HCL to 0.5 N

+ conc.HF to 0.5 N

mixing well

ION EXCHANGE (137Cs)
ON 4g KCFC-II
0.1-0.2 mm size

flow rate 40 ml /min

EFFLUENT

Washing the column with

1L 0.02N HCL (10 ml / 1h)

drying of effluent at 115°C
for 2h

DRY KCFC-II (137Cs)

GAMMA- SPECTROMETRY (4g in con-
tainer (40mm))

or

BETA MEASUREMENT of 10-125 mg

TABLE - 3

Some preliminary results for model solutions -water(tap water)
+HCL +Cs carrier + ¹³⁷Cs .Separation Scheme-B / KCFC-II /

No	tap water l	conc.HCL l	Cs-carrier mg	cesium-137 pCi/ aded	KCFC g	Imp./min / N ± ΔN/ 100mg	A pCi/4g
1	50	2.7	160	1870	4	18.5	1495
2	50	2.7	160	- " -	4	17.4	1243
3	- " -	- " -	- " -	- " -	- " -	18.0	1297

mean 18.3 ± 1.4 1318 ± 100

Calculation: A pCi/4g or 50 l $\frac{18.3 \pm 1.5 / 4}{0.25 \cdot 0.1 \cdot 2.22 \cdot 10^{-12}}$

0.25 = η = efficiency
 0.1 = KCFC - mass
 / 18.3 ± 1.5 / p/min

A pCi/4g or 50 l (1318 ± 100)

RESULTS FROM the MODEL EXPERIMENT:

Activity added: 1870 pCi

Activity found: 1318 pCi

Efficiency yield = 70.5 %

RESULTS RECEIVED USING SEPARATION
 SCHEME -B;

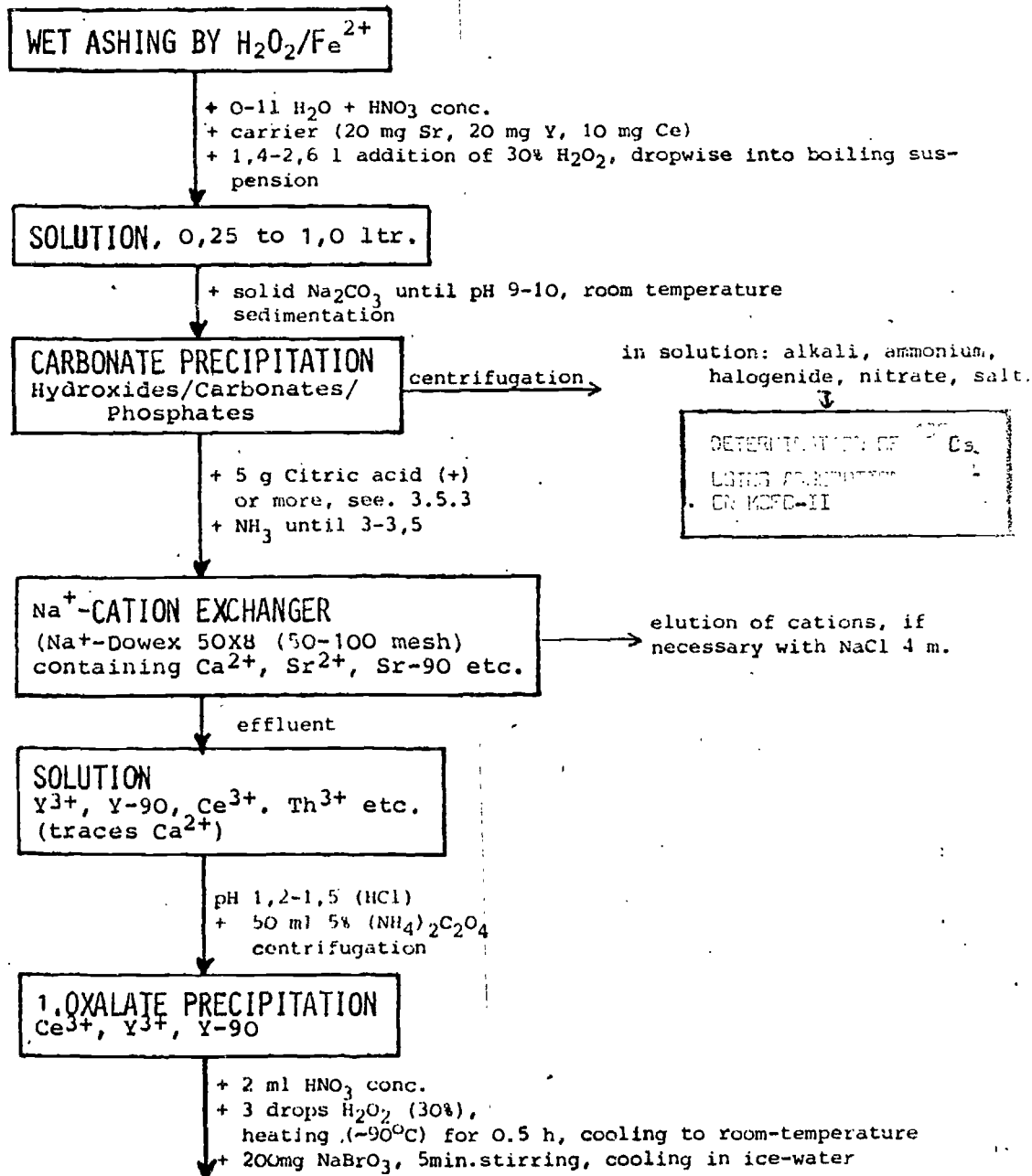
ion exchange on 4g KCFC-II in other
 conditions; flow rate 50ml/min

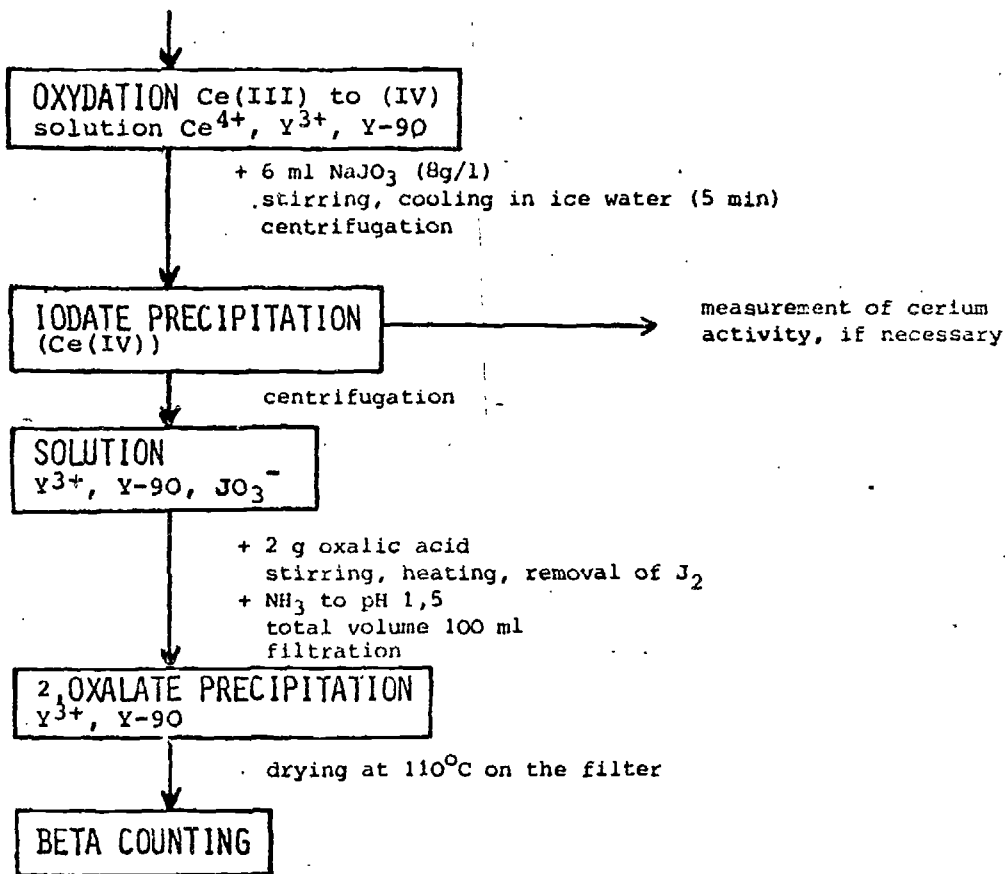
TABLE 4 SEPARATION SCHEME - 4

SCHEME FOR DETERMINATION OF LOW LEVEL ACTIVITIES OF STRONTIUM-90
IN FOOD AND OTHER BIOLOGICAL MATERIAL

(W. KRACKE, Y. M. LIN, M. RADITCHEVA, B. SANSONI 1974/76)

Sample: 100 to 1000 g of foodstuff or other biological or organic environmental material, reduced to small pieces



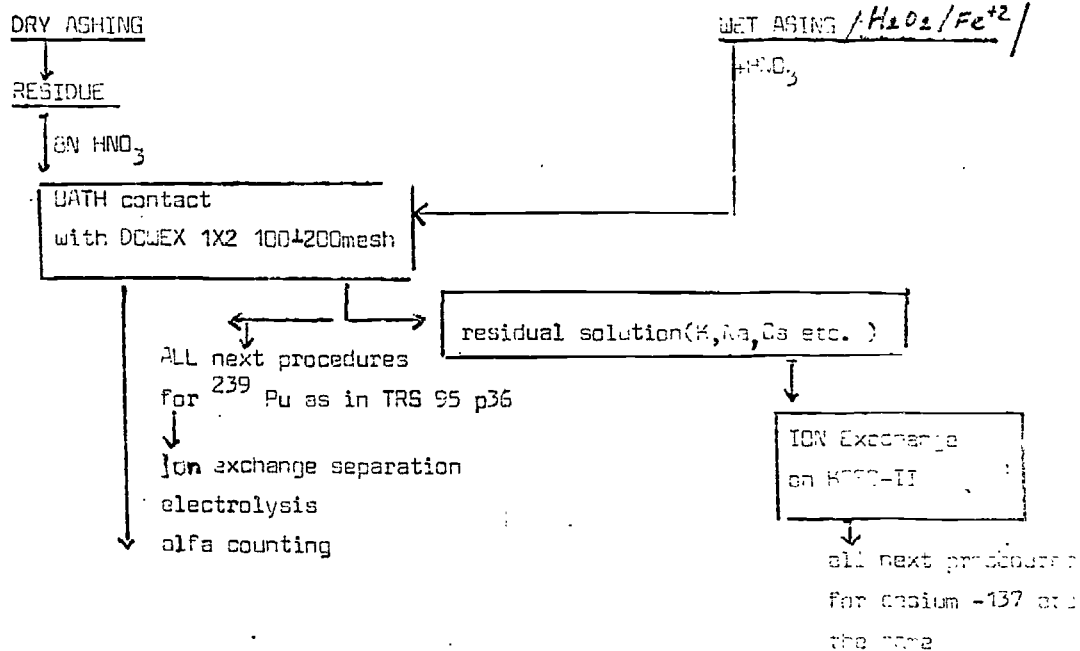


NOTE: THIS SEPARATION SCHEME IS DEVELOPED
 UNDER RESEARCH PROGRAM OF IAEA FELLOU-
 SHIP SC/202/BUL/7503

TABLE - 5

SEPARATION SCHEME FOR SIMULTANEOUS DETERMINATION OF 137 -cesium
and 239 -Pu in one and the same sample /PRELIMINARY SCHEME /

/FOR ORGANIC MATTER /



Remark; The method for plutonium is recommended by IAEA as a rapid method
Autors: S. Suzuki et al.
ATOMIC FUEL CORPORATION, TOKAI, JAPAN