

Simultaneous Determination of ²²⁶Ra and ²¹⁰Pb in Water and Soil Samples by using Liquid Scintillation Counter – Suspension Method

²²⁶Ra ²¹⁰Pb

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, , ,

19

²²⁶Ra

²¹⁰Pb

Ra Pb

²²⁶Ra

²¹⁰Pb

BaSO₄

²¹⁰Pb

PbSO₄

²²⁶Ra

BaSO₄

PbSO₄

BaSO₄

PbSO₄

Instagel XF, UltmaGold AB

8 : 8 : 4

10°C

PSA

95

2L

²²⁶Ra

²¹⁰Pb

²²⁶Ra

²¹⁰Pb

1.19

mBq/L

5.24 mBq/L

90% 60%

1g

²²⁶Ra

²¹⁰Pb

0.67 Bq/kg

20.6 Bq/L

80%

50%

²²⁶Ra ²¹⁰Pb

가

가

²²⁶Ra

²¹⁰Pb

7.2 %

1.6 %

Abstract

The simultaneously analytical method of ²²⁶Ra and ²¹⁰Pb in groundwater and soil samples by liquid scintillation counting (LSC) through the modification of the conventional isolation method of BaSO₄ precipitate has been developed. For time saving for making counting sample, suspension gel method

has been also invested.

In preparing samples for counting, the optimum ratio of water, gel forming agent and scintillator was 8 : 8 : 4. No variation of the counting efficiencies of ^{226}Ra and ^{210}Pb was observed up to 38 days after preparation of the samples. The optimum pulse shape analysis (PSA) level for the measurement of ^{226}Ra and ^{210}Pb was 95. The detection limits for ^{226}Ra and ^{210}Pb in groundwater were 1.19 mBq/L and 5.24 mBq/L, respectively. The detection limits for ^{226}Ra and ^{210}Pb in soil were 0.67 Bq/L and 20.6 Bq/kg, respectively. The analytical results of ^{226}Ra and ^{210}Pb in spiked groundwater samples were in good accordance with the known concentration of ^{226}Ra and ^{210}Pb . The analytical results of ^{226}Ra and ^{210}Pb in soil reference samples were within 7.2% and 1.6% of the relative error from the reference values, respectively.

1.

^{226}Ra α-Spectrometry, γ-spectrometry
 . α-Spectrometry ^{226}Ra 가 Ra
 [1,2,3],
 가 [4]. HPGe ^{226}Ra ^{226}Ra (186.1
 keV) U-235 (185.7 keV) ^{226}Ra
 ^{214}Bi (609 keV) [1]. ^{226}Ra
 ^{226}Ra ^{214}Bi 30 [1,5,6]
 [1]. ^{226}Ra
 BaSO_4
 [7].
 ^{210}Pb ^{210}Pb
 Polex™ ^{210}Bi [8], 6
 ^{210}Pb ^{210}Po α-spectrometry
 [8,9] . α-Spectrometry 가
 spectrometry ^{210}Pb 150-250g γ-
 [10,11,12].
 ^{226}Ra ^{210}Pb
 BaSO_4 BaSO_4

2.

²²⁶Ra

[7]. ²²⁶Ra 2 L Ba (25mg/ml) Pb
 (25mg/ml) 2ml 가 4ml (1+1) 5g 가
 Ba(Pb)SO₄ . Ba(Pb)SO₄ 0.1M EDTA (pH9.0) 10ml
 3ml 가 10% 5ml
 pH 4.2-5.0 Ba (BaSO₄) Pb .
 BaSO₄ Ra ,
 가 500ml 7ml (1+1) 2g PbSO₄
 . PbSO₄ 0.1M EDTA(pH 9.0)
 (1+1) 7ml 2g . PbSO₄
 가 2

²¹⁰Pb

BaSO₄ 1M EDTA (pH 9.0) 10ml 3ml
 가 0.22μm membrane filter 10%
 pH 4.2-5.0 Ba . BaSO₄
²¹⁰Pb 20ml 1ml 2 .
 50ml
 2 . BaSO₄ ²²⁶Ra

1g 500 °C 3 Ba
 (25mg/ml) Pb (25mg/ml) 2ml . 10ml
 10ml 가 .
 10ml 2 . (1+1) 10ml
 4M 30ml 가 가
 가 500ml (1+1) 10ml 2g Ba(Pb)SO₄

BaSO₄ PbSO₄ 20ml
 가 가 Ra
 Pb . 8ml 가
 Instagel XF 8ml, UltamGold AB 4ml 21
 (Wallac 1220 Quantulus™) 60 .

50ml Ba (25mg/ml) Pb (25mg/ml) 2ml 가
 50ml ²²⁶Ra ²¹⁰Pb Ba
 (25mg/ml) Pb (25mg/ml) 2ml 가

60 5
²²⁶Ra ²⁶⁶Ra
²²⁶Ra, ²¹⁰Pb ²¹⁰Pb ²¹⁰Pb
²¹⁰Pb ²²⁶Ra
 (²²²Rn, ²¹⁸Po, ²¹⁴Po) 394% ²¹⁰Pb 72.6%

3.

²²⁶Ra ²¹⁰Pb
 BaSO₄ PbSO₄
²¹⁰Pb ²²⁶Ra
²¹⁰Pb ²¹⁰Pb
²²⁶Ra ²¹⁰Pb ²¹⁰Bi ²¹⁰Po
 BaSO₄ PbSO₄
 Instagel XF, UltmaGold
 AB 8 : 8 : 4 10°C
 PSA(pulse shape analysis) BaSO₄
 1000dpm α- (²⁴¹Am) β- (³⁶Cl)
 PSA 80 140 10 가 α- β-
²⁴¹Am ³⁶Cl α- ²⁴¹Am
 가 β- ³⁶Cl 가 PSA
 PSA 95
²²⁶Ra α 394% (300%)
 Ba 80%
²¹⁰Pb β 72.6% Pb 50% 2L

^{226}Ra ^{210}Pb 1.19 mBq/L 5.24 mBq/L
 ^{226}Ra ^{210}Pb 0.67 Bq/kg 20.6 Bq/kg
 2L ^{226}Ra 0.0Bq, 10.7Bq,
 21.7Bq, 32.2Bq, 39.3Bq 가 가
 가 6.4% , ^{210}Pb ^{210}Pb 가
 가 IAEA NIST , ^{226}Ra 7.2%
 ^{210}Pb 1.6%
 , ^{222}Rn
 [13], Optiphase HiSafe III ^{222}Rn
 10% 20 [14]
 38
 BaSO_4 ^{222}Rn 2% BaSO_4
 Jang holtzman[14]

4.

^{226}Ra
 BaSO_4 ^{210}Pb 가 가
 BaSO_4 PbSO_4
 Instagel XF, UltimaGold AB 8 : 8 : 4
 PSA 95 , ^{226}Ra 394%
 ^{210}Pb 72.6% 2L ^{226}Ra ^{210}Pb
 1.19 mBq/L 5.24 mBq/L ^{226}Ra ^{210}Pb 0.67
 Bq/kg 20.6 Bq/kg . ^{226}Ra ^{210}Pb 가
 ^{226}Ra ^{210}Pb 가 ^{226}Ra
 ^{210}Pb 7.2% 1.6% . 38
 ^{226}Ra ^{210}Pb ,

5.

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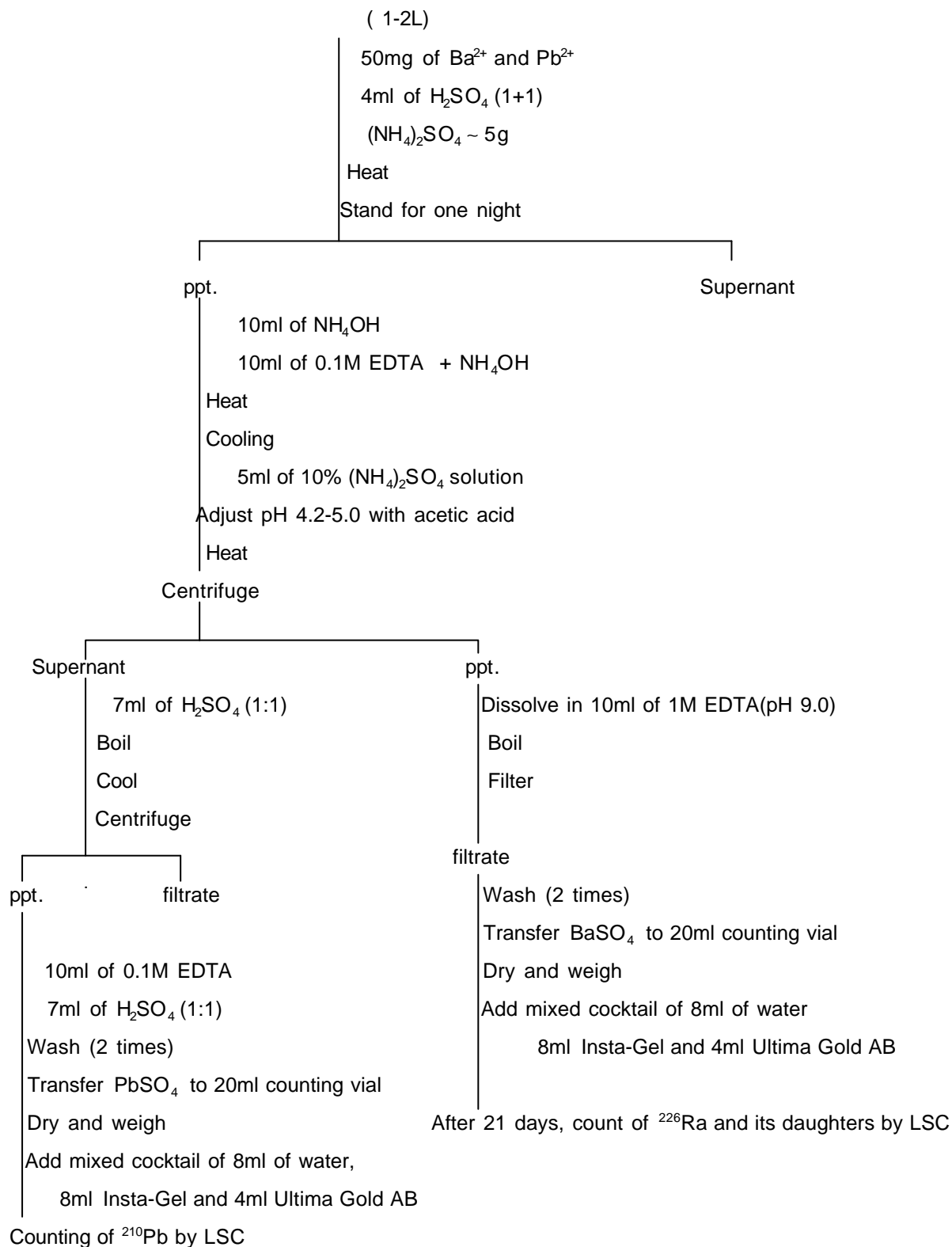


Fig. 1. A Procedure for determination of ^{226}Ra and ^{210}Pb by suspension method with LSC.

Table 1. The analytical results of ^{226}Ra in reference samples

Sample name	Analytical activity (Bq/kg)	Reference value (Bq/kg)	error (%)	Chemical yield (%)
IAEA Soil-6	75.6 ± 6.5	79.92	-5.4	88.6
IAEA-135	25.4 ± 1	23.9	6.3	94.0
IAEA-300	54.6 ± 2.3	56.5	-3.4	83.6
IAEA-312	283.2 ± 4.3	269	5.3	88.6
IAEA-375	20.6 ± 2	19.9	3.6	83.2
NIST4350B	33.2 ± 1.7	35.8	-7.2	92.9

Table 2. The analytical results of ^{210}Pb in reference sample

Sample name	Analytical activity (Bq/kg)	Reference value (Bq/kg)	error (%)	Chemical yield (%)
IAEA 300	354 ± 20	360	1.6	67.4