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Determination of ^{222}Rn by Air Luminescence Method*

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The method of α-particles measurements by air luminescence has been applied to the determination of ^{222}Rn and the daughter nuclides using commercially available liquid scintillation spectrometers in the present studies.

In order to determine the counting efficiency of this air luminescence method, the disintegration rates of ^{222}Rn and the daughters in the counting vial were determined as follows :

(a) The pulse-height spectrum of ^{222}Rn and the daughters dissolved in the liquid scintillator were obtained by subtracting the lower pulse-height spectrum due to air luminescence of ^{222}Rn in the space above the liquid scintillator from the total pulse-height spectrum.

(b) The disintegration rates of ^{222}Rn and the daughters in the liquid scintillator were obtained by using integral counting techniques ; i.e., integral counting rates were measured at several pulse-heights. These integral counting rates were then extrapolated to zero pulse-height to obtain the true disintegration rate of the sample.

(c) The ratio of the concentration of ^{222}Rn in the liquid scintillator to that of ^{222}Rn in the gaseous space was taken as the solubility of ^{222}Rn in toluene-base liquid scintillator. Then

$$\frac{A_l/V_l}{A_g/V_g}=\beta,$$

where A_l and A_g are the disintegration rates of ^{222}Rn in the liquid scintillator and in the gas phase, respectively, β is the Ostwald's coefficient of solubility at the temperature of the sample, and V_l and V_g are the volumes of the liquid scintillator and the gaseous space above it, respectively. Taking $\beta=14.1$ at 13℃, it was calculated that 82.0% of ^{222}Rn would be dissolved in the liquid scintillator at 13℃ for a ^{222}Rn sample with 15.5 ml gas phase above 5 ml of the toluene-base liquid scintillator. Thus the total activity of ^{222}Rn and the daughters in the counting vial can be determined.

(d) In comparison of the total activity in the counting vial with the air luminescence counts, the counting efficiency for the air luminescence method was determined :

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The total activity of ^{222}Rn and the daughters in the counting vial was 63036 ± 102 dpm, while the counting rates of the air luminescence were 26448 ± 66 cpm and 26223 ± 66 cpm for each counting system. From these data the average counting efficiency of the air luminescence method for ^{222}Rn and the daughters is found to be $42.0 \pm 0.2\%$.

Advantages of this method are its negligible quenching effects except those caused by oxygen, rapid and easy sample preparation, and relatively high counting efficiency. In addition, since the end-point of the air luminescence spectrum corresponds to 18 keV, in actual practice, it is not necessary to put the pulse distribution into a multichannel analyzer to measure the spectrum but the window setting of the liquid scintillation spectrometer which is usually used for ^{3}H counting will be sufficient to measure ^{222}Rn in air.