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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°C , it was calculated that 82.0% of ^{222}Rn would be dissolved in the liquid scintillator at 13°C 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 ^3H counting will be sufficient to measure ^{222}Rn in air.