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Determination of ²²²Rn by Air Luminescence Method*

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The method of α -particles measurements by air luminescence has been applied to the determination of ²²²Rn 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 ²²²Rn and the daughters in the counting vial were determined as follows :

- (a) The pulse-height spectrum of ²²²Rn and the daughters dissolved in the liquid scintillator were obtained by subtracting the lower pulse-height spectrum due to air luminescence of ²²²Rn in the space above the liquid scintillator from the total pulseheight spectrum.
- (b) The disintegration rates of ²²²Rn 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 ²²²Rn in the liquid scintillator to that of ²²²Rn in the gaseous space was taken as the solubility of ²²²Rn in toluene-base liquid scintillator. Then

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

where A_i and A_g are the disintegration rates of ²²²Rn 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_i 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 ²²²Rn would be dissolved in the liquid scintillator at 13°C for a ²²²Rn sample with 15.5 ml gas phase above 5 ml of the toluene-base liquid scintillator. Thus the total activity of ²²²Rn 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 ²²²Rn 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 ²²²Rn and the daughters is found to be $42.0\pm0.2\%$.

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 ²²²Rn in air.