§5. Measurement Method of Thoron Exhalation Rate from Wall

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We have studied a new type of passive monitors with solid state nuclear track detector (SSNTD). Figure 1 shows the passive integrating ^{222}Rn and ^{220}Rn cup monitors. To control ^{222}Rn or ^{220}Rn exchange rate, we have made a 5 mm filtered opening for ^{222}Rn monitor and four openings of diameter 20 mm for ^{220}Rn monitor.

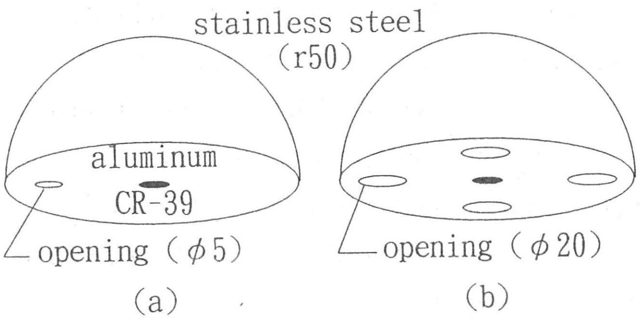

Fig. 1 Passive integrating (a)^{222}Rn and (b)^{220}Rn cup monitors.

Calibrations of the ^{222}Rn monitors were performed in high ^{222}Rn concentration air. The calibration factor was derived to be (4.17 ± 0.24) $X10^{-3}$ tracks·cm^{-2}(Bq·m^{-3}·h)$^{-1}$. Calibration experiment of the ^{220}Rn monitors is quite difficult because of the short half-life of ^{220}Rn (55.6 s). Therefore, the calibration factors of both monitors have been calculated by using molecular diffusion model. The calculated factors were 4.71X10^{-3} and 0.62X10^{-3}tracks·cm^{-2} (Bq·m^{-3}·h)$^{-1}$ for ^{222}Rn and ^{220}Rn monitors, respectively.

The ^{220}Rn concentrations have been measured with six pairs of cup monitors in the various dwellings. The results in a dwelling with soil wall are shown in Fig. 2. The ^{220}Rn concentration at a distance of X m from wall could be expressed by following equation[1]

$$Q(X) = \frac{E_{Tn}}{\sqrt{\lambda_{Tn}\cdot D}} \exp(-\sqrt{\lambda_{Tn}/D})X, \qquad (1)$$

where Q(X) is the ^{220}Rn concentration at a distance of X m from wall in Bq·m^{-3}, E_{Tn} is the ^{220}Rn exhalation rate from wall in Bq·m^{-2}·s^{-1}, λ_{Tn} is the ^{220}Rn decay rate in h^{-1}, D is the effective diffusion coefficient of ^{220}Rn in air in m^2·s^{-1}, and X is the distance from wall in m.

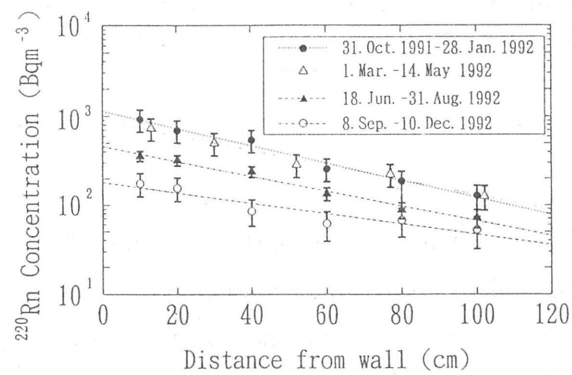

Fig. 2 The distributions of ^{220}Rn concentrations indoors.

The values of E_{Tn} and D have been determined by using the least squares method. The calculated values of E_{Tn} ranged from 0.8 to 6.4 m^2·s^{-1} in the dwellings with soil wall. The exhalation rates from soil walls show more than ten times as much as those from brick and heavy concrete ranging from 0.01 to 0.11 Bq m^{-2}·s^{-1}. The annual mean effective dose equivalent due to ^{220}Rn progeny was expected to be 0.67 mSv·y^{-1} in the dwellings with soil wall[2].

Since the half-life of ^{222}Rn is 3.8235 d, we could not use the same procedure for measuring the ^{222}Rn exhalation rate from wall. Then, we thought a new equipment that consists of three boxes between which filters are positioned to make the difference of ^{222}Rn concentrations. When we set the equipment on the wall, we could obtain the ^{222}Rn exhalation rate from the differences.

REFERENCES
1) Katase, A. et al.: Health Phys. 54(1988)283.
2) Guo, Q. et al: J. Nucl. Sci. Technol. (in printing).