Measurement of Radon Concentration in Air

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In the last annual report, it was reported that some radioactive products in air polluted worker's skin, which triggered an alarm in a hand-foot-cloth monitor [1]. They identified the pollution to be radon originated products by the decay time of the activities and roughly estimated that the radioactive concentration in the West Hall air exceeded 100 Bq/m^3 when ventilation was kept off.

Here we report on our quantitative measurement of radon daughters by using a radon monitor which was made by an Oto group at RCNP [2].

First, we tried to confirm nuclide of the activities which were observed by the monitor. We introduced air of the West Hall into the radon monitor and obtained a spectrum similar to one in ref. [2]. Then we purged the air by radon-free nitrogen gas. The decay rate of the 7.7 MeV peak of detected alpha particles was measured and is plotted as a function of time in Fig. 1. These data are well reproduced by a calculation for ^{214}Po, as also shown in the figure, and we conclude that the activities observed are ^{222}Rn originated products.

In the quantitative measurement of ^{222}Rn concentration, the chamber of the monitor was filled by 70ℓ of sample air and rate of the 7.7 MeV alpha particles are encountered after a 1.5 hours wait for reaching equilibrium. For the collection efficiency of ^{214}Po ions, we referred to an absolute calibration made by the Oto group. The humidity dependence of the efficiency is practically negligible in the present condition.

Figure 2 shows transition of the radon concentration when ventilation was turned to off in the West Hall of the Ring Cyclotron building. The radon concentration is 40–50 Bq/m^3 during the time when ventilation is on. But after turning off the ventilation, the value increases rapidly and reaches about 270 Bq/m^3. The time constant of this rise up is about 13 hours, though the reason of this time-constant value is still unclear.

Radon concentration in air for various region inside and outside the buildings are shown in Fig. 3. The most highest value has been observed in the Neutron Hall, which volume is much smaller than the W experimental hall and, nevertheless, air-refreshment time is much longer because of existence of a 100 m TOF tunnel. The radon concentration amounts to about

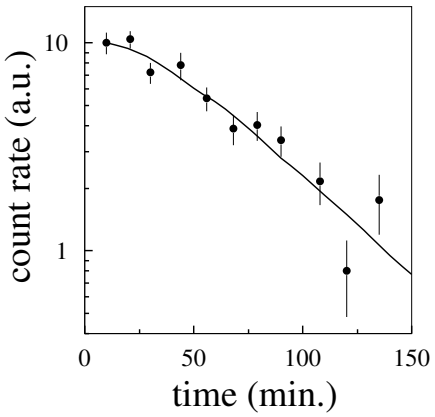

Figure 1: Counting rate of the 7.7 MeV alpha particles after a purge of air by nitrogen gas. The curve is estimated decay rate of ^{214}Po originated form ^{222}Rn , when a radiation equilibrium with parent nuclei is assumed as the initial condition and the gas purge is assume to be complete. The absolute value of the curve is normalized to the data.

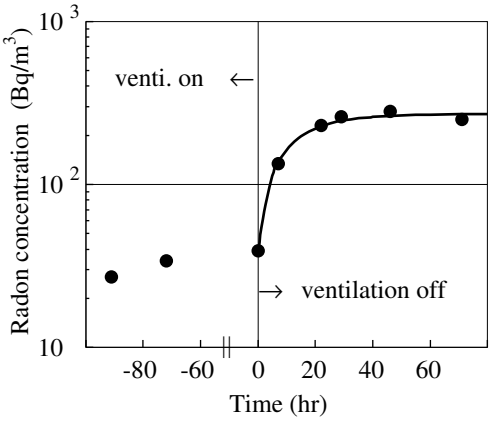

Figure 2: Time dependence of radon concentration in the air of the West Hall before and after the ventilation is switched off.

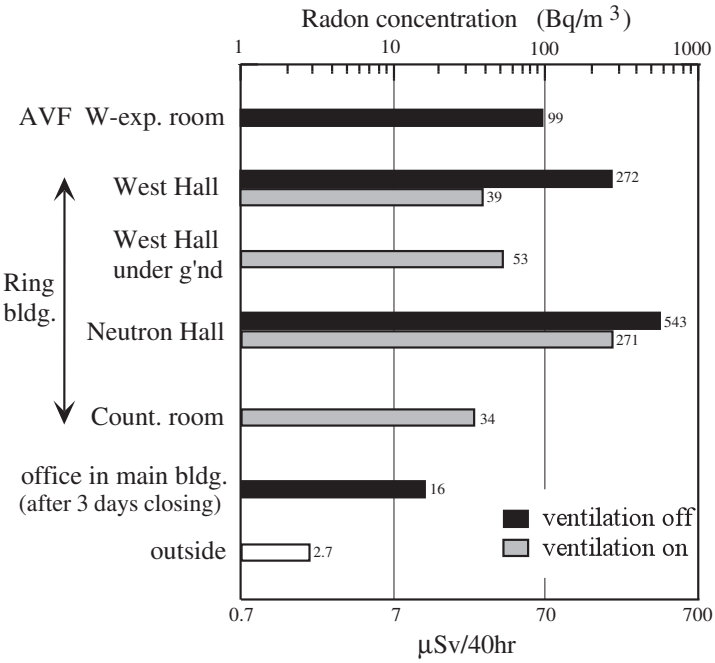

Figure 3: Radon concentration in air at various point in RCNP. The horizontal axis in the bottom shows exposure of a person who works for a week in the air with corresponding radon concentration.

220 Bq/m^3 in EEC$_{Rn}$[1] when ventilation is off. This value is higher than 20% of the lawful limit, 1000 Bq/m^3, applied for unlocked rooms in a control area, though such activities from usual building-components are not under the application of the law for radiation facilities. It may be worth notified that even the concentration in a usual office, in the main building outside the radiation control area, becomes 6.4 Bq/m^3 in EEC$_{Rn}$, 70% of the maximum limit 9 Bq/m^3 for exhaust air from a control area, after a long closing. Regardless of present law, the values for the Neutron Hall is higher than the *action level* of 200 Bq/m^3 in the Pub. 39 by ICRP and we should be prudent in keeping the ventilation for the hall off.

Figure 3 also shows significant differences among three buildings, the highest for the Ring, middle for the AVF and the lowest for the main building. The reason, whether it depends on nature of concrete, thickness of the wall or difference of paints, is an open problem.

References

[1] A. Shimizu *et al.*, RCNP Annual Report 1997, p. 317.
[2] K. Takahisa *et al.*, RCNP Annual Report 1997, p. 87.

[1] Equilibrium equivalent radon concentration; the ratio of EEC$_{Rn}$ to actual concentration is 0.4.