THE SIZE DISTRIBUTION OF RADON DAUGHTER AEROSOL PARTICLES IN INDOOR AND OUTDOOR AIR AND THEIR DEPOSITION TO RESPIRATORY TRACT

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INTRODUCTION

Since the effective dose equivalent due to radon daughter products has estimated to be more than 30 percent of total one exposed to natural and artificial radiation in the UNSCEAR 1982 Report, the human lung dose to radon daughter products has attached special interest. For precisely estimating the lung dose, the size-distribution is needed because it gives precisely evaluation of the amount of radon daughter products deposited to the respiratory tract. It is therefore important to obtain the knowledge of many particle size-distributions of radon daughter products in various indoor and outdoor airs. In this work, measurement of the size-distribution of radon daughter products in indoor and outdoor air was carried out and the deposition of those to respiratory tract was calculated.

MEASURING METHOD

The diffusion battery method was used in sampling; The sampling device separates into two parts, a screen-type diffusion battery SDB and a filter holder. When the sampling air passes through the SDB, a part of radon daughter products in the air is settled on the surface of wire-screen and remains is sampled on a backup membrane filter. Alpha particles emitted from the surface of backup filter were counted with a ZnA(Ag) sintillation counter.

The SDB is constracted with a cylindrical tube and many pieses of wire-screen(165 mesh), which was made of stainless steel and mounted on a brass ring of 40 mm inner diameter and 3 mm thickness, one by one. Utmost 43 pieces of wire-screen ring can be put into the battery tube. In measurement, the five SDBs, in which adequate pieces of the wire-screen ring n is respectively set, were simultaneously used with the flow rate of 4 l/min (measured value was to be Ai). Another one in which is set a piece of wire-screen ring for settling unattached fraction, is prepared at this time (measured value; Ao). Measurement was carried out two times for obtaining a penetration curve (relation

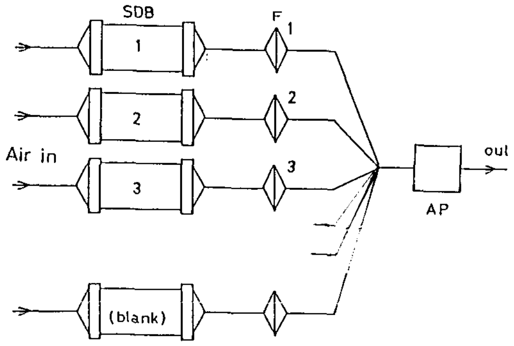

Fig.1. Schematic diagram of the experimental apparatus. SDB; Screen-type diffusion battery, F; Filter holder, AP; Air pump.

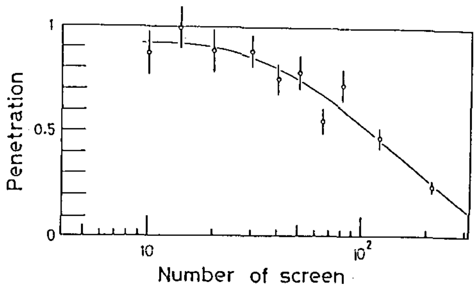

Fig.2. An example of the penetration curve.

between n and Ai/Ao, i=1 ~ 10) (see Figs. 1 and 2).

One series of measurement is planned as follows; Total measuring time (i.e. sum of sampling and counting times) for obtaining ten measurements is 2 hours; The first sampling time is 40 min, the waiting time from end of sampling to start of counting is 3 min, and the counting time 30 min. The second sampling is started under the same measurement condition of the first sampling within 10 min of the end of first sampling.

A computor program with the iterative method was applied to calculating the size-distribution from the penetratrion curve.

MEASUREMENTS

Measured sites Measurements were performed in a dwelling which is a tipical Japanese house, in two rooms in a building of Nagoya University and in outdoor air on the campus. One of the rooms was a meeting room and the other was a laboratory room.

Example of measurement Some examples of measurement are shown in Fig.3. These example are not always representative of the size-distribution of radon daughter products in each measured site and time but also rare one. We could rather think that similar results are often taken in various sites and time.

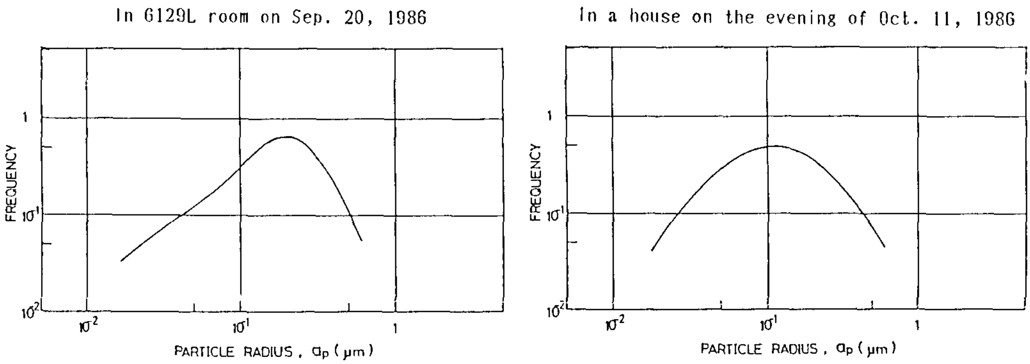

Fig.3. Examples of the size-distribution of radon daughter products.

DEPOSITION OF RADIOACTIVE PARTICLES TO RESPIRATORY TRACT

The radioactive aerosol particles are classified into two groups; One is the unattached atom (atomic size order) and the other is the attached atom in the range of 0.02 - 0.2 μm radius.

In the calculation of deposition for radioactive aerosol particle to the respiratory tract, the Gormley and Kennedy formula was applied to the unattached atom. On the other hand, for the attached particle, the deposition which was calculated by Takahashi and Kawamura for monodisperse aerosol particles, by using a Yeh and Schum lung model modified, was used together with the observed size-distribution data. The parameters considered in the calculation were the tidal volume (1,000 and 1,500 cm^3), the rate of respiratory (7.5 and 15 min^{-1}), and the unattached fraction (0.1, 0.2 and 0.4) taking into account the human life-stile.

An example of deposition calculated on the left and right lobes is shown in Fig.4. The results are as follows; (1) Unattached atoms deposit entirely in the upper respiratory tract (before generation 17) and almost 80 % of attached atoms is expired and remains deposits mainly in the lower respiratory tract. (2) Deposition is more in lower lobe than upper lobe. (3) Difference of deposition among the obtained size-distribution is relatively small.

CONCLUSION

The present work is summerlized as follows: (1) The suitablly-measuring condition of the screen-type diffusion battery for obtaining

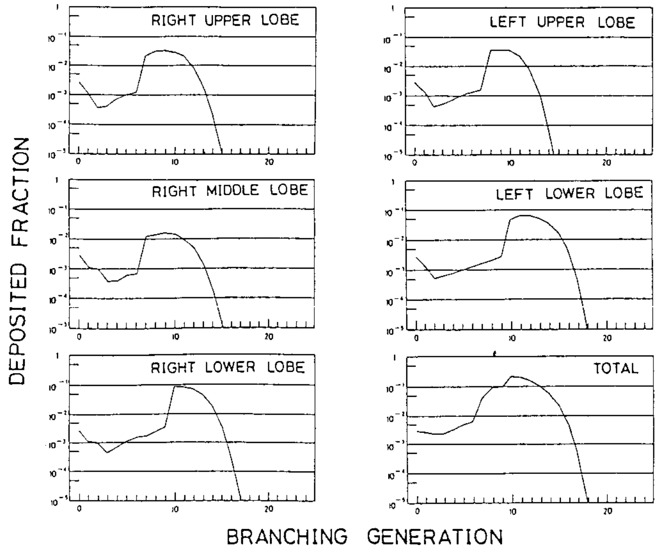

Fig.4. An example of deposition of radioactive aerosol particles to the respiratory tract.

the radioactive aerosol size-distribution were decided. (2)The measurements of the size-distribution of radon daughter products were carried out in outdoor and several indoor air; The aerosol particles were dispersed with log-normal mode and/or bi-modal distribution, and their radii were mainly in the range of 0.1 -0.2μm. (3) The deposition of radon daughter aerosol particles to the human respiratory tract was estimated to be 100 % for unattached atom and about 20 % for attached atom.

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