A RADON EXPOSURE CHAMBER IN HONG KONG

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ABSTRACT

A radon exposure chamber was constructed. Both ^{222}Rn and ^{220}Rn can be injected independently or simultaneously into the chamber from separate dry sources. The air flow in the chamber can be adjusted manually in a 100% flow-through mode, 100% recirculate mode or flow-through/recirculate mode. Water vapour and aerosol particles of variable sizes are injected into the chamber through computer controlled mechanism. The continuous radon and radon progeny concentration and working level, and aerosol concentration are constantly monitored by the microcomputer.

INTRODUCTION

The Radioisotope Unit (RIU) of the University of Hong Kong has had a programme of research on radon and its decay products started a number of years ago. Surveys on radon concentration and working levels have been conducted which indicated that the arithmetic means of both indoor radon concentration[1] and working level[2] are higher than most other countries and the world average[3].

Because of the special geological conditions and tropical monsoon climate, Hong Kong deserves special attention to the adaptability and response of radon detectors which were otherwise proved to be good in Continental or high latitude countries. With the experience gained and quality of measurements assured through participating in the Asian/Australasian Regional Intercomparison Programme in 1987/88[4] and a similar programme in China in 1989, the RIU has successfully constructed a radon exposure chamber which is essential for calibrating radon and radon progeny measuring instruments over a range of temperature, humidity and aerosol concentration likely to be experienced in this region of the world. In addition to calibrating instrument and detectors, the chamber will also provide service for interlaboratory comparison studies (one such programme is being conducted during the writing of this paper), and for other research and development projects.

THE RADON EXPOSURE CHAMBER

A schematic diagram of the exposure chamber is shown in Fig. 1. The chamber is made of stainless steel and has a volume of 1.4 m^3 (1.3m x 1.2m x 0.9m). A smaller conditioning chamber having a volume of 0.056 m^3 is attached to the side of the main chamber. Radon gas, recirculated gas, water vapour and aerosols are injected into the conditioning chamber where they are mixed before being passed into the main chamber. The gas diffuses into the main chamber through a series of perforated tubing laid at the bottom of the chamber to ensure an even mixture. The air flow in the chamber can be adjusted manually in a flow-through, recirculate or flow-through/recirculate mode so that a wide range of environmental condition can be simulated. The maximum air exchange rate (including recirculated air through the conditioning chamber) is about 1 hr^{-1}. The various flow modes are illustrated in Fig. 2.

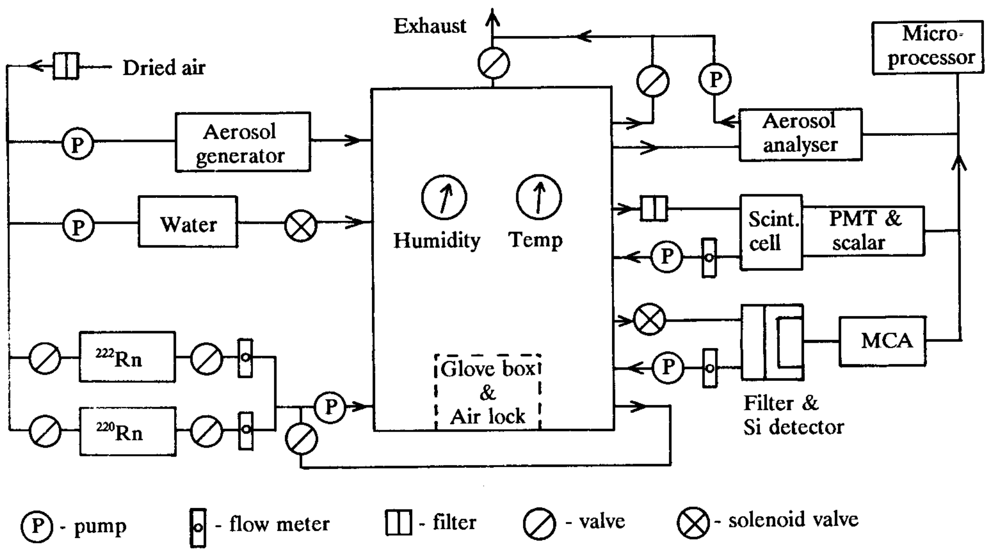

Fig. 1 Schematic diagram of the radon exposure chamber

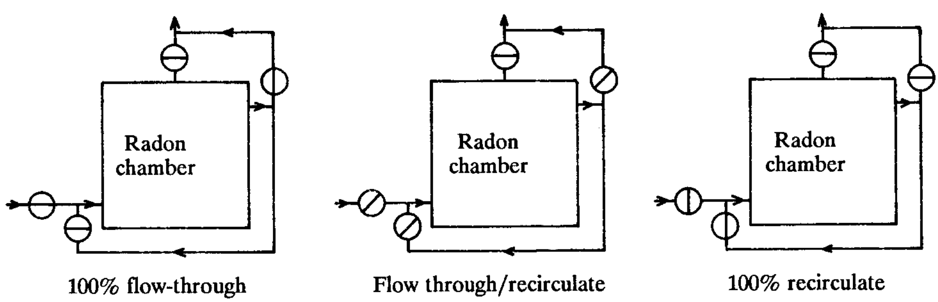

Fig. 2 The air flow mode of the radon chamber

The chamber is totally heat insulated from the surrounding by 1/2 inch foam insulator which allow it to operate in a temperature other than room temperature. On the front of the chamber is a viewing glass which can be opened for putting large equipment into the chamber. Smaller piece of equipment can pass through an airlock at the side of the chamber without having to shut down the system completely. A pair of long armed glove is provided for easy access of the inside of the chamber. The following is a brief description of the peripheral equipment installed to the chamber.

1. Radon source. Flow through type dry source of ^{222}Rn and ^{220}Rn (RN1025 and TH1025, Pylon Electronic Development Co., Canada) of various activity are used to provide a wide range of radon concentration. Dry and filtered air carries the radon gas and is mixed with the recirculated gas before being pumped into the conditioning chamber. The radon concentration inside the chamber depends on the source strength and the circulation mode. The nominal range is from a few hundred Bq m^{-3} to 10^5 Bq m^{-3}. It is to be noted that the flow rate through the radon source becomes critical when the chamber is operating at low concentration under a 100% flow through mode.

2. Aerosol generator. To maintain a steady aerosol size and concentration, a high output atomizer (Model 3076, TSI Inc, USA) together with a diffusion dryer (Model 3062, TSI) is installed. The aerosol particle size can be altered by changing the amount of solute in the solution. Typical particle size is from 0.02 μm to 0.3 μm. The pump for the atomizer is computer controlled to turn on and off intermittently. By adjusting the ejection duration and interval, a wide range of aerosol concentration can be achieved.

3. Water source. Water is sprayed into the conditioning chamber through pressure exerted to a reservoir of water by a pump. The pump and the solenoid valve which gates the water pathway are controlled by the computer to maintain the desired humidity.

4. Temperature control. A simple heating coil inside the conditioning chamber is used to warm the chamber gas to above room temperature. For low temperature, the gas is circulated through a freezer by a coil of copper tubing outside the chamber. By using the heater and freezer independently or simultaneously, a temperature range of about 0 °C to 60 °C can be achieved.

5. Radon gas measurement. The gas inside the chamber is continuously pumped through a scintillation cell connected to a photomultiplier tube and a counter. The radon daughters are first removed by a filter and the radon gas that decays inside the scintillation cell is recorded. The continuous radon concentration is then calculated by an algorithm which takes into account of activities of previously deposited radon daughters and also corrects for different humidities and flow rates.

6. Radon daughter measurement. The radon daughters are sampled intermittently by a filter and Si α-detector assembly. The complete α spectrum of the radon daughters collected in the filter paper can be recorded in a computer controlled multichannel analyzer (PCA-II, Tennelec Inc, USA). Alternatively, three count method, five count method or similar algorithm are also being used to determine the daughter activities and working levels. The gas flow through the filter is governed by a solenoid valve and a pump which are again controlled by the computer.

7. Aerosol measurement. A condensation nuclei counter (Model 3760, TSI) is used to count the aerosol concentration. A variable number of stainless steel wire screens can be added to

the front of the analyzer to discriminate the size of aerosol particles inside the chamber. The analyzer will be operated intermittently and the data can be communicated to the computer. A maximum of 2.5×10^4 particle per cc can be measured.

AN INTERCOMPARISON PROGRAMME

Despite of the small area of Hong Kong, at least five organisations (higher institutions including RIU and Government Departments) are doing investigations on radon in one way or the other. It is noted that a wide range of detectors are being used by different organisations. Most of them were commercially bought and therefore the calibration factors rely solely on the manufacturers. Because of the lack of locally available calibration standards, some inconsistency has already been observed among detectors owned by different organisations. As the best equipped and experienced laboratory in Hong Kong on the radon issue, the RIU of the University of Hong Kong is conducting a territory radon intercomparison programme with this newly built radon exposure chamber. The result of the programme will be reported in due course. Hopefully, the exercise will assure the quality of measurement done by all the participating organisations.

CONCLUSION

A radon exposure chamber has been built which can be operated at various simulated environmental conditions. Studies on ^{222}Rn, ^{220}Rn or a mixture of them can be done precisely. Calibration of detectors and some form of intercomparison are other applications of the chamber.

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