# VENTILATION INFLUENCE UPON INDOOR AIR RADON LEVEL

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**ABSTRACT**

Levels of indoor radon in air are studied by a continuous electrostatic radon monitor under normal living conditions to evaluate the influence of air conditioned ventilation on indoor air radon level. Results show that the indoor air radon concentrations are not much more than those without household conditioner living condition, although using household conditioner requires a sealed room which should lead to a higher radon level. Turning on air conditioner helps lower indoor radon level. Therefore, the total indoor air Rn levels are normal >ventilation>exhaust or indraft > exhaust plus indraft.

**Keywords** Radon, Conditioner, Ventilation, Exhaust, Indraft

## 1 INTRODUCTION

It is well recognized that greater part of environmental radiation dose to human comes from natural radiation, while its major contribution is from radon and its short-lived daughters in air. Their inhalation can induce lung cancer which has brought about popular notice. The effect of indoor radon and its daughters in air on inhabitants health is concerned as their main living space is indoor. Indoor air radon levels are 20–30 $Bq/m^3$ under normal living conditions in China. But it can vary due to alter some housing conditions, such as fixing air conditioner. Since air conditioners have already came into population's homes. It has actual meanings to study their affection on indoor radon level as a previous research in health physics field.

## 2 EXPERIMENTAL

The continuous electrostatic radon monitor (CERM, see Fig.1) and household air conditioner are employed under normal housing situations, i.e. closing doors and windows. The entrance of CERM is located 1.2 m up the ground of room center to simulate breathing height of sitting posture. The air to be measured goes through a filter and sampler into sampling system by a three way cock to control the flowrate (1 L/min), then enters the CERM by a way of phosphorous pentoxide dryer, finally flows out the system via the flowrate meter. The filter filters out all of radon daughters in measured air and lets only air with radon enter CERM. The radon in CERM decays into $^{218}Po$ (RaA), its 80%–90% are positive ions in decay moment which is gathered on a collector by a -3000 V electrostatic field. In order to overcome the affect of moisture on electrostatic collection efficiency, measured air must be got rid of the wet by phosphorus pentoxide dryer. Alpha particles of RaA and its daughter $^{214}Po$ (RaC′) go through the collector and enter into a

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ZnS(Ag) detector to form photo-signal which is transformed into electro-signal by a photomultiplier, then amplified and analysed, finally acquired and processed by a interface and NEC PC-8801 computer which can read out the counts every 10 min, give the radon concentration each an hour, and save automatically the data into a floppy disk every day (see Table 1).

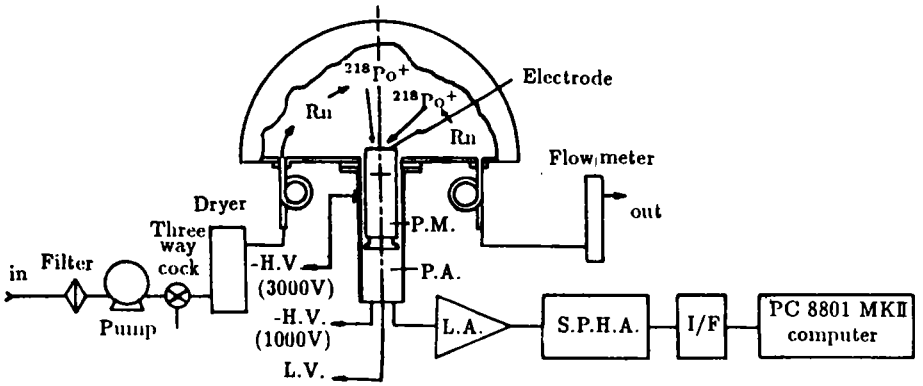


**Fig.1 Continuous electrostatic radon monitor system**

**Table 1**

**Indoor air Rn level in 1993** Bq/m$^3$

| Time/h | Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12/13 | 12/14 | 12/15 | 12/16 | 12/17 | 12/18 | 12/19 | 12/20 |
| 0:0 | 0.00 | 10.13 | 14.52 | 20.30 | 9.76 | 17.54 | 20.74 | 11.07 |
| 1:0 | 0.00 | 10.58 | 19.47 | 16.92 | 12.61 | 18.14 | 18.01 | 14.29 |
| 2:0 | 0.00 | 9.33 | 17.15 | 20.40 | 14.80 | 18.90 | 19.70 | 13.55 |
| 3:0 | 0.00 | 10.68 | 16.79 | 16.80 | 15.42 | 16.53 | 17.25 | 14.42 |
| 4:0 | 0.00 | 10.23 | 16.81 | 16.18 | 15.63 | 15.49 | 20.06 | 15.29 |
| 5:0 | 0.00 | 8.62 | 15.00 | 12.35 | 16.28 | 18.32 | 18.70 | 16.22 |
| 6:0 | 0.00 | 9.85 | 16.57 | 8.20 | 21.29 | 11.12 | 20.76 | 14.31 |
| 7:0 | 0.00 | 11.37 | 18.28 | 10.19 | 15.89 | 13.93 | 18.48 | 13.69 |
| 8:0 | 17.37 | 9.08 | 17.58 | 8.45 | 15.87 | 15.53 | 17.75 | 14.50 |
| 9:0 | 15.13 | 12.51 | 16.05 | 8.90 | 21.02 | 17.76 | 20.53 | 12.60 |
| 10:0 | 13.18 | 12.65 | 20.24 | 9.38 | 18.46 | 18.87 | 20.84 | 11.41 |
| 11:0 | 12.52 | 10.84 | 17.03 | 9.03 | 18.32 | 14.25 | 20.02 | 11.74 |
| 12:0 | 9.66 | 9.89 | 19.04 | 6.43 | 17.88 | 14.38 | 19.64 | 7.99 |
| 13:0 | 10.25 | 9.88 | 23.12 | 6.77 | 20.93 | 16.94 | 16.33 | 10.36 |
| 14:0 | 11.69 | 7.99 | 17.71 | 8.66 | 22.85 | 17.85 | 17.47 | 0.00 |
| 15:0 | 11.85 | 10.12 | 18.97 | 7.63 | 18.68 | 20.37 | 19.20 | 0.00 |
| 16:0 | 11.83 | 10.54 | 19.79 | 8.84 | 22.32 | 20.80 | 17.90 | 0.00 |
| 17:0 | 9.24 | 13.63 | 22.13 | 8.89 | 18.44 | 20.77 | 18.40 | 0.00 |
| 18:0 | 10.55 | 17.28 | 22.26 | 7.53 | 20.67 | 21.02 | 17.83 | 0.00 |
| 19:0 | 12.11 | 17.64 | 20.43 | 7.32 | 20.59 | 21.59 | 17.60 | 0.00 |
| 20:0 | 9.69 | 17.28 | 20.08 | 6.50 | 20.89 | 22.93 | 13.07 | 0.00 |
| 21:0 | 11.77 | 20.45 | 21.23 | 6.04 | 21.52 | 18.60 | 10.02 | 0.00 |
| 22:0 | 11.08 | 20.18 | 22.86 | 8.20 | 19.06 | 19.78 | 13.03 | 0.00 |
| 23:0 | 12.22 | 15.35 | 19.22 | 7.75 | 20.74 | 20.16 | 8.98 | 0.00 |
| Range | 9.24–17.37 | 7.99–20.45 | 14.52–23.12 | 6.04–20.40 | 9.76–22.85 | 11.12–22.93 | 8.98–20.84 | 7.99–16.22 |
| Mean | 11.88±2.01 | 12.34±3.61 | 18.85±2.37 | 10.32±4.28 | 18.33±3.19 | 17.98±2.77 | 17.60±3.16 | 12.96±2.14 |
| GM | 11.73±2.02 | 11.88±3.64 | 18.70±2.37 | 9.61±4.34 | 18.01±3.20 | 17.75±2.78 | 17.24±3.18 | 12.76±4.29 |

## 3 RESULTS AND DISCUSSION

Household conditioner can ventilate, exhaust and indraft the air in houses, and been combined freely each other. The observations are conducted under doors and windows closed, and at good meteorological situations.

It is well known that outdoor radon levels in air are very sensitive to wind and rain, and affect strongly indoor ones. This experiment was conducted during windy December of Beijing. For this reason, the affection of windy weather must be got over and except the days when the wind is more than grade 3 (see Table 2). Table 2 shows indoor radon concentrations are not even although under closing doors and windows and stable meteorological conditions. Conditioner ventilation can promote air flow, but radon concentration is decreased to 0.86 in ratio to normal. Maybe it is due to indoor radon comes mainly from building materials, the radon emanated from wall, floor and ceiling; its diffusion needs certain time; and the ventilation accelarates well-distributed; therefore, it reduces. Besides, atmospheric pressure at the ventilation is a little lower than normal; and a few outdoor air can enter indoor through the seams of doors and windows.

The conditioner has exhaust and indraft functions. They have certain affection on the concentrations (Table 2). Although adjusted wind is only about 10%–15% of the ventilation in order to save energy, they have same results 0.68 in ratio to normal under above conditions. Both influences supply each other if both functions are used at the same time. Therefore, the ratio lowers to 0.58.

**Table 2**
**Influence of ventilation on indoor air radon concentrations**

| | Normal | Ventilation | Exhaust | Indraft | Exhaust+indraft |
|---|---|---|---|---|---|
| Radon level /Bq·m$^{-3}$ | 27.90±3.29 | 24.02±2.09 | 19.05±2.03 | 18.96±2.33 | 16.06±3.32 |
| Ratio to normal | 1.00 | 0.86 | 0.68 | 0.68 | 0.58 |

It is noticed that there are ventilators in many homes, and their ventilation affection is better than the one of conditioner because of its bigger wind. Radon levels in air drop from 19.11±4.03 to 11.47±0.54 Bq/m$^3$ when a ventilator of $\phi$300 mm and 35 W operates. The ratio is about 0.60, so the effect of reducing radon is better than the conditioner.

However, experimental data indicate that the action of conditioners is very limited. Benefits for reducing radon are got only convenient when the air is conditioned. It is discovered in practice that the strong wind affection is much larger than the conditioner. Indoor mean radon concentration is about 12 Bq/m$^3$ in strong wind (more than grade 3), and the ratio reduces to 0.43. There are two reasons in it. One is that outdoor radon concentration lowers obviously in December, in Beijing its mean value is 10.19±3.55 Bq/m$^3$, but it lowers to 5–6 Bq/m$^3$ in windy days. Consequently, indoor radon level in air follows outdoor to drop. The other is that strong wind can go through the seams of doors and windows into indoor. The outdoor and indoor air exchanges violently (flow sound can be heard) and indoor concentration reduces rapidly.

Under above conditions, present preliminary impression is as following. Indoor air Rn levels are normal > ventilation > exhaust or indraft > exhaust and indraft. Using household conditioner needs sealing the room and this causes to raise indoor radon concentration. But, turning on it is beneficial to indoor radon level reduction and radon daughter deposition in air because of air flow, so that the harm to human drops.