

Use of a portable gas chromatograph and tracer  
gas for rapid determination of air ventilation rates

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Abstract

The normal problem with determination of air ventilation rates in practical cases is the difficulty of obtaining an accurate reading rapidly and in finding a piece of equipment which does not require the release of substantial quantities of gas. A method is described utilising a highly portable gas chromatograph with an electron capture detector which measures sulphur hexafluoride tracer gas. This system will detect the tracer gas without interference from other materials which may be present. The technique takes about six minutes to determine the ventilation rate. Practical examples and further extensions of the technique for carrying out cross air movements for example in a hospital are quoted.

Introduction

The air ventilation rate of a room or building is a quantity which is often taken for granted because of the difficulty of making a direct measurement. Ventilation systems and air conditioning performance is relatively easily determined in rooms of known dimensions where the ventilation is artificially controlled and the controlling equipment has a known performance. Where natural ventilation is involved or where the effects of indeterminate

and the time for the concentration to fall to half of its value determined directly from the graph.

let  $u$  = volume of air leaving the room per hour

$v$  = volume of the room

$R = \frac{u}{v}$  = ventilation rate in air changes per hour

$c$  = concentration of SF6 at time  $t$

$C_0$  = concentration of SF6 at time 0

Now the rate of loss of SF6 is proportional to its concentration in the room or

$$\frac{dc}{dt} = -\frac{uc}{v} \text{ ----- 1.}$$

$$\therefore c = C_0 e^{-Rt}$$

$$\therefore R = \frac{2.303}{t} (\log_{10} C_0 - \log_{10} C) \text{ ----- 2.}$$

If the concentration falls to half value in time  $t_{\frac{1}{2}}$

$$\text{then } \log_{10} C_0 - \log_{10} C = \log_{10} \frac{C_0}{C} = \log 2 \text{ ----- 3.}$$

and from 2.

$$R = \frac{2.303}{t_{\frac{1}{2}}} \times \log 2 \times 60 \text{ air changes per hour ----- 4.}$$

$$\therefore R = \frac{42}{t_{\frac{1}{2}}} \text{ ----- 5.}$$

Thus the time determined from the graph can be inserted in the formula (5) and the rate determined in air changes per hour.

### Description of Equipment

The equipment comprises a portable battery operated chromatograph weighing 12 lbs. plus a portable nitrogen tank and a small lecture bottle of SF6. The SF6 can be conveniently dispensed from a syringe. The chromatograph

from the mid point through the sample loop. The office was measured to be approximately 36 cubic meters in volume and therefore to give a concentration of 5 parts in  $10^9$  approximately 0.1 cc of gas is required. This was drawn from a bottle of SF<sub>6</sub> gas outside the building downwind. A gas tight syringe was used. When the gas was discharged the air was stirred up by waving boards about and the first reading taken by depressing the sample valve. The first set of readings were taken with a window open, and are shown in table 1.

A further set of readings were taken with all ventilation closed off. In this case, the amount of SF<sub>6</sub> introduced was inadvertently too large but it was a simple matter to open all doors and windows to rapidly bring the readings on scale.

Both sets of readings were plotted on log/linear graph paper as shown in figure 2. The time for any reading to fall to half its value is readily determined. With the window open the rate is 16.8 changes per hour and with the window closed the rate is 2.19 changes per hour. There was a wind of about 10 m.p.h. blowing outside at the time of the experiment.

#### Verification of performance and further applications

The accuracy of this method has been checked in a sealed chamber with controlled ventilation. The method was found to be reliable and reproducible.

The method need not be restricted to the use of SF<sub>6</sub> as a tracer gas. A modification of the equipment is being used

is fitted with a six port sample valve, a short separating column and an electron capture detector. The detector cell is operated using a pulsed supply of 50 V, 1 microsecond with 100 microsecond space and the output to the meter is via an f.e.t. front end packaged amplifier. The electronics run from four 8.6 V mercury cells and a 9 V rechargeable nickel cadmium battery operates a small pump which draws air continuously through the sample loop of the valve. When the instrument is in operation, nitrogen from the tank flows through the sample valve, to the column and from the column to the detector cell before venting into the atmosphere. When the sample valve is operated, the sample loop is put into the nitrogen line and the air plus any SF<sub>6</sub> is flushed by the nitrogen into the column and to the detector. The property of the column is chosen so that the SF<sub>6</sub> is slowed down during its passage through the column and the result is that the oxygen emerges from the column first followed by the SF<sub>6</sub>. A single operation of the sample valve produces an off scale peak on the meter reading for oxygen after eight seconds and a second peak for SF<sub>6</sub> appears 20 seconds after injection. The height of this peak is proportional to the concentration of SF<sub>6</sub> in the sample loop at the time the sample valve was operated.

#### Experimental determination of ventilation rates in an office

The SF<sub>6</sub>B was connected to a portable nitrogen cylinder, switched on and after two minutes the meter zero was steady. The probe was set to draw air from the mid point of the room and the pump in the instrument switched on to draw air

to determine cross-infection air flow in new hospitals. In this case the column is changed to a 6 ft. 20% squalene column and the tracers used are Freon 12, Freon 14 and Bromochlorodifluoromethane. The components appear 0.5 minutes, 1.5 minutes and 2.5 minutes respectively after the sample is injected. Samples are taken at a number of points in the hospital and the tracer gas released at different places simultaneously.

Table 1

Time	Window Open	Window Closed
0	36	49
1	39	49.5
2	33	48.0
3	27.5	48.0
4	21.0	47.0
5	17.0	45.0
6	13.0	44.5
7	9.5	43.5
8		40.0
9		38.5
10		37.0
11		36.5

