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CONSTANT CONCENTRATION MEASUREMENT WITH 2 TRACERS

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ABSTRACT

The technique of tracer gas measurement has during recent years tended towards increasingly complicated measuring methods. The new measuring techniques are essential in order to procure more information about the circulation of air through buildings, or in order to perform more accurate measurements in large and complex buildings.

The measuring method by means of "constant concentration of tracer-gas", which has been applied at Technological Institute for about 7 years, has proved to be a very accurate measuring method for both small and very large buildings. The method has the advantage of being able to continuously register the air change in a measuring area divided in numerous zones. The limitation of this method is that only information about the infiltration from outside into the measuring area is obtained, whereas no details are given about the air-flow between the individual zones of the measuring area.

The limitation of the measuring method can be overcome by using 2 tracer-gases. The article describes the different philosophies on which measurements with "constant concentration of 2 tracer-gases" might be based, measurement result to be obtained and discusses whether there is any advantage of using more than 2 tracer-gases. In addition a specific measurement is described, where the method with "constant concentration of 2 tracer-gases" is used.

INTRODUCTION

Using the "constant concentration of tracer-gas" method of measuring air change the total air change in the building as a function of time can be calculated, and it is possible to map-out where the outside-air has entered the building. The measurement method is characterized by the fact that the outside air is always registered in the zone in which it first enters the building and that its flow through the building cannot be traced further. Figure 1 illustrates the air-flow which can be measured.

If one wishes to measure how air flows between the individual zones in a building it is necessary to use more than the one tracer-gas witch is used during a normal measurement using the "constant concentration of tracer-gas" method. The more tracer-gases one uses the more information one can obtain about the internal flow of air in the building. A full overview of the air flow between the individual measurement zones in the building can only be obtained by using a different tracer-gas for each individual zone.

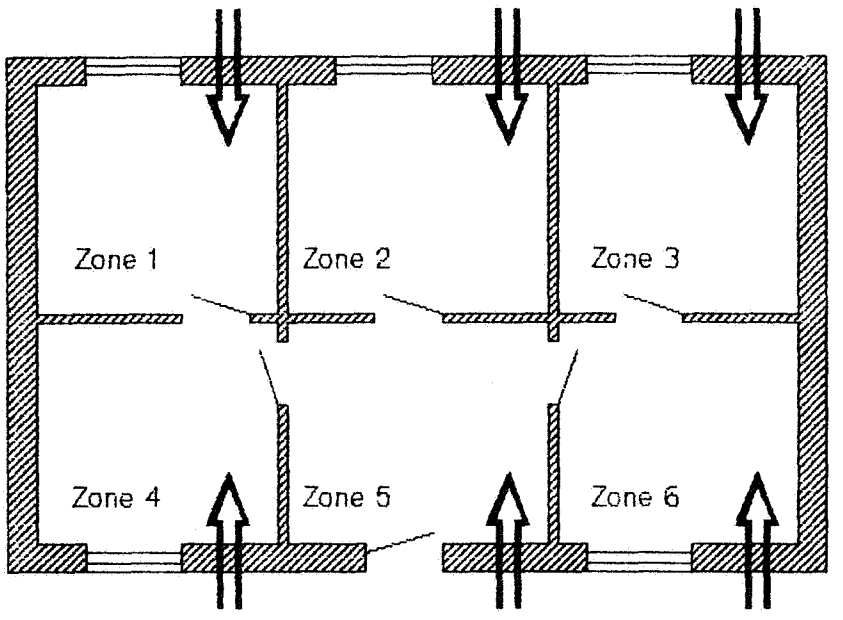

Fig. 1. Air-flow which can be measured using the "constant concentration of tracer-gas" method.

The measurement method using many tracer-gases demands larger gas consumption, more complicated, and therefore more expensive, measuring instruments, as well as more man-hours to set the measuring system up and to calibrate the instruments. There are therefore many good reasons for limiting the demand for measurements of internal air-flow in buildings.

In light of the experience we have obtained in using the "constant concentration of tracer-gas" method, it is clear that there are two distinctive situations which call for a method which is able to measure how air flows between the various zones inside a building. One situation is where it is necessary to have more detailed information about the air-flow into a particular zone in a building; and the other situation is where it is necessary to find out how pollutants spread around a building. In most cases measurements of the type mentioned can be performed by using only 2 tracer-gases.

MEASUREMENT OF AIR-FLOW TO AN PARTICULAR ZONE

In many cases when measuring air changes in offices and dwellings there is a special need to measure how much outside air enters a particular room directly from outside and how much outside air enters the room indirectly, that is, from adjoining rooms. It could, for example, be an air change

measurement in a dwelling where one focuses specially on the air change in a bedroom during the night; or the air change measurements in an office building where there is a need to measure the flow of air into a crowded room.

During this type of measurement one keeps a constant concentration of the one tracer-gas (A) in all the rooms in the measuring area, and a constant concentration of the other tracer-gas (B) in the room in which air-flow is being studied. If one wishes to investigate the air-flow in other rooms in the building, one doses one room at a time with the second tracer-gas. Figure 2 illustrates the air-flow which can be measured using this measuring method. The solid arrows indicate the air-flow which can be measured with gas A. The dashed arrows indicate the air-flow which can be measured with gas B.

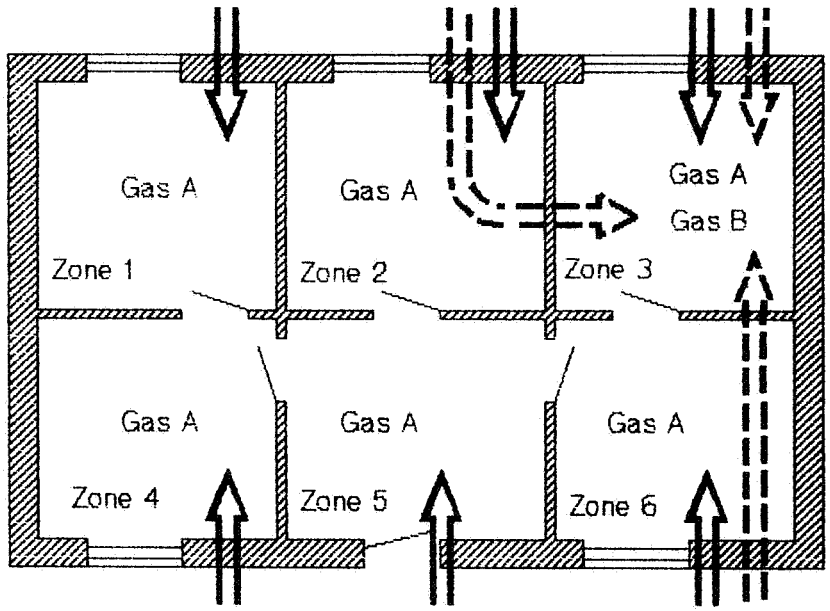

Fig. 2. The air-flow which can be measured when the concentration of tracer-gas A is kept constant in all the rooms and the concentration of tracer-gas B is kept constant in one room.

In this type of measurement tracer-gas A is used to measure the total air change in the building and the individual outside air change in each room, and tracer-gas B is used to measure the total air change in one individual room - both the part of the outside air which enters directly from outside and the part which enters the room from adjoining rooms. This type of measurement also enables one to find out how pollutants from a room which is dosed with tracer-gas B spreads to other rooms in the building.

MEASURING THE SPREAD OF POLLUTANTS

When the spread of pollutants is being studied it is necessary to measure the concentration of the pollutant in all the rooms as well as the air change in the polluted area, the air change in the clean (non-polluted) area and the air-flow between these two areas. If all these parameters are measured it is possible to evaluate the pollution problem and find out if pollution is best limited by reducing emission of the pollutant, increasing ventilation in the polluted area, increasing ventilation in the clean area or by improving the separation between the polluted area and the non-polluted area.

Pollution mapping and control as described above is not only a good tool in industrial environments but can also be used in office and home environments. The method can, for example, be used to study radon pollution. Radon diffuses upward through the soil from underground sources and pollutes the crawl-space beneath the floorboards in buildings and eventually pollutes the air in the living areas of these buildings.

When measuring the spread of a pollutant the tracer-gas A is kept at a constant concentration in all the rooms which are polluted and tracer-gas B is kept at a constant concentration in all the other rooms (clean rooms) in the measuring area. Figure 3 illustrates the air-flow which can be measured using this method. The solid arrows indicate the air-flow which can be measured with gas A. The dashed arrows indicate the air-flow which can be measured with gas B.

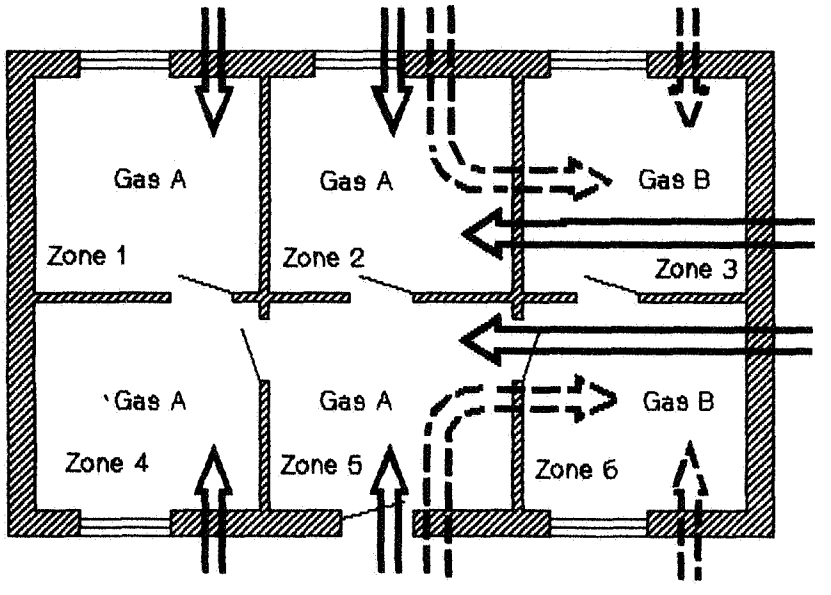

Fig. 3. The air-flow which can be measured when the concentration of tracer-gas A is kept constant in the polluted rooms and the concentration of tracer-gas B is kept constant in the clean rooms.

In this type of measurement tracer-gas A is used to measure the total air change in the polluted area of the building and tracer-gas B is used to measure the total air change in the clean areas of the building.

The flow of polluted air from zones dosed with tracer-gas A (area a) to zones dosed with tracer-gas B (area B) can be calculated by using the outside air change in area A and the concentration of tracer-gas B in area A. If the concentration of tracer-gas B is the same in all A zones the air-flow can be precisely calculated. If the concentration of tracer-gas B varies from zone to zone in area A the air-flow can be calculated to within certain limits.

If one compares the air-flow from area A to area B with the air-flow from area B to area A it is possible to find out whether there is any unfavorable difference in the air-pressure between the two areas.

One of the disadvantages of this measuring method is that the total air change of the building is apparently not able to be calculated from the total air changes measured in the two different areas.

EXAMPLE

The measurement shown was conducted in 3 rooms in the corner of an office-building with mechanical ventilation. The ventilation system was running a part of the night, in order to cool the building. A plan with the rooms measured is shown in figure 4. Room number 1 is dosed with tracer-gas R-22, and

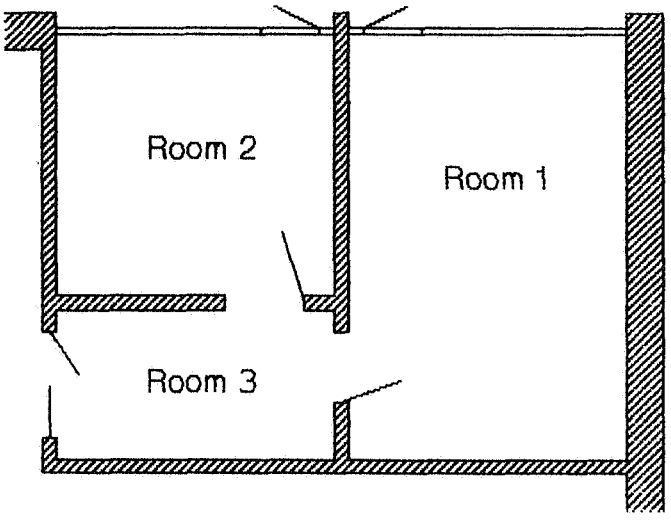

Fig. 4. Plan of the measurement area. There is mechanical ventilation with injection and extraction in each room.

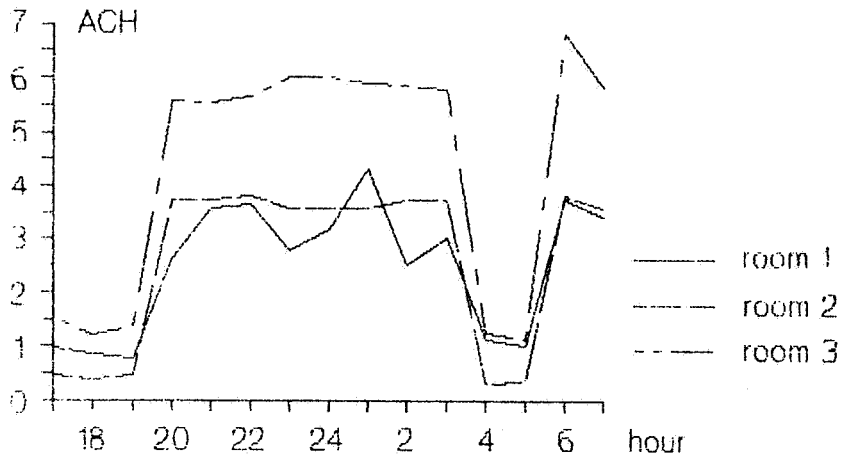

Fig. 5. Measured air-change in the 3 rooms.

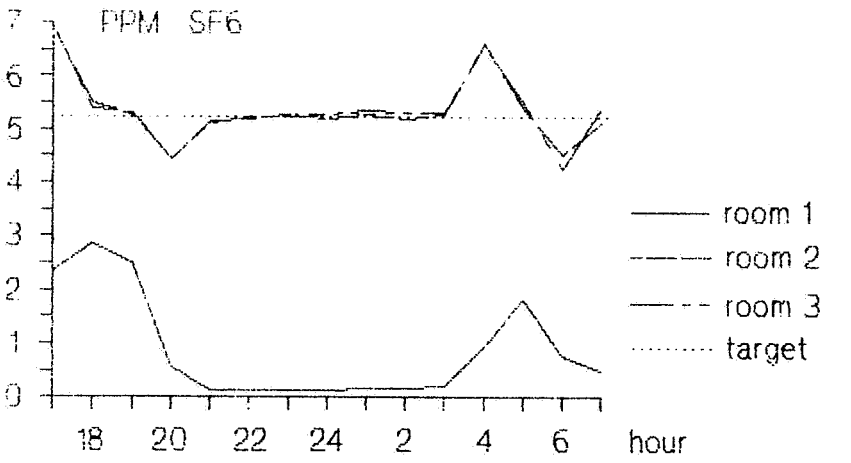

Fig. 6. Concentration of tracer-gas R-22 in the 3 rooms.

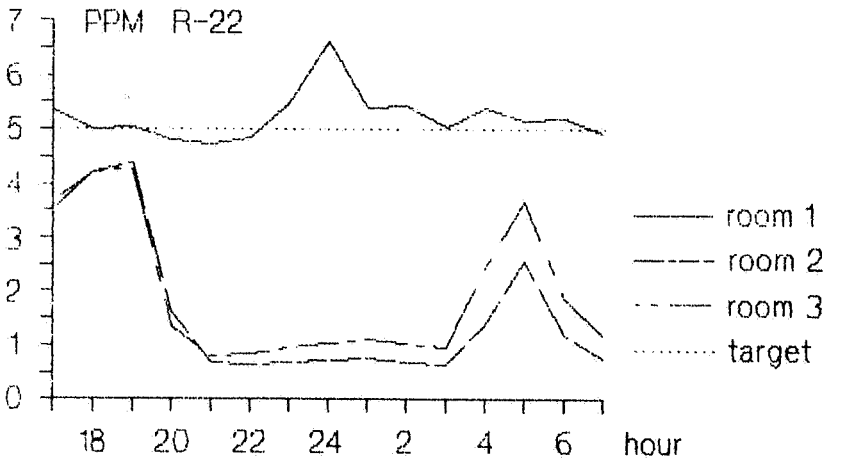

Fig. 7. Concentration of tracer-gas SF6 in the 3 rooms.

room 2 and 3 is dosed with SF6. Figure 5 shows the measured air-change rate in the 3 rooms, and figure 6 and 7 show the concentration of the tracer-gases in the rooms.

If we look at the airflow during the night, it is seen that there is almost no flow from room 2 and 3 into room 1. In the opposite direction there is a flow on app. 70 m3 each hour.

CONCLUSION

The "constant concentration" measurement method using 2 tracer-gases is a very efficient tool for continuously measuring the air change and internal air-flow in buildings. The advantages of the method is that one can perform measurements in buildings which are in use, and that one can perform measurements in buildings which are divided into numerous zones. The disadvantage of the method is that when using 2 tracer-gases one can only measure the air-flow across one individual boundary in the building at a time. If one wishes to measure the air-flow across all boundaries in a building at the same time, it is necessary to use the measurement method where each zone is dosed with a different tracer-gas. This measurement method also has a disadvantage, in that the number of rooms in which measurement can be performed cannot be greater than the number of tracer-gases which can be handled by the measuring equipment being used.

If one compare the two measurement method it must be concluded that the measurements performed using the "constant concentration with 2 tracers" is the most flexible method, while the measurements performed with more than 2 tracer-gases gives more detailed information about the internal air-flow in buildings.