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A MULTI-TRACER GAS SYSTEM WITH VARIABLE INTERVAL SAMPLING

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Introduction

The concentration decay technique is widely used for measurement of air flow in buildings (Lagus and Persily, 1985). This technique involves the injection of a known amount of tracer gas into a building followed by a period of mixing to establish a uniform tracer concentration. The decay of tracer gas is then measured. In the case of air flow measurements made between two zones, the variation of tracer gas concentration with time depends on the size of the doorway and on the temperature difference between the two zones. Recent work has indicated that the accuracy of air flow estimation is strongly influenced by the number of samples taken during the transient period (Riffat, BSR&T, 1989). This is the first 2-10 minutes of the experiment when then the concentration of tracer gas is varying most rapidly. Tracer gas decay systems which are currently available do not have sufficient flexibility to provide accurate measurements of air movement through large openings as their sampling/analysis times are too long (typically 3-4 minutes) to allow a sufficient number of measurements to be taken during the transient period. Clearly there is a need to develop a new system which allows a large number of tracer gas samples to be taken at intervals as short as 5 seconds during the transient period and a small number of samples at intervals greater than 5 seconds during the dominant period.

Principle of operation

The automated sampling system is shown in Figure 1. The sampling speed of the system can be adjusted so that a large number of tracer gas samples can be collected during the transient period of an experiment and smaller number during the dominant period. This technique minimises the error in the term dC/dt (where C is the concentration of tracer gas and t is time) and hence allows an accurate estimation of air flow rate to be made (Riffat, Vancouver 1989).

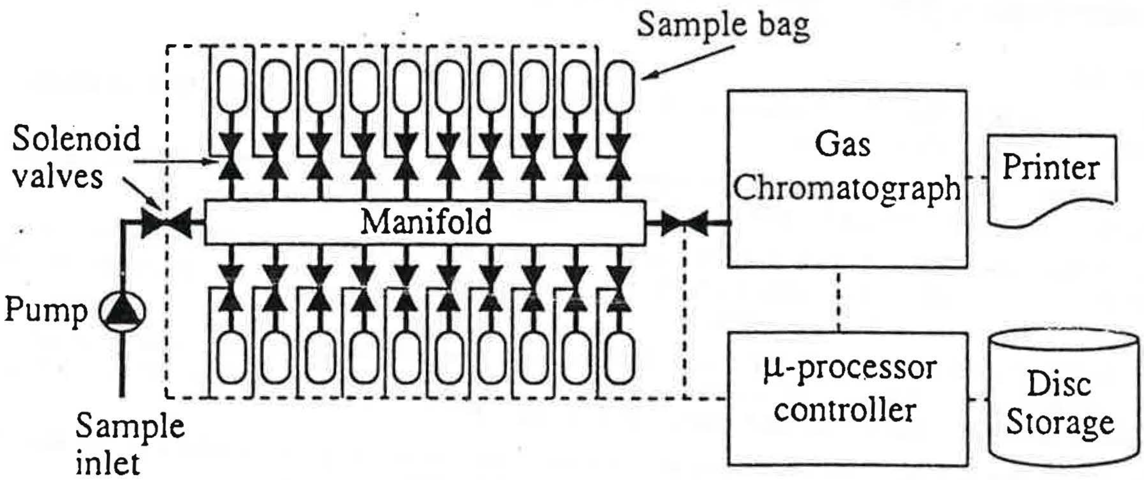

Fig.1: A multi-tracer gas system with variable interval sampling.

The tracer gas system is flexible and could be used for on-site analysis or for grab-sampling. On-site analysis involves connection of the sampling system to a portable gas chromatograph so that tracer gas samples can be injected directly into a chromatograph. Grab sampling involves the collection of tracer gas samples for subsequent analysis in the laboratory using a more sophisticated gas chromatograph. In this case, more than one tracer gas could be used in each experiment.

In order to measure interzone air flow, a sampling system is placed in each zone. Different tracer gases are then released, one gas in each zone, using automatic injection units. After tracer gas release and mixing, samples are collected and analysed in the laboratory. The sampling system is designed to collect as many as 40 samples from a zone at intervals appropriate to the experiment. In a typical experiment the system would collect about 30 samples during the transient period (at 5-10 second intervals depending on the size of the opening and the temperature difference) and about 10 samples (at intervals greater than 10 seconds) during the dominant period.

Hardware description

The microprocessor-controlled tracer gas system is capable of taking samples at intervals as frequent as every 5 seconds. In essence, the tracer gas sampling system incorporates solenoid valves, tracer gas sampling bags, a pulse pump, a microprocessor-based controller, a manifold and a by-pass valve. The short sampling period is achieved using a specially designed microprocessor controller. This contains a central processing unit and programme memory with a capability of 60 input/output.

The portable chromatograph consists of a 6-port valve connected to a 0.5 ml loop, a column, a chromatographic oven and an electron capture detector. The system incorporates a microcomputer, a parallel printer and interface cards for both analogue and digital data. The system could be used for sampling various tracer gases. We chose to use sulphur hexafluoride (SF6) and perfluorocarbons (PFTs) as they have desirable characteristics in terms of detectability, safety and cost. In addition their suitability has been demonstrated previously by their successful use in other air movement studies (Riffat et al, 1987, Dietz and Crote, 1982).

Tracer gases are released automatically using portable and free-standing units. The perfluorocarbon release system consists of a small cylinder wrapped with a heating mat and fitted with a pressure relief valve. The SF6 release system consists of a small SF6 cylinder, a pressure regulator and a solenoid valve. The solenoid valve is normally closed but can be opened automatically using the microprocessor. The volume of tracer gas released depends on the size of the building and is controlled by adjusting the length of time that the valve is open.

References

P. Lagus and A.K. Persily, "A review of tracer gas techniques for measuring air flow in buildings", *ASHRAE Trans. 91, Part 2, 1985.*

S.B. Riffat, "Air flows between two zones: Accuracy of single-tracer gas measurements for estimation", *Building Service Research and Technology, 10(2), pp.85-88, 1989.*

S.B. Riffat, "A study of heat and mass transfer through a doorway in a traditionally-built house", *ASHRAE Symposium on Calculation of Interzone Heat and Mass Transfer in Buildings, ASHRAE annual meeting, Vancouver, B.C., Canada, 1989.*

S.B. Riffat, M. Eid and J. Littler, "Development in a multi-tracer gas system and measurements using portable SF6 system", *Proceedings of the 8th AIVC Conference - Ventilation Technology Research and Application, Federal Republic of Germany, 1987.*

R.N. Dietz and E. Cote, "Air infiltration measurements in a home using a convenient perfluorocarbon tracer technique", *Environment International, 8, pp.419-433, 1982.*