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Titre: CONTINUOUS AIR INFILTRATION MEASUREMENTS IN THE LESO

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ABSTRACT

The total air infiltration rates can be determined by the decay tracer gas method. But to measure the influence of the inhabitants or the convective exchanges between rooms, the constant concentration is more suitable. In order to measure these effects, the Compact Equipment for Survey of Air Renewal (CESAR), developed at the LESO, was used to perform an air exchange analysis on data recorded at regular intervals in up to 10 locations simultaneously. Three tracer gas methods were implemented : decay, constant concentration and continuous flow. Successfull continuous measurements were worked out in 10 locations and the exchange flow rates as well as the inhabitants' effects were measured by the constant concentration method.

KEYWORDS

Constant concentration, air infiltration, inhabitants' influence, exchange flow, CESAR.

INTRODUCTION

The study of solar units at the LESO solar passive building (Faist, 1983) requires an accurate determination of air renewal rates and convective exchanges between rooms to calculate their energy balance. The tracer gas method offers a good manner of measuring air infiltration. Using the decay method only the total air infiltration rate n hr^{-1} can be determined. To investigage the inhabitants' effect or the exchanges between units, the constant concentration was used. An automated equipment based on tracer gas method was developed. Measurements during the winters of 83-84 and of 84-85 were done in the LESO.

Description of the Apparatus

The Compact Equipment for Survey of Air Renewal (CESAR) developed at the LESO can be used to perform a simultaneous and periodical air exchange analysis in up to 10 locations. This apparatus consists of a microcomputer, a 10-channel programmable gas injection unit, a 10-channel gas sampling unit, an N_2O/H_2O infrared gas analyzer and an anemometer. Continuous measurements can be taken over several days. After the survey an automatic analysis is done on the data, and the essential parameters such as air renewal rates, wind velocity and wind direction are displayed.

Tracer Gas Methods

Three tracer gas methods are implemented : decay, constant concentration and continuous flow. The decay curve in figure 1 gives a measure of the total air infiltration rate but neither the inhabitants' effects nor the convective transfers can be determined.

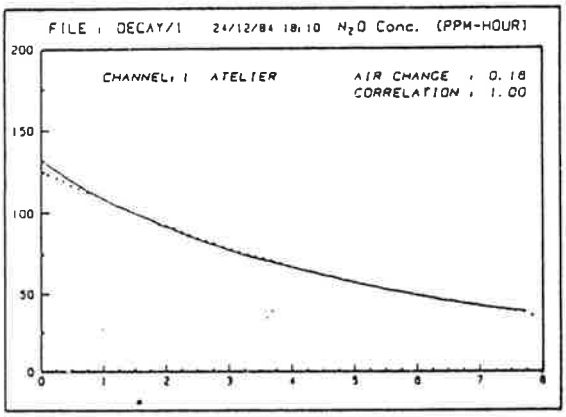


Fig. 1 : Analysis of a solar unit by the decay method. The dashed line is the concentration of N_2O versus time. The dotted line is the fitted exponential curve.

With the constant concentration method (Figure 2), the inhabitants' effects and the convective transfers can be estimated. The measurements are continously checked by the microcomputer and a regulation program computes the amount of tracer gas to be injected in the room to keep the concentration constant. The concentration ranges from 0 to 200 ppm of N_2O

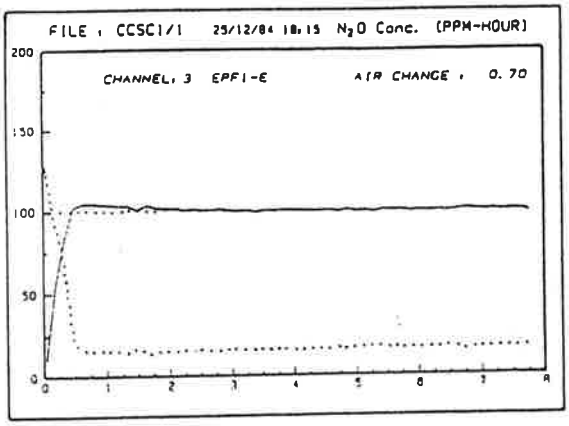
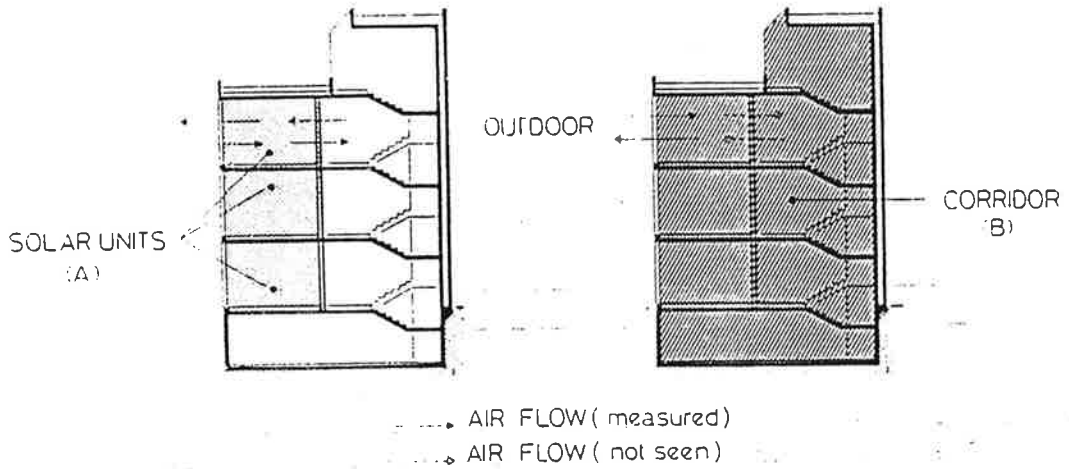


Fig. 2 : Analysis of a solar unit by the constant concentration method. The dashed line is the concentration ppm versus time Hr . The dotted line fixed at 100 ppm is the desired concentration. The second dotted line shows a qualitative representation of the amount of injected versus time.

Description of the Tests at the LESO

Determination of the transfers between the rooms and the corridor

During the winter of 1983-84, the transfers from the corridor to the solar units without inhabitants were investigated. The method used to determine the air flow between room A and the corridor B is as follows :



1° Find the total air infiltration rate of A

2° Make a second measurement with the same concentration in A and B so that the exchanges between A and B are not "seen" in A.

3° The difference of air renewal rates of A give the air flow rate from B to A.

Figure 3 shows the corridor and the outdoor to room infiltration fluxes measured from March to May 1984.

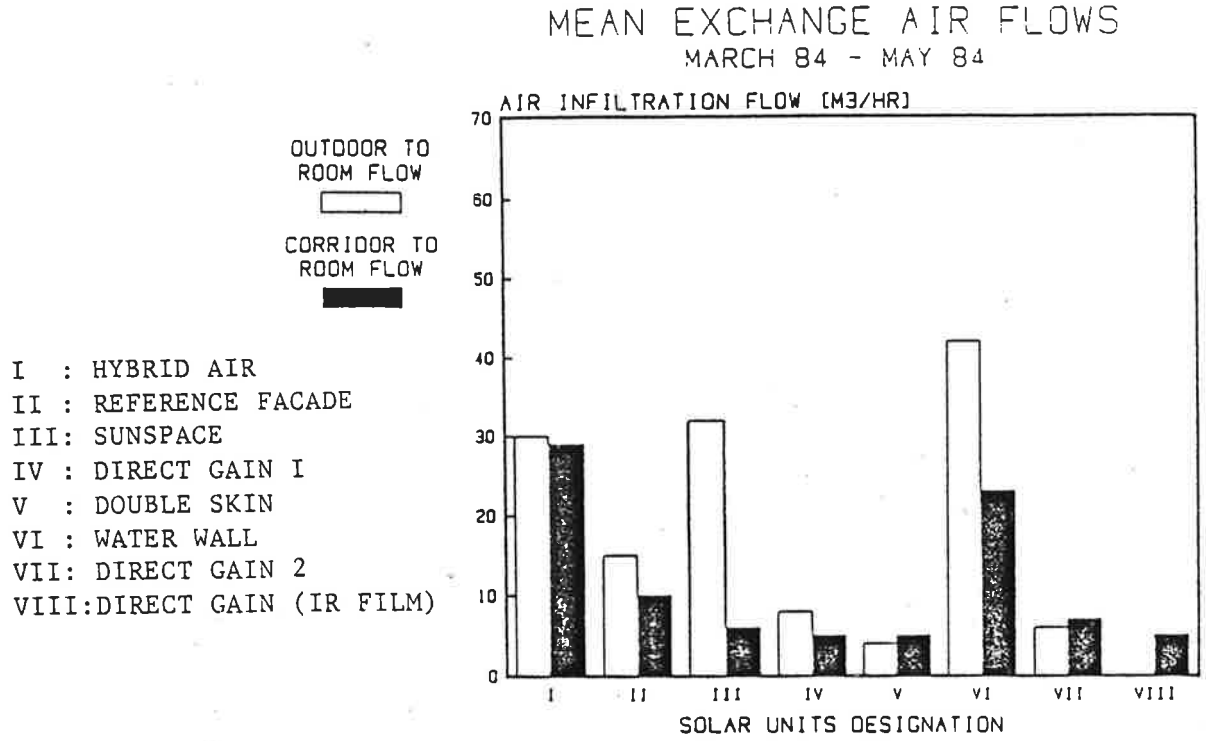


Fig. 3 : Outdoor-to-room and corridor-to-room air infiltration flows measured from March to May 1984.
Mean external temperatures : 5 - 18 °C
Mean wind velocity : 1.1 - 4.3 m/s

The outdoor-to-room infiltration fluxes lie in the range of 0 to 42 m^3/hr. For each solar passive system it has been possible to determine the corridor-to-room air infiltration; a flow of 5 m^3/hr is measured for the systems which have one door opening to the corridor.

Influence of the inhabitants on the total air infiltration rate

During the winter of 1984-85, an experimental survey was made to point out the inhabitants' effects. The air infiltration rates of the empty rooms during the night and on weekends, and in the daytime with habitants were measured. The results are displayed in figure 4 where the black bars give the air infiltration rak hr^{-1} with occupants. Thre is no doubt that the inhabitants have a great influence on air renewal. The most important increases were measured in the passive systems where people were often circulating. In the direct gain façade (IV), the secretary office of the LESO, the air renewal rate was 200 % greater than when it was empty. The four persons working in the double skin unit caused an increase of 150 %. Systems with one employee (the 7^{th} and 8^{th} units) have a lower rate change.

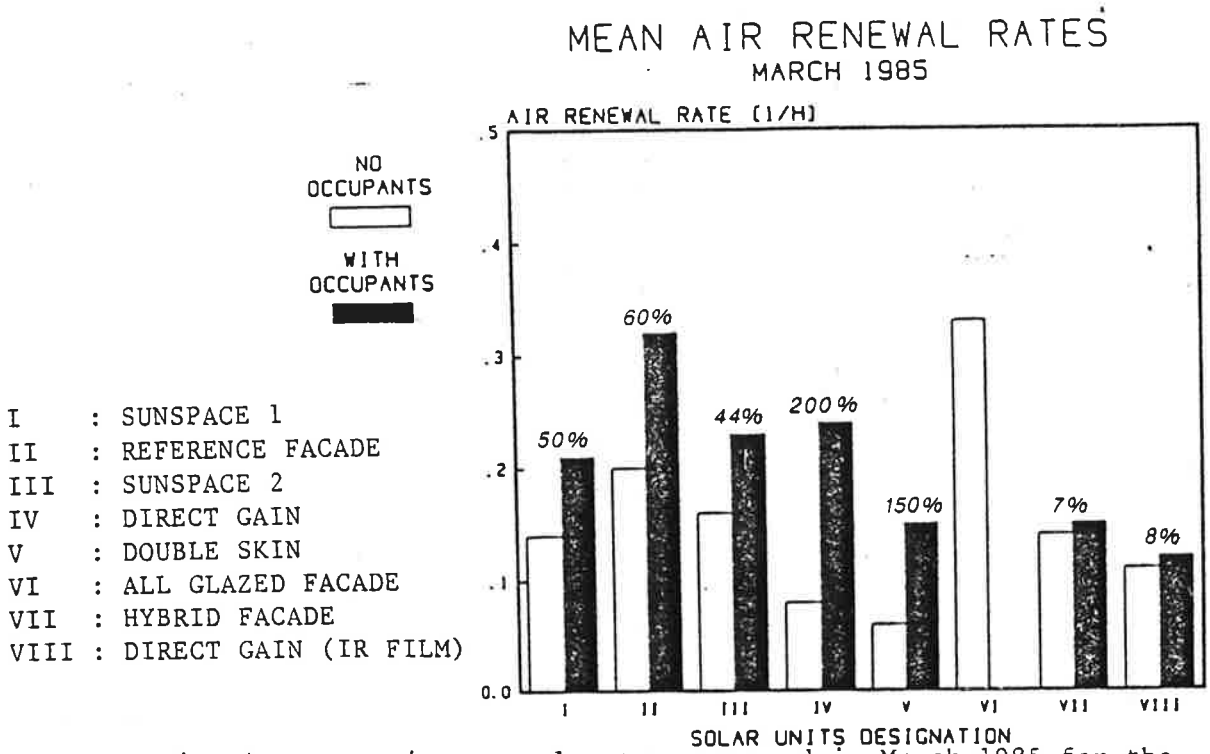


Fig. 4 : Mean air renewal rates measured in March 1985 for the 8 solar unites. The percentage given on the black bars represent the gains in the air renewal rate caused by the inhabitants.
Mean external temperatures : - 1.8 to 6.2 °C
Mean wind velocity : .5 to 7.7 m/s

The 6th unit remained empty so there is no measurement with inhabitants.

CONCLUSIONS

Simultaneous measurements were taken in up to 10 locations during several days with success. The constant concentration method allowed three major goals to be reached :

- To measure the air renewal rate in all the locations
- To determine the transfers between the solars units and the corridor
- To measure the effects of inhabitants on the total air infiltration rate.

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