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Demand Controlled Ventilation: A Case Study

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1.0 Synopsis

Good indoor air quality in buildings becomes such a major concern that new design recommandations emerge in many countries (USA, Nordic Countries, ...) Improvement of the interior environment should not be at the expense of higher energy consumption. Heat recovery systems are one appropriate answer to this challenge. However, additionnal energy savings could be achieved by applying demand controlled ventilation when the internal loads vary significantly.

A CO2 controlled ventilation system has been installed in a conference room with high variable occupancy in mid 91. In this paper, we present the survey of 6 months of use, the limits and the benefits of such a system. We focus on the practical aspects to offer the optimum air quality and to integrate the occupants and building owner's requirements.

2.0 Description of the building and its ventilation system

The two story building is located in the subburb of a small town. Offices and exhibition hall benefit of a conventionnal exhaust ventilation system with a fixed flow rate. CO2 controlled ventilation system has been installed in a 200 M2 room used for conferences, training courses, business meetings, reception ceremony as well as parties. Internal loads can vary from an occupancy of 2 to 50 persons. This room has an independent VAV ventilation system.

Figure 1 represents a sketch of the installation. A CO2 meter is located on the main internal partition at a 1.4 meters height above the floor level. It analyses continiously the CO2 concentration. The measurement is based on the infrared photoacoustic principle. The sensor delivers a linear output signal (0-10 Volts) proportional to the carbon dioxide concentration in the 0 -2000 PPM range. A frequency inverter integrates the sensor signal over a two minute period. Diagram 1 shows its programmed answer in response to the input signal. The motor ajusts its rotation speed according to the frequency and the exhaust flow rate of the fan varies linearly with the input between 350 and 1100 M3/H. Six low pressure exhaust valves are uniformly distributed over the room ceiling. Fresh air is supplied through air inlet grilles evenly located on the facade.

3.0 Experimental set-up

The CO2 concentration and the total flow rate have been recorded during 6 months every 5 minutes. Occupants filled up questionnaires. An agent visited the installation evey other months to check any potential problems.

3.1 Results

The occupancy of the room varies greatly and exceeds sometimes the maximum expected number. It reflects the various uses of this room. The CO2 concentration fluctuates between 350 ppm to 850 ppm with a peak at 1100 ppm when the internal load was extreme. The sensibility of the system can be appreciated with the detection of events such as aperitifs. When the room is used after a period of absence, the dilution time is noticed. During a meeting, any variation in the internal load is perceived by the sensor and consequently the flow rate is adjusted. As already noticed in other experiments [1], the CO2 sensor can adjust the air flow much more quickly than a temperature or enthalpy sensor.

During the survey, the room was less used than expected. Therefore, the minimum ventilation rate was often encountered. Keeping the ventilation to a minimum seems to guaranty the quality of the air, even at 8 a.m. the day after a high occupancy. The room is correctly purged of pollutants.

Integration time of the frequency inverter should be long enough in order to avoid any pumping and acoustic effect in the ductwork. The absence of integration time induces a contineous variation of frequency and an erratic input to the fan motor.

The CO2 sensor does not integrate all the pollutions. For exemple, after a party, the odor of wine and food is persistent. Even if some people may appreciate, it is not acceptable. Therefore, new systems integrate a boost position within the room. Occupants or managers can interfere on the functioning of the ventilation when special events occur.

Different means of variable air volume exists but frequency inverters act proportionnally on the speed of the motor and therefore, the functioning point of the fan moves along a network curve. When the CO2 concentration decreases, the flow rate decreases proportionally and the pressure also but to the square. No noise is generated whatever the working point is situated.

In the design stage of any buiding, the profiles of occupancy as well as the density are key parameters which are rarely well apprehended. An on/off or a two level ventilation system can induce a high energy consumption and a poor indoor air quality because the the exhaust or supply air flow is not adapted to the needs. CO2 ventilation partly solves this problem.

3.2 Occupants'perception

Six questions were asked to the occupants:
1. Are you satisfied of the air quality ?
2. Do you notice a difference with the others spaces?
3. How do you judge the acoustic environment?
4. Do you encounter a difference in the air quality over the space and the time?
5. Do you notice a better indoor environment in the presence of smokers in comparison with the other spaces?
6. Do you know the type of ventilation system if any?

The occupants were unanimous in their answers to questions 1,3,4. The air quality is qualified from good to excellent within the entiere space and over the time. Special mentions and positive comments were related to the high quality of the acoustic environment. For questions 2 and 5, occupants were either without opinion or noticed an improvment with other spaces. Interwieved occupants did not know always the existence of a ventilation system and even less the type.

4.0 Conclusions

In this building, occupants and managers were delighted by the quality of air and specially the acoustic environment, the ease of operation and the energy benefit. CO2 controlled ventilation with frequency variation explains this satisfaction. The cost reduction of these two essential components: the sensor and the inverter should lead to a larger use of this ventilation process.

5.0 Reference

1 L. NORELL
Demand-controlled Ventilation
Flakt Review n°74, Energy Conservation

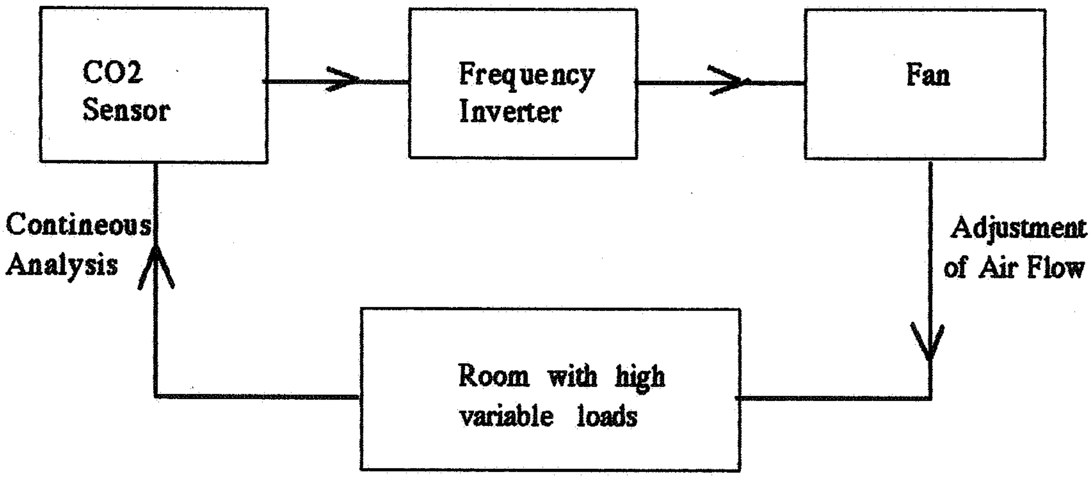

Figure 1: Principle of the system

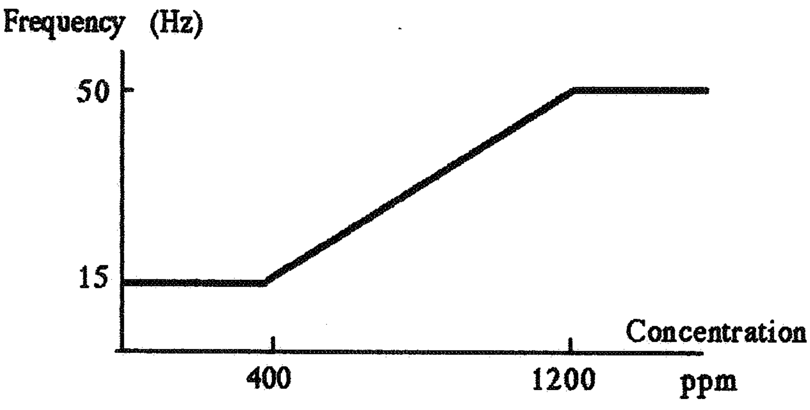

Diagram 1 : Response of the frequency inverter