EXPERIMENTATION : HUMIDITY CONTROLLED SYSTEM IN FRENCH COLLECTIVE BUILDINGS REFURBISHMENT

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ABSTRACT

In France, most of the public project managers have collective dwellings built in the 70's – 80's with "first generation" mechanical ventilation systems. These systems are not well perceived by the occupants who find them noisy, uncomfortable in winter and with a high energy consumption.

To avoid these problems, most of the occupants do their own modifications (by blocking the trickle vents or stopping the system) which alters ventilation performances. Such changes lead to several negative consequences, including: health problems, uncomfortable climate, possible moistures in the rooms, etc.

As part of an experimental project on 9 flats, a humidity controlled ventilation system has been installed to prevent the bad effects noted earlier. The originality of this system is to place additional humidity controlled trickle-vents in kitchens and a roof extract fan with a 24-hours clock timer for high speed (pre-set cycles).

In order to evaluate the performances and the interest in that system, in situ monitoring of temperature, CO_2 concentration, humidity, fan airflow rate was performed during two periods of 15 days with cold and mild climates.

KEYWORDS

Ventilation, Field measurement, Humidity controlled, Indoor Air Quality, Thermal comfort

INTRODUCTION

This study involves the rehabilitation of a collective building ventilation system owned and managed by "OPAC de l'AIN": « Les Peupliers » - Meximieux (01) – France. This operation aims at improving the hygiene and comfort conditions ensuring the match of the new solutions with the residents habits, the economical constraints and energy conservation.

For the study, different measures have been made in 4 flats (2 type T4, 1 type T2 et 1 type T3) before and after the renovation during two periods of 15 days, in cold season and temperate season. The measurements concern :

- The temperature and the relative humidity in the kitchen, bathroom, main bedroom and the living-room;
- The temperature and the relative humidity outside the building;
- The CO_2 level in the main bedroom;

- The total air flow extracted by the fan;
- The real energy consumption of the system.

Together with the measurements taken (quantitative aspect), an inquiry (qualitative aspect) is made concerning the residents feelings towards the new system, taking in account their comfort and the practical aspects of the system.

DEFINITION OF THE VENTILATION SYSTEM

The building manager chose the system according to 3 points :

- Make the minimum of works in occupied flats;
- The experiment could be repeated for other operations;
- The global buying costs so as the installation costs.

On the terrace-roof

The fan has been replaced with a more efficient ventilator. This ventilator is equipped with a 24-hour clock timer to evaluate the pros and cons of a dual speed extract fan. The extraction fan, an ATLANTIC brand AIRVENT M1450 is adapted to the humidity controlled ventilation system. According to the manufacturer, its electrical power drawn is 350 W. The dustbins premises originally connected to the ventilation system have been modified to be ventilated naturally. Therefore, they are no longer linked to the extraction fan. Manual sealing of the ducts has been performed.

In the cellars

A self-balancing exhaust vent 15 m³/h is installed in each cellar.

In dustbins premises

Natural ventilation of the room using the existing vertical duct end up with a roof vent – ANJOS CTM.

In the kitchen

An additional humidity controlled air-inlet is set up at the top of the window. This inlet opens gradually from 55 % of relative humidity (RH) in the room, up to a maximum flow of 40 m³/h at 73% RH. The air extraction is made thanks to a dual flow self-balancing exhaust air terminal device (ATD) with a high flow manual setting; a built-in timer limits the high flow to 30 minutes Find underneath, the flows according to the type of flat.

Table 1. Flow characteristics of the exhaust ATD (model ALIZÉ AUTO TEMPO)

Flat	Minimum Air flow (m³/h)	Maximum Air flow (m³/h)
Type 2	30	120
Type 3	45	135
Type 4	45	135

In the bathroom

To replace the previous exhaust VMP 60, we installed a humidity controlled exhaust ALIZÉ HYGRO. Its flow varies from 10 to 60 m³/h from 30 to 80 % relative humidity whatever the flat type is.

In the toilets

To replace the previous exhaust VMP 60, we installed an exhaust type ALIZÉ Tempo which ensures a minimum extract flow of 5 m³/h and a maximum flow of 30 m³/h, controlled manually (opening time 30 minutes).

In the living-room and bedroom

Humidity controlled air-inlets are placed in these rooms. For the bedrooms, their flow characteristics are 7/40 m³/h for 20 Pa. For the living-room, we can put two types of trickle vents : 4/40 m³/h or 7/40 m³/h at 20 Pa.

ENERGY RESULTS

Fan flow measurements

At low speed (LS), the medium extracted flow in the whole building is 1220 m³/h compared at 1400 m³/h in high speed. The difference between the two speeds is then of 180 m³/h, which means a decrease in LS of around 13 %.

Electric consumption of the extractor

To estimate the possible gains on electric consumption of the fan installed, it is important to compare it with the consumption of the previous one. Therefore, according to the measurements before works, the medium global flow in the building was 1668 m³/h for an electric power of 560 W, i.e. a specific fan energy use of 0.34 Wh/m³.
During the experimentation, the consumption monitored shows a medium power of 280W for a medium flow of 1300 m³/h, which means a specific fan energy use of 0.22 Wh/m³. This value takes in account the electric consumption of the fan, the transformer and the clock. We can note that the difference of consumption between low and high speed is not very significant, but this set-up aims at decreasing energy losses by renewing air at a lower airflow rate 18 hours per day, i.e. 75% of the time.
The different pieces of information are summarized in Table 2, knowing that the building floor-area is 504 m².

Table 2. Results and comparison of the fan energy consumptions

	Per day	Per year	
	Average consumption (kWh)		Specific fan energy use (kWh/m²)
Before works	13.5	4900	9.7
After works	6	2200	4.3
Decrease in %	55		

The energy saving per flat, without taking into account ventilation losses is 300 kWh/year.

COMFORT AND INDOOR AIR QUALITY ANALYSIS

Generally speaking, the study regarding the hygrothermal comfort in the 4 tested flats, consists in taking hygrothermal measurements in each room (kitchen, bathrooms, and living-room), during the same period (January) before and after the works. The period of comfort corresponds to the time spent in a “comfort polygon” defined by (Recknagel, 1995):
17°C < T < 20 °C; 40% < RH < 70%; 5+ (1/6) (T – 17) < w < 10 + (1/9) (T-17) where w is the specific humidity in g/kg.

In the kitchens, the comfort period has been significantly improved (by a factor of 10), whatever the flat type is (see Table 3).

Table 3. Results of hygrothermal comfort in kitchen

		Kitchen			
		T2/1	**T4/2**	**T4/3**	**T3/3**
January 2001 (pre-retrofit)	HR < 30%	67 %	80 %		2 %
	HR < 40%	100 %	98 %		63 %
	HR > 70%	0 %	0 %		0.1 %
	Comfort	0.1 %	4 %		56 %
January 2003 (post-retrofit)	HR < 30%	59 %	8 %	3 %	4 %
	HR < 40%	96 %	77 %	49 %	42 %
	HR > 70%	0 %	1 %	0 %	0 %
	Comfort	11 %	45 %	66 %	64 %
March 2003 (post-retrofit)	HR < 30%	34 %	9 %	4 %	25 %
	HR < 40%	89 %	78 %	42 %	85 %
	HR > 70%	0 %	0.1 %	0.1 %	0 %
	Comfort	28 %	43 %	76	27 %

In the bedrooms, besides the comfort aspect, we studied the difference of CO2 levels. Those ones have been significantly cut down after the works: our measurements indicate concentrations in general well below 2000 ppm compared to values greater than 4000 ppm measured before (Figure 1).

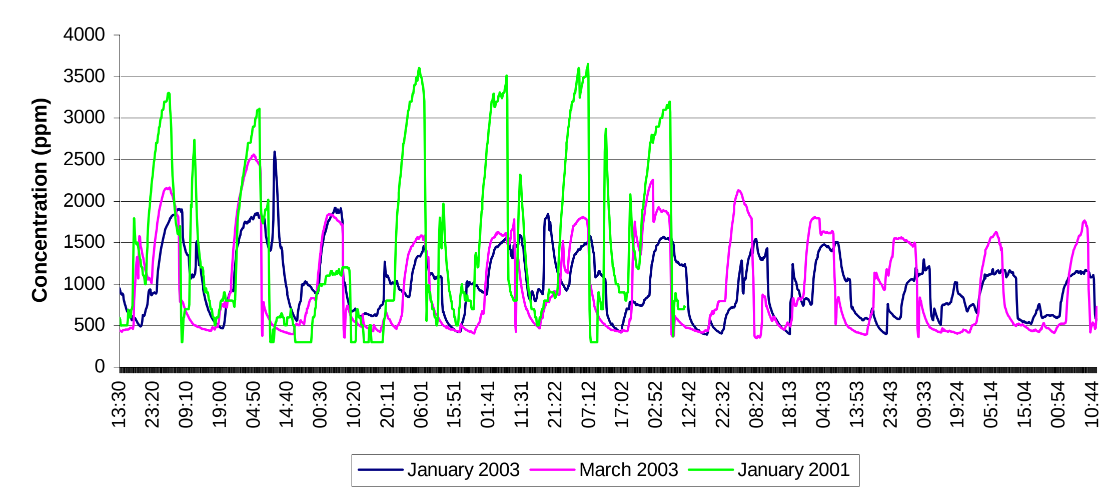

Figure 1. CO_2 concentration in the bedroom T4/2. Post-retrofit (2003).

In the bathrooms, the humidity level between 2001 and January 2003 decreased from 5 to 20% HR, making the humidity variation between 25 to 45% (Figure 2). These figures confirm the relevance of the humidity controlled exhaust which adapt the air extracted according to the humidity in the room.

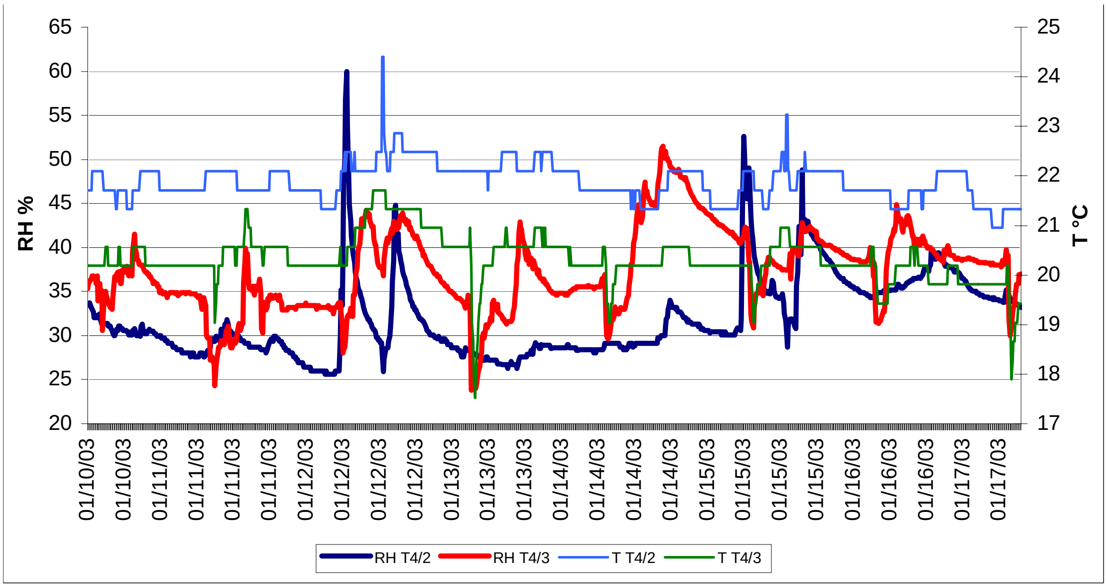

Figure 2. Temperature and the relative humidity in the bathrooms of the flat T2/1.

In the living-rooms, the results of the hygro 0/40 air-inlet, on the range of 55-73% RH associated with an inlet 7/40 show that this scenario is not adequate as the humidity level is too low (< 55% RH) in this type of rooms, due to constantly low number of occupants (Figure 3).

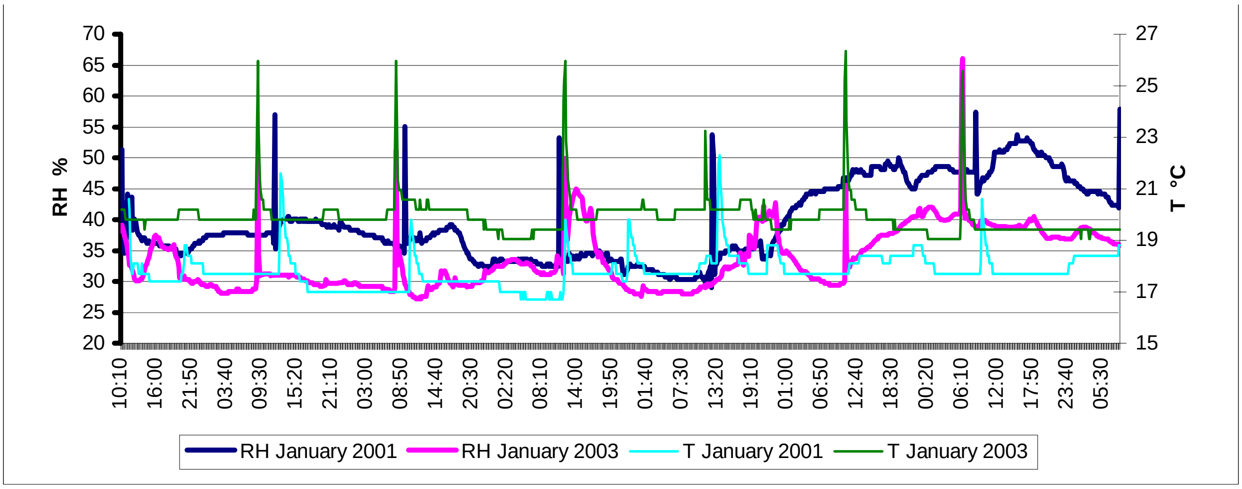

Figure 3. Temperature and RH in the living-room of both T4. Post-retrofit (2003).

ANALYSIS OF THE RESIDENTS OPINIONS

We made the survey, inquiring the residents of different flats in the building. It has been conducted on 7 residents out of the 9 concerned by this retrofit.

Residents habits

Most of the people surveyed said that they opened windows once a day to let the new air coming in and to evacuate stale air (cooking or cigarette smells). The windows are shut normally when the weather conditions change.

Residents feelings

Further to the renovation works, most of the residents did not change their habits concerning window opening.
Nevertheless, their feelings regarding ventilation are much more positive, and they confirm that the system is more efficient than before the works (less humidity, less condensation and "feels" healthier). When interviewed, they said they better understood the reasons behind the need for ventilation. Ventilation is perceived essential for 80% of the residents and useful for 20% of them.

The occupants confirm that they regularly clean the exhaust vents (between 15 days to 2 months), which allows them to keep the system efficient. Generally speaking, the residents accepted to unblock the trickle vents following the OPAC instructions which concern the needs and the use of letting new air coming in.

Finally, the clearest improvement due to the renovation works concerns the temperature which is more regular and less cold, as well as a better elimination of odours.
The wet cleaned floor and the linen hanged out dry quicker, these elements are good proof and are well perceived by the occupants.

CONCLUSION

Based on the energy savings (around 300 electric kWh/year) made on this operation, we obtain a decrease of CO_2 level rejection of 27 kg per year and per flat (evaluated on the average of 0.09 kg of CO_2 per electric kWh per year).

The renovation of the ventilation system which follows the replacement of the windows has to be treated as a global system, taking in account the insulation, the building airtightness, the quality of heating control and production, the potential of renewable energy use. Here appears the real importance of the renovation of ventilation systems in such operations, as it is well known that tightening the building (e.g., by changing the windows) can damage the indoor air quality if the ventilation aspects are not considered.

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