ASSESSMENT OF IMPROVEMENTS BROUGHT BY HUMIDITY SENSITIVE AND HYBRID VENTILATION / HR-VENT PROJECT

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ABSTRACT

Introduced for the first time at 25th AIVC Conference in Prague in September 2004, the HR-Vent project still delivers new rich teachings since its start in January 2004. Until December 2005, more than 700 million data have been recorded on 180 extract units in 5 occupied collective buildings located in NANGIS (France).

Directly linked to the local meteorological data, these measurements aim at evaluating the ability of the new installed hybrid ventilation system to erase the back draught effects as well as to improve the natural draught and the connected gas appliance operation ; They also allow to show the effectiveness of the connected humidity sensitive extract grilles in the wet rooms by recording every minute the data of relative humidity, temperature, pressure and opening surface. All these data are measured by specifically developed sensors integrating a high accuracy low pressure manometer.

Specific and statistical analysis on pressures and airflow, comparisons between rooms, between storeys and buildings, influences of wind speed and outdoor temperatures are very interesting teachings for all of us who need a really significant monitoring to improve their knowledge on natural and hybrid ventilation behavior.

The first results can particularly show the IAQ and energy effectiveness in a microscopic view as in a macroscopic analysis.

KEYWORDS

Measurements, monitoring, HR-VENT, passive stack ventilation, mechanical assistance, hybrid ventilation, humidity sensitive, needs, punctual, mean.

INTRODUCTION

The behavior of ventilation, especially the passive stack and the hybrid ventilation, is still a source of speculations for all of us who try to assess its performances. It is to come out its deep secrets that a large-scale project named HR-VENT has been monitored. This project, located in France in the City of NANGIS, is being applied from January 2004 until December 2005 in 5 occupied collective buildings. Not less than 700 million data are being recorded on 180 extract units to collect information on humidity, temperature, pressure, grille opening surface and gas appliance working. After a first presentation at 25th AIVC Conference in Prague in September 2004[1], some new major results and teachings regarding the improvements brought by the humidity sensitive extract grilles and the mechanical assistance are presented in this article.

PROJECT REMINDER – MEASURED PARAMETERS

HR-VENT project consists in recording every minute the following parameters:

WC and bathroom equipped with a humidity sensitive extract unit.	**Kitchen with domestic boiler**	**Outdoor conditions**
Measured parameters		
Temperature (°C) Relative humidity (%) Aperture of the grille (cm^2) Pressure difference (Pa)	Temperature (°C) Relative humidity (%) Temperature of the combustion gas (°C) Pressure difference (Pa)	Temperature (°C) Relative humidity (%) Wind velocity (m/s) Wind direction (°)
Calculated parameter		
Airflow (m^3/h)	Airflow (m^3/h)	

The 5 buildings are equipped with the following components:

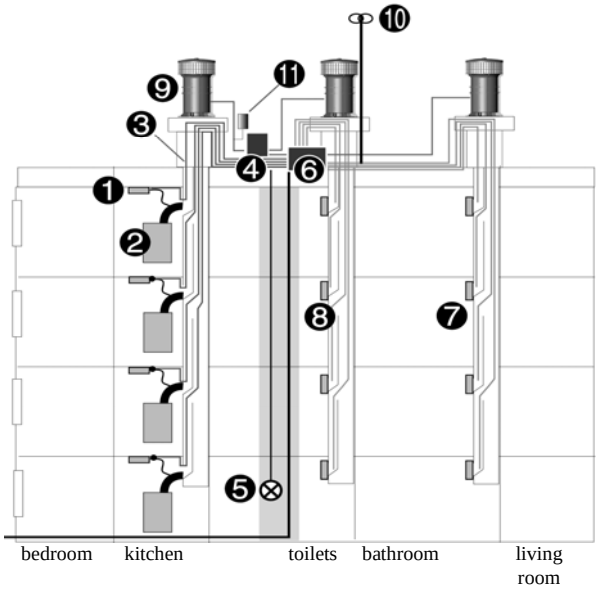


Figure 1 :

Cut of a schematic view of a building stack (example with 4 levels)

[1] Siret, F., Savin, J.L., Jardinier, M. and Berthin, S. (2004). " Monitoring on hybrid ventilation project - first results." *25th AIVC conference.*

	Component	*Function*
1	**Instrumented grille - Kitchen**	Acquisition of : Pressure / Burnt gas Temperature / Room temperature / Room Relative humidity. Frequency : each minute.
2	Connected gas appliance	Hot water production for domestic use.
3	**Data bus cable**	Carry data acquired by components 1,3 and 8.
4	Complete control panel	Transformation of 230 VAC to 15VDC Electrical protection Fan power supply management Simultaneous working of fans management.
5	Working indicator	Indication of good working of the fans equipping this stack of dwellings.
6	**Instrumentation box**	Registers data acquired by components 1,3 and 8.
7	**Instrumented grille - bathroom**	Acquisition of : Pressure / Grille opening section / Room temperature / Room Relative humidity. Frequency : each minute
8	**Instrumented grille - Toilets**	Acquisition of : Pressure / Grille opening section / Room temperature / Room Relative humidity. Frequency : each minute.
9	VBP very low pressure fan	Very low pressure fan for passive stack ventilation assistance.
10	**Meteorological station**	Acquisition of : Wind speed / Wind direction / External local temperature / External local relative humidity. Frequency : each minute.
11	Temperature sensor	Controls the VBP fans speed according to temperature (normal speed / low speed).

Note : Components in charge of registering data are mentioned in bold.

CONTRIBUTION OF THE MECHANICAL ASSISTANCE

The installation of a very low pressure mechanical assistance fan (VBP) has allowed to report various results on the pressures measured at the 100 cm² fix extract grille in the kitchen[2].

Note : the case of the fix extract grille in the kitchen (instead of a humidity sensitive extract grille) allows to "isolate" the impact of the mechanical assistance.

On the charts Figure 2 are presented the airflow on the different floors of a duct column equipped with VBP assistance fan, which has been cut off during one hour (from 13.45 to 14.45 [3]).

We can report that the airflow at the kitchen fix extract grille remains almost constant at 70 m3/h in this period inside each kitchen when the assistance is working. Not only the assistance provides a quasi-constant airflow although the external temperature thus the thermal draught varies, but it also equalizes the airflow between the different floors. When the fan is cut off, the airflow – thus the pressure- varies more greater during this short time inside the room ; it also varies according to the different floors, due to the thermal draught effect, from 20 m3/h up to 50 m3/h.

The assistance fan has not only increased the airflow (x 1.75 on average) to reach a better level but it has also allowed to stabilize the pressure (thus the airflow as it is a fix grille) inside the room and between the floors.

[2] The kitchen is desserved by a fix extract grille which connects the gas appliance.
[3] Data recorded on the 05/17/05, on one stack of 5 kitchen.

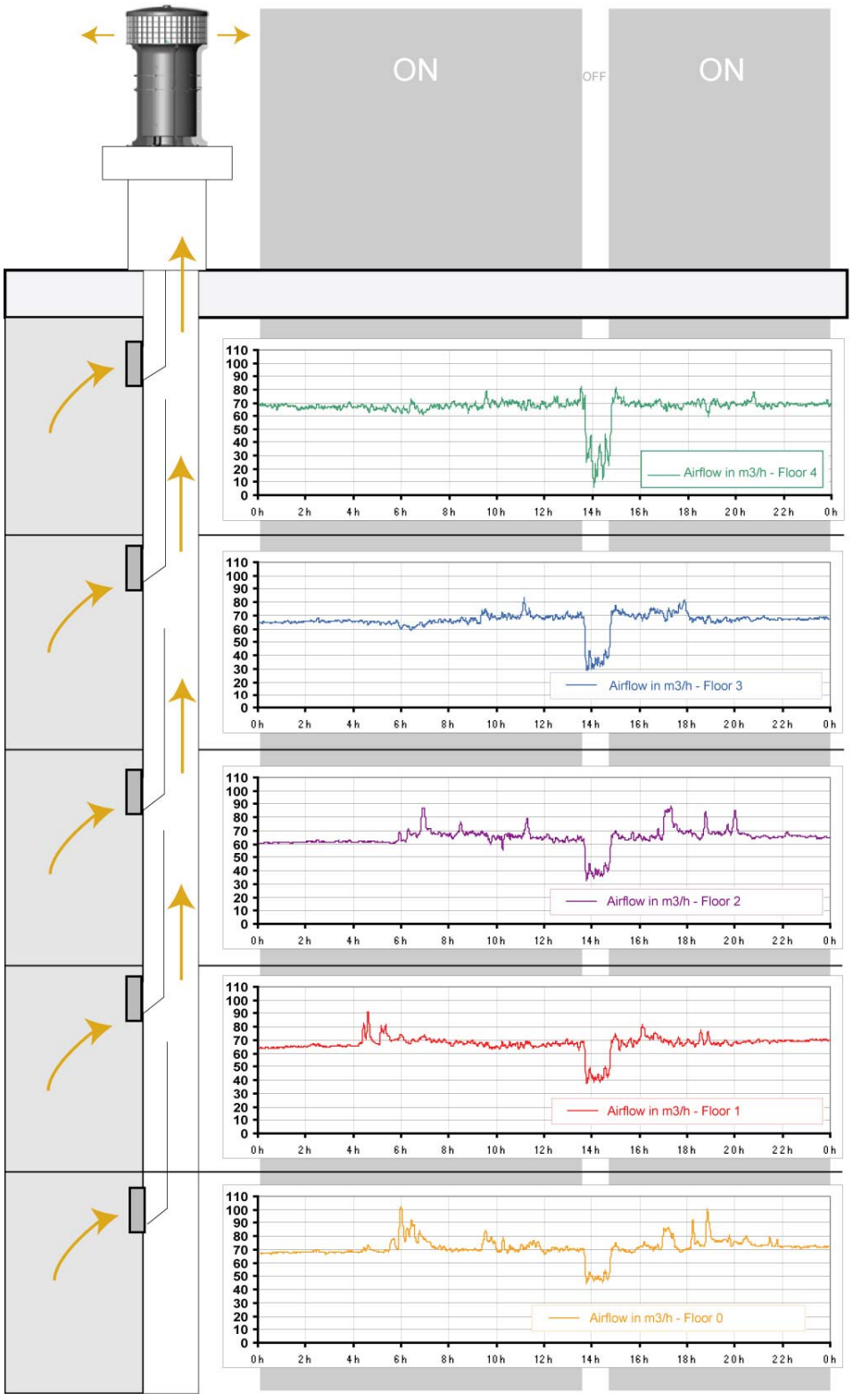


Figure 2 : Comparison on fix extract grille airflow in the kitchen on 5 dwellings connected to the same duct ; with (ON) / without (OFF) fan assistance (example on one day).

CONTRIBUTION OF THE HUMIDITY SENSITIVE EXTRACT GRILLES

This part intends at showing the contribution of the humidity sensitive extract grilles in improving the performances of the natural or hybrid ventilation.

Instantaneous behavior of the humidity sensitive extract grille

On the following chart (Figure 3) is presented the day variation of aperture vs. relative humidity for a humidity sensitive extract grille located in a bathroom. We can notice that the variations of aperture follow well the evolution of relative humidity, with a fast reactivity ; it succeeds in following the large variation of relative humidity.

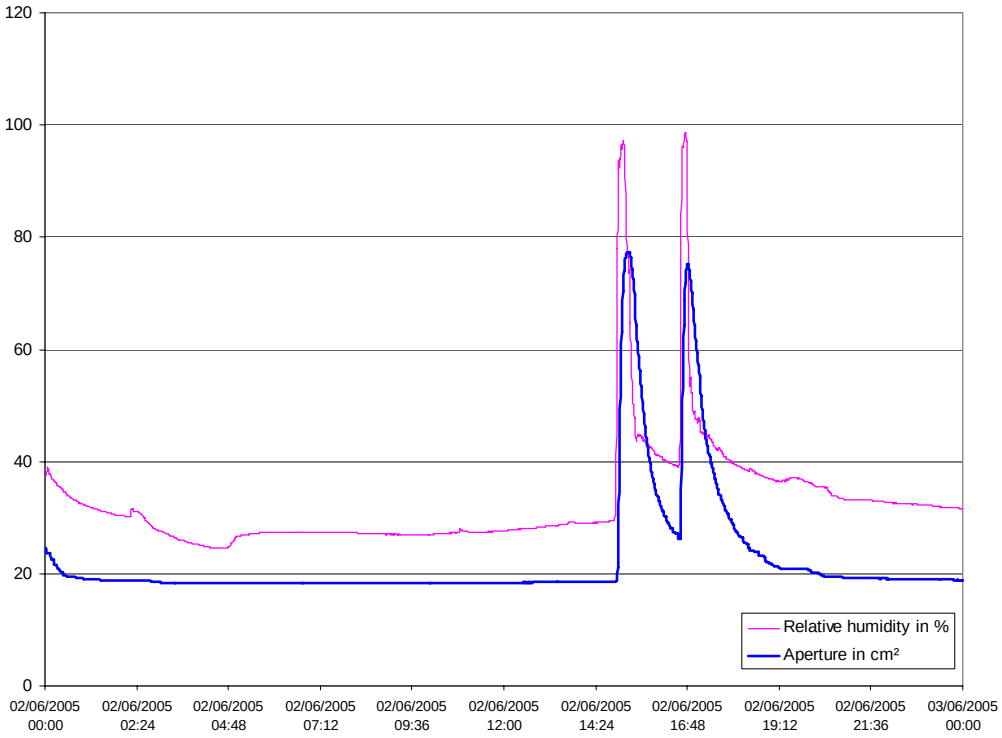


Figure 3 : Aperture vs. relative humidity of a humidity sensitive extract grille in the bathroom

Statistical behavior of the humidity sensitive extract grilles

On the chart Figure 4 can we see both the punctual variability of the grille aperture vs relative humidity and the relative stability of the mean aperture according to the thermal season. Due to the evolution of the mean internal relative humidity all the year long, the grille is mainly close to the closed position in the cold season ; in the hot season the grille aperture becomes wider. The charts on Figure 3 as on the left column of Figure 4 show that **the humidity sensitive extract grille detects permanently the punctual humidity variations to adapt its aperture.**

Only the mean level of aperture varies according to the thermal season during the year. This lower airflow level during the cold season allows to erase over-ventilation thus allows to save energy on thermal losses due to ventilation, while optimizing IAQ as it remains adapted to the punctual needs of air renewal.

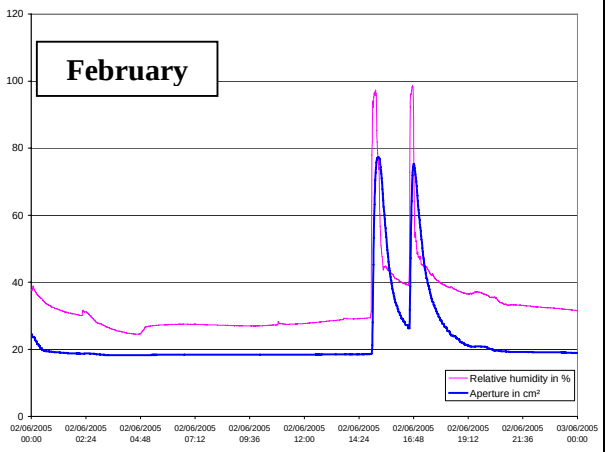
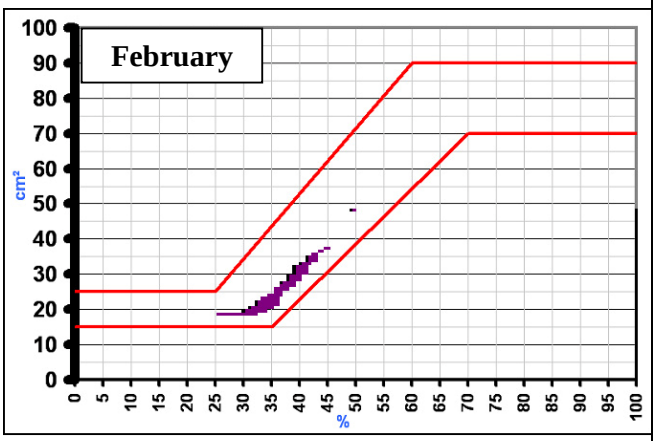
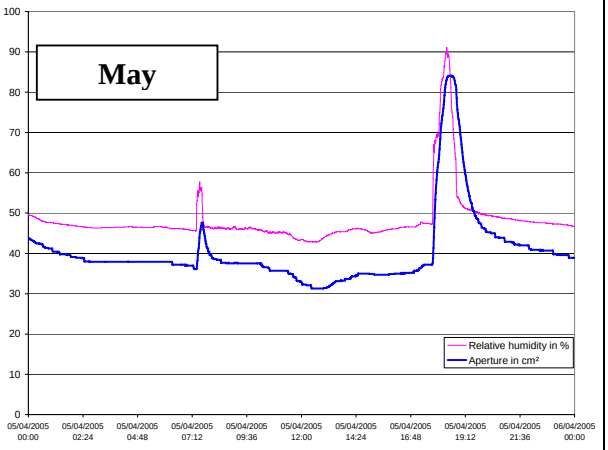
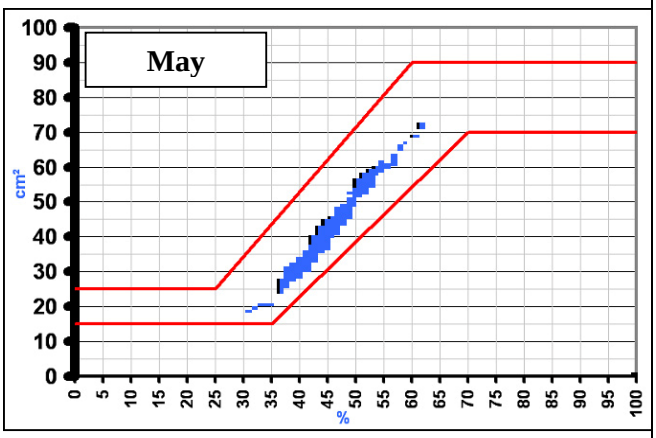
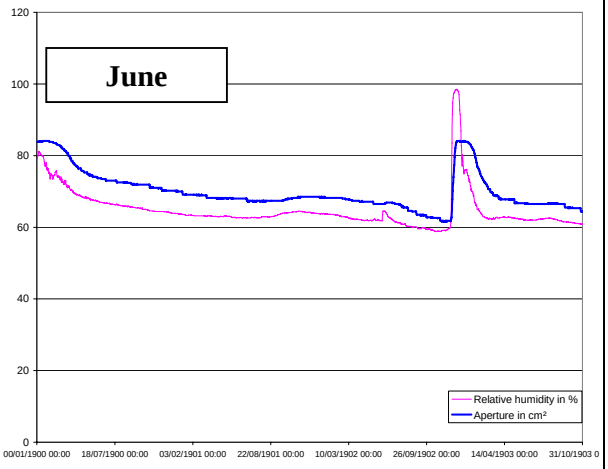
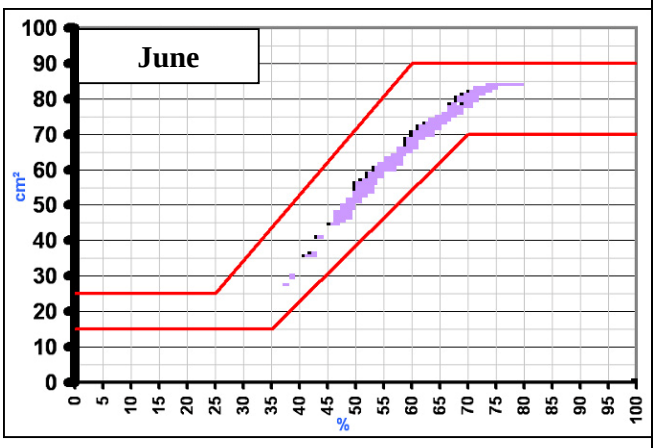
Instantaneous / punctual behavior	Statistical behavior
Microscopic view (one day) of Aperture vs Relative humidity variations for one humidity sensitive extract grille in one bathroom, for different thermal seasons.	Macroscopic view (all minute points of the month) of Aperture vs Relative humidity variations for one humidity sensitive extract grille in one bathroom, for different thermal seasons. (only 95% of points)
	
	
	

Figure 4 : Microscopic day-view and macroscopic monthly view of the variation of Aperture Vs Relative humidity of one humidity sensitive extract grille in one bathroom.

COMPARISON BETWEEN FIX, HUMIDITY SENSITIVE AND ASSISTED VENTILATION

The following analysis concerns the study of the mean monthly airflow, which is naturally different from the instantaneous airflow which is variable in the case of the humidity sensitive ventilation (see previous chapters).

- *Fix extract grille in PSV (Figure 5)*

If we consider the variation of airflow according to the pressure for a fix grille of 50 cm² for example, we know that the airflow depends directly and mainly on the stack effect, thus on the thermal season (Figure 5).

Due to the thermal draught, the pressure thus the airflow is higher in winter, and decrease to go to null or reverse airflow in summer.

The variation of the mean airflow is thus important, although the mean needs are similar. As airflow are more important in winter, it directly increases the thermal losses. The fix extract grille is not able to adapt its airflow to the punctual variations of needs of air renewal.

- *Fix extract grille with assistance fan (Figure 6)*

On Figure 6 can we notice the improvement brought by a mechanical assistance on a fix extract grille. The airflow are increased as the pressure, and the variation of airflow between February and July is reduced from Δ=30 m3/h to Δ =20 m3/h.

It is also remarkable to report that the mechanical assistance has allowed to erase reverse airflow, all year long.

- *Humidity sensitive extract grille in PSV (**Error! Reference source not found.**)*

As seen before, we know that the mean value of aperture of the humidity sensitive extract unit is reduced in winter, increased in summer. So the change of aperture compensates the variation of natural forces ; the humidity sensitive extract unit can be consequently considered as an airflow stabilizer (**Error! Reference source not found.**).

But the main fact to remember is that the mean airflow variations are limited, and the winter mean airflow is decreased up to 50% compared to a fix grille, which make the humidity sensitive extract grille an important contributor for energy saving.

- *Humidity sensitive extract grille with assistance fan (Figure 8)*

By putting a mechanical assistance on the vertical duct connected to the humidity sensitive extract grilles (Figure 8), the ventilation tends to be optimal : higher in hot season when the aim is to fight against reverse airflow, lower in cold season when the enemy is the thermal loss.

The mixed-effect of mechanical assistance and humidity sensitive extract grilles allows to reach an higher IAQ in winter as in summer, and improve its anti-reverse airflow power in summer.

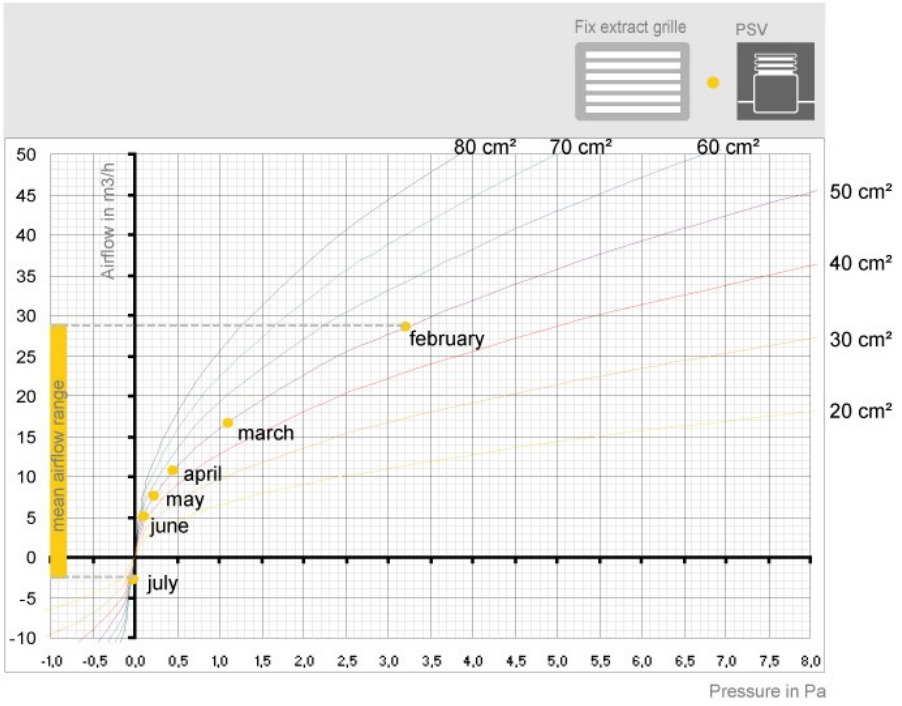


Figure 5 :

Fix extract grille + PSV – **Mean*** monthly value of airflow / pressure

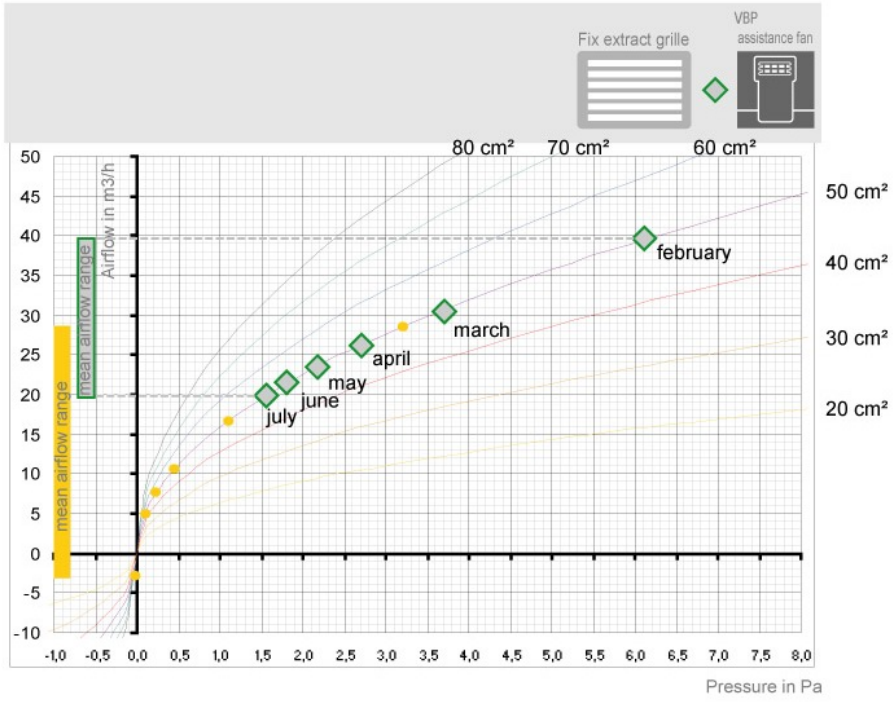


Figure 6 :

Fix extract grille +assistance fan – **Mean*** monthly value of airflow / pressure

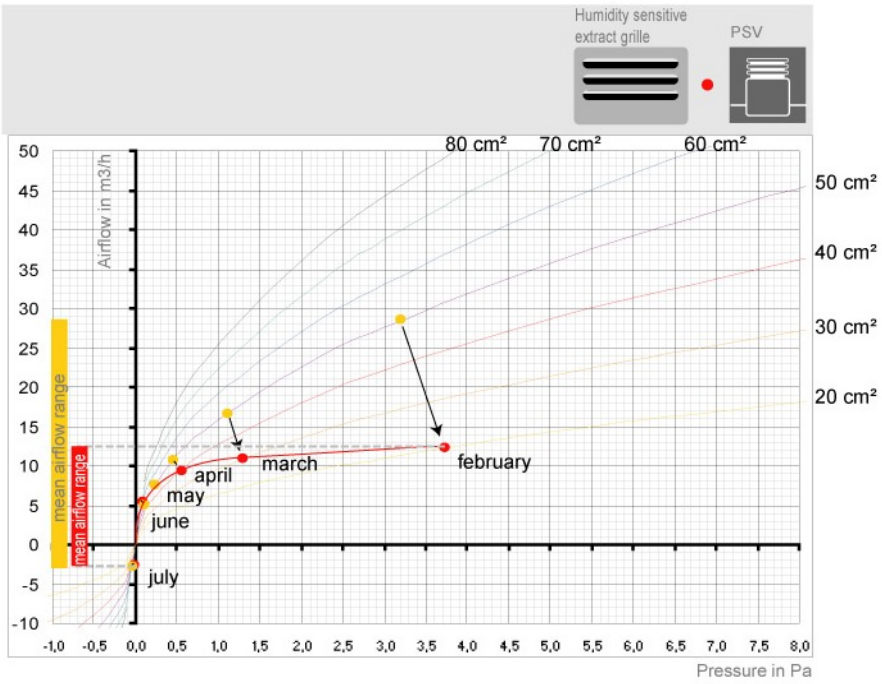


Figure 7 :

Humidity sensitive extract grille + PSV – **Mean*** monthly value of airflow / pressure

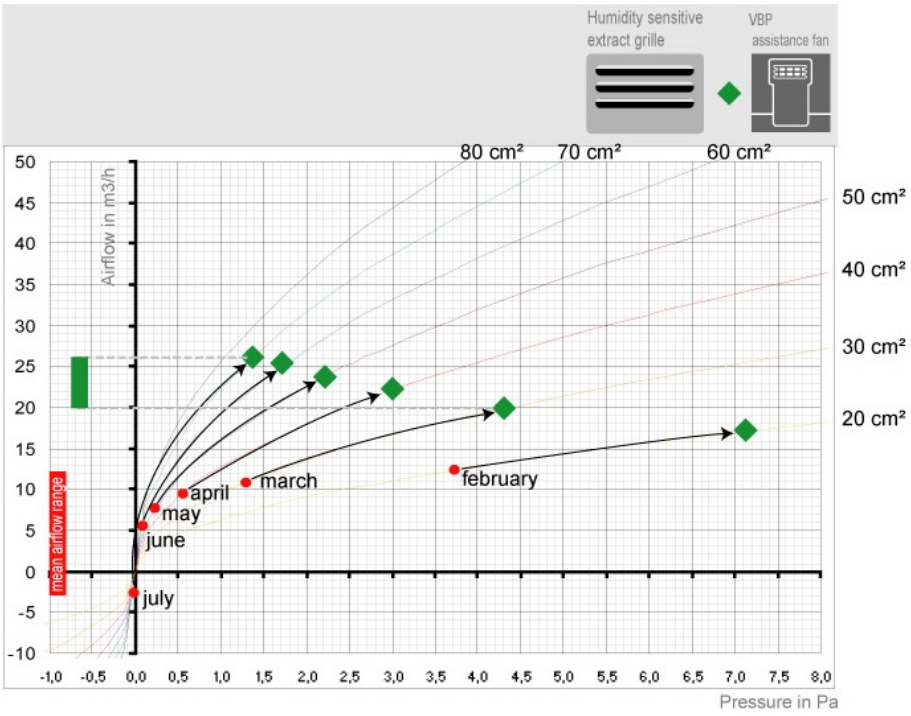


Figure 8 :

Humidity sensitive extract grille + assistance fan – **Mean*** monthly value of airflow / pressure

* : the mean value of the airflow corresponds to the average of all the airflow / pressure points on one month on one bathroom extract grille **; the instantaneous behavior of the humidity sensitive extract grille remains <u>variable</u>, adapted to the needs** (see Figure 3 and Figure 4).

This example, for determined conditions of meteorology, type of building, floor level, type of dwelling, is representative of the majority of the cases. All the details of the study will be available in the final monitoring report in the 1st 2006 semester.

AIRFLOW RANGE REPORT FOR SEVERAL TYPES OF BUILDINGS

The mixed-effect of humidity sensitive ventilation and fan assistance is illustrated in an other way in the Figure 9, which represents the average airflow range from winter to summer in 4 types of buildings (2, 3, 4 and 5 floors) depending on the floor level and on the technical room.

This synthesis intends at showing the influence of parameters such as height of buildings, number of floor, working of assistance fan and type of extract unit.

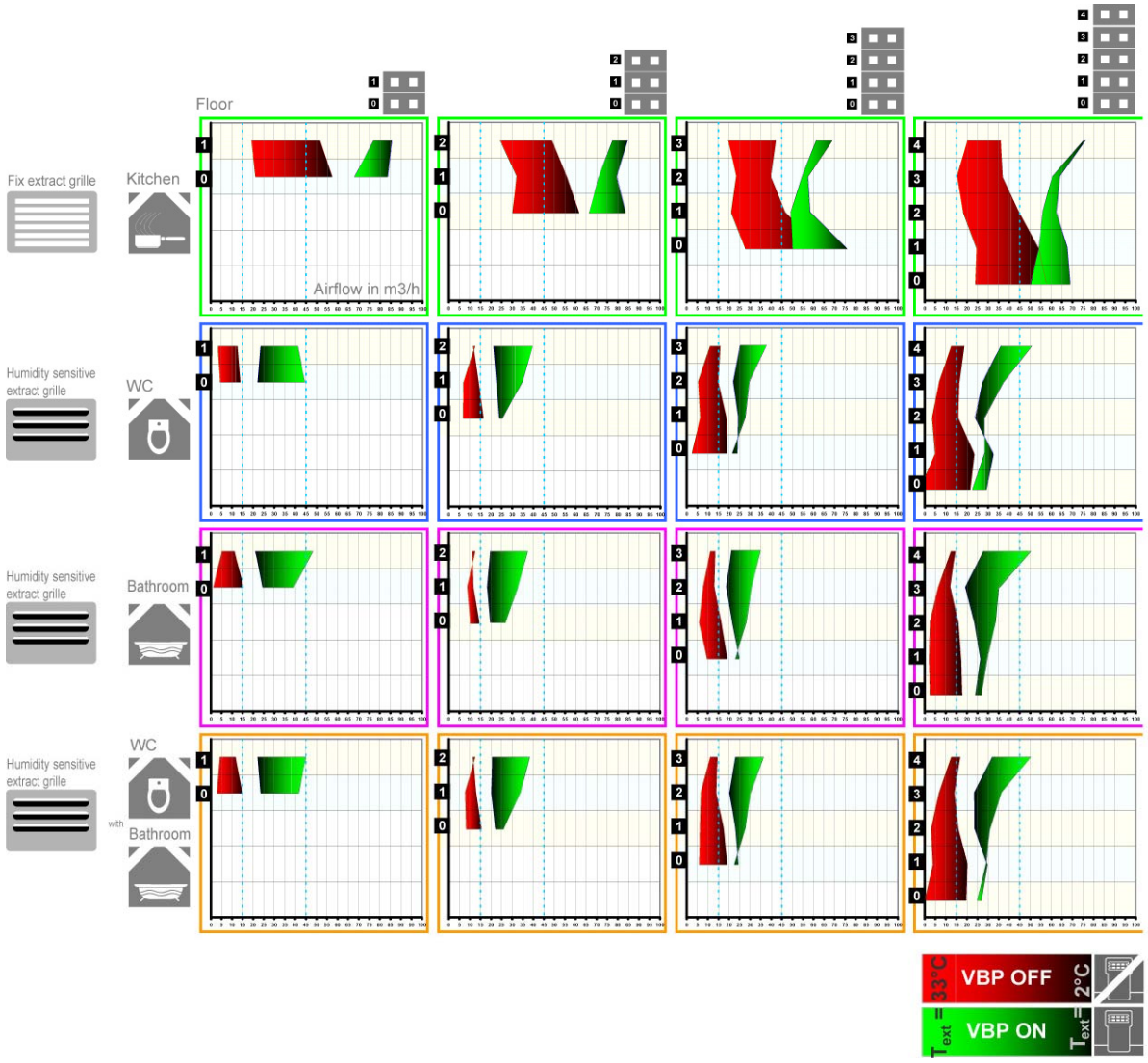


Figure 9 : Comparison on airflow range for different types of technical rooms, different types of buildings (2 to 5 floors), with / without fan assistance.

Legend:
The width of the spectrums corresponds to the range of external temperature. In red (left) is the airflow with mechanical assistance OFF. In green (right) is the airflow with mechanical assistance working. Compilation of all year long data, all extract units (166).

In the kitchen where the grille is fix, we can notice that the range of airflow is wider than in the bathroom and WC where extract grilles are humidity sensitive. It is also remarkable to report that the mean airflow (not the punctual airflow) is considerably lower with the humidity sensitive ventilation.

This variability of airflow for one technical room is reduced with the mechanical assistance, in the fix grille as in the humidity sensitive grille. The mechanical assistance tends to favor the higher floors while the PSV favors the lower floors (in winter), and increases widely the mean airflow of the range.

The higher is the building, the more we have airflow variation between the floors. But these differences are reduced by both humidity sensitive extract units and mechanical assistance.

CONCLUSION

HR-VENT project has allowed to confirm and to discover more behaviors of passive stack and hybrid ventilation. It confirms the efficiency of the humidity sensitive ventilation as an IAQ provider and energy saver by showing its ability to adapt instantaneously the airflow to the punctual needs of air renewal, while the mean airflow is lowered in winter. It also shows that the mechanical assistance ensures an anti-reverse airflow power required in summer, which, mixed to the humidity sensitive extract grilles, provides a complete optimized solution for energy savings as IAQ.

More teachings and information will be available in the final report of HR-VENT, to be issued in the 1st 2006 semester.

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