HUMIDITY SENSITIVE SYSTEM IS 20 YEARS OLD

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ABSTRACT

During the last 20 years, the humidity sensitive ventilation system evolved to products increasingly simplified thus standardised. At Aereco, there were 5 generations of extract units, each modification of product was due to a change in the acceptation criteria.

In many countries, systems with variable airflows are accepted and recognised ; regulations moved. In other countries, the orthodoxy of the constant airflow of an air change per hour remains in force for simplifying reasons or by ignorance of the real interest.

Laboratories and design offices had also to adapt themselves to new technologies, it was the case when the thermostatic radiator control or the programmable thermostats appeared on the market. The period of the all-or-nothing is definitively over.

1.500.000 dwellings equipped with humidity sensitive ventilation systems in the world is the evidence that the system is working well and that it is well accepted. The yearly energy saving is 1.500 giga Wh.

The control of the energy consumption is now an important issue, even the politics are involved : less consumption means less pollution, so few risk of super oil tanker passing by our coasts. The saving of our technology is close to a super oil tanker each year.

Ventilation plays a small part in the overall necessary energy saving however it is real role.

KEYWORDS

Keywords : heat loss, humidity sensitive, energy saving

GENERAL PRINCIPLE OF THE HUMIDITY SENSITIVE SYSTEM

A central fan is working permanently and maintains a sufficient depression in the ductwork of the ventilation. Extract units installed in technical rooms exhaust the stale air proportionally to the humidity of the rooms. The replacement of the extracted air is ensured by air inlets located in main rooms ; these ones distribute the air as per the needs in each room.

BIRTH OF THE HUMIDITY SENSITIVE SYSTEM IN FRANCE

The birth of the humidity sensitive system was in a context of energy crisis and search for solution to save energy. At the end of the Seventies and beginning of the Eighties, the French Ministry of Housing brought up the energy saving question. The messages incited people to increase air-tightness of windows by installing weather striping and to reduce the indoor temperature to 18°C. Many books were published on the subject by the Ministry, the official organisations or social building companies. Furthermore, the regulation regarding ventilation changed for lower flows. (Decree of March 1982).

The reduction of the indoor temperature and the ventilation rate in the dwellings generated a large wave of condensation and moistures all over France.

The problem was posed, it was necessary to save energy without degrading the indoor air quality. Two possibilities :

- the heat recovery ventilation ; in such case, energy is saved at any time even if needs vary,
- a variation of the airflow when the need of ventilation changes : the energy saving is thus statistical. Sometimes there is small saving, sometimes great.

The second solution was chosen ; this was not the simple one because when the energy saving is statistical, it is necessary to agree on source documents and mode of calculation.

TABLE 1

Répartition des résidences principales par nombre de personnes selon le nombre de pièces en milliers de logements

nombre de pièces / nombre de personnes	1	2	3	4	5	6	Ensemble
1	933	1304	1028	550	212	134	4162
2	278	1067	1727	1356	618	404	5453
3	64	331	1144	1120	613	344	3617
4	18	118	561	1069	687	486	2939
5	4	29	160	498	387	336	1415
6 et +	3	17	67	251	331	383	1053
Ensemble	1300	2867	4690	4845	2848	2089	18641

Enquête logement 1978

In the above example of statistics used at this time (see table 1), 1 or 6 persons can occupy a same standard housing (a 4 main-room apartment for example). Furthermore different sizes of families can live in such a dwelling.

The French regulation is based on the number of main rooms of housing, which is relevant on an average point of view. 3 or 4 persons generally occupy a 4-main-room apartment, consequently, the average airflow per person is between 30 and 22.5 m3/h, which is usually recognised as good ventilation. But if the actual occupation rate is different from the average one and if the dwelling is only occupied by 1 or 2 persons, then the average flow per person becomes considerably too high : 90 m3/h and 45 m3/h. For higher occupation, airflow seem insufficient.

It was thus necessary to find an index of presence and human activity in dwelling to be able to be the closest possible to the need. The humidity was selected for reasons mentioned further. So, it is possible to reduce the flows to get energy savings or to increase ventilation, if necessary, to guarantee a good indoor air quality and thus, without making any energy saving. The weighted average flows for one year is lower than what is required by the regulation. The difference between the lawful reference and the average flow corresponds to the energy saving. For example, for a 4-main-room apartment today, the lawful average flow calculated for the ventilation heat losses is of 96.5 m3/h and for a 4-main-room apartment equipped with an humidity sensitive system, this flow is only of 54 m3/h ; That means a saving of 42.5 m3/h or 44 %. As per thermal factors are concerned, the humidity sensitive system behaves as a system with heat recovery that would have an efficiency of 44 %. The great difference between the two systems is that in the first case it is possible to recover part of the heat that it was not necessary to extract, and in the second case, the air quantity of ventilation is optimised.

The most widespread system of ventilation in France is a central mechanical extraction with extracts in the technical rooms (kitchen, bathrooms, toilets) and direct intake of fresh air from outside (air inlets) in the main rooms. If the reduction of the extracted flow can generate energy saving, it is necessary to use the entering air (same quantity as the extracted air) the most effectively as possible, thus, to distribute this air where the people are : living room during the day and bedrooms during the night. The presence of the occupants is detected through the change of humidity rate.

For example and approximately, if the extracted flow is 60 m3/h and there are 4 identical openings on the outside (25%, 25%, 25%, 25%), then the airflow is 60/4=15 m3/h for each air inlet, which is sufficient in some cases but not for a double bedroom. But if the openings are different, for example 50%, 25%, 15%, 10% the same flow of 60 m3/h is divided into: 30 m3/h, 15 m3/h, 9 m3/h, 6m3/h.. The double bedroom can be ventilated with 30 m3/h and the almost empty rooms are only ventilated with 9 and 6 m3/h..

Once this research, simulation and calculation work carried out, it was necessary to convince the Ministry for the well founded of this solution. It was necessary to agree on models of calculation, to make choices on the assumptions, to document the statistics as much as possible. For example, finding which was the vapour emission rate of one person (breathing, evaporation) was difficult ; now there are many works on the subject and there is a consensus. The computer equipment used in 1982 did not make it possible to find the true curve of the humid air ; it was reduced to a cubic equation. The APPLE lle computer had only 64 KB for the program. The taking into account of the meteorological files, the absorption of the humidity by the materials, etc. was made gradually, progressively with knowledge and studies.

The Ministry recognised the humidity sensitive system and made change in the regulation in November 1983 in order to allow the advanced systems of ventilation. This latter are only accepted under the strict control of the technical procedure of technical advises (a group of experts appreciates the well founded of a product). Both Ministries of Health and Housing must countersign the authorisation of selling.

Without the quantified recognition of the energy savings made by the humidity sensitive ventilation, this one partially compensating the over-cost compared to a traditional system, this system of ventilation would not have been created. It is necessary to recognise to the former French authorities a true courage in this work carried on and perpetuated by their successors.

Evolution of the Humidity Sensitive Systems of Ventilation

The systems evolved as well in technology as in the performances. The control of the manufacturing process is now total with a very small drift of the products in the long run (5 % in 10 years of working). With the experience, it is now possible to confirm some technological choices we made at the beginning : the process remains the same in the main lines. Now we know how respond the polyamide strips ; on the 100 stages to manufacture this fabric, 25 have an importance for us and have an impact on the hygroscope characteristics of polyamide.

The first products did not correct mechanically the reading of the humidity and the management of the opening according to the humidity rate. Now, the fabric is directly in connection with the opening shutter and it is working thanks to its own force. The first products required a rather significant maintenance of the mechanism, now, the maintenance is similar even lower than for a standard extract unit (see figure 1).

Figure 1 : Photo of the products

Many accessories and solutions came to improve the system :
- Temporised extract units in the toilets
- Humidity regulated extract units with pneumatic or electronic boost (detection of presence or switch)
- Acoustic solutions on air inlets or outlets
- Widening of the range of pressure of working (80-120 Pa at the beginning, 65-150Pa now), this allows more flexibility in the design of the ventilation ductwork.
- Extract units for commercial buildings (hotels, …)

The evolution of the products and accessories confers a popularisation of the humidity sensitive system ; this is not any more an "almost" measuring gage system as it was considered at its beginnings.

The adjustment of the products also evolved a lot according to the scenarii of dwelling occupancy and the acceptation criteria of the indoor air quality. We now take into account new parameters like the air-tightness of the dwellings, absorption of the humidity by materials (wall, floor), etc. It seems that there are now consensus and acceptance of the selected assumptions. The simulations made by the CSTB show that it is preferable to have slow response curves for the extraction and very marked ones for the air inlets. Thus energy savings and indoor air quality are assured in main rooms.

Measures in Laboratory and Monitoring

When a new solution arrives on the market, it is necessary to be able to measure the performances and to check that what is announced is real. It is even truer in the case of humidity sensitive ventilation system because the energy saving is statistical and is based on many assumptions among the adjustment of the products : flow, humidity range, hygro-thermal characteristics of the air inlets. The first measurements made in other laboratories than our, showed relatively significant precautions to be taken. The way of measuring and climatic conditions had to be standardised. For example, it is absolutely necessary to separate the notion of opening in function of the humidity and the reaction speed of the product to sudden variations of humidity. For reading the answer, the temperature must not fluctuate even if the relative humidity rate is the working criteria. It is also necessary to separate the intrinsic hysteresis of the product from its average response to the humidity rate.

Many monitoring were made in many countries.

- In France in Paris area, a house was equipped in 1982 with a complete system with the collaboration of CETIAT and EDF ; measurements of flow, humidity and temperature were made on a recorder with paper. From this monitoring, in addition to the fact that the in-situ behaviour was conform to the expectation, we changed the adjustment of the extract units in order to take into account the stratification of the temperature in the rooms and, in our installation document, we asked to insulate the ducts when passing in the attic. This requirement is now generalised to all the systems. This first monitoring allowed the acceptation of the system.
- In Europe in collaboration with CSTC, TNO, EDF, CETIAT (Belgium, Holland, France) a JOULE project allowed to equip many dwellings with humidity controlled natural ventilation systems ; the CO2 was measured in dwellings for the first time. The greatest lesson we draw from this monitoring is the undeniable demonstration of the link between CO2 and moisture in dwelling ; the criteria of humidity as index of pollution of the dwellings was previously disputed (see figure 2).

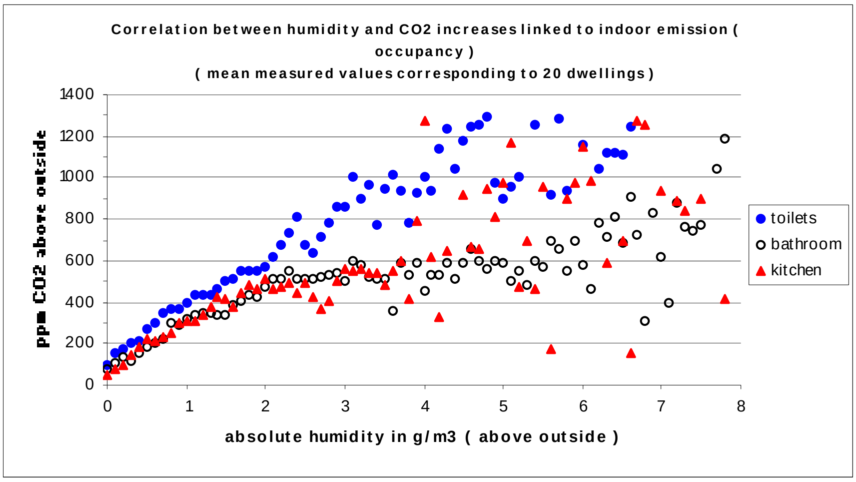

Figure 2 : curve

- In Canada in the area of Ottawa in 1990, two houses were equipped with the assistance of Energy, Mines and Resources. The variation of the flows was recorded ; in addition for the first time the measurement of the opening of the air inlets was made.
- In Canada in the area of Vancouver, a house heated with warm air was under monitoring. Measurements showed a spillage in the fume duct of the boiler, which generated CO2 jumps.
- In Japan, a whole season was recorded on the working of grilles in natural ventilation.
- In England, with the BRE, two laboratory houses (program PIT) were followed and compared, the first one in natural ventilation "according to the regulation", the second one in humidity sensitive natural ventilation. An energy saving of 25 % was proved on these houses.
- In Germany, a house near Frankfort. Humidity, temperature, flow, consumption are permanently recorded. The variation of the flows was recorded even in summer.

This wave of in-situ measurements allowed making credible the principle of the humidity sensitive system. Many obstacles have to be faced at each monitoring : technical ones, in the analysis, presentation of the results, conclusions too often conservative and even sometimes political. A measure remains a measure and according to the state of mind of the analysts, it can be good or bad according to criteria that are sometimes not very scientific. In any event, knowledge in general on the way of measuring and what to measure to demonstrate what, increased. There was progress, in particular with the growth out of equipment in laboratories.

Energy savings, Regulation

Energy savings and regulation always go together because, as previously explained, energy savings can be calculated in different ways. In any event, it is necessary to compare a traditional system as a reference to the humidity sensitive system. Energy savings must be calculated with performance and indoor air quality equal or similar. The best means of energy saving is to stop ventilation but in this case the indoor air quality is not acceptable. Since the birth of the humidity sensitive ventilation, about 1.500.000 dwellings have been equipped with this system. Considering an average energy saving of 1000 kWh per annum and by system, the total energy saving made each year compared to fixed flows is 1.500 Giga Wh i.e. a saving of 0.45 mega tons of CO_2 in primary energy as far as natural gas is concerned (1 kWh=0.3 primary kg CO_2 emitted for primary energy with natural gas).

European regulations changed to open the doors to this type of ventilation. An European directive currently under discussion reinforces requirements regarding energy savings in buildings.

DEVELOPMENT AND EVOLUTION

The evolution of the humidity sensitive system is not called into question, quite to the contrary. On the other hand it is probable that the energy benefit is at its optimum with the existing criteria. The latter should not change basically in the future except in case of scientific discovery on certain components of the air or due to particular requirements. An important work on the auxiliaries (fans) is in process ; a substantial economy on electric consumption can be made either on traditional fans with "high" pressure 100-200 Pa or on the hybrid ventilation which combines natural ventilation (wind and thermal force) and mechanical assistance to low pressure (5-15 Pa). In both cases the humidity sensitive ventilation is possible and desirable. The first studies show that it is possible to go down from 40W/dwelling for the fan to less than 4W, the global solution would allow 45 % savings on flows (1000 kWh) due to the humidity controlled system and 90 % on electrical consumption of the fan (300 kWh) for a 4-main room apartment.

The double flow with or without heat recovery can have a real future considering filtration, acoustic isolation on the outside, the modulation of the flows with motion sensor, humidity sensitive sensors and so on (VOC, smoke detectors…). Once again, if the benefit regarding thermal, acoustic, comfort and health advantages is developed through a regulation, it can be a commercially viable solution, if not, this type of system will remain expensive and really marginal.

REFERENCES

AERECO, BBRI, TNO (1987), Demonstration Project EE/166/87
Avis Technique AERECO (2001), 14/01-627
E.N. (2002), Directive 2002/91/EC
J-R MILLET, J RIBERON / CSTB (1991), Deux Composants de l'Air Intérieur CO2 et H2O
J-R MILLET / France (2001), Ventilation in New French Thermal Regulation RT2000
Réglementation Aération des Logements (1982-1983), Arrêtés du 24-03-82 et 28-10-83