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PRINCIPLE AND AIM OF A NATURAL HUMIDITY-CONTROLLED VENTILATION SYSTEM

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The aim of the natural humidity-controlled ventilation system AERECO is to improve ventilation in dwellings in existing residential buildings where ventilation ducts coming up to the roof can already be found. This paper intends to explain the purpose of the natural humidity-controlled ventilation system AERECO, why such a solution turned out to be developed, the expectable performing results calculated by the means of an adapted calculation programme in the field of a study that we have worked out for the the French Ministry of Housing.
Such a process is being tested as well on three experimental sites : NAMUR (Belgium), SCHIEDAM (The Netherlands) and Les ULIS (France). AERECO, CETIAT, E.D.F. (France) - BBRI (Belgique) and T.N.O. (The Netherlands) are partners in this experiment, on which Messrs P. Wouters and L. Vandaele from BBRI will submit another paper.

Principle and aim of a Natural Humidity-Controlled Ventilation system

In many residential buildings as built in Europe, there can be found natural ventilation ducts provided at first for the air renewal of service rooms : kitchens, bathrooms and toilets. But, on the contrary, nothing is provided for the air renewal of main rooms : livingroom, bedrooms. The air quality in dwellings becomes thus highly dependent on the air permeability of the building or on the occupants' behaviour, whether or not they feel like opening the windows. Refurbishing such buildings with a view to save energy during the heating season (external thermal insulation, weathertight windows with insulating glazing etc ...) often leads to reduce air infiltrations. As a consequence, condensation and moisture appear in the main rooms. Generally in such a situation, the occupants do not know how to react and often take unadequate steps that do not correspond to the real need e.g. :
- in bedrooms, windows are frequently left open during daytime when there is nobody in, but are closed at night when they should be left ajar because of the presence of the occupants.
- to prevent disturbing cold draughts, windows are less often left opened in winter, when condensation is more likely to appear, than in summer. So, whereas heat losses through the building envelope are lessened and mastered, those originated by the air renewal may reach uncontrollable values. Such problems are to be coped with thanks to the natural humidity-controlled process that we are going to explain. This process was indeed developped and based on the results of a study carried out by the Company SERVA. Improving natural ventilation in existing dwellings was the object of this study, as requested by the French Ministry of Housing. Such a study, mainly theoretical, lead us to

develop computerized calculation models specifically adapted to simulate a natural humidity-controlled ventilation system when brought into operation. These calculations models enabled to estimate the expectable performance of the process, as shown on the following pages. These results will have to be compared to the measurements results carried out in 60 dwellings, shared between three sites : Les Ulis (France), Namur (Belgium) and Schiedam (The Netherlands) in the field of an experimental study funded by the E.E.C. and worked out by the following partners : AERECO, E.D.F., CETIAT (France), BBRI (Belgium) and T.N.O. (The Netherlands). The original measuring methods especially developped on that purpose and the results of the first measurements campaigns will be introduced in another paper by Messrs P. Wouters and L. Vandaele (BBRI).

Presentation of the Natural Humiditiy-Controlled Ventilation process

The outside air flows into the bedrooms and livingroom through humidity-controlled air inlets, the opening section of which varies according to the dwelling humidity. Then, this air goes out of the main rooms towards the kitchen, the bathroom and the toilets. At last, it is exhausted to the outside through humidity-controlled air outlets connected to natural ventilation ducts.
On **Figure** 1 is shown the principle of the air circulation and on the right hand side of it, a common ventilation duct with individual connections of one storey height, as there used to be found in the existing blocks of flats.

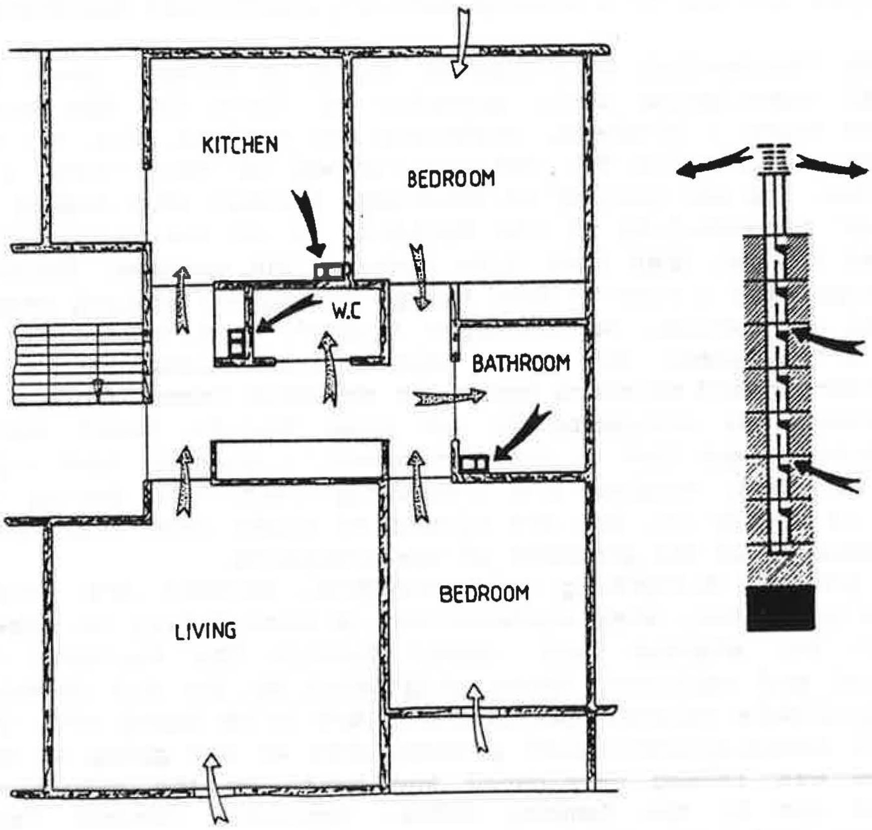

FIG.1

The outside air used to renew the air in the dwellings contains all the less water vapour as it is colder. Consequently, the indoor atmosphere is thus kept all the dryer as the outdoor temperature is lower.

Figure 4 highlights the reversed evolution of the outdoor humidity and of the natural draught when the outdoor temperature varies. There can be seen as well, how the ducts height may be of influence. The stippled curves represent the natural draught available in the dwellings respectively of the ground floor, third floor and seventh floor of a seven-storied building. The graph with a continuous line represents the outdoor humidity. It is thus obvious that natural draught and humidity inversely evolves and it is this fact of capital importance that lead to develop the natural humidity-controlled ventilation system AERECO.

The purpose of such a process is to stabilize the natural draught effects : the resistance of air inlets and outlets, that get progressively closed when the indoor humidity decreases, is thus counterbalancing the "motor" that accelerates as the outdoor temperature gets colder, and inversely.

The natural humidity-controlled ventilation system does not only make up for the natural draught effects but also offers many other advantages, i.e. :

- the air distribution is better shared between the building storeys. In winter, the stack effect tends to make the air better circulate in the down storeys than in the upper storeys of a building. Thus the air of the upper storeys contains more humidity than the air of the down storeys. By reacting to these different humidity rates, the humidity-controlled systems tend to reduce the air flow rates differences between storeys.

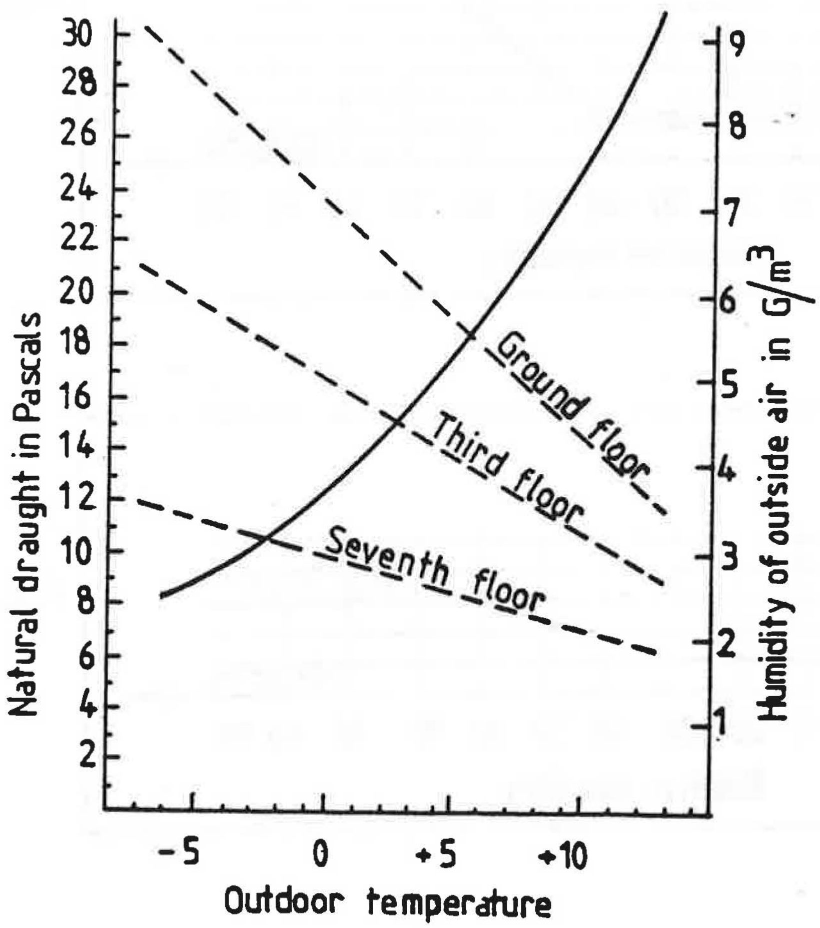

FIG.4

On **Figures** 2 & 3, there can be seen the average characteristical curves of the humidity-controlled air inlets and outlets as expected in the process. The operating mechanism of these inlets and outlets is composed of several nylon bands, the length of which varies according to the humidity rate, thus opening or shutting one or several louvres accordingly.

Justification of the natural humidity-controlled ventilation Natural draught can be compared to a "motor" with uncontrolled power, depending on the wind velocity and wind direction, which both are very much fluctuating, and on the stack effect Tt which is all the more important as the outdoor temperature is lower and as the ventilation ducts are higher :

Tt = 0,0044 x h x (Ti-Te) is an approaching formula valid for ventilation and with :
Tt in Pascals
h = the heigth of the duct in metre and
Ti, Te = respectively the temperatures of the indoor and outdoor air.

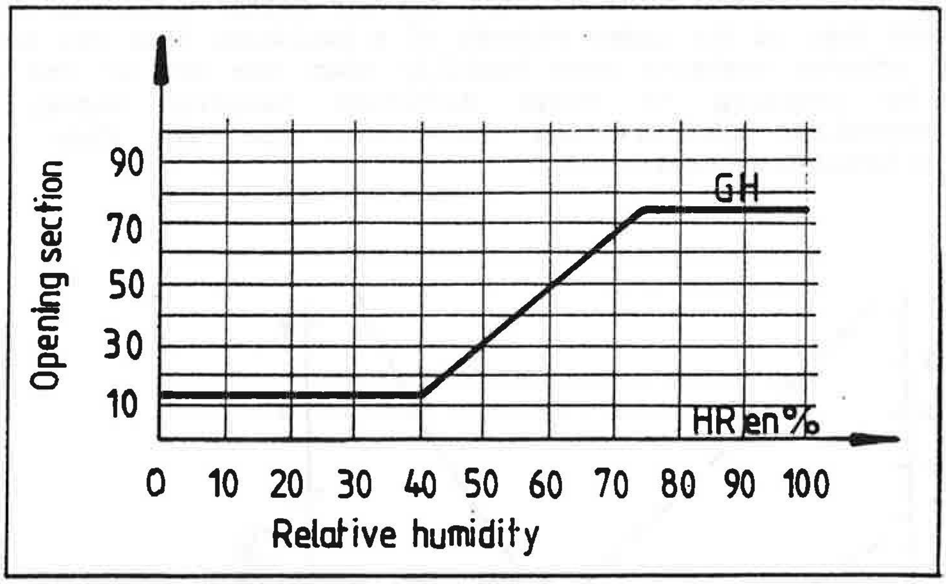

FIG.2

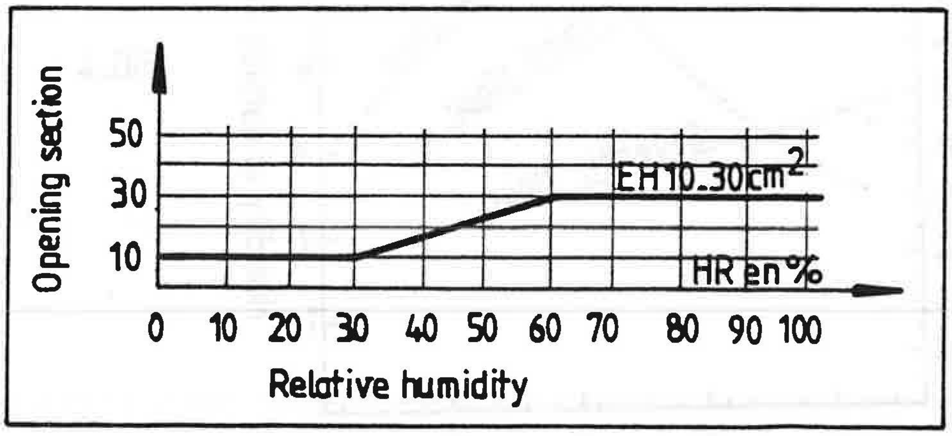

FIG.3

- during the heating season, excess ventilation is prevented when the wind blows too much. When dwellings are overventilated because of the wind, the humidity of the air in the dwelling is rapidly exhausted which causes the air inlets and outlets shut progressively.
- the air renewal in dwellings is modulated in adequation with the real need in each dwelling. The dwelling humidity depends much on the number of its occupants and on their activities which results in an automatic and adequate opening of the humidity-controlled air inlets and outlets.

Expectable performances

To illustrate the interest offered by that solution, results concerning calculations made on a particular case are explained hereafter : e.g. a pile of 5 dwellings, composed each of 1 livingroom, 2 bedrooms, 1 kitchen, 1 bathroom and toilets. These dwellings have a double exposure and an air permeability of 100 m3/h/10 pa. Three common ducts measuring 20cm x 20cm are respectively connected to kitchens, bathrooms and toilets. Each main room is equipped with 2 humidity-controlled air inlets, the characteristics of which are shown on **Figure** 3. Toilets and bathrooms are equipped with humidity-controlled exhaust grilles, the characteristics of which are shown on **Figure** 2. Kitchens are equipped with unmovable exhaust grilles of 100 cm2.
In **Figure** 5, a comparison is drawn between the humidity-controlled solution and a reference solution. With the latter, unmovable air outlets of 30 cm2 section are replacing humidity-controlled air inlets and unmovable air outlets of 75cm2 section are replacing humidity-controlled exhaust grilles to be found in bathrooms and toilets.
Curves on **Figure** 5 represent the total air renewal flows in the dwellings of the first four floors according to the outdoor temperature

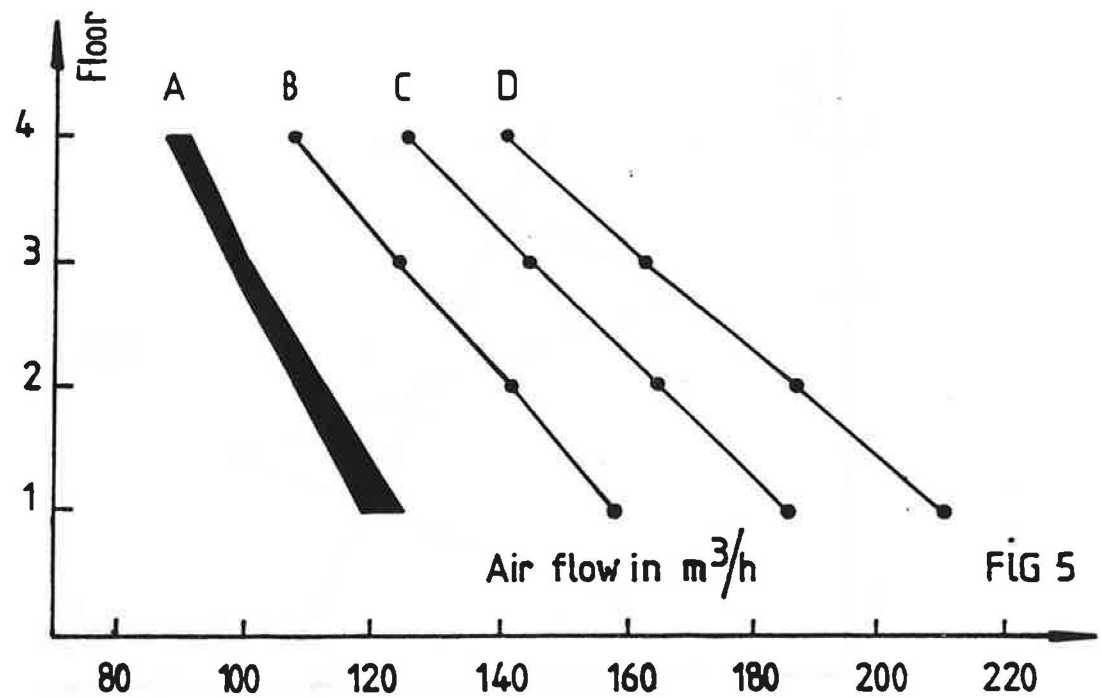

FIG 5

(Te) and taking into account an average wind velocity of 4 m/s. These curves correspond to an average of 3 occupants per dwelling. Results as per the humidity-controlled solution remain within the dark area A of the graph when Te varies from -7°C up to +13°C. With the reference solution, the airflows remain identical to the humidity-controlled solution when Te = 13°C but they increase as soon as the outdoor temperature gets colder and thus correspond to the respective values of curves B, C, D when Te indicates 6,5°C, 0°C, -7°C. Whereas with the humidity-controlled solution, the average air flow remains at a value of around 100 m3/h, whatever the outdoor temperature is. This value goes up from 100 m3/h to around 170 m3/h with the reference solution when Te goes from 13°C down to -7°C, which causes an unnecessary increase of heat losses. With the humidity-controlled solution, air flows go up from 90 to 120 m3/h, from the fourth floor down to the first one, whatever Te is; they go up from 140 m3/h to 210 m3/h with the reference solution when Te = -7°C, which originates heat losses imbalances.

On **Figure 6** is shown the adequation to the needs when using humidity-controlled natural ventilation with an outdoor temperature of 6°C. The continuous lines represent the results obtained in dwellings of 3 occupants each. As for the broken ones, the dwellings of the first and third floors are occupied by one person; those of the second and fourth floors are occupied by 5 persons. On the third floor there can be seen that the air flow goes from 100 m3/h with three occupants down to 70 m3/h with only one occupant and that on the fourth floor, the air flow automatically goes up from 90 m3/h with three occupants to 110 m3/h with five occupants.

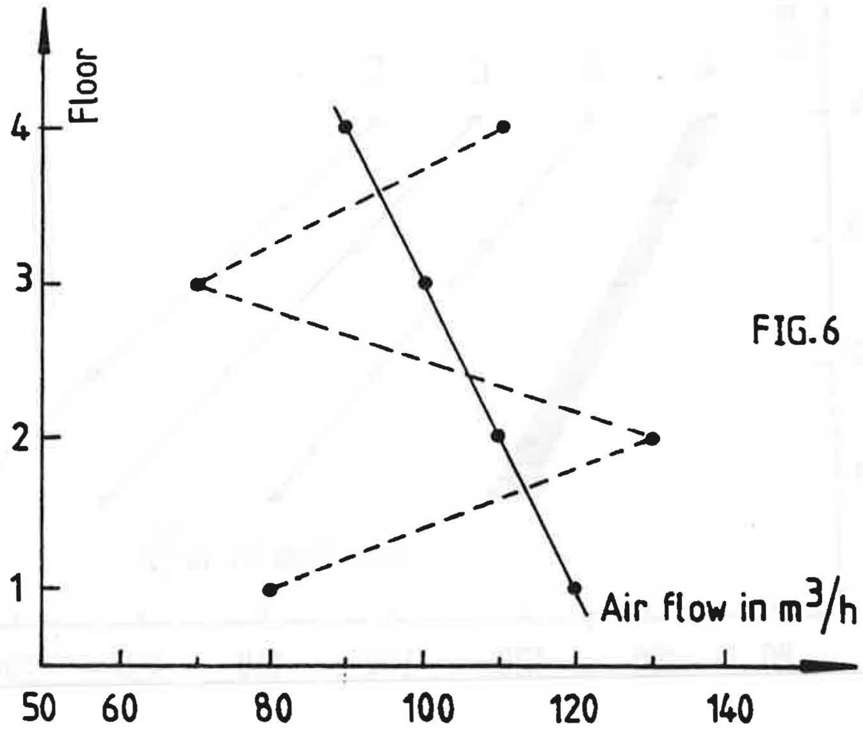

FIG.6