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HOW TO FIGHT CONDENSATION

WHILE SAVING ENERGY :

T H E F R E N C H E X P E R I E N C E

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I/ THE NEED FOR VENTILATION

It comes from 3 main causes :

- air renewal for human breathing
- pollutants and in particular smell to evacuate
- condensation

Except smell, this need is not likely to be detected by the occupants before the lack of ventilation has had bad effects.

May we now emphasize on condensation :

1) WHAT IS THE ORIGIN OF IT ?

* the quantity of water vapour acceptable in a given quantity of air varies with the temperature.

  For instance at 20° C air may contain up to 14 g wv/kg
  at 0° C it may only contain 4 g

  When the air is becoming colder, this water vapour pours down as liquid.

* Man's life is producing water vapour at an average rate of 80 g/per person and per hour.

  i.e. in an average two bed-dwelling containing approx 100 kg of air, 2 people will produce a 100 % humidity in less than 5 hours (if there is no ventilation).

* Of course, in winter, the difference between outside and inside air as well as the air movement due to heating will create condensation especially on the external walls and in the colder parts of the dwelling.

2) HOW IS VENTILATION DRYING CONDENSATION ?

The cold external air being dryer, its drying power when recirculated in warm internal air is high.
This drying power decreases proportionnally to the difference in temperature.

This leads to 2 fundamental remarks :

i the colder the external air is, the lower is the quantity of air needed to solve the condensation problems :

<u>ONE NEEDS LESS VENTILATION IN WINTERTIME</u>

ii well-insulated modern buildings are less ventilated through the walls than old badly insulated ones, where air leakage was important. Then, INSULATION INCREASES CONDENSATION.

More, the wall conduction concentrates cold on some points where deeper condensation may occur.

In recently built dwellings, the major risk of condensation exists when outside temperature is about 10° C.

3) VENTILATION VS CONDENSATION

Chart 1 corresponding to a bedroom occupied by two persons shows the airflows needed to avoid condensation and moisture on the endangered points
(surface temperature = 1/3 (Ti-To)

Ti being the inside temperature, To the outside temperature.

Above is shown the percentage of days during the heating season (To inferior to 13°C) where To is superior to a given figure.

Example : if Q = 15 m3/h and Ti = 19°C, condensation will appear when To is superior to 8° i.e. more than 1/3 of the days.
To totally avoids condensation with a constant Ti = 19° you will need a minimum 20 m3/h.

i if you lower Ti to save energy, you greatly increased the risks of condensation when ventilation is poor :

if Q = 15 m3/h and Ti = 16°, condensation will occur 3/4 of the days.

ii passive ventilation, based on natural draught provides bigger airflows when To is lower : it is not likely to be sufficient to solve the problem when To reaches the above figures.

iii this need for ventilation being localised in bedrooms is not likely to be detected by hygrostats fitted in kitchens and bathrooms, as well as by occupiers, the humidity increasing during their sleep.

The ventilation system must then provide in main rooms :

- either a permanent minimum airflow avoiding condensation during average occupancy, for inside temperatures chosen by the occupants to reduce heating costs (for instance 16° C in bedrooms), whatever the outside temperature may be;

- either airflows adapted to the actual need of each room, the adaptation being done automatically using a reliable indicator. This will be satisfactorily achieved by a humidity-controlled system.

Anyway, the ventilation must never be totally stopped, especially in well-insulated buildings, where you cannot rely on leakage.

II/ COST OF VENTILATION

We will come back on that subject when considering the different types of ventilation.

Nevertheless, I would like at this point to show you a few figures which will give you an idea of the size of that problem.

SOME DATA ON VENTILATION COSTS :

1 PERMANENT VENTILATION OF 100 M3/h

NEEDS 1 KW WHEN OUTSIDE TEMPERATURE IS - 10° C

COSTS 2 000 KWH PER YEAR

MAKES AN AIRFLOW OF 1 000 TONS PER YEAR

OCCUPIERS DON'T SEE THEM !

OCCUPIERS ARE NOT CONSCIOUS OF THAT NEED.

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ONE OPENING OF 10 CM2 COSTS 50KWH PER YEAR

ONE OPEN FIRE CHIMNEY COSTS MORE THAN 1000 KW/H

THE ANNUAL CONSUMPTION TO HEAT THE AIR IN DWELLINGS IN FRANCE

COSTS SOMETHING ABOUT 2 BILLIONS FRF
I.E. £ 200 MILLIONS ...

AND THIS IS LIKELY TO BE THE SAME IN U.K. !

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This appears to be in contradiction with the preceeding statements : it is obvious that a permanent ventilation will cost more and a balance has to be found between the fight against condensation and the necessity of saving energy.

III/ SYSTEMS OF VENTILATION

To approach factually the question of selecting an appropriate ventilation system, I suggest we consider what has been done in France since the 50's.

*** Up to 1969 ***

The regulation did only take into account what the occupants themselves were detecting i.e. smell and technical pollutants like cooking vapour and burnt gas.

Then fresh air was ducted to kitchen, bathroom and toilets, then extracted from these rooms by a separate duct. Differences of temperature between these ducts were considered to ensure the functioning of the system.

The insulation of buildings being quite poor, leakage was important and condensation did not appear at that stage as a major problem.

*** In 1969 ***

While our chairman, Mr. JARDINIER was in charge of Surveys on ventilation in the C.S.T.B. (the French equivalent to B.S.R.I.A.), some criticisms have been made about the system :

- arriving external air was creating very uncomfortable cold airflows, especially in bathrooms,
- pollutants and water vapour may migrate from technical rooms to main rooms,
- condensation was then appearing in main rooms, when they were not enough ventilated individually (which was likely to occur),
- two separate ducts were very expensive

The new 1969 regulations then stipulated that air was to enter through inlets provided in main rooms, to be extracted from the kitchens and bathrooms.

This was answering to most criticisms, if adequate air changes were obtained : Regulations stipulated that the total volume of air contained in the dwelling was to be renewed every hour.

This was achieved either by passive or mechanical ventilation.

Let us remark that, the ventilation of each room being dependant of airflows coming from or to other rooms, this system needs to be PERMANENT to operate satisfactorily because it is obvious that, as the entering flow is equal to the extracted flow, if one closes either the inlets or the outlets, no air will circulate anymore :

a) THE VENTILATION MUST BE OUT OF THE OCCUPANTS' CONTROL
b) IT MUST NOT BE DRIVEN BY "yes or no" CONTROLS SUCH AS HYGROSTATS

*** In 1982 ***
occurred the energy crisis

People as well as authorities began to look for savings on heating costs.
The cost of heating air changes amounted to 1/3 of the heating cost.

The first reaction was to reduce ventilation, while the insulation was improved. We have seen that this was not a good way to cope with that problem.

We then had to come to a better monitoring of ventilation :

1/ Passive ventilation is operating the wrong way : the colder the outside air is, the larger is the airflow.
We have seen on the contrary, that the need for ventilation is diminishing. It is as well unlikely to provide sufficient ventilation when the temperature increases.

2/ The need for ventilation does not depend on the volume of the dwelling, but on the occupancy of such volume (it is irrelevant to ventilate a cathedral for instance).
Smaller rooms, and particularly smaller technical rooms, must be better ventilated than larger ones.

The regulation then came to stipulate airflows instead of airchanges.

The most commonly used system has been since then permanent mechanical ventilation, which is the only reasonable way to achieve the regulation's requirements as much for efficiency as cost.

A balance has been made to stipulate reasonable flows for both using less energy but achieving a minimum of condensation as well.

IV/ HUMIDITY-CONTROLLED VENTILATION

Anyhow, the permanent mechanical ventilation is not totally satisfactory because it does not vary with the actual need of ventilation and then wastes a lot of energy in heating useless air (less than passive, but still too much !).

An excellent indicator of this need is RELATIVE HUMIDITY because it rises with :

- the occupancy
- the activity
- the increase of the outside temperature
- the lowering of the inside temperature.

It will be then an excellent solution to any ventilation problems to ADJUST THE AIRFLOW according to RELATIVE HUMIDITY.

That is what AERECO has achieved since 1984 and a new regulation has been edicted to allow for this major improvement.

Three-star energy saving label has been granted to AERECO products by the Electricity Board allowing users to get special premiums and tax rebates.

FUNCTIONING OF THE HUMIDITY-CONTROLLED VENTILATION

Like in most permanent mechanical ventilation systems, fresh air is admitted in the living and bedrooms, and the stale air is mechanically extracted in kitchen and bathroom.

The system of AERECO is composed of :

- humidity-controlled extract units which determine the total extracted air in kitchen and bathroom as function of the average humidity of the dwelling

- humidity-controlled air inlets which distribute the airflow in each main room according to their respective humidity.

The adjustment of the airflow is achieved by changing the section of air inlets and outlets.
These are driven automatically by way of polyamid strips stretching or shrinking according to humidity. This exclusive technique gives maximum reliability with no maintenance while avoiding tampering.

. The flows are adjusted to the need as shown in chart (2),

. the bedrooms are better ventilated at night, (chart 3)

while ventilation is mainly through the living rooms during the day and reduced to the minimum when the dwelling is empty. (chart 4)

Let us compare the flows obtained in chart 3 with the need shown on chart 1 : you will see that they correspond especially when the risk of condensation is high i.e. when outside temperature is over 8° C.

We may then achieve very significant savings, while condensation is efficiently stopped, and comfort improved, with no unreliable intervention of the occupants.

Up to now 100.000 dwellings in France are satisfactorily equipped with AERECO humidity-controlled systems.

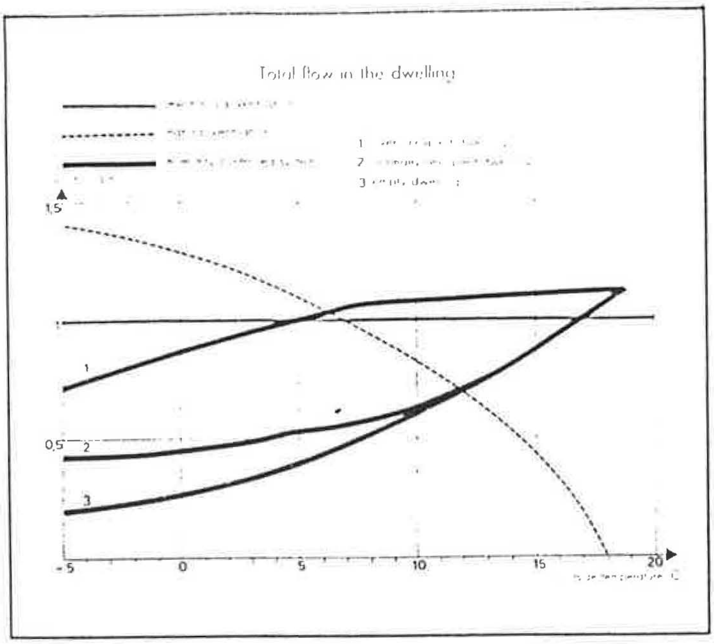
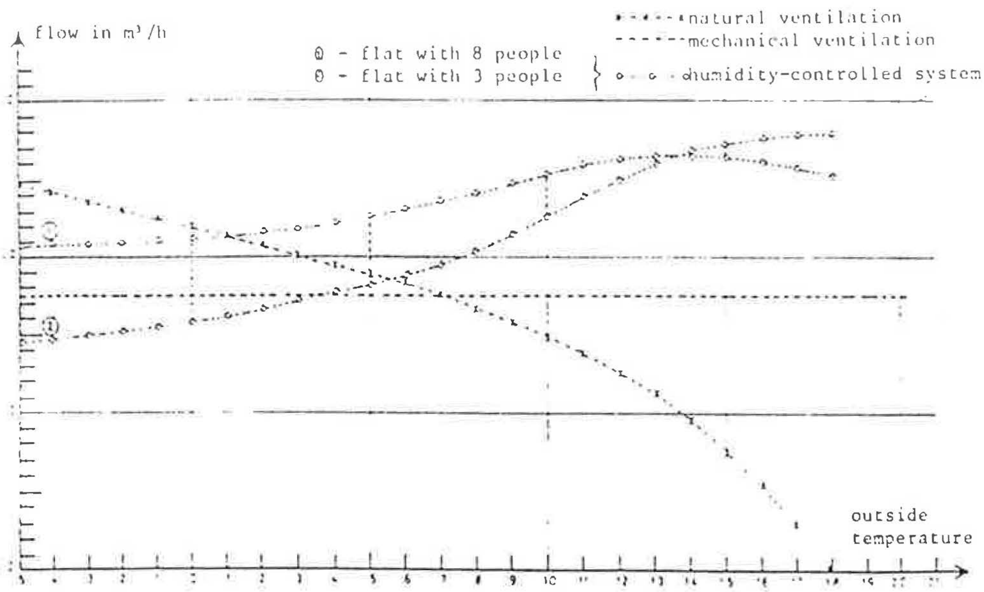


Chart 2

FLOW IN AN HEATED BEDROOM (18°) OCCUPIED BY 2 PEOPLE

Chart 3



NECESSARY POWER TO HEAT THE AIR WITH DIFFERENT SYSTEMS OF VENTILATION : NATURAL - MECHANICAL - HYGRO - (THREE ROOMS FLAT)

Chart 4

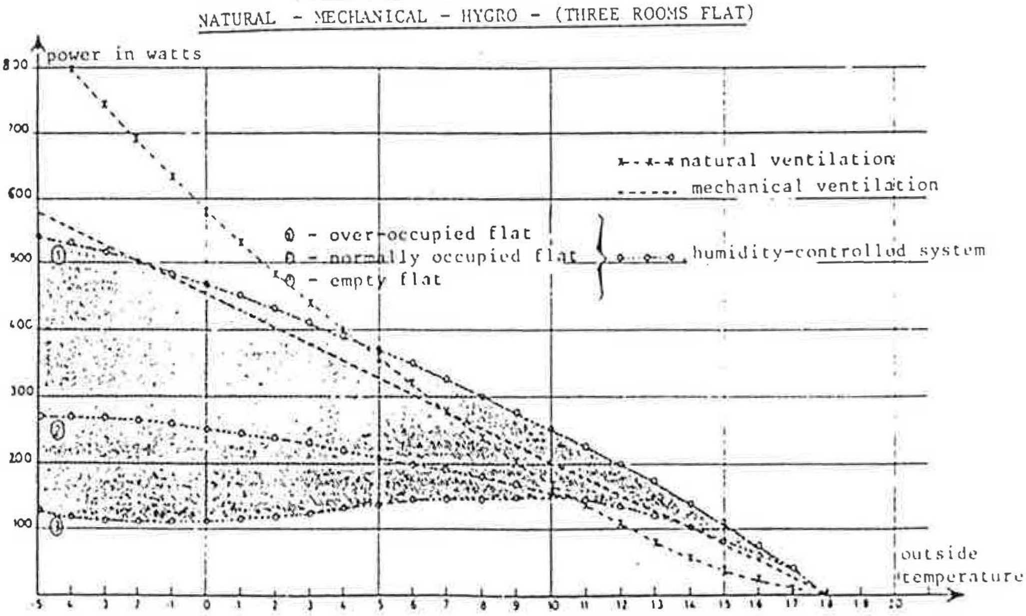
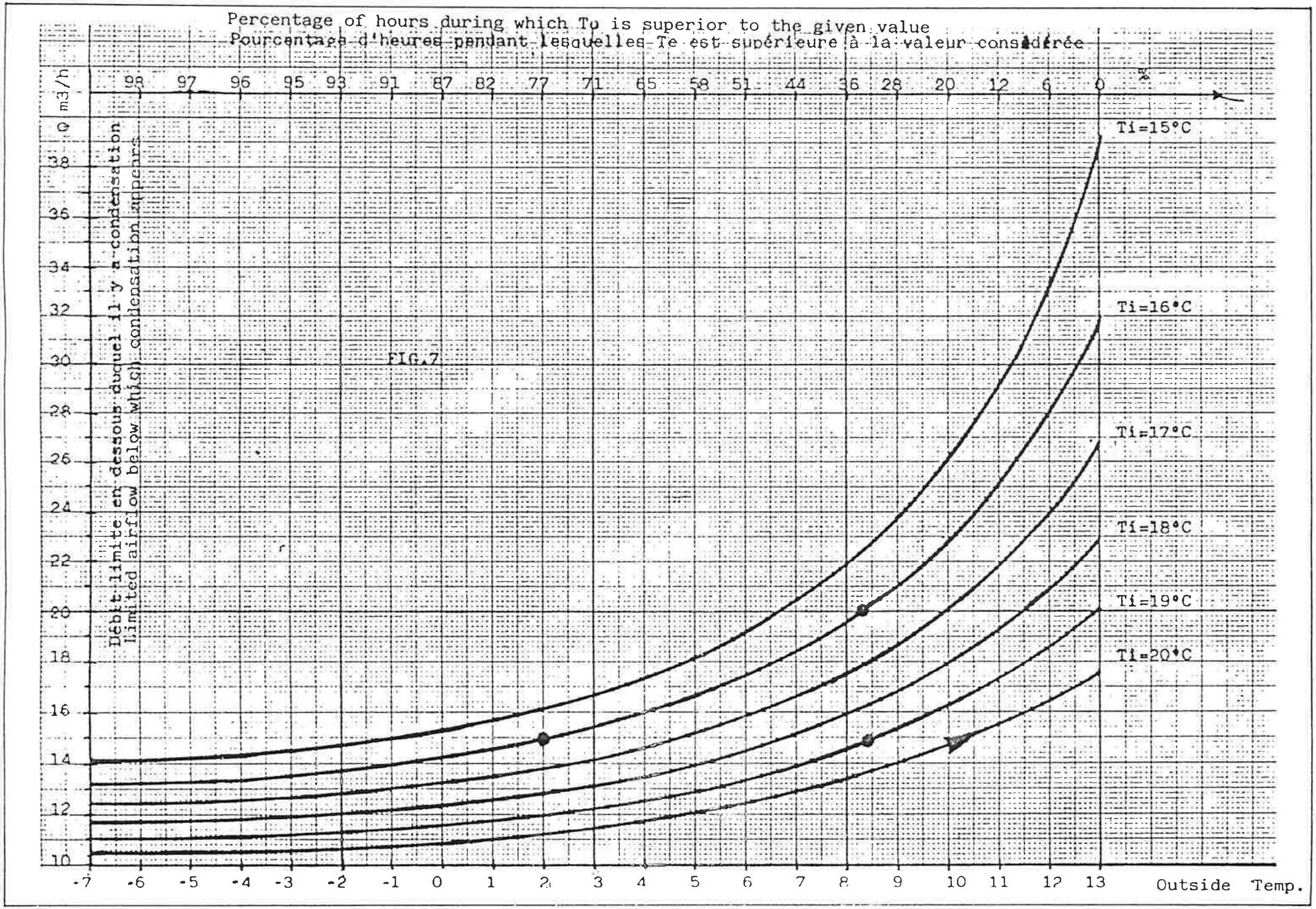


Chart 1


Percentage of hours during which To is superior to the given value
Pourcentage d'heures pendant lesquelles Te est supérieure à la valeur considérée
98 97 96 95 93 91 87 82 77 71 65 58 51 44 36 28 20 12 6 0 %
Q m3/h
Débit limite en dessous duquel il y a condensation
Limited airflow below which condensation appears
38 36 34 32 30 28 26 24 22 20 18 16 14 12 10
FIG.7
Ti=15°C
Ti=16°C
Ti=17°C
Ti=18°C
Ti=19°C
Ti=20°C
-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13
Outside Temp.