

## **INNOVATIONS IN VENTILATION TECHNOLOGY**

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### **Airtightness and Underpressures Measurements in French Apartments**

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## SYNOPSIS

Dwellings airtightness is not well known in practice, in France.

When dwellings are equipped with mechanical ventilation systems (which represents about 95 % of the new dwellings in France) the airtightness can strongly influence the performance of ventilation.

In the frame of the European Joule Project TIP-VENT (Towards Improved Mechanical Ventilation Systems) [1], measurements of airtightness and underpressures were made on three multifamily buildings. It was the first step of a site testing procedure for the evaluation of a new ventilation component which was developed in this project.

This paper presents the methodology and the results of the measurements.

Airtightness and underpressures were characterised in about thirty apartments, equipped with a mechanical exhaust ventilation system, including air inlets in façades and exhaust terminal devices in wet rooms.

Airtightness was measured in two configurations :

- air inlets "closed up" : it gives the permeability of the dwelling, excluding air inlets ; it shows the importance of infiltrations ;
- air inlets "self regulating" : it gives the permeability of the dwelling, including air inlets ; or global permeability of the dwelling.

Underpressure was measured in the second configuration, and when boosted air flow was activated.

The measurements were made without additional specific fan unit, but only by using the existing mechanical exhaust ventilation system.

## BUILDINGS

3 buildings were selected for the measurements :

- New multifamily building (location : Fenouillet, F-31150) :

- 30 dwellings : from T1 to T5 (1 to 5 habitable rooms)
- ventilation is a central extraction system (both extractions of air and combustion gazes from individual boilers – it is called VMC-Gaz)
- self regulated ventilation inlets and outlets for 28 dwellings, and humidity controlled inlets and outlets for the last 2 dwellings (inlets are installed on windows)



- Gendarmerie (location : Lorient, F-56000) :

- 9 dwellings : 3 T4 and 6 T5
- ventilation is a central extraction system (both extractions of air and combustion gazes from individual boilers - VMC-Gaz)
- self regulated ventilation inlets and outlets

- Existing multifamily building (location : Lyon, F-69000) :

- 10 dwellings : all the same type T3
- ventilation is a central extraction system
- individual boilers are "closed" ones (no link with indoor air)
- windows are high quality (thermal insulation and airtightness)
- self regulated ventilation inlets and outlets



## METHOD

The tests consisted in measurements of ventilation air flow and related underpressure into the dwellings, on a large range of air flows.

The permeability of the dwellings was measured in two configurations :

- all the ventilation air inlets "closed up" : air permeability of the dwelling, excluding air inlets ;
- all the ventilation air inlets "self regulating" : global air permeability of the dwelling, including air inlets ;

No improvement on air leakages was made.

The ventilation air flow is equal to the sum of the individual air flows measured at the different exhaust air terminal devices (for example : kitchen, bathroom, toilets).

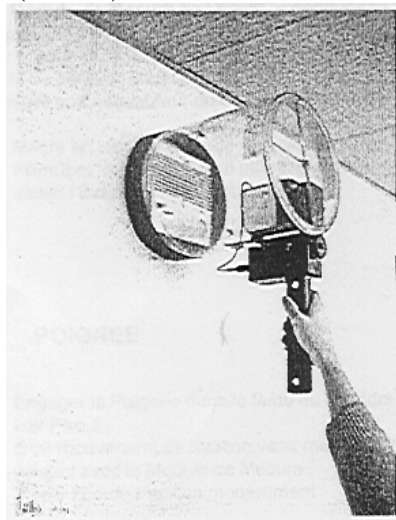
The pressure was measured inside and outside the dwelling.

Different values of air flows were obtained either by using the two positions low/high ventilation air flow (the command is generally on the kitchen exhaust air terminal device) either by suppressing some outlets to artificially increase the air flow and the underpressure inside the dwelling when this underpressure was too low to be accurately measured.

## MEASURING DEVICES

For the needs of this study, measurements were mainly pressure and air flow measurements.

- pressure :  
a micromanometer "FURNESS FC016 0-200 Pa" was used to measure the pressure inside and outside the dwellings
- air flow :  
an airflowmeter "AERECO SAM 5-400 m<sup>3</sup>/h" was used to measure the air flows at the exhaust air terminal devices (outlets)

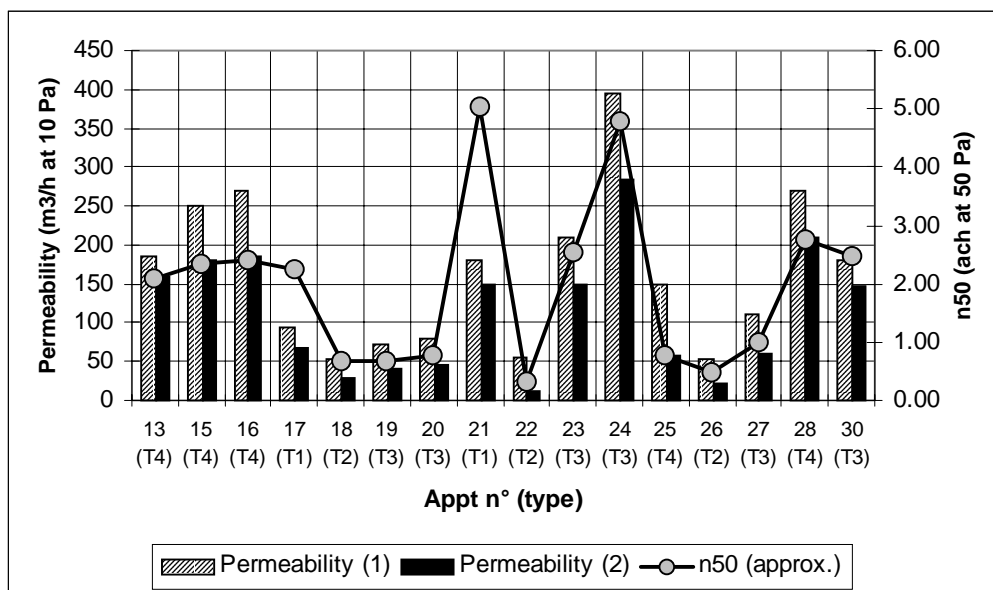


## RESULTS

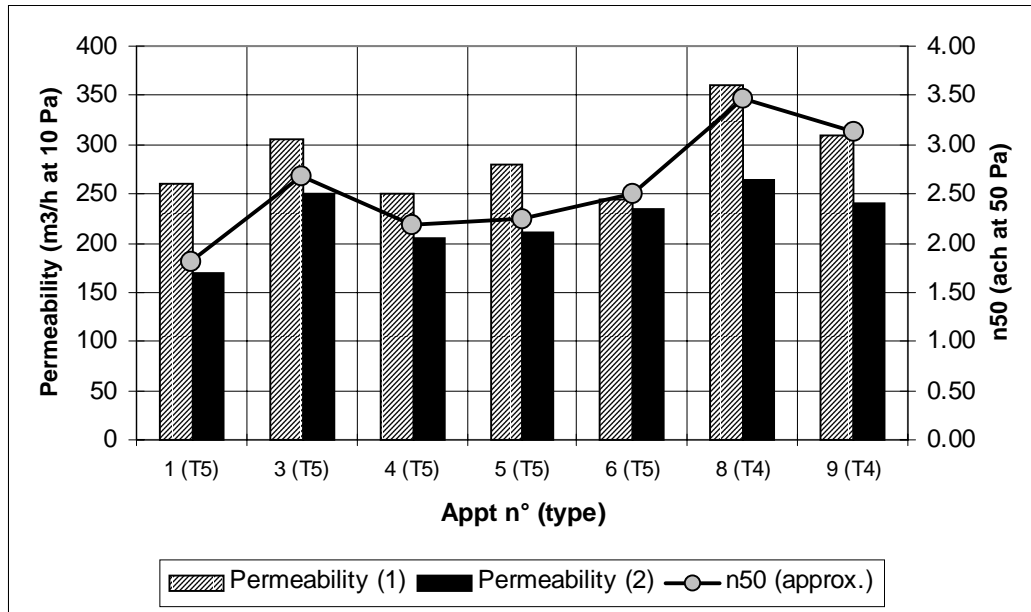
The results of dwellings airtightness (in fact the permeability is expressed) are given in the following tables and curves.

Values of permeability are given in m<sup>3</sup>/h at 10 Pa and also in ach at 50 Pa or n50 (for n50 evaluation, it is considered that the height of dwellings is 2.5 m and the surfaces according to the number of habitable rooms : T1 ≈ 35 m<sup>2</sup>, T2 ≈ 50 m<sup>2</sup>, T3 ≈ 70 m<sup>2</sup>, T4 ≈ 90 m<sup>2</sup>, T5 ≈ 110 m<sup>2</sup>).

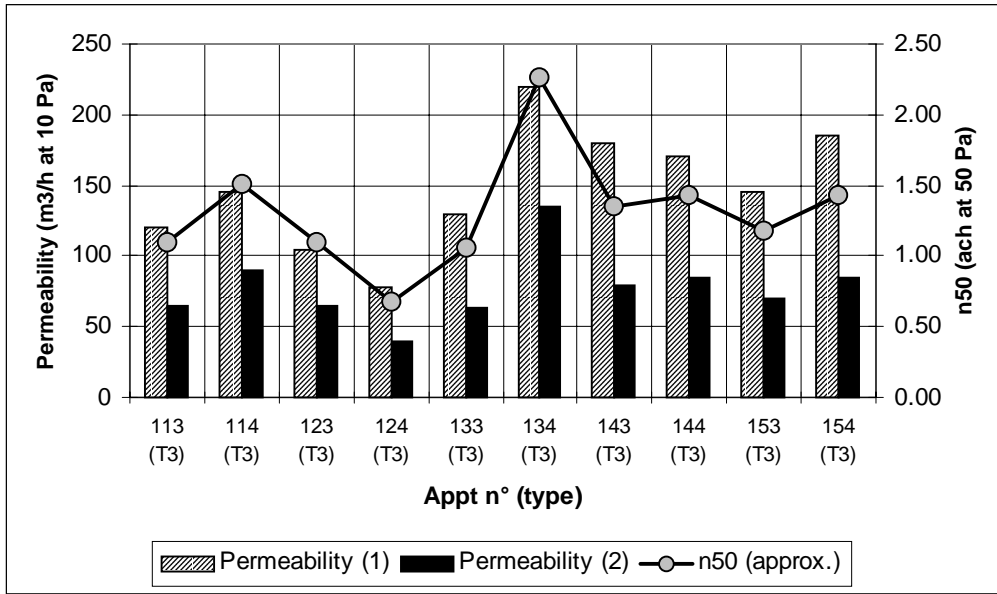
New multifamily building (location : Fenouillet, F-31150)				
	Air inlets "self regulating"		Air inlets "closed up"	
Appt n° (type)	Underpressure (high air flow)	Permeability (1)	Permeability (2)	n50 (approx.)
	(Pa)	(m <sup>3</sup> /h at 10 Pa)	(m <sup>3</sup> /h at 10 Pa)	(ach at 50 Pa)
13 (T4)	12.1	185	160	2.09
15 (T4)	9.3	250	180	2.35
16 (T4)	8.7	270	185	2.42
17 (T1)	21.1	95	67	2.25
18 (T2)	40	52	28	0.66
19 (T3)	33.1	73	41	0.69
20 (T3)	22.7	80	45	0.76
21 (T1)	7.5	180	150	5.04
22 (T2)		56	13	0.31
23 (T3)	6.2	210	150	2.52
24 (T3)	3.7	395	285	4.79
25 (T4)	15.5	150	58	0.76
26 (T2)	31.5	53	21	0.49
27 (T3)	13.8	110	60	1.01
28 (T4)	7.5	270	210	2.74
30 (T3)	8.2	180	147	2.47



Gendarmerie (location : Lorient, F-56000)				
	Air inlets "self regulating"		Air inlets "closed up"	
Appt n° (type)	Underpressure (high air flow)	Permeability (1)	Permeability (2)	n50 (approx.)
	(Pa)	(m3/h at 10 Pa)	(m3/h at 10 Pa)	(ach at 50 Pa)
1 (T5)	5	260	170	1.82
3 (T5)	4	305	250	2.67
4 (T5)	9	250	205	2.19
5 (T5)	5	280	210	2.24
6 (T5)	11	245	235	2.51
8 (T4)	5	360	265	3.46
9 (T4)	7	310	240	3.14



Existing multifamily building (location : Lyon, F-69000)				
	Air inlets "self regulating"		Air inlets "closed up"	
Appt n° (type)	Underpressure (high air flow)	Permeability (1)	Permeability (2)	n50 (approx.)
	(Pa)	(m3/h at 10 Pa)	(m3/h at 10 Pa)	(ach at 50 Pa)
113 (T3)	12.6	120	65	1.09
114 (T3)	8.4	145	90	1.51
123 (T3)	11.6	105	65	1.09
124 (T3)	22.5	78	40	0.67
133 (T3)	8.2	130	63	1.06
134 (T3)	4.6	220	135	2.27
143 (T3)	5.9	180	80	1.34
144 (T3)	6	170	85	1.43
153 (T3)	8	145	70	1.18
154 (T3)	3.7	185	85	1.43



## DISCUSSION

On the first building, the variation in airtightness between the different dwellings is quite large, from "good" to "bad" :

- 7 dwellings have rather "good" airtightness :  $n_{50} \leq 1$
- 7 dwellings have rather "poor" airtightness :  $2 \leq n_{50} \leq 3$
- 2 dwellings have rather "bad" airtightness :  $n_{50} \approx 5$

On the second building, airtightness is quite homogeneous between the different dwellings, and rather "poor" :  $2 \leq n_{50} \leq 3.5$ .

On the third building, airtightness is quite homogeneous between the different dwellings, and rather "good" :  $1 \leq n_{50} \leq 1.5$ .

The third building, where the best results are found, is equipped with high-performance certified windows.

This study shows interesting results (it must be reminded that dwellings airtightness measurements are rare in France – [2]) :

- either in existing or in new buildings, "good" or "bad" airtightness can be found ;
- a large range of airtightness values can be found in the same building, between different apartments ;
- finding a "good" airtightness is possible, in a whole building ; and, fortunately, using performant components (like windows) seems to be a good way to get good results.

At the end, the ventilation performance will be dependant of the airtightness quality of the dwellings.

One of the ventilation components which was developed in the frame of the European project TIP-VENT (see synopsis) is an additional air inlet for mechanical ventilation system, which role is to avoid high underpressures inside dwellings when using intermittent and high air flows (like when cooking). Of course, the performance of such a component will be dependent of the airtightness of the dwelling.

## REFERENCES

- [1] *TIP-VENT Towards Improved Mechanical Ventilation Systems*  
*EC – JOULE III Project, Contract JOE3-CT 97-0080*  
*1997-2000*
- [2] *J. CHAMBAUD, J. CHAMAL*  
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