CERTECH
CEntre de Ressources TEchnologiques en CHimie

Report n° 08/325

Study of the no olfactory remanence phenomena of the Olfacom technology

The experiments allowed the determination of the molecules concentrations in a flow generated by the opening of the cartridge in the diffuser

A theoretical calculation shows that the time needed to obtain no perception of the odour of a molecule with a low odour threshold (for example acetaldehyde and o-xylene) is around a few seconds after switching off the diffuser.

As the odorous flow is not an aerosol, there is not re-emission of odorous molecules after switching off the diffuser.

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Study for :	**Olfacom**
Attention of :	**Mr Pozzo**
Customer request nr :	**Letter of 25-03-2008**
Certech request nr:	**M193**
Certech quotation nr :	**OP/08/008/CP**

Emission date : **09/05/08**

Scientific Approval,

Quality Approval,

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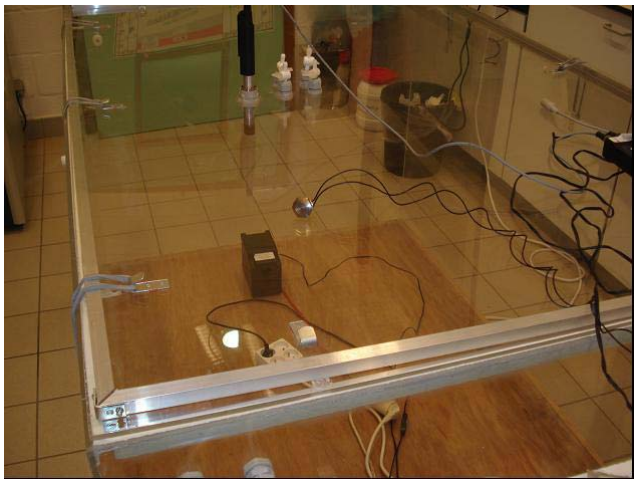
1. Study aim:

Olfacom had developed an odour diffuser working in a dry way. The system is based on the encapsulation of the odorous molecule with a polymer. This mixture is integrated in a sphere which avoid contact with air and light. In control manner, the sphere can be opened to allow an air flow to pass through the polymer and be charged with the odorous molecules. This process permits to go from one olfactory note to another one without a remanence of previous olfactory notes.

2. Methodology

An equimolar mixture of acetaldehyde, acetone, n-heptane, toluene and o-xylene (prepared by CERTECH has been set by Mr Pozzo.
Olfacom provided one modified Olfacom diffuser with an external ON/OFF switch, as well as two cartridges of 12 g of PeBax charged with the mixture (18,5g compound mixture/100 g PeBax).

The diffuser was installed in an airtight box (1,2m³). The box atmosphere is analysed online by gas chromatograph (GC-PID) (Picture 1).



Picture 1 : diffuser in the airtight box.

The objective of the study is to determine the time needed to detect the molecule emitted by the diffuser with time (see the schematic graph below). This will allow the quantification of the amount of molecules present in the diffuser flow. This amount will be compared to the odour threshold of the model molecules.

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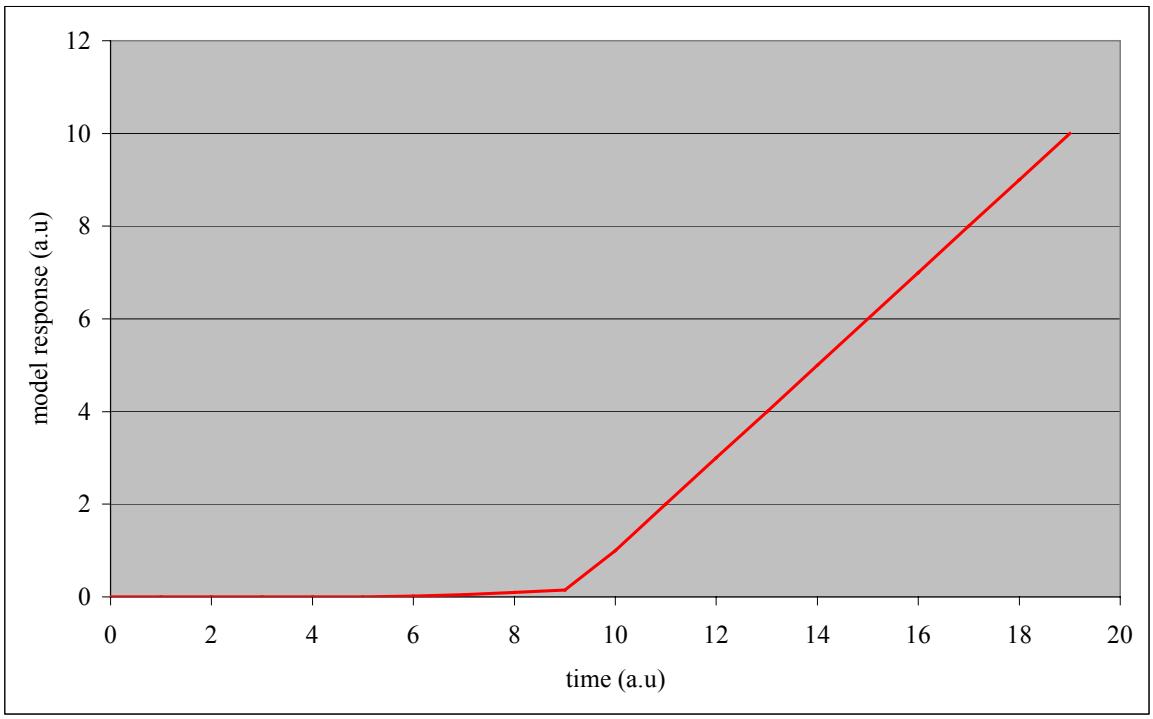
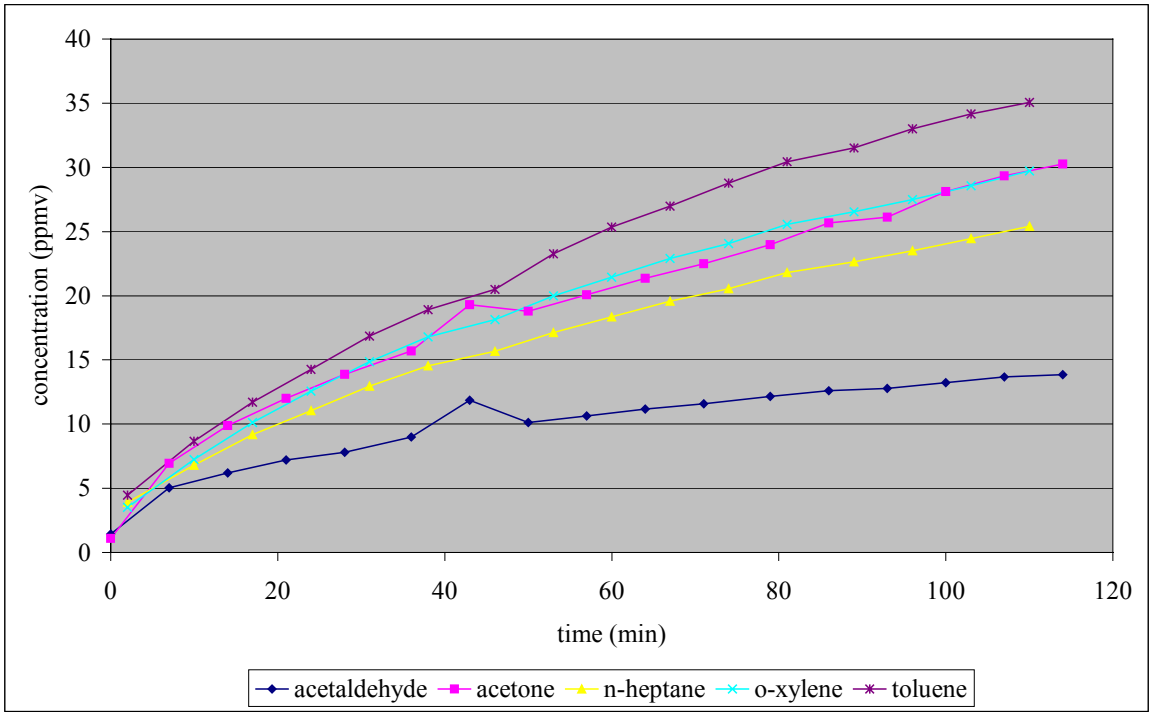


Graph 1 : theoretical profile (a.u : arbitrary unit).

3. Results

The diffuser was installed in the chamber with the push button outside the chamber (see picture 1). The GC-PID was started simultaneous with the diffuser. The chemical air composition was followed with time. The test was conducted for 120 minutes.

The evolution of the 5 components concentration versus time is shown in graph 2.



Graph 2 : Evolution of the 5 components concentration versus time.

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Unexpectedely, the 5 components concentration were very high in the test chamber and, this since the beginning of the test.

The concentration evolutions of this test were not directly usable due to some peaks saturation on the GC, as example for toluene (see figure 1).

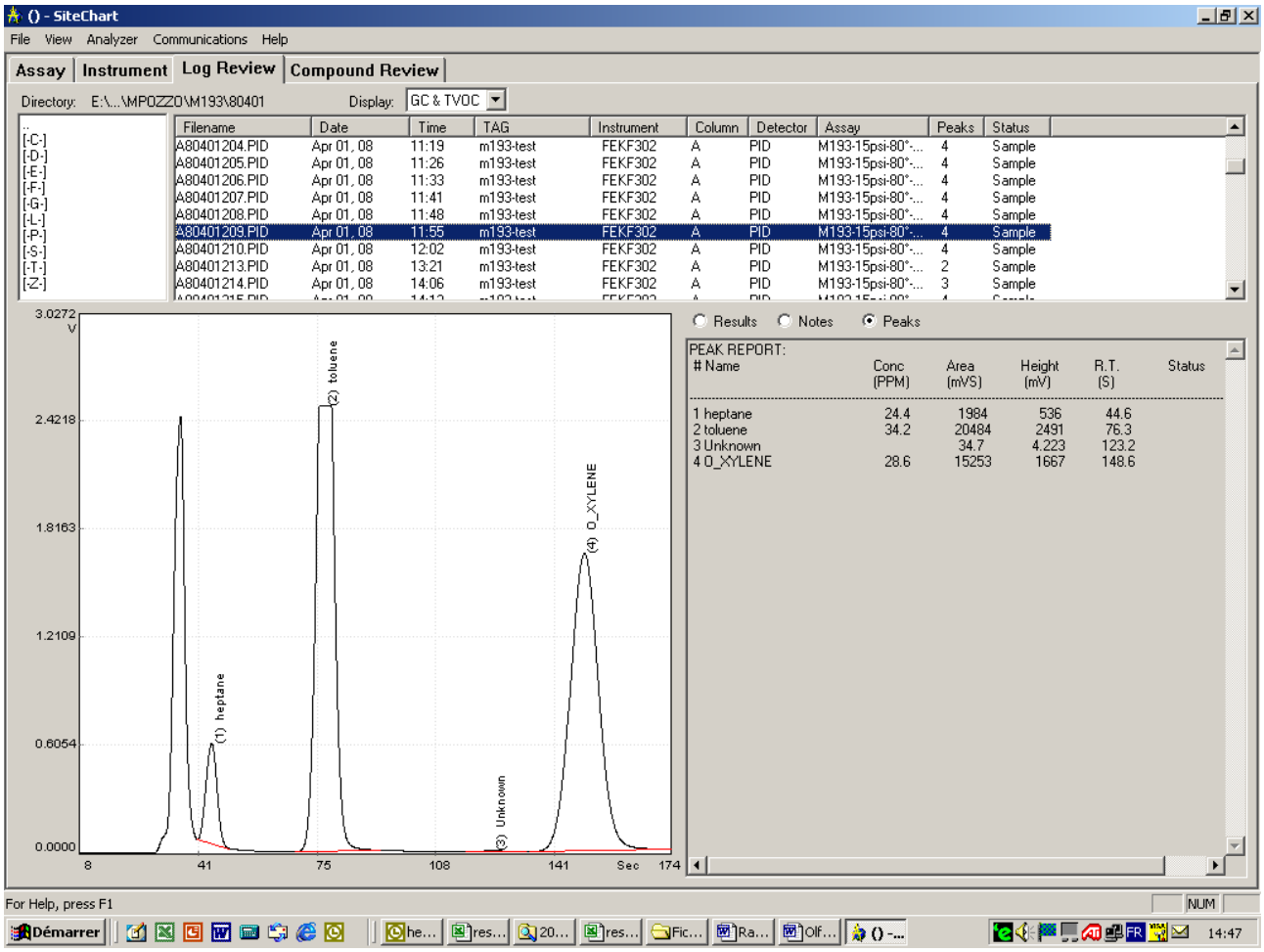

Figure 1 : GC- analysis of the test chamber atmosphere, toluene saturation.

The test chamber was purged and a second test was carried out. The cartridge opening durations have been controlled at 2, 5, 15, 30 and 60 seconds.

The concentration evolutions of the mixture versus time are shown in graph 3.

The first opening was done after 35 minutes. As it can be seen , some natural diffusion from the cartridge is observed. Each step observed in graph 3 is due to the opening of the cartridge in the diffuser.

The amount of each component released in relation with the opening time is reported in graph 4.

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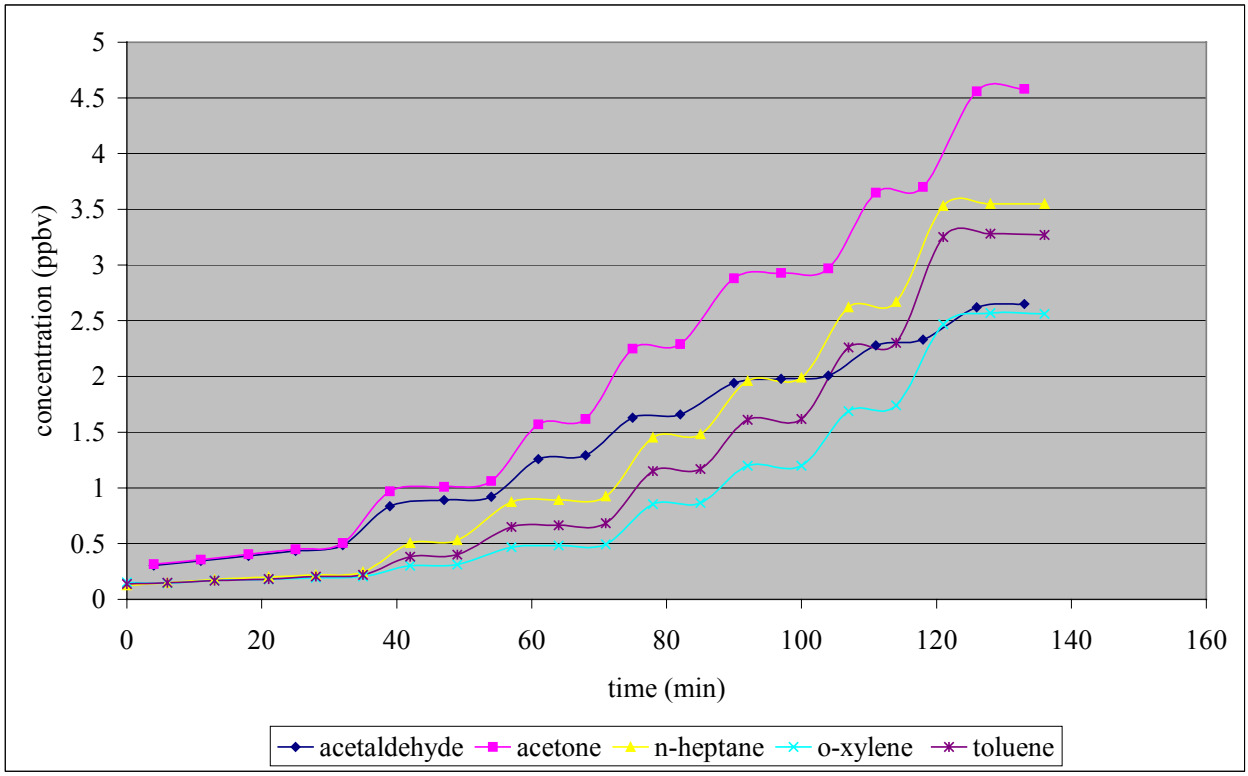
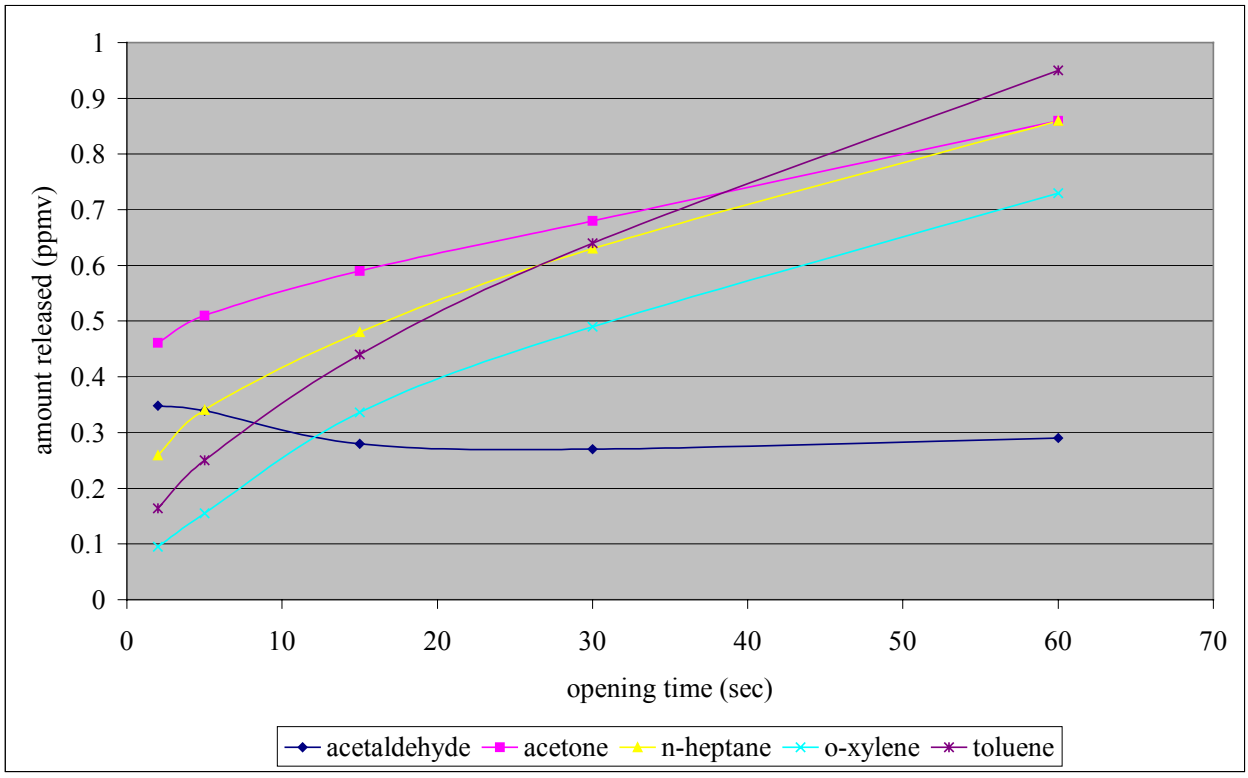


Graph 3 : Concentration evolution versus time.



Graph 4 : amount released in relation with the opening time of the cartridge.

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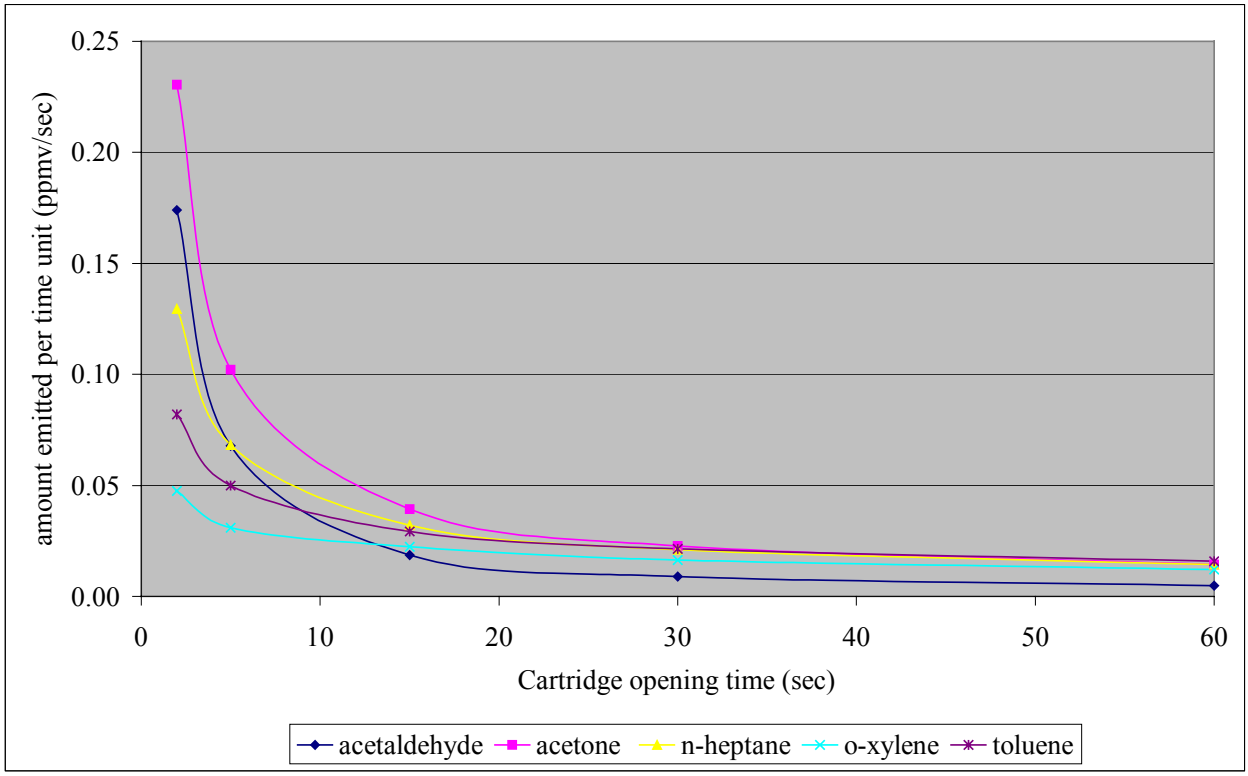
The graph 5 presents the amount of component emitted per time unit.



Graph 5 : amount emitted per time unit (ppmv/sec) versus cartridge opening duration (sec).

We observe that for short opening time, the amount of chemicals emitted per time unit is more important than for large opening time. This is due to two main reasons :

1° : an inaccuracy of the cartridge opening time for the short time.
2° : the presence of the chemicals in the gas phase of the cartridge which are quickly released in the air flow.

A second test was carried out with the second cartridge and for larger opening durations : 30, 60, 90, 120 and 180 seconds.

For each compound, the evolutions of its concentration is shown in graph 6.

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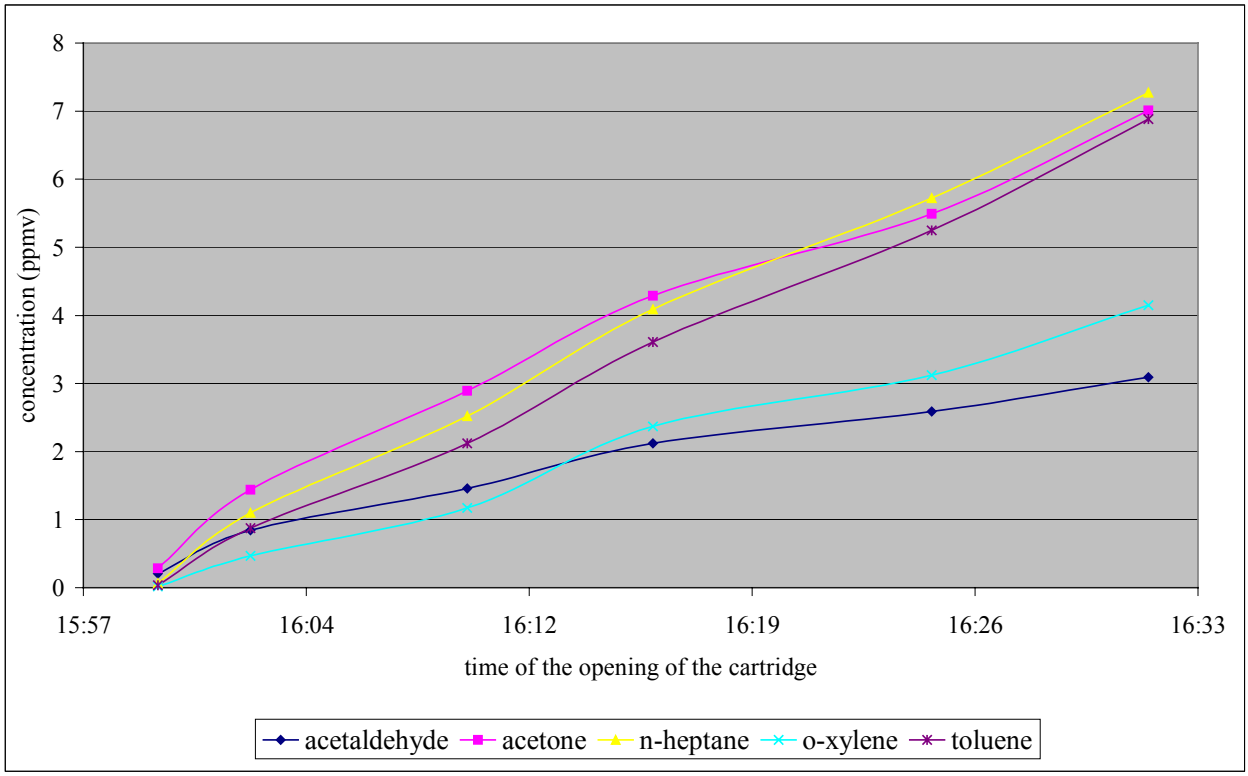
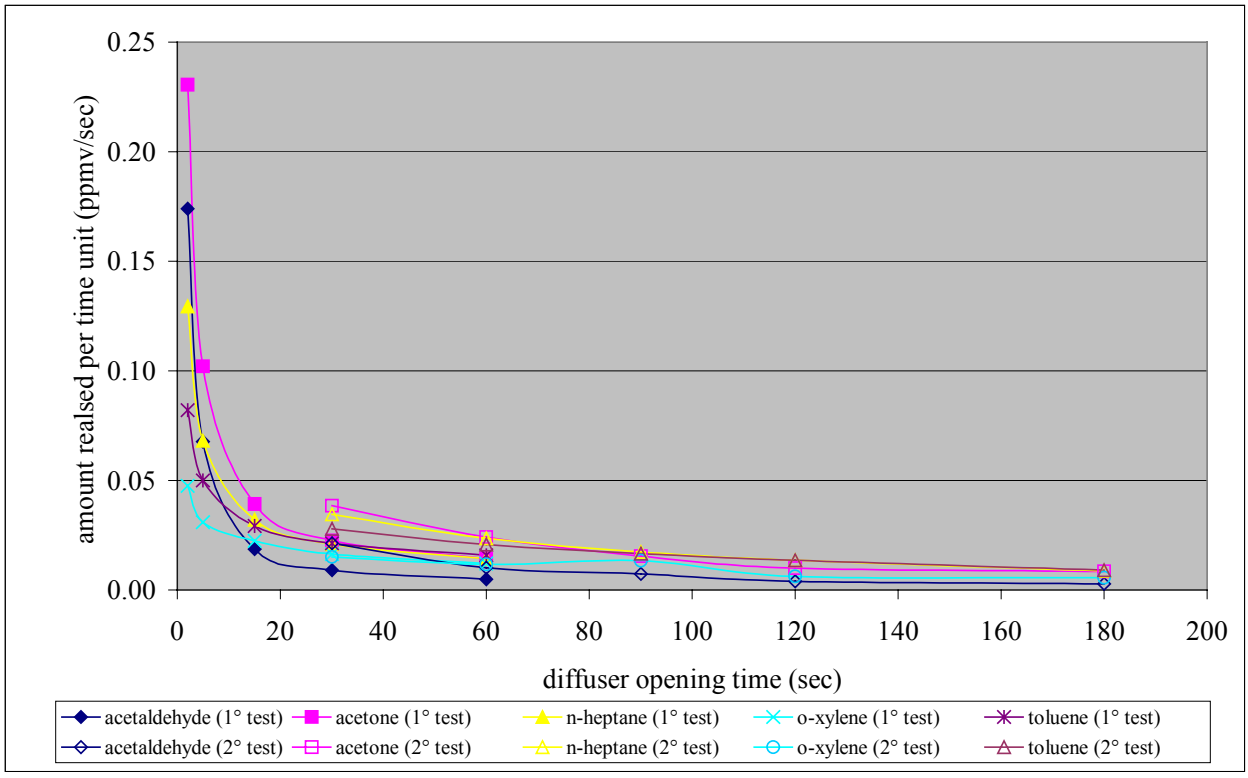


Graph 6 : concentration evolution in the test chamber after each cartridge opening.

Graph 7 presents the component amount released per time unit (ppmv/sec) versus the diffuser opening time (both tests).



Graph 7 : amount released per unit time (ppmv/sec) versus diffuser opening duration (sec) (both tests).

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From graph 7, it is possible to estimate, theoretically, the persistence time of the odour. An odorous molecule is perceived if its concentration in the gas phase is higher than its odour threshold.

The odour threshold of the 5 components are given in table 1.

Table 1 : odour threshold ppmv (1)

Acetaldehyde	Acetone	n-heptane	o-xylene	toluene
0.05	13	9.8	0.07	2.5

(1) **« Comparaison des seuils olfactifs de substances chimiques avec des indicateurs de sécurité utilisés en milieu professionnel » INRS, Hygiène et sécurité du travail- Cahier de notes documentaires-1° trimestre 2005, 198/7, ND 2221-198-05**

Knowing the diffuser opening time and the flow speed, it is possible to evaluate the amount of each component in a known volume.
The flow speed, measured with an anemometer, is 1,65 m/sec.
The opening diameter of the diffuser is 0,03m which corresponds to a surface of 0.0007 m².
The volume generated for 1 second : 0.0012 m³.

The amount per time unit (ppmv/sec) of each component for a cartridge opening of 15 sec , as well as the concentration of each component in the flow are reported in table 2.

Table 2 : Component concentration in the flow volume (ppmv)

	acetaldehyde	Acetone	n-heptane	o-xylene	toluene
ppmv/sec*	0.019	0.039	0.032	0.022	0.029
ppmv in the flow volume	19	40	33	23	30
Odour threshold (ppmv)	0.05	13	9.8	0.07	2.5

* measured in a chamber volume of 1.2m³

We can observe that the concentrations of each component in the flow are higher than their odour threshold.
Acetaldehyde and o-xylene are the more odorous molecules, because their odour threshold are the smallest .

Table 3 reports the concentration of the 5 molecules in the air flow for different cartridge opening duration.

For small opening time, the component concentrations in the flow are very high, this can explain the olfactory flash at the diffuser opening.

Table 3 : concentrations in the flow for different cartridge opening duration (ppmv)

Opening time (sec)	Acetaldehyde	Acetone	n-heptane	o-xylene	toluene
2	179	237	133	49	84
5	70	105	70	32	51
15	19	40	33	23	30
30	9	23	22	17	22
60	5	15	15	13	16
30*	22	40	35	16	29
60*	11	25	24	12	21
90*	8	16	18	14	17
120*	4	10	14	6	14
180*	3	9	9	6	9
Odour threshold	0.05	13	9.8	0.07	2.5

* second test with the second cartridge.

To explain the rapidity and no olfactory remanence of the system, two extreme cases will be used. Firstly, we consider that the molecules will diffuse naturally in the air with a speed of 0,02 m/sec (natural diffusion coefficient).
Secondly, we consider that the molecules will keep the speed of the diffuser flow : 1,65 m/sec.

In the first case, the molecules will diffuse linearly in all directions, which will increased the volume where the chemicals are (see figure 2).

On the contrary, for the second case, the volume expansion is realised only in the flow direction and perpendicularly to it.

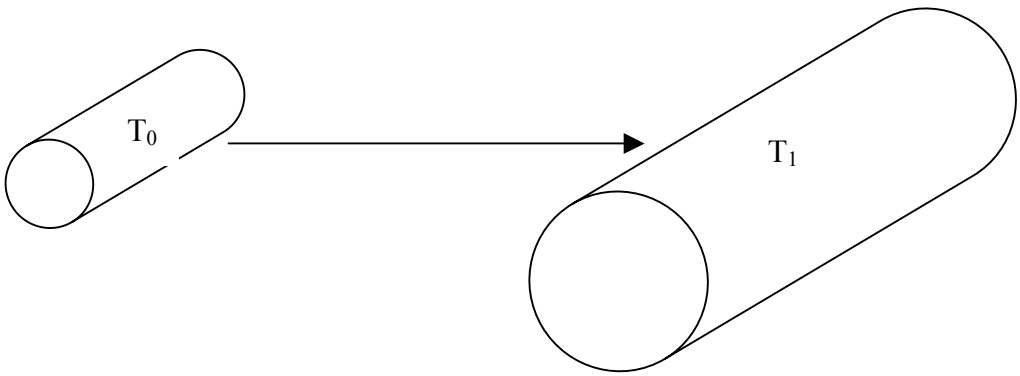

Figure 2 : flow volume expansion with time after switching off the diffuser.

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Tables 4 and 5 summarise the theoretical results for the two conditions.

We reported in tables 4 and 5 the time after switching off the diffuser, he initial volume (t=0) which corresponds to the volume created after 1 second of cartridge opening, the volume increased with time and the molecules concentration in the new volume. The numbers in red correspond to the first concentration below the odour threshold of the corresponding molecule.

Table 4 : natural diffusion (0,02 m/sec)

time (sec)	volume (m^3)	acetaldehyde (0,02 m/sec)	acetone (0,02 m/sec)	n-heptane (0,02 m/sec)	o-xylene (0,02 m/sec)	toluene (0,02 m/sec)
0	0.0012	19	40	33	23	30
2	0.0164	1.363	2.871	2.336	1.635	2.141
4	0.0513	0.437	0.920	0.748	0.524	0.686
5	0.0769	0.291	0.614	0.500	0.350	0.458
10	0.2977	0.075	0.159	0.129	0.090	0.118
12	0.4351	0.051	0.108	0.088	0.062	0.081
15	0.7014	0.032	0.067	0.055	0.038	0.050
Odour threshold		0.05	13	9.8	0.07	2.5

Table 5 : flow of 1,65 m/sec

time (sec)	volume (m^3)	acetaldehyde (1.65 m/sec)	acetone (1.65 m/sec)	n-heptane (1.65 m/sec)	o-xylene (1.65 m/sec)	toluene (1.65 m/sec)
0	0.0012	19	40	33	23	30
1	29	0.0008	0.0016	0.0013	0.0009	0.0012
2	171	0.00013	0.00027	0.00022	0.00016	0.00021
5	2125	1.05E-05	2.22E-05	1.81E-05	1.26E-05	1.66E-05
Odour threshold		0.05	13	9.8	0.07	2.5

Graph 8 summarises table 4 and 5 (zoom at low concentration).

If the molecules diffuse naturally, acetaldehyde and o-xylene are not perceived anymore after 10 seconds, the three others after only 2 seconds.

In the second case, where molecules kept the speed of the flow, all of them are not perceived anymore after less than 1 second.

The reality should be between both values. It means that odorous molecules are not perceived after a few seconds.

Because the odorous flow is not an aerosol, there is not re-emission of odorous molecules after switching off the diffuser.

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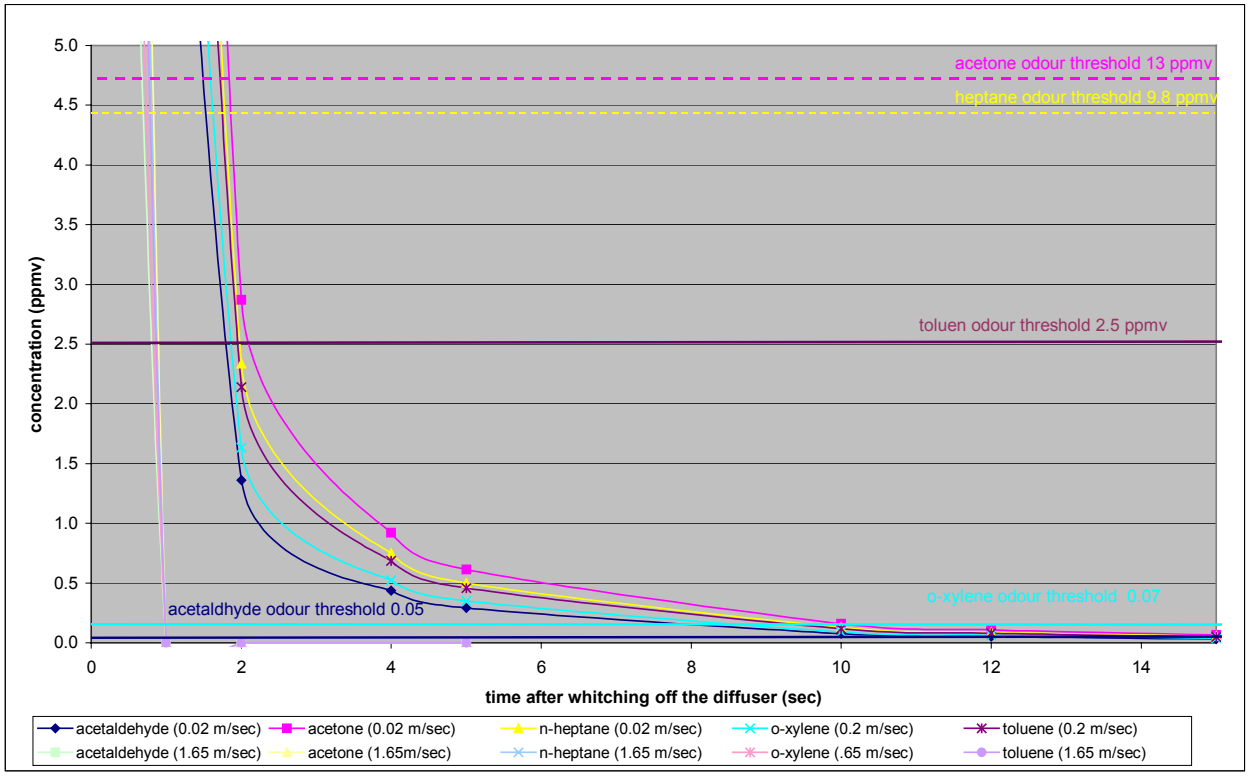

Graph 8 : concentration evolution versus time after switching off the diffuser

4. Conclusions

The experiments permit to determine the molecules concentrations in a flow generated by the opening of the cartridge in the diffuser.

For a diffuser time opening around 15 seconds, the chemical concentrations in the flow is about 30 ppmv. For cartridge loaded with similar chemical concentrations than the test cartridge and for a similar diffuser configuration, this value should be representative of the molecules concentration released by the system in the odorous flow.

A theoretical calculation shows that the time needed not to perceive the odour of a molecule with a low odour threshold (for example acetaldehyde and o-xylene) is around a few seconds after switching off the diffuser.

As the odorous flow is not an aerosol, there is not re-emission of odorous molecules after switching off the diffuser.

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