CONCEPTQAI

VERS UNE MAITRISE DE LA QUALITÉ DE L'AIR INTÉRIEUR

Assessment of VOCs material/air exchanges of building products and their assemblies using the DOSEC-SPME method

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Atmos'Fair 2016

OBJECTIVES
PROJECT OBJECTIVES

Create a new database with a predictive model of the indoor air quality

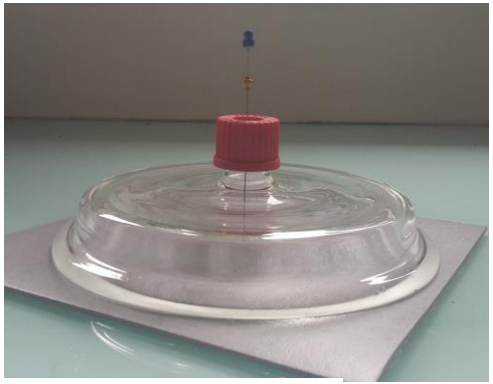
- VOCs emission
- Formaldehyde sorption kinetics
- Assemblies effects
- Compare in-situ and laboratory results

Compare DOSEC-SPME methodology with ISO 16000-9

PRESENTATION

- DOSEC-SPME methodology
- Analytical methodology
- Material selection
- Screening results
- Choice for further experience

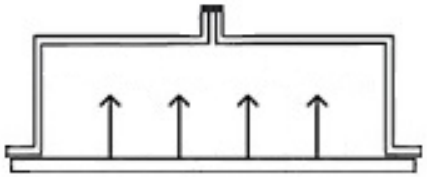
DOSEC-SPME
METHODOLOGY



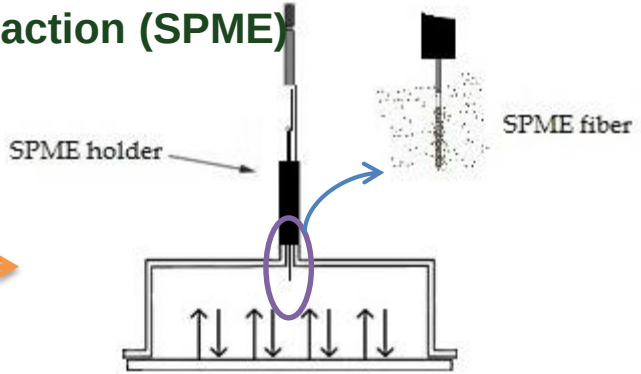
DOSEC : Device for On-Site Emission Control

- Passive sampling
- In situ measurement
- Easy to implement on-site

VOCs preconcentration by Solid Phase Micro-Extraction (SPME)

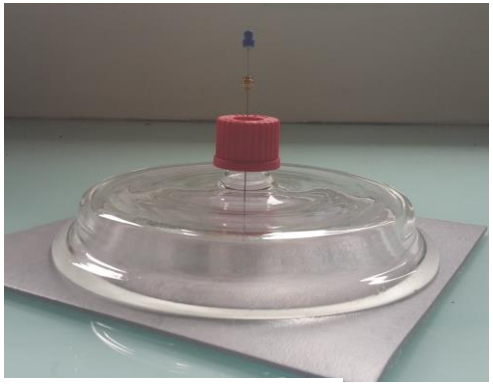


Compounds diffusion in DOSEC



At equilibrium SPME extraction

DOSEC-SPME
METHODOLOGY



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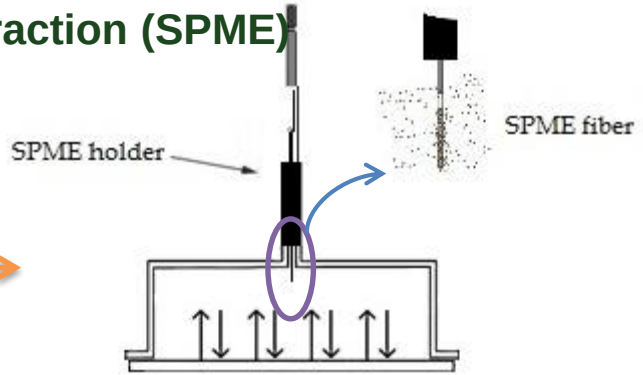
VOCs preconcentration by Solid Phase Micro-Extraction (SPME)

Fick's first law of diffusion

$$T = -D\frac{dC}{dx} = -D\frac{C_a - C_{as}}{L}$$

T : emission rate ($\mu g.m^{-2}.s^{-1}$)
D : diffusion coefficient in the air ($m^2.s^{-1}$)
C_a : concentration in the air ($\mu g.m^{-3}$)
L : thickness of the boundary layer (m)
C_{as} : gas phase concentration at the material surface ($\mu g.m^{-3}$)

Measured



At equilibrium
SPME extraction

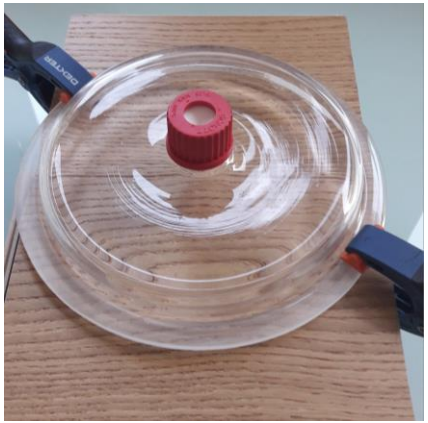
DOSEC-SPME

EMISSION MEASURMENTS

DOSEC-SPME method at 3 days

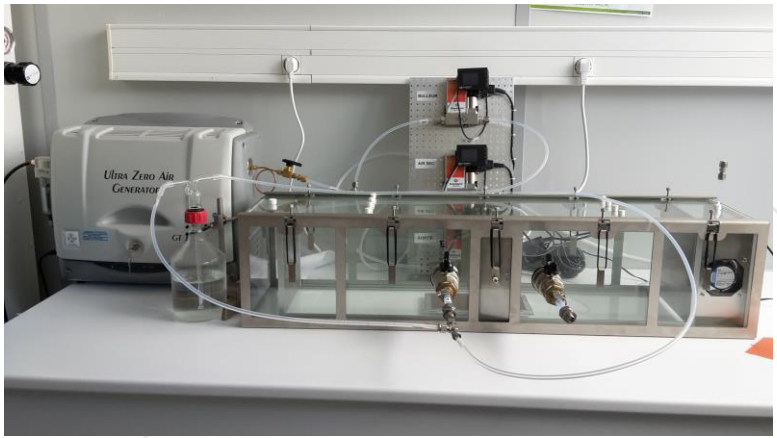
Equilibrium = 7h

Extraction = 10min



Compare with

ISO 16000-9 method at 3 and 28 days

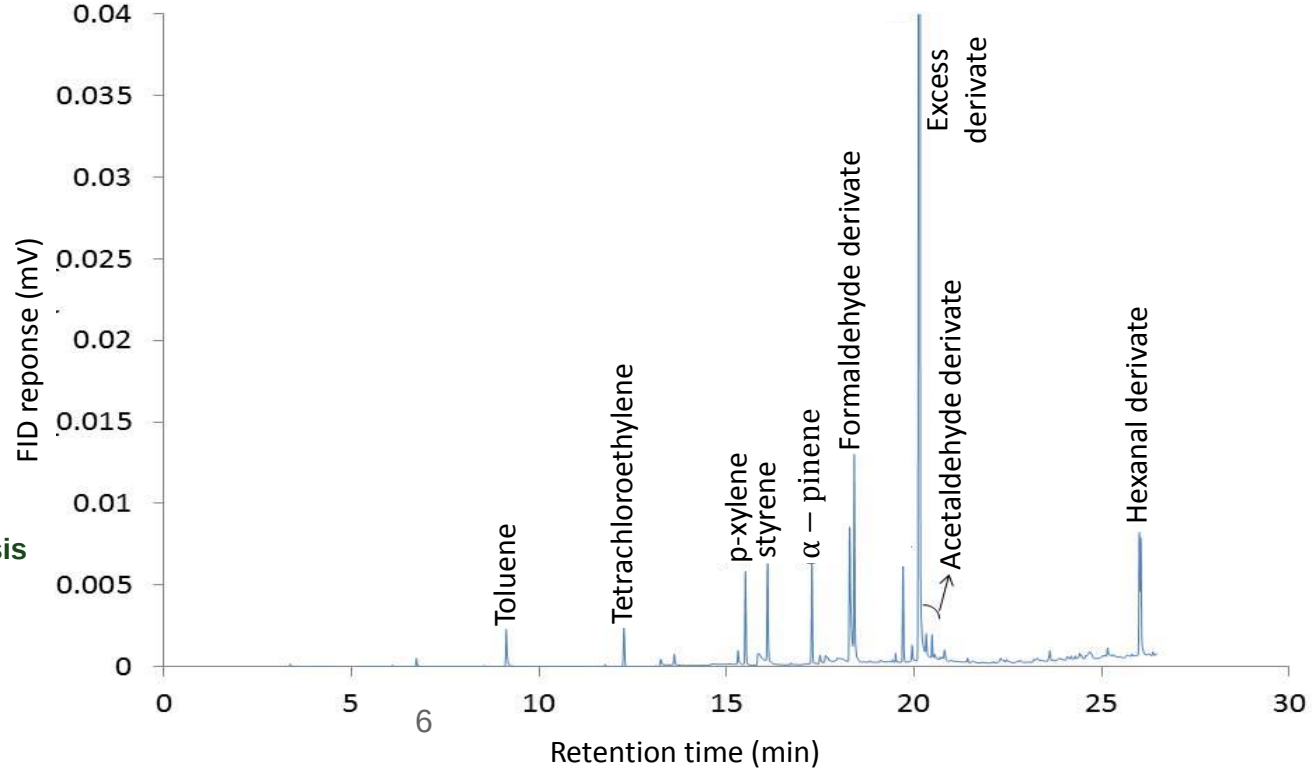


ANALYTICAL METHODOLOGY

Simultaneous sampling and analysis of VOCS and carbonyls

Thermal desorption and VOCs analysis by

gas chromatography - mass spectrometry - flame ionization detection (GC-MS-FID)



TESTED MATERIALS

Classical materials **Bio-based materials** **Decontaminating materials for formaldehyde**

Wood based	Flooring	Isolation	Wall	Plaster
Paneling	PVC 1	Glass wool 1	Paint 1	Plasterboard 1
OSB Panel 1	PVC 2	Glass wool 2	Paint 2	Plasterboard 2
OSB Panel 2	Rubber	Hemp	Paint 3	Plasterboard 1
Multi layer panel 1	Linoleum	Rockwool ceilling	Cover panel 1	Plasterboard 2
Multi layer panel 2	Carpet	Sheep wool	Cover panel 2	
Parquet	Carpet	Wood wool	Earth dividing wall	
		Cellulose wadding	Lime primer	

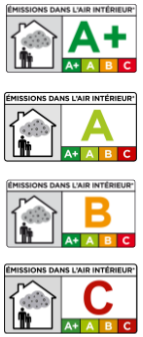
First selection of 20 materials

QUANTIFIED COMPOUNDS

Results for calibrated compounds for a Full Scan analysis

Compound	LOD (µg.m^{-3})	LOQ (µg.m^{-3})	RSD
Formaldehyde	0,28	0,92	12,3%
Acetaldehyde	3,81	12,57	17,9%
Toluene	0,37	1,11	11,7%
Tetrachloroethylene	0,38	1,14	12,5%
Xylene	0,65	1,97	21,5%
1,2,4-trimethylbenzene	0,33	1,00	10,8%
1,4-dichlorobenzene	0,36	1,09	11,7%
Ethylbenzene	0,64	1,93	20,8%
2-Butoxyethanol	0,49	1,51	14,9%
Styrene	0,59	1,78	19,6%
TVOC	Eq Toluene		
Hexanal	4,62	15,25	16,8%
Alpha-pinene	0,50	1,52	15,7%
Limonene	0,36	1,09	12,0%
3-carene	0,35	1,07	11,7%

Wood armature house and indoor wood materials



French mandatory from april, 19th 2011

Other VOCs quantified in Toluene equivalence

Other Aldehydes quantified in Formaldehyde equivalence

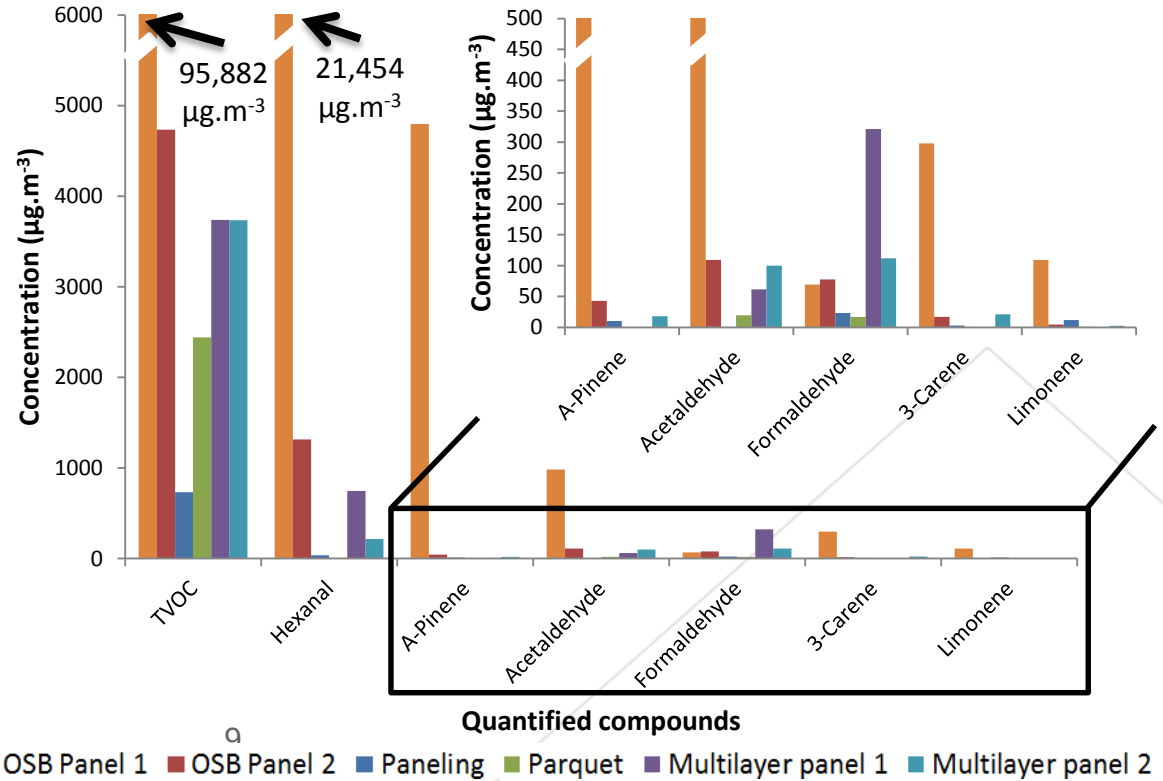
EMISSION SCREENING BY DOSEC-SPME

High concentrations for carbonyl compounds

Terpenes : wood tracers

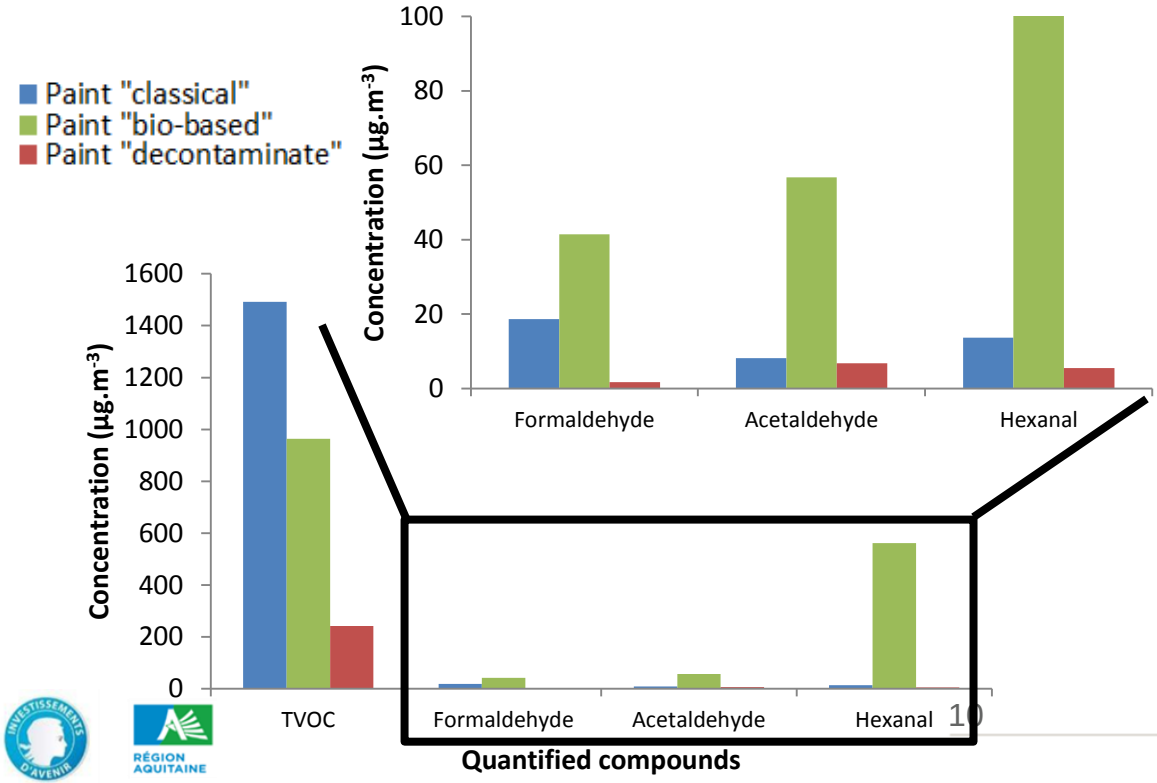
OSB 1 > Multilayer panel > Parquet > Paneling

Surface concentrations of selected VOCs for wood based materials



EMISSION SCREENING BY DOSEC-SPME

Surface concentrations of selected VOCs for paints



TVOC highest concentration: classical

Ester compounds in TVOC

But highest emission for selected compound for bio-based in this case

Depolluting in agreement with this function

GENERAL RESULTS

For 20 materials tested :

More than 100 detected compounds

46 emited by more than 1 material

6 emited by more than 5 materials

Results for 14 quantified compounds

Compounds	Recurrence	Min conc. ($\mu g.m^{-3}$)	Max conc. ($\mu g.m^{-3}$)	Median conc. ($\mu g.m^{-3}$)
Formaldehyde	90%	1.7 ± 0.3	321 ± 64	24 ± 5
Hexanal	65%	5 ± 1	21,454 ± 4,291	31 ±6
Acetaldehyde	60%	4 ± 1	985 ± 197	22 ± 4
Limonene	30%	1.1 ± 0.2	109 ± 22	8 ± 2
α-pinene	20%	11 ± 2	4,799 ± 960	31 ± 6
3-Carene	20%	3 ± 1	298 ± 60	19 ± 4
Xylene	15%	12 ± 2	103 ± 21	15 ± 3
Toluene	10%	41 ± 8	88 ± 18	65 ± 13
Ethylbenzene	10%	9 ± 2	12 ± 2	11 ± 2
1,2,4-trimethylbenzene	5%	11 ± 2	11 ± 2	11 ± 2
1,4-dichlorobenzene	5%	7 ± 1	7 ± 1	7 ± 1
Benzene	0%	< LD	< LD	< LD
Tetrachloroethylene	0%	< LD	< LD	< LD
Styrene	0%	< LD	< LD	< LD

6 wood based materials on 20 tested materials => lot of aldehydes / terpenes

GENERAL RESULTS

CHOICE FOR NEXT MEASURMENTS

Composés	Nombre de matériaux émetteurs
Formaldéhyde	18
Hexanal	13
Acétaldéhyde	12
Limonène	6
Alpha-pinène	4
3-Carene	4
Hexane	3
Xylène	3
Toluène	2
Ethylbenzène	2
1,2,4-trimethylbenzène	1
1,4-dichlorobenzène	1
Benzène	0
Tétrachloroéthylène	0
Styrène	0

Quantified compounds

9 kept

6 removed

5 added

Composés	Nombre de matériaux émetteurs
Formaldéhyde	18
Hexanal	13
Acétaldéhyde	12
Acétate de butyle	4
Alpha-pinène	4
2-éthylhéxanol	4
Propanal	4
Pentanol	3
Xylène	4
Camphène	3
Toluène (ÉTALON)	2
Ethylbenzène	2
1,2,4-triméthylbenzène	1
Styrène	0

CONCLUSION

- **20 different building materials tested**
- **In this first study, bio-based materials are not less emissive than classical**
- **Good performances:**
  - Wide range of VOCS
  - Short sampling time (less than 8 hours)
  - Good limit of detection (< 0,5 µg.m^{-3})
  - Good limit of quantification (<1 µg.m^{-3})

WORK IN PROGRESS

- **3 days measurments**
- **Formaldehyde sorption measurments**
- **Comparison beetween ISO and DOSEC methods**
- **Database creation :**
  - Surface emission, formaldehyde sorption kinetic, use….
  - Connected with a predictive model

THANK YOU FOR YOUR ATTENTION