

The Langage des Nez[®]: an asset to limit olfactory pollution incidents – An application to the industrial-port zone in the city of Le Havre

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Context



The problem of odor nuisance in Le Havre: a long story...

- An active industrial zone since the 70s': Renault factory, Total's refinery, one of the biggest ports, etc.
- After many complaints, investigation → determine possible sources¹
- Results → 26 industrial sites (petrochemicals, Coffee roasters, etc.)
- Incident in Lubrizol, Rouen 2013 → need to anticipate incidental odors



1- Quéré, 1994: Odour annoyance in industrial zones of the river Seine estuary

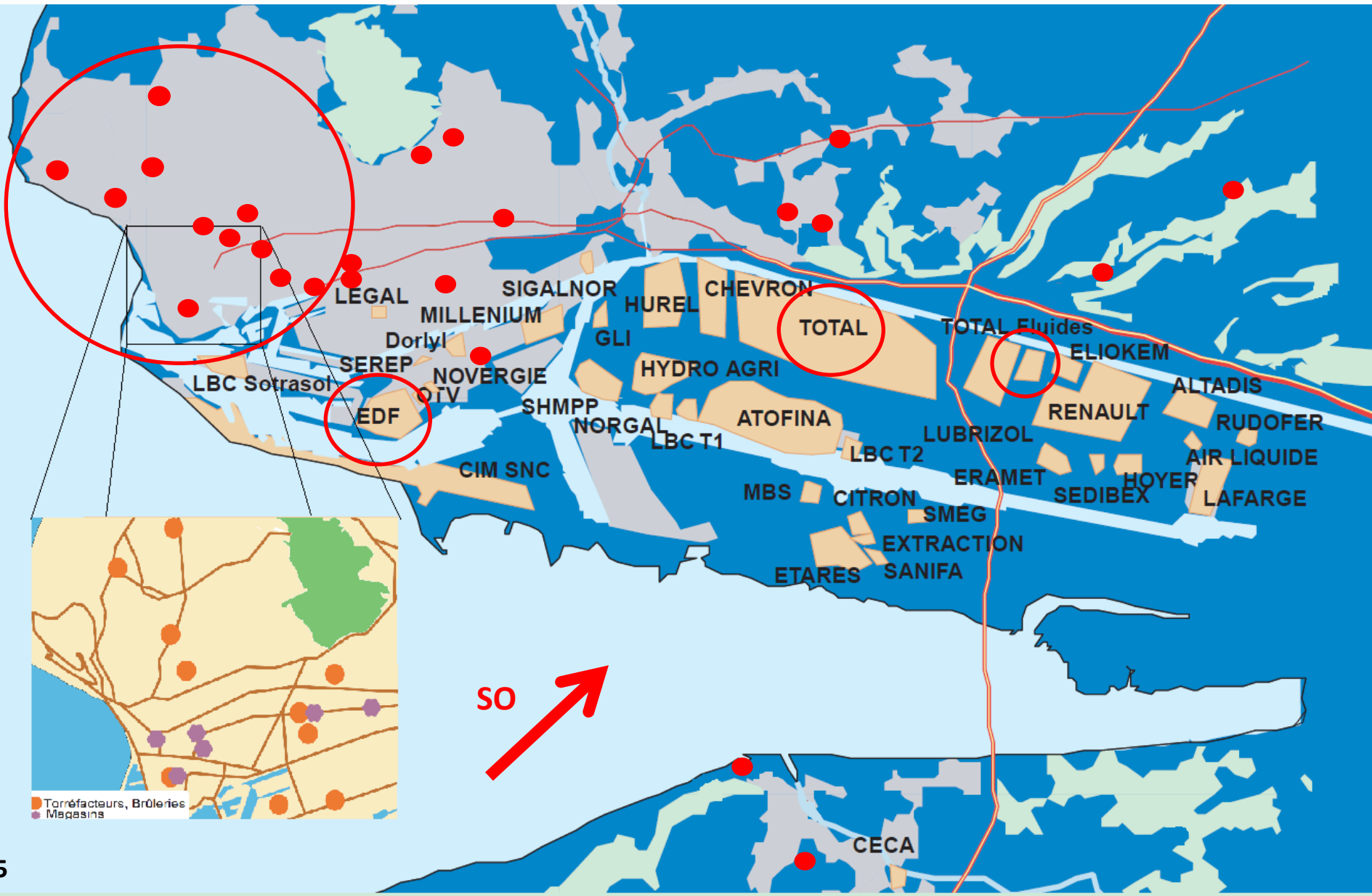
Chemistry, odors and their survey

- Odors caused by volatile chemical compounds → structures define a characteristic odor²
 - Structure-characteristic not well understood
 - In environmental odor's survey, 24/24 chemical analyses is not possible
- Atmo Normandie deployed a network of around 200 local and industrial panelists to survey odor character of ambient air



2-Bushdid, 2016: ces molécules qui nous mènent par le bout du nez.

Map of the Seine-Maritime region



Objective

What are the odors' natures that may be smelled in case of an incident in the city of Le Havre??

➔ In order to develop the network of panelists into an effective surveillance tool in case of incidents

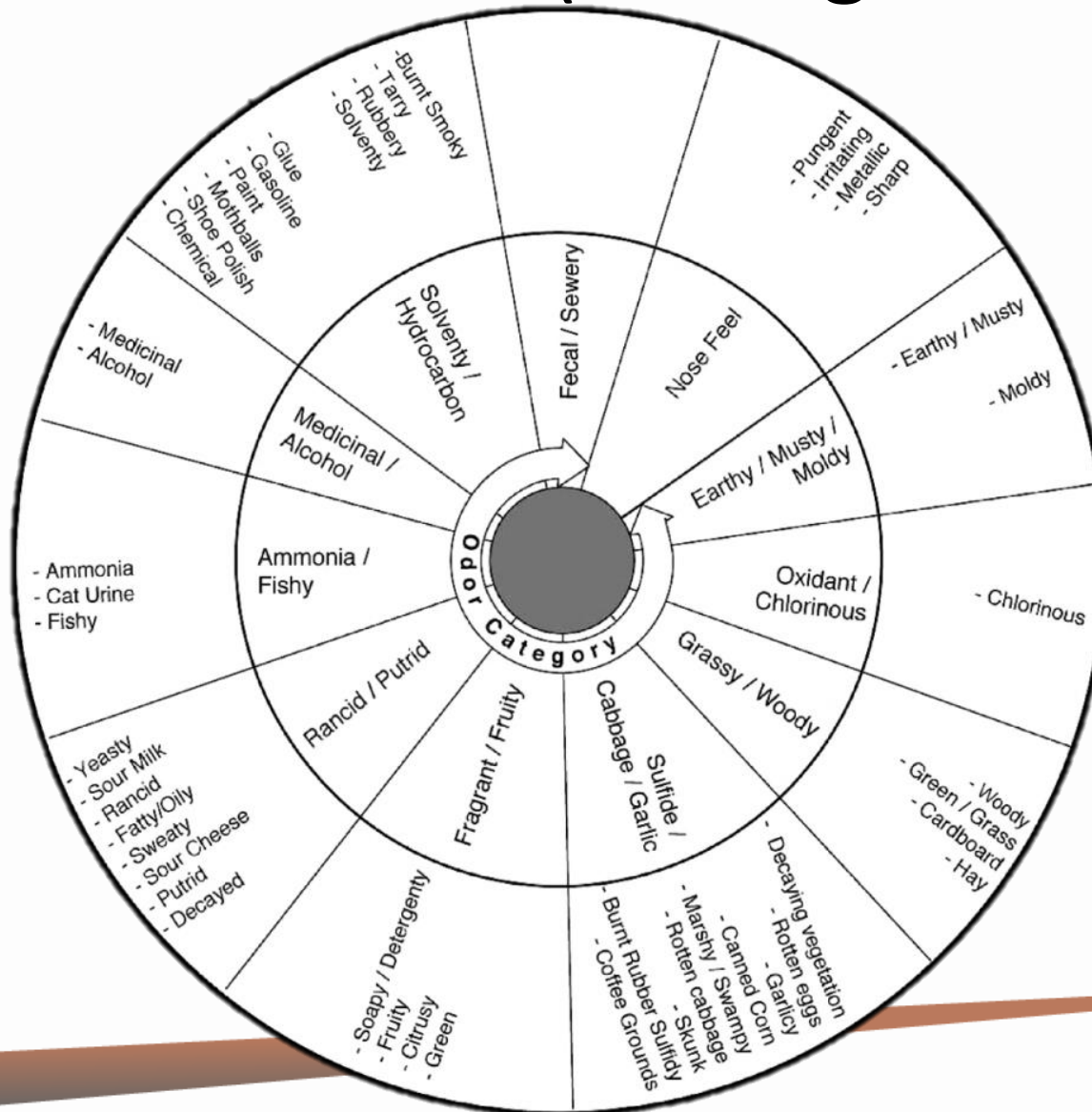


How do we characterize odors?

- Conventional methods uses evocations: The memories affiliated to a scented odor
 - Memories change from a person to another
- ➔ subjective³

3-Jaubert, 1990: Des éléments de la construction de notre référentiel olfactif.

Application of evocative description : wheel of odors (Burlingame 2004)

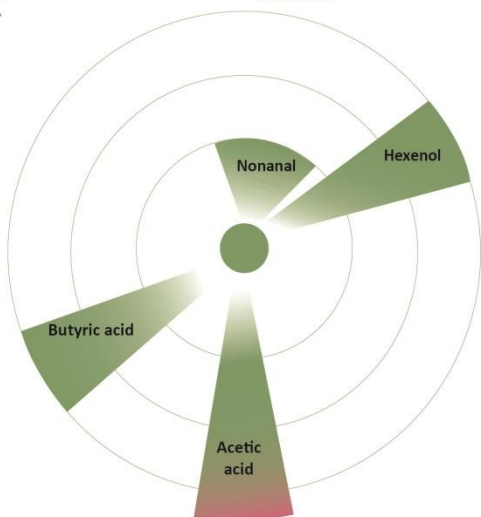


Langage des Nez®

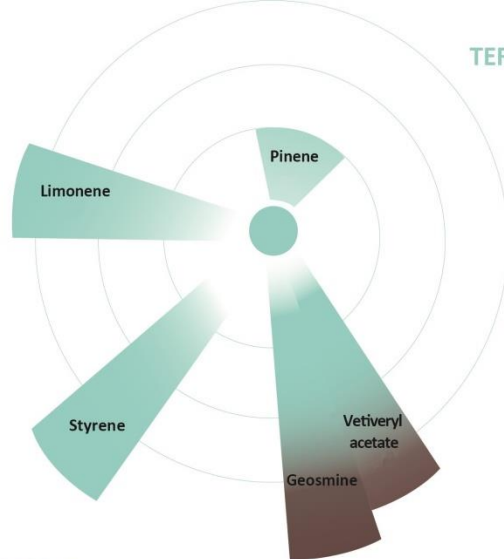
- Method uses chemical odorants as odors referents instead of descriptions⁴
- Panelists need to memorise a list of referents
- Lexicon is precise, stable and objective.

4- Leger, 2017:Le Langage des Nez®, nouveau référentiel mis en place pour le suivi des odeurs. Expérience d'Air Normand, association agréée de surveillance de la qualité de l'air en Haute-Normandie

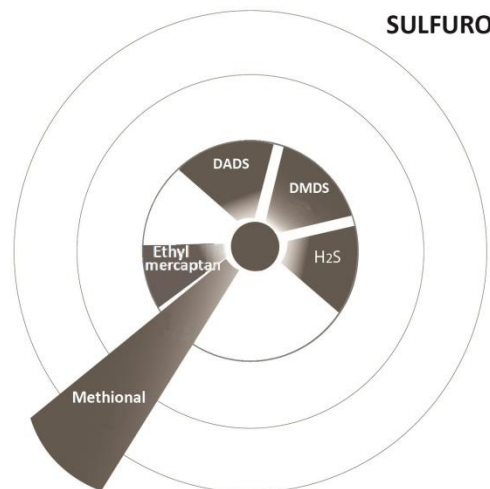
ALKYL



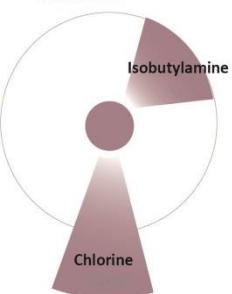
TERPENES



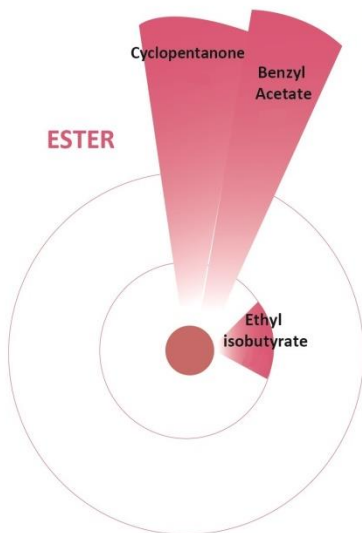
SULFUR



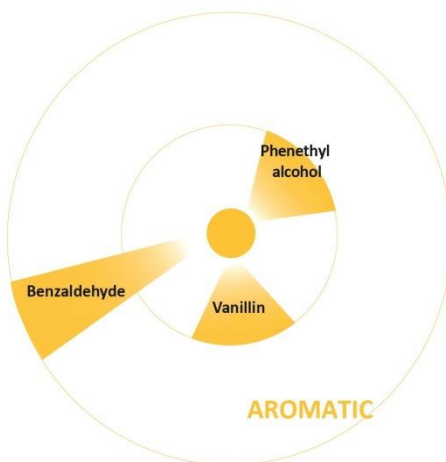
AMINE



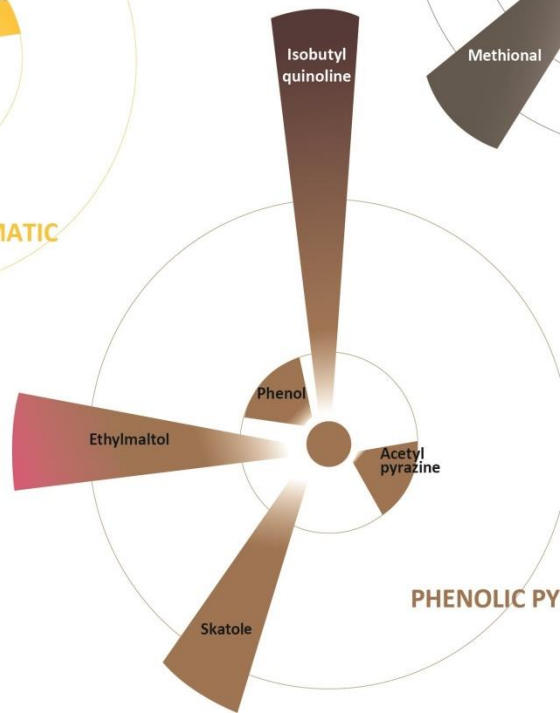
ESTER



AROMATIC

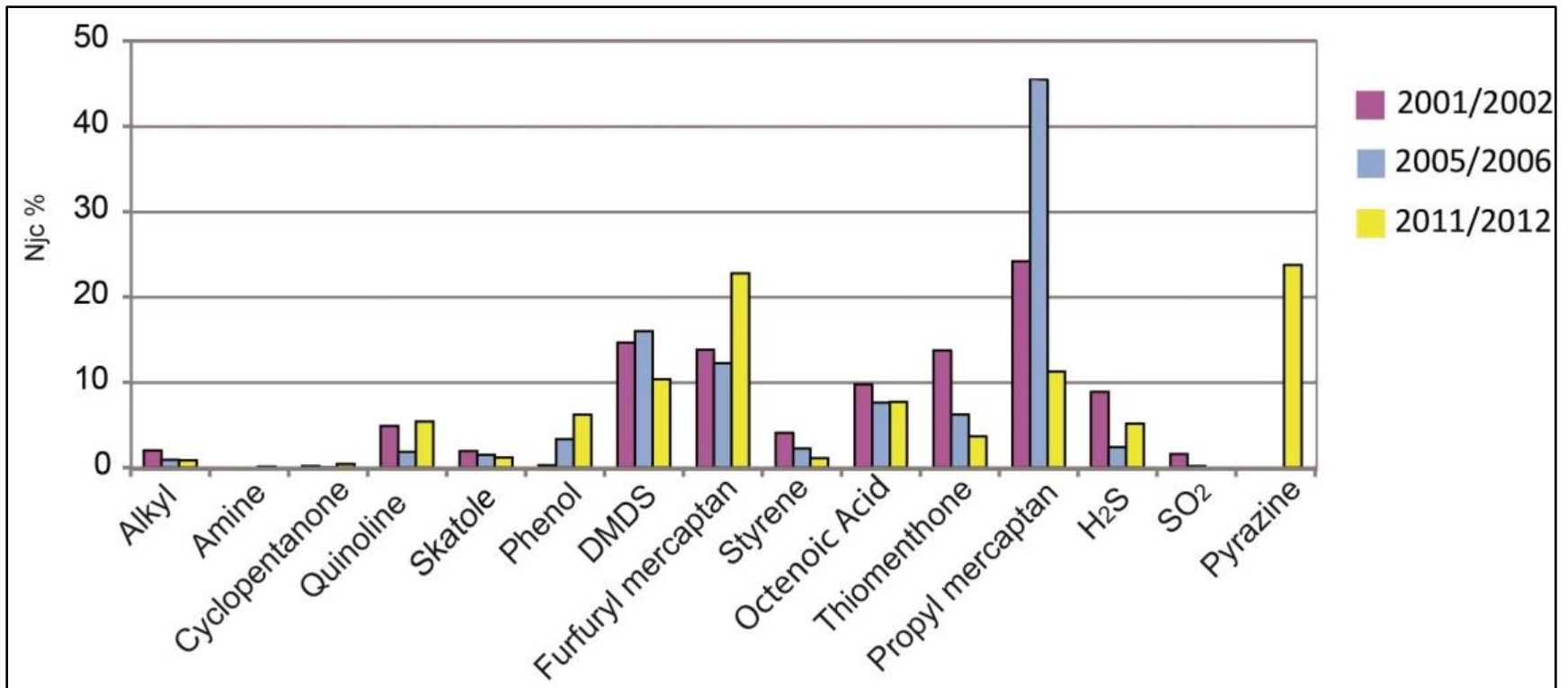


PHENOLIC PYROGENIC



Example of an application of Langage des Nez[®]

Global olfactory profile of Notre Dame de Gravenchon, Normandy, France, during a campaign in 2012 showing the evolution of the odor's character from 2001 to 2012



Outline

- Approach
- Materials and Methods
- Results and discussion
- Conclusion and outlook



Approach



Which products
can be released
incidentally?

Detection
threshold and
toxicity of
products

Objective
description
with
Langage des Nez

Visual
presentation

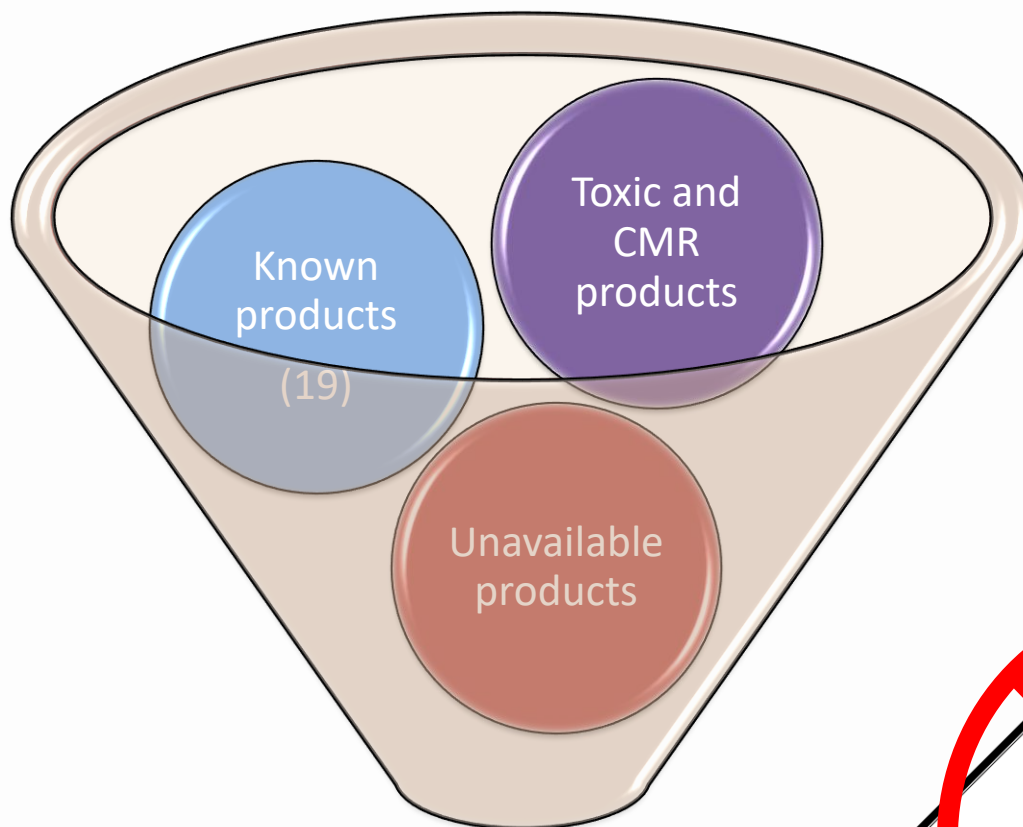


Preliminary works

- Establishment of a list of 85 compounds stored, secondary products or released incidentally → Atmo Normandie / France Chimie en Normandie
- Detection threshold (literature)
- Evocative descriptions (literature)
- Toxicological data



Selecting compounds of interest



44 compounds to be characterized:
molar mass 45.1 - 444.6 g/mol

Sulfurous, amines, alcohols, esters, ethers, aromatic, etc.



Materials and methods



Samples preparation and results treatment

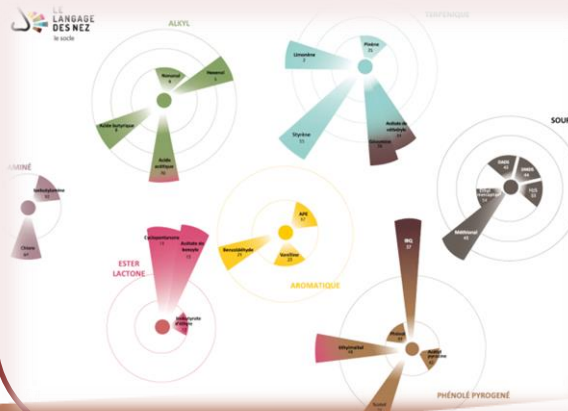
Solutions

- In triacetin
- Concentration \Leftrightarrow Intensity of Langage des Nez's referents
- Verification of stability over time



Analyses sensorielles

- 18-58 assessors: ARPAC's students, local and industrial noses, Atmo Normandie's employees and 5 experts of Langage des Nez
- Description of each compound's odor using 1,2 or 3 ref from the Langage des Nez with a value over 9 for each ref
- Place the odors on the socle



Results treatment

- By considering frequency of citation of each reference and their values:

f = frequency of citation

$$N_{ic} = \frac{\sum \text{values of ref}}{\sum \text{total values}}$$

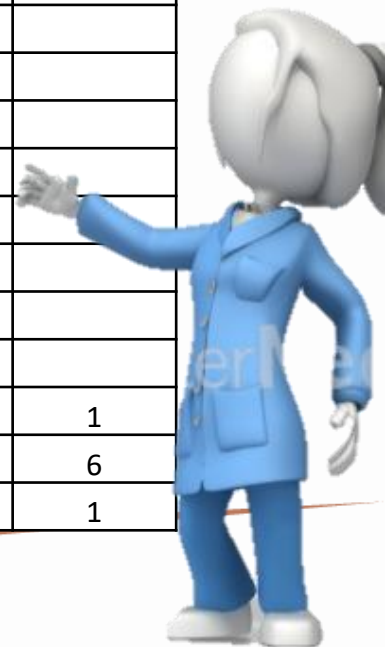


Results and discussion



Data treatment

Indene	Cyclopentanone	Styrene	Phenol	APE	Benzaldehyde	Chlorine	H ₂ S	Skatole
Assessor 1	1	6	2					
Assessor 2		5		2	2			
Assessor 3		9						
Assessor 4		5	4					
Assessor 5		7				2		
Assessor 6		9						
Assessor 7		4	4				1	
Assessor 8		6				2		1
Assessor 9		7	2					
Assessor 10		4	5					
Assessor 11	3	6						
Assessor 12		8					1	
Assessor 13		9						
Assessor 14		9						
Assessor 15		9						
Assessor 16		9						
Assessor 17		9						
Assessor 18		9						
Nb of citations	2	18	5	1	1	2	2	1
f	11	100	28	6	6	11	11	6
N _{ic}	2	80	9	1	1	2	1	1



Incidental odors' characterisation

An example of compounds characterised using method of
Langage des Nez

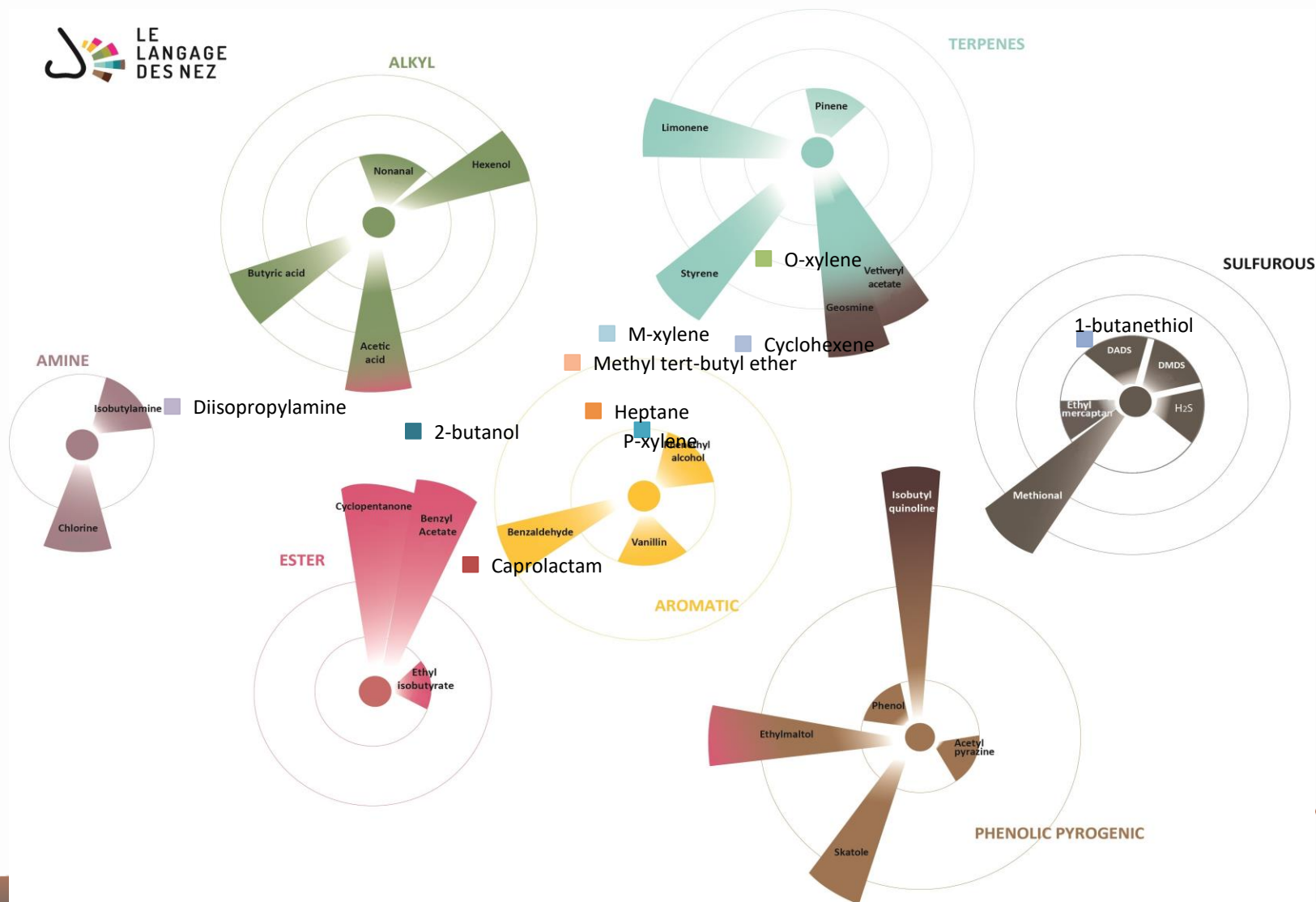
Substance	Number of panelists	Odor references		
		1	2	3
1-Butanethiol	20	Diallyl disulfide (9)		
Acetic Anhydride	49	Acetic acid(9)		
Caprolactame	20	Benzaldehyde (4)	Chlorine (3)	Cyclopentanone (2)
Diisopropylamine	37	Isobutylamine (9)		
Diphenylamine	41	Limonene (9)		
Methyl methacrylate	47	Diallyle disulfure (5)	Styrene (9)	
m-Xylene	35	Styrene (9)		
o-Xylene	20	Styrene (5)	Pinene (4)	
ortho-Xylene	50	Styrene (4)	Phenyl ethyl alcohol (3)	Phenol (2)
meta-Xylene				
para-Xylene				

Chemical structures of Xylene isomers:

- ortho-Xylene
- meta-Xylene
- para-Xylene

Representation on the Socle

Positions of certain compounds' odors



Discussion

- 44 compounds characterized objectively

Compound	Evocation	Langage des Nez
Caprolactam	Unpleasant ¹	Benzaldehyde (4), Chlorine (3), Cyclopentanone (2)
Ethylbenzene	Aromatic ²	Styrene (9)
1,2,4-trimethylbenzene	Aromatic ³	Geosmine (5), pinene (3), styrene (1)

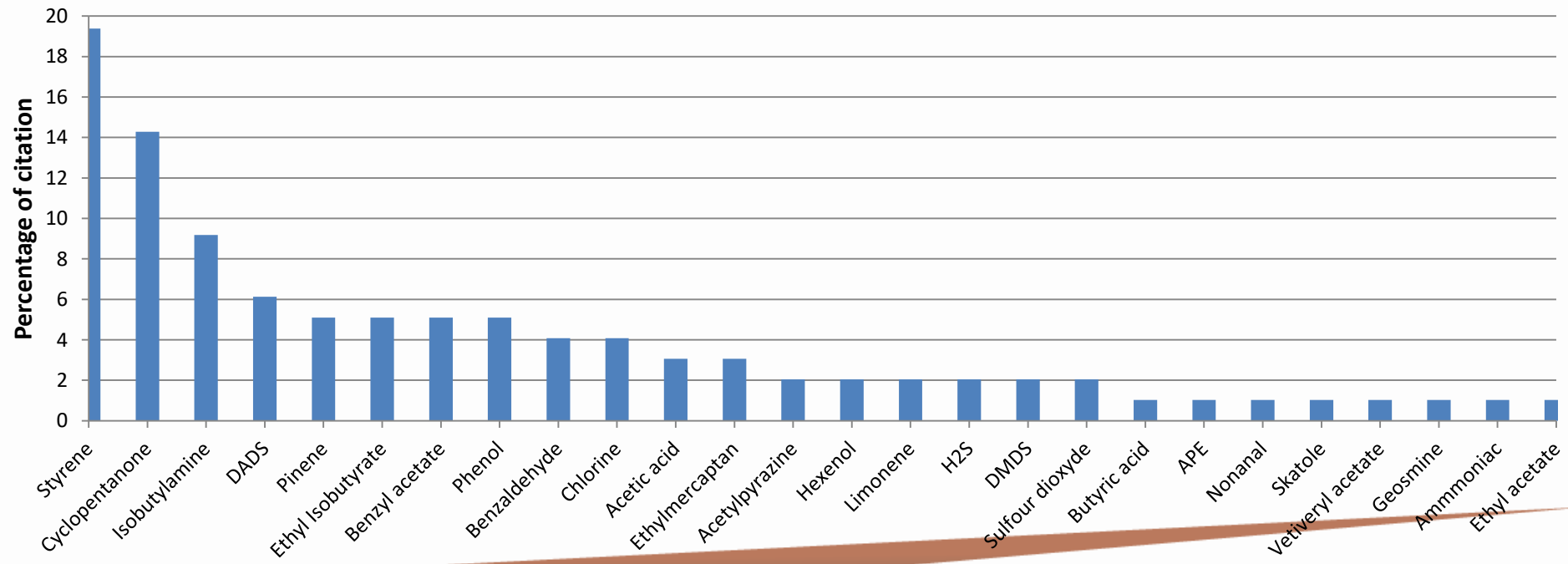
1. Zarra, 2008: Odour monitoring of small wastewater treatment plant located in sensitive environment.
2. Ruth, 1986: Odor Thresholds and Irritation Levels of Several Chemical Substances: A Review.
3. NIOSH, 2010: NIOSH Pocket Guide to Chemical Hazards.



Incidental odors major character

- Majority of the compounds' odors were referred to styrene, cyclopentanone, amines and sulfurous referents

Graphic showing the distribution of odors characteristics by reference



Conclusion and outlook



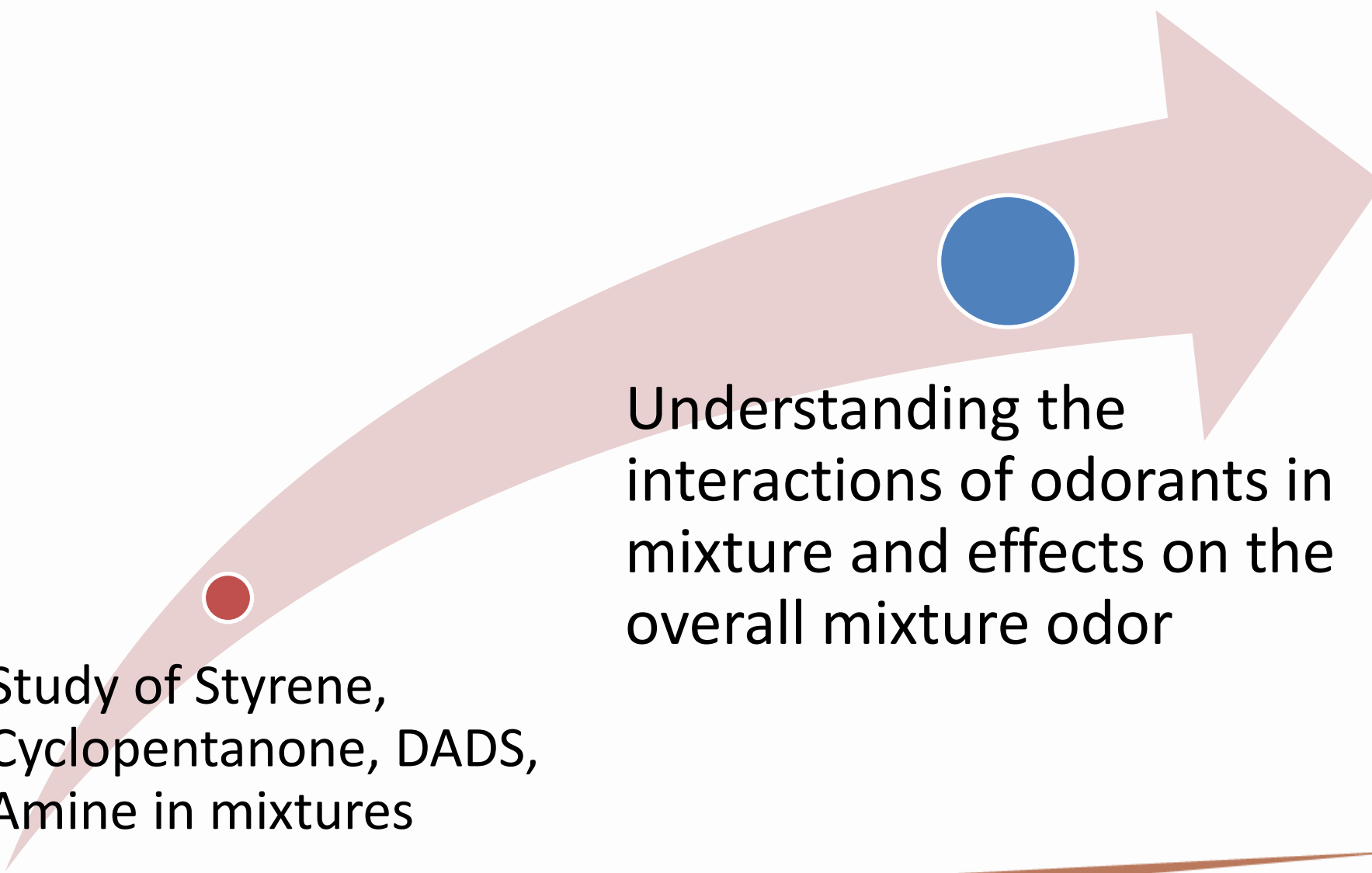
Conclusion

- Method allows to group odorants by their odor reference
- ➔ Easier assessment of source of odor in case of incident

Cyclopentanone	Styrene	DADS
1-propanol	Chlorobenzene	1-butanethiol
2-butanol	Cyclohexene	Methyl acrylate
Diethyl ether	Ethylbenzene	Methyl methacrylate
Diisopropyl ether	Heptane	n-Butyl acrylate
Isopropyl acetate	Indene	Pyridine
Nitromethane	m-Xylene	
	o-Xylene	
	p-Xylene	



Outlook



Study of Styrene,
Cyclopentanone, DADS,
Amine in mixtures

Understanding the
interactions of odorants in
mixture and effects on the
overall mixture odor

THANK YOU



References

1. Quéré, S., Perrin, M.L., Huchet, N., Delmas, V., Ledenvic, P., 1994. Odour Annoyance in Industrial Zones of the River Seine Estuary, in: *Studies in Environmental Science*. Elsevier, pp. 127–136.
[https://doi.org/10.1016/S0166-1116\(08\)72049-1](https://doi.org/10.1016/S0166-1116(08)72049-1)
2. Jaubert, J., 2010. La gêne olfactive : composantes – moyens d’appréciation. *Pollut. Atmos.*
<https://doi.org/10.4267/pollution-atmospherique.91>
3. Jaubert, J.N., 1990. Des éléments de la construction de notre référentiel olfactif. *Parfums Cosmétiques Arômes* 87–94.
4. Léger, C., 2017. Le Langage des Nez®, nouveau référentiel mis en place pour le suivi des odeurs. Expérience d’Air Normand, association agréée de surveillance de la qualité de l’air en Haute-Normandie. *Pollut. Atmos.* <https://doi.org/10.4267/pollution-atmospherique.5231>
5. Verrièle, M., Plaisance, H., Vandenbilcke, V., Locoge, N., Jaubert, J.N., Meunier, G., 2012. Odor evaluation and discrimination of car cabin and its components: application of the “field of odors” approach in a sensory descriptive analysis: odor evaluation of car cabin. *J. Sens. Stud.* 27, 102–110.
<https://doi.org/10.1111/j.1745-459X.2012.00371.x>