Preserving food and cosmetics quality

permeation of organic vapors

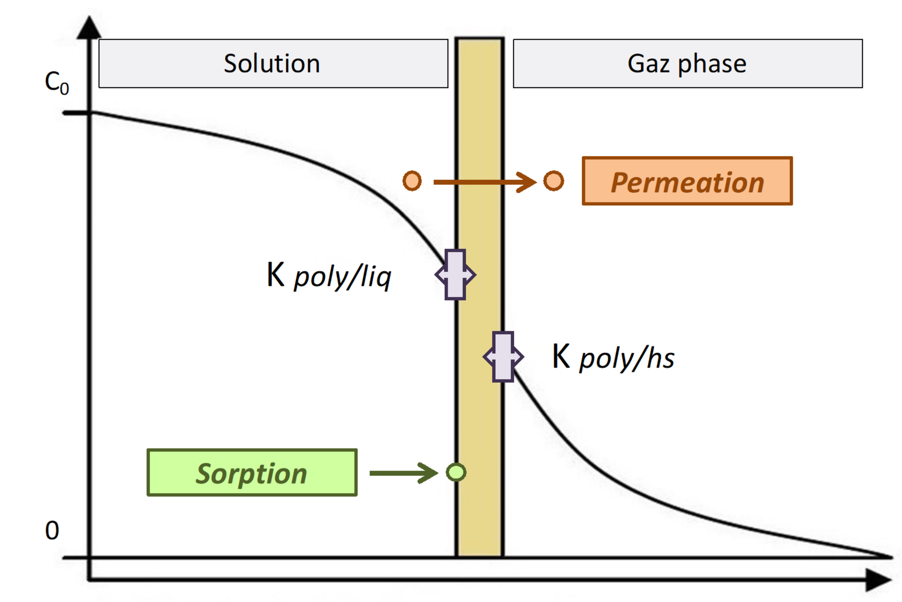
In-house methodological developments

Introduction

The cosmetics industry has specific requirements with respect to packaging. In particular, cosmetic products contain often high concentrations of volatile aroma compounds. Some of them, such as menthol or eucalyptol, are known to interact strongly with the packaging polymers, causing quality problems, such as recrystallization or stress cracking. With respect to the need of decreasing the environmental footprint of cosmetics packaging, new technologies which are alternatives to aluminum complexes are developed. In particular, multilayer materials with decreased thickness of layers of high barrier polymers or using new designs are investigated. Moreover, due to the long shelf life of cosmetic products, the packaging needs high barrier properties to organic vapors. Yet, no commercial equipment exist for the measurement of the permeation of organic vapors through polymer films. Therefore, a specific permeameter was developed in house.

Objectives:

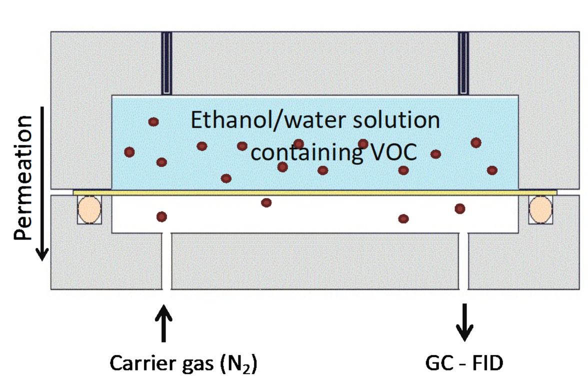
- Design and realize an equipment for the online measurement of the permeation of organic vapors through polymer films
- Validate the measurements with the help of known polymer films
- Analyze the effect of different packaging designs in the cosmetics industry on the permeation of volatile organic compounds which are commonly used in cosmetics formulations



Development of the permeameter

Many service situations of cosmetic packaging correspond to the pervaporation of volatile organic compounds dissolved in the formulation.

Permeation cell

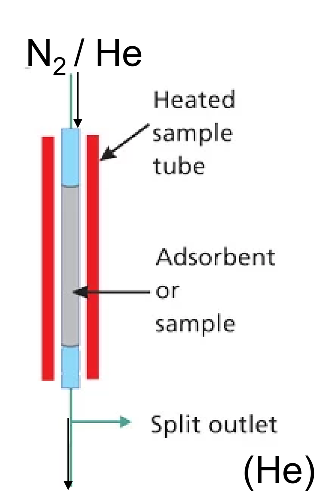


Heated transfer line

Semi-dynamic design of pervaporation cell :

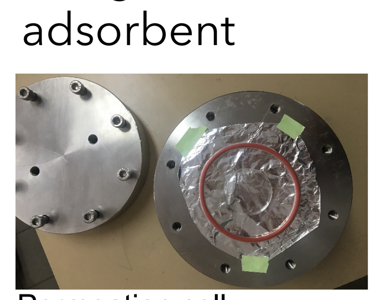
- Known concentration of analytes in the upstream compartment (concentration in the range of real formulations)
- Sweeping of permeated compounds in regular time intervals from the downstream compartment
- Temperature control of environment and carrier gas

Permeant concentration



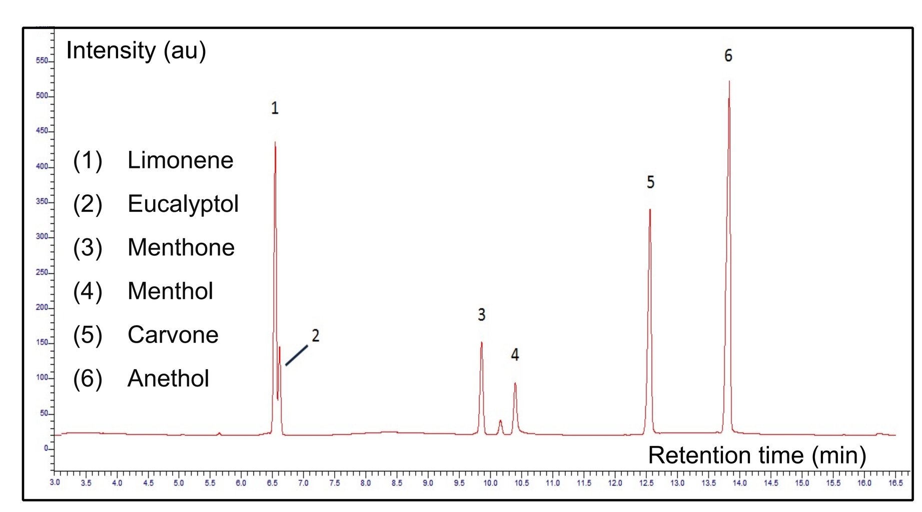
Thermodesorption:

- Cold trap of organic vapours using or not an adsorbent

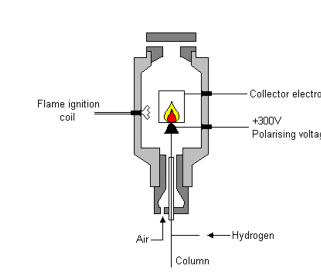


Permeation cell

Fast chromatographic separation

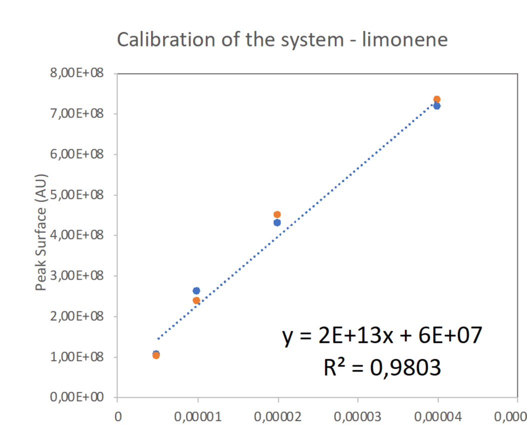


Quantification



FID detector

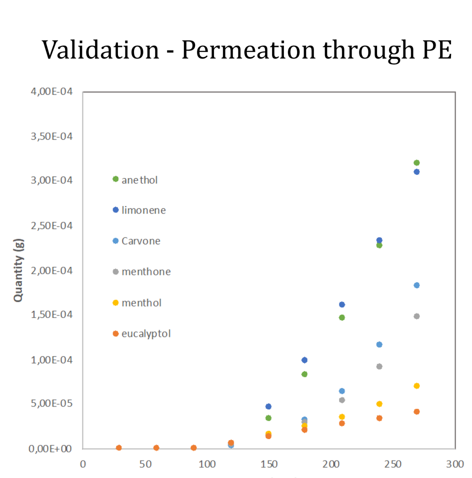
CV = 5.6 %
LOQ = 5 µg

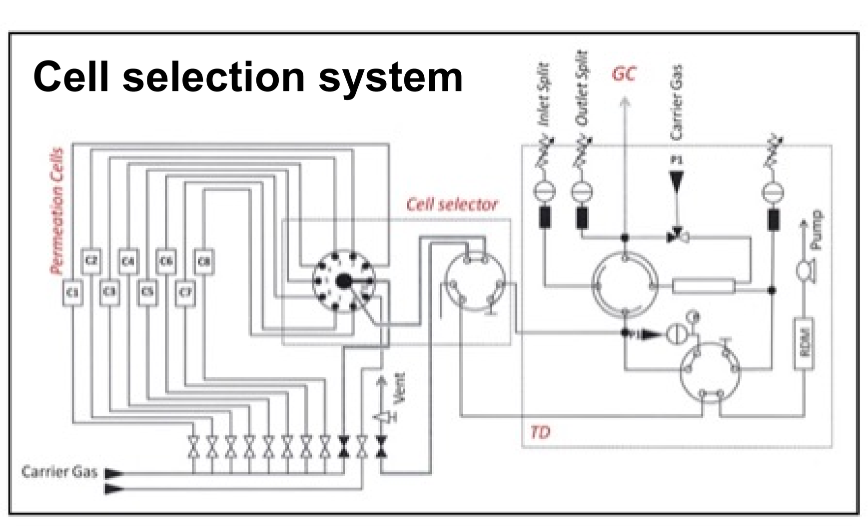


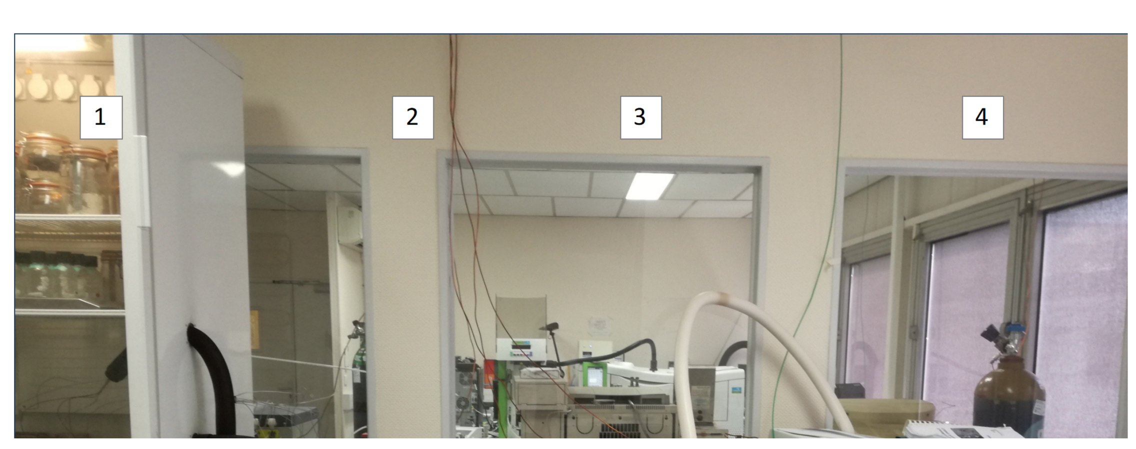
	Limonene	Eucalyptol	Menthone
D (m^2/s)	$2.8 * 10^{-12}$	$3.5 * 10^{-12}$	$2.5 * 10^{-12}$
P (kg.m/(m^2.d))	$3.6 * 10^{-13}$	$3.7 * 10^{-14}$	$1.8 * 10^{-13}$

	Menthol	Carvone	Anethol
D (m^2/s)	$3.1 * 10^{-12}$	$2.4 * 10^{-12}$	$2.6 * 10^{-12}$
P (kg.m/(m^2.d))	$7.2 * 10^{-14}$	$2.3 * 10^{-13}$	$3.9 * 10^{-13}$

Zhou et al, Packag. Technol. Sci., no.17, pp.175–185, 2004: D(limonene) = $3.78*10^{-13}$ (m^2/s)
P(limonenen) = $1.21*10^{-13}$ (kg.m/ m^2.s.Pa)





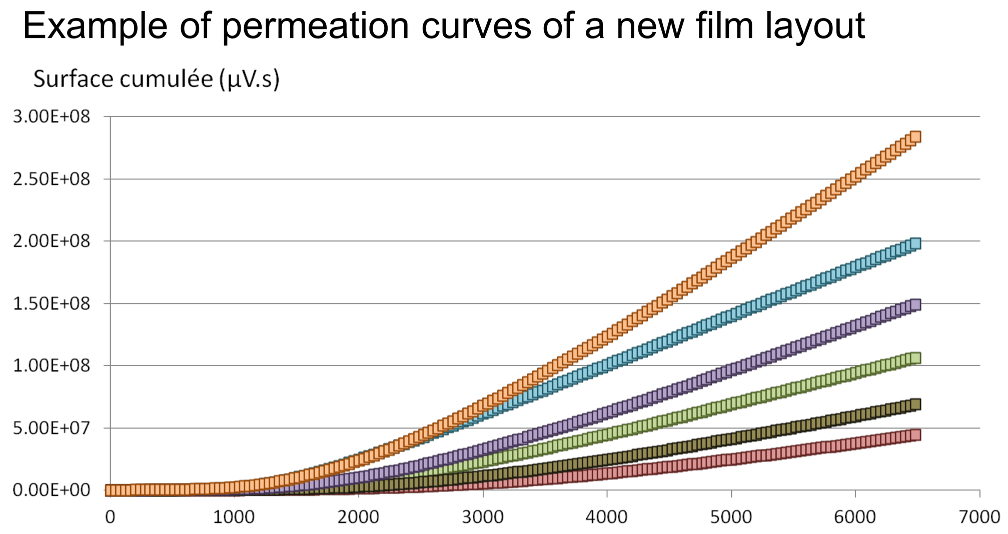


1. Permeation cell in thermoregulated environment (8 parallel cells)
2. Cell selection system
3. Thermodesorption system
4. GC-MS-FID

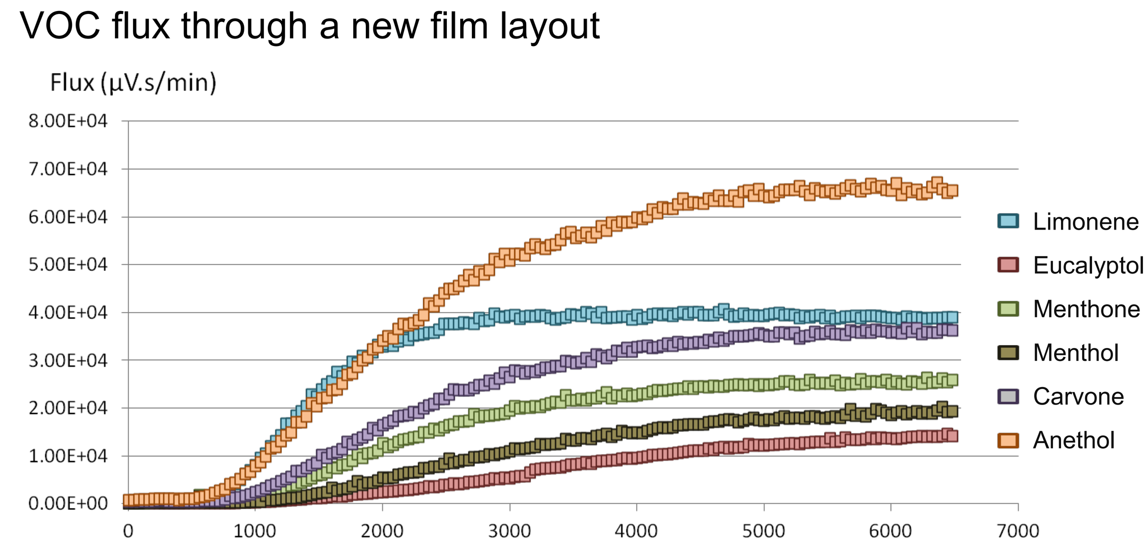
Temperature range: RT → 60 ° C
Sampling frequency: 1/30 min
6 parallel cells + 2 blank circuits

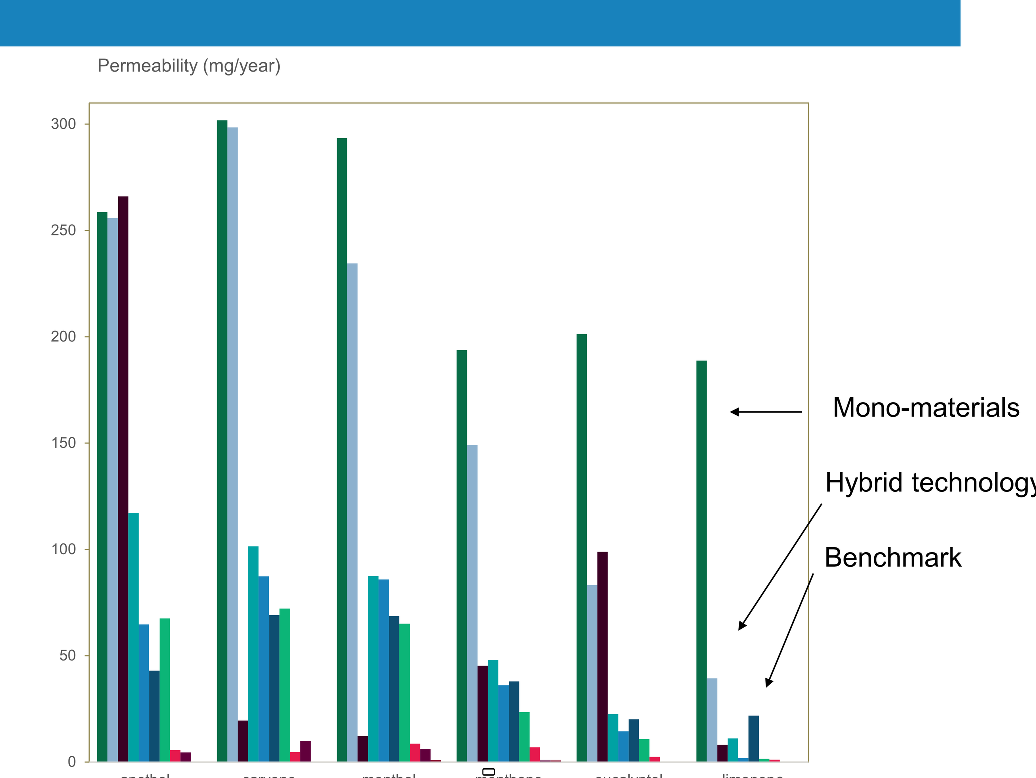
Application on industrial samples

Example of permeation curves of a new film layout



VOC flux through a new film layout





Analysis carried out using a formulation of VOC in ethanol/water (5 vol% ethanol):

- Anethol showed fastest permeation kinetics
- Test of different barrier technologies with respect to a benchmark containing an EVOH layer
  - EVOH most efficient technology
  - Several hybrid technologies tested successfully
  - Mono-material technologies need optimization

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