Indoor air quality in show cases – an attempt to standardise emission measurements

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Introduction

Exhibit cases should protect **cultural objects** from **dust** as well as from **mechanical damage**.

Vienna,
museum for natural history

- several building materials, including woods and coatings, are possible **sources of VOC** in the indoor environment
- a variety of different emission measurements clarify that many substances such as formaldehyde, acetic and formic acid have a **high hazardous potential**

Is it necessary to establish limiting values?

What about risk potentials of substances such as siloxanes?

Experimental methods - overview

1) **Dynamic headspace method** (thermal extraction)

2) Emission measurements in **test chambers** (or test cells)

- investigation of **new materials / products**
- **long-term studies**

3) In-situ measurements, applied to **exhibition rooms**, **show cases** and **storage rooms**

Experimental methods – thermal extraction

Materials	Emission
glass paint, air-dried	cyclohexanone, propylene glycolether derivate
glass paint, heat-dried	cyclohexanone, propylene glycolether derivate
powder varnish	no substances detected
polymer adhesive	alkanes, alkenes, butyl hydroxyl toluene, various aromatic compounds
1-component adhesive	methyl isobutyl ketone, oximes
2-component adhesive	cyclic siloxanes
silicon sealant	oximes, siloxanes, 1-methoxy-2-propyl acetate, acrylic acid ethylhexyl ester

- the results reflect actual conditions only to a **limited extend** and are therefore only moderately suitable for quantitative estimations
- provide essential information about **whether pollutants** could be **emitted from the materials at all**

Experimental methods – emission tests

- **VOC sampling** is accomplished using **Tenax TA** or activated **carbon filters** with a follow-up thermal desorption and **GC/MSD** analysis

Tenax TA tube (200 mg, 60-80 mesh)

- thermal desorption (Gerstel TDS-2) combined with
- gas chromatography (Agilent Technologies 6890N)
- mass spectrometer (Agilent Technologies 5973N)
- analytical column: HP1, 60 m × 0.25 µm × 0.25 mm or DB624, 30 m × 0.25 µm × 1.4 mm
- quantification with **internal standards** (cyclodecane, toluene-d8 in methanol) or external quantification

Experimental methods – emission tests

- characterisation of aldehydes and ketones by use of derivatisation with **dinitrophenyl-hydrazine** (**DNPH**) followed by solvent extraction with acetonitrile and HPLC analysis

DNPH cartridge (LpDNPH S10)

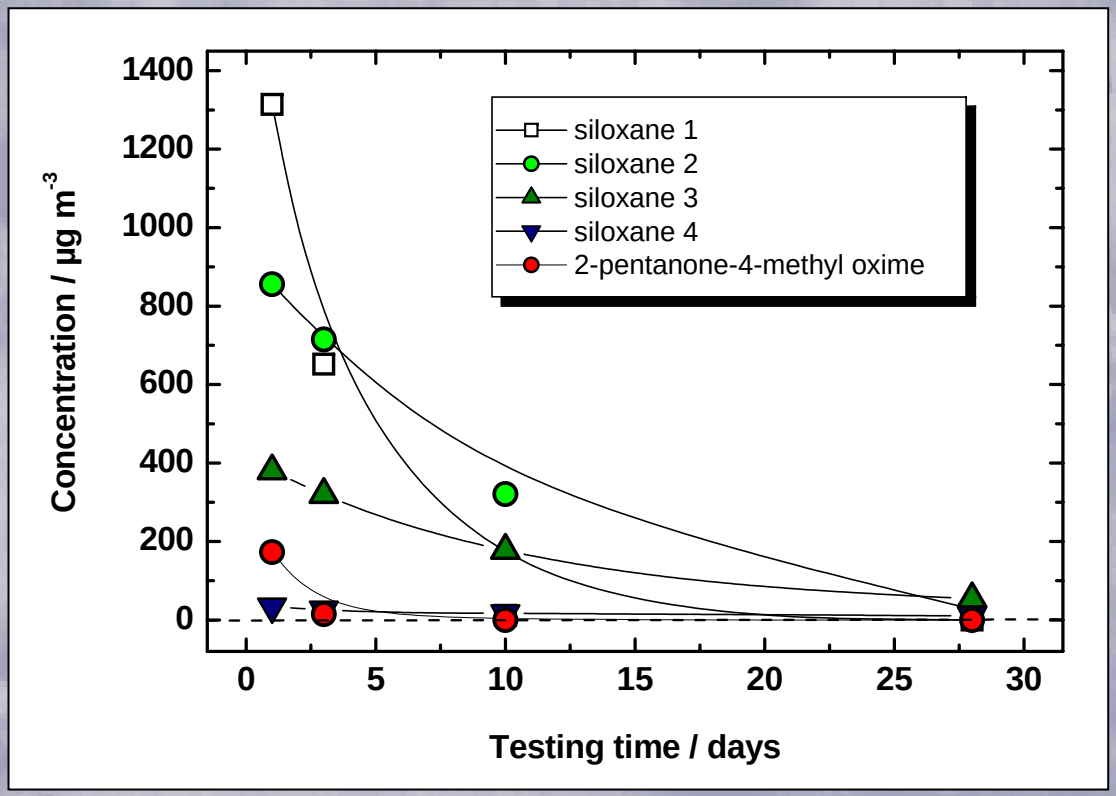
- elution with acetonitrile
- HPLC with coupled UV-detection at **365 nm**
- analytical column (ULTRASEP ES ALD, 125 × 2.5 mm × 3 µm)
- pre-column (3×10 mm)
- solvent A: acetonitrile / solvent B: water; gradient programme
- **external calibration**

Experimental methods – emission tests

- **SVOCs** are collected on **polyurethane foams**. After solvent extraction the analyses are also carried out with **GC/MSD**

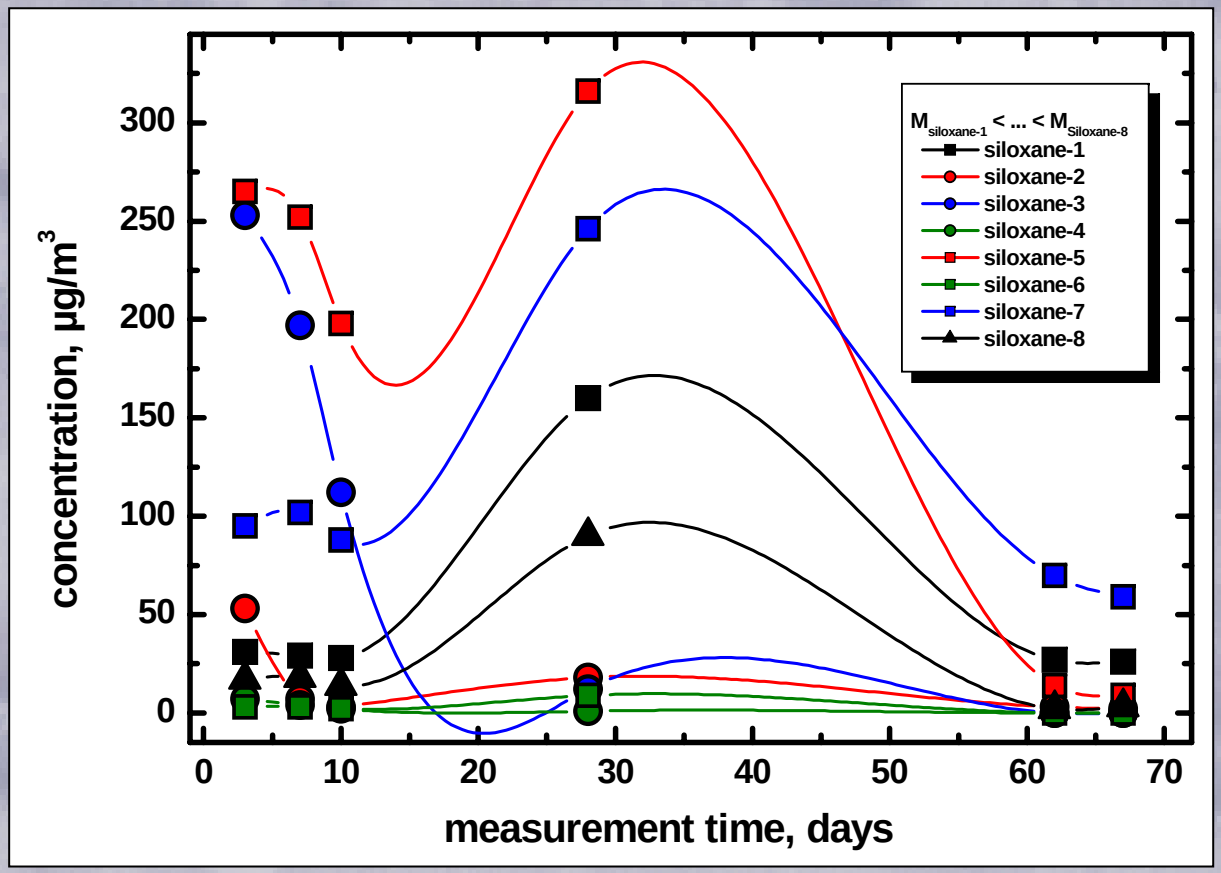
- liquid injection combined with
- gas chromatography (Agilent Technologies 6890N)
- mass spectrometer (Agilent Technologies 5973N)
- analytical column (HP1, 30 m × 0.25 µm × 0.25 mm)
- **external quantification**

Results – emission of siloxanes



- concentration profiles of siloxanes and pentanone-methyl-oxime as a function of testing time
- characterisation by means of TENAX sampling
- **clear decrease** in concentration over 28 days
- siloxane compounds as well as pentanone-methyloxime **do not present any damage potential after 4 weeks**

Results - influence of “time“



after 20 days: signifiant increase of siloxane concentration

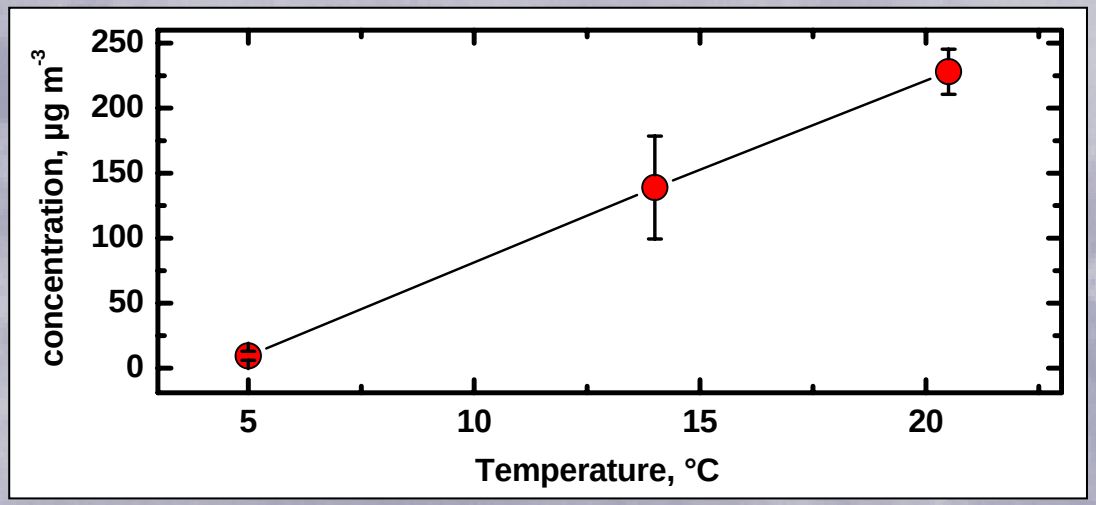
new formation of different siloxanes:

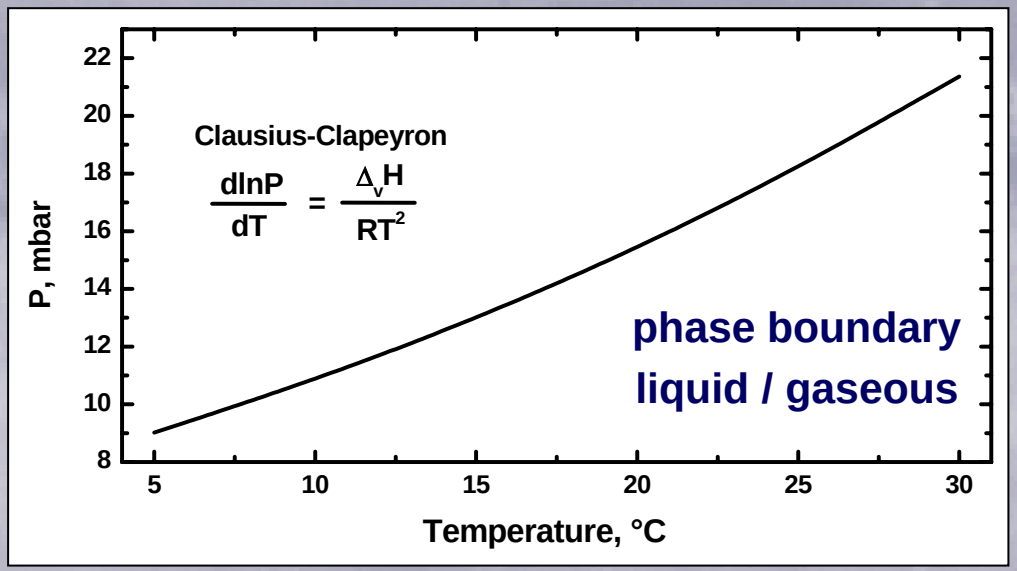
- **polymerization process?**
- **ageing process?**

⇒ **up to now only few data available**

Results - influence of temperature

Emission of **acetic acid** as a function of temperature

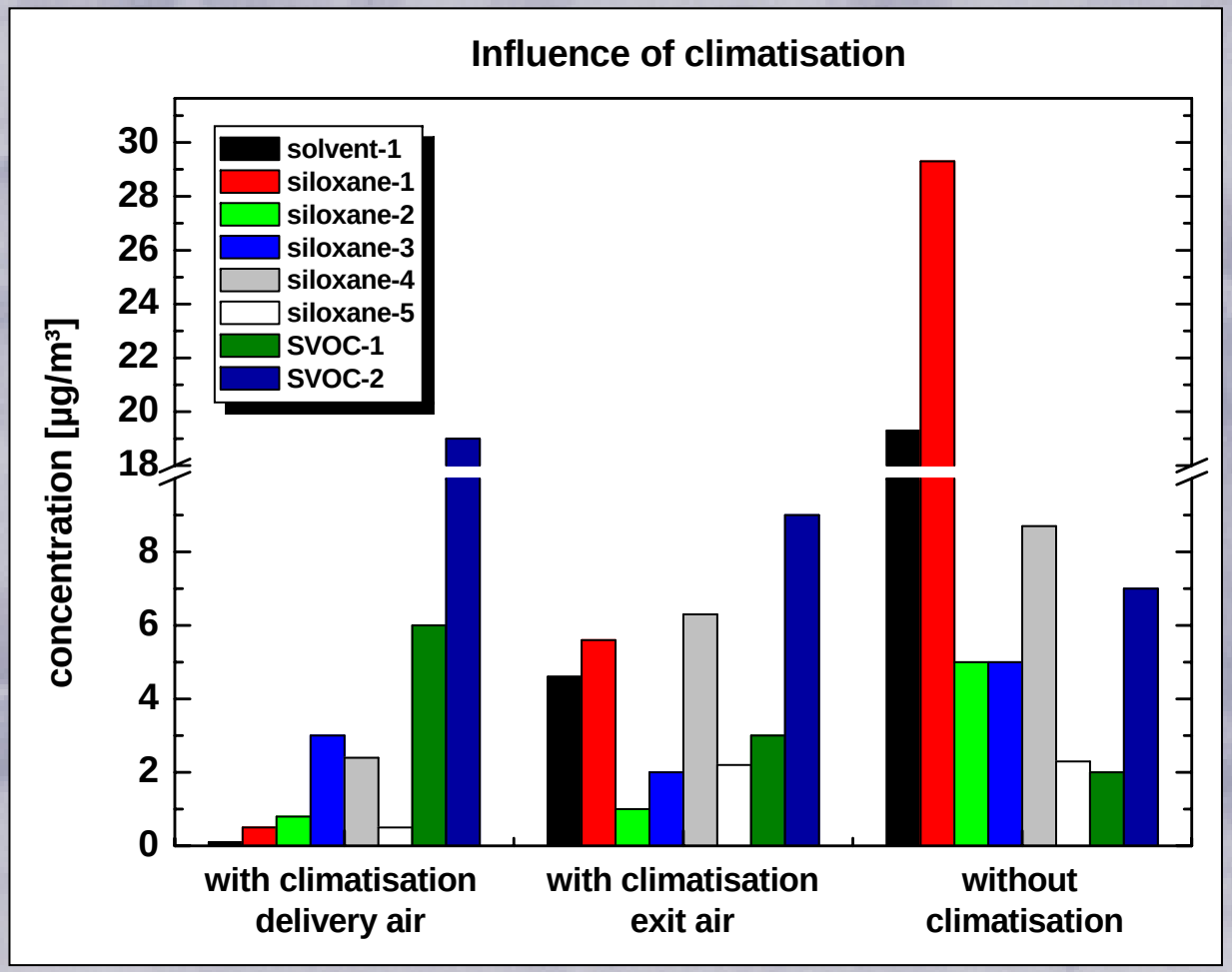




rough estimation possible

- **migration**
- **diffusion**
- **adsorption**

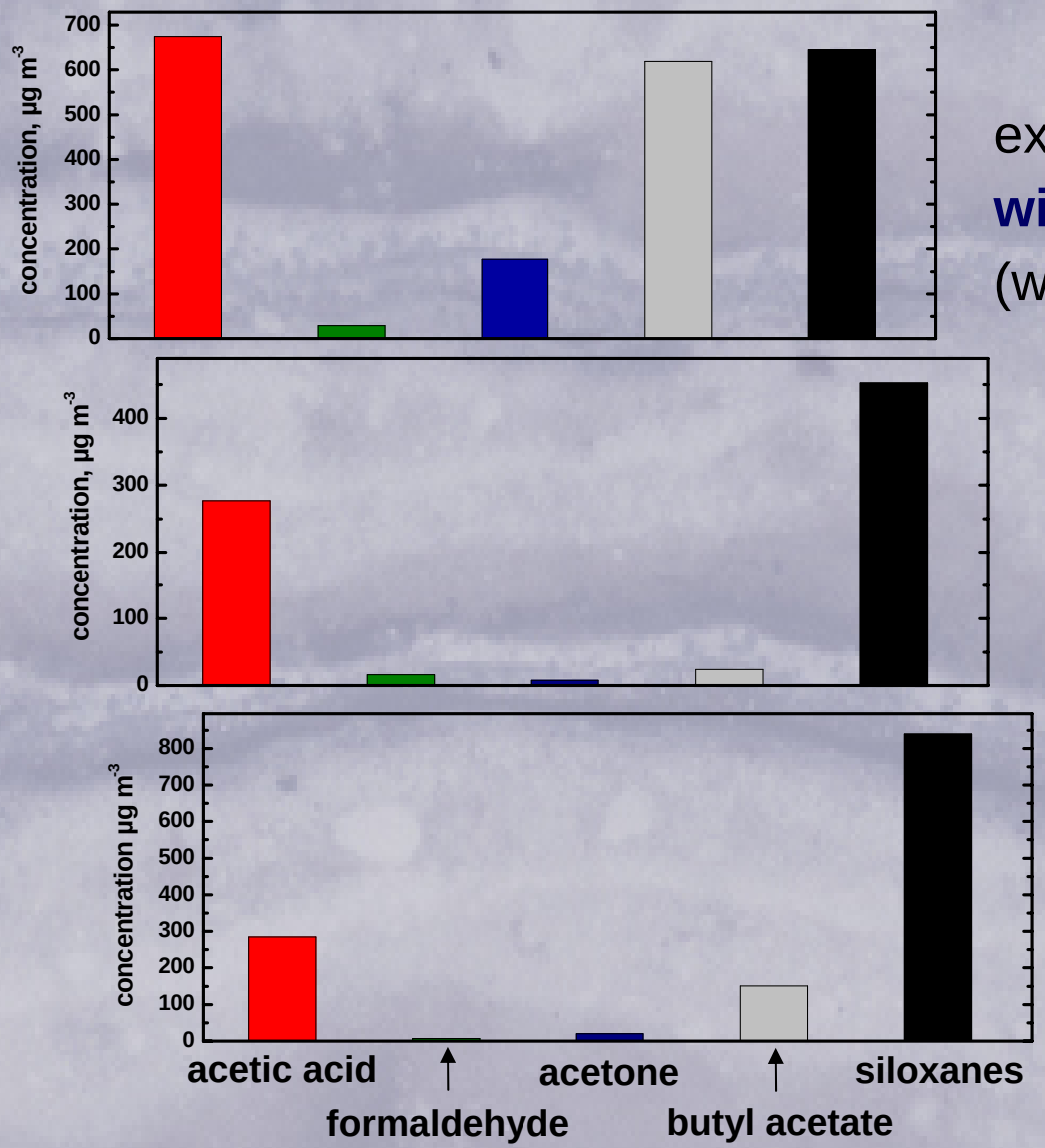
Results - influence of climatisation



investigation of exhibition case with internal climatisation:

⇒ **ventilation decreases emission**

Results - influence of sample preparation



exhibition case **with fixtures** (wood, textiles)

exhibition case **with fixtures** and **adsorber/filter material**

exhibition case **without fixtures**

Conclusion

scientists

improvement of measuring techniques

- reliability
- reproducibility
- round robin tests
- detection limits

manufactors

consideration of further „quality demands“

- closeness of exhibition cases
- adherency of sealants
- processability of building materials

restorers / conservators

protection of cultural heritage

- avoidance of hazardous materials
- optimal storage

Conclusion

emission measurements in **emission test chambers** / test cells

- investigation of **new materials / products**
- **long-term studies**
- **standard conditions**

in-situ measurements applied to **exhibition rooms**, **show cases** and **storage rooms**

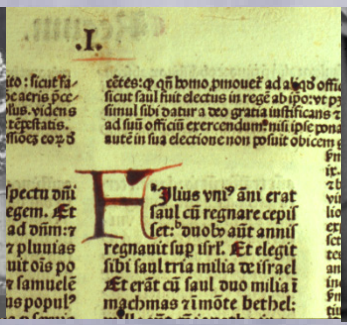
- **under working conditions**

Is it necessary to establish limiting values?

What about risk potentials of substances such as siloxanes?

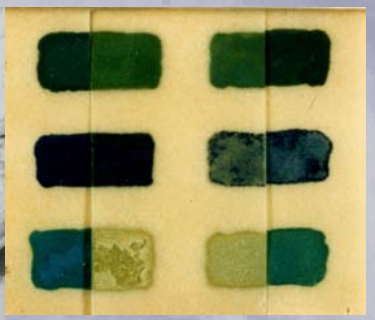
Conclusion

glass corrosion



pigment degradation

lead corrosion



fading

- **many corrosion processes are characterised**
- **risk potential of acetic acid, formic acid, formaldehyde, insecticides is well known**
- **for many substances it is not possible to establish limiting values!**
- **we have to estimate the impact of differents compounds (such as siloxanes) on a variety of different materials**

Acknowledgement

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Thank you for your attention!

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