



From model rooms towards a modelled indoor environment

Joint COST FP1303 conference with IPPS 2015
International Panel Products Symposium
7th & 8th October 2015, Llandudno, Wales, UK

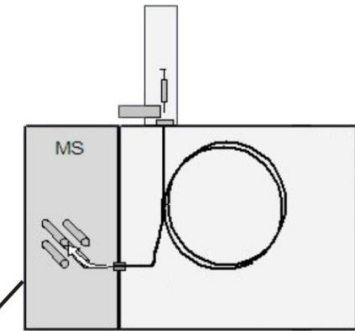
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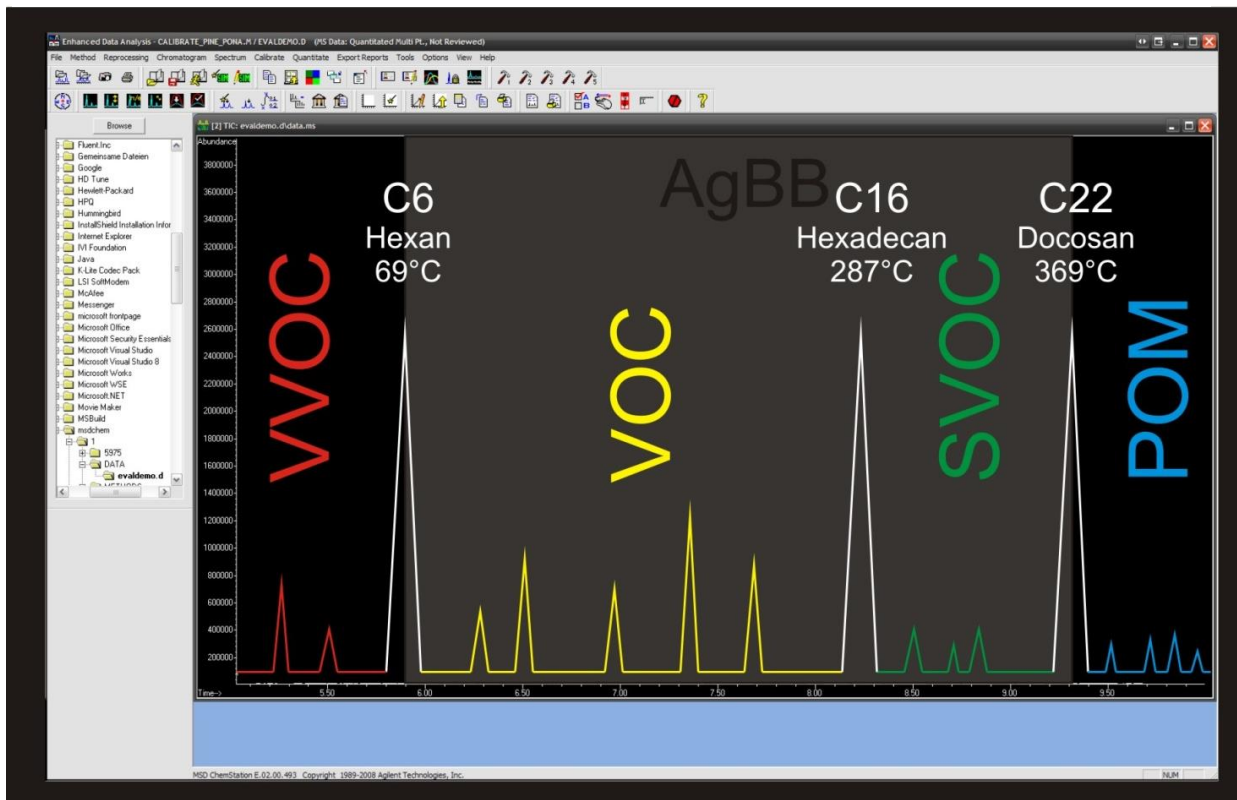
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VOC – Definition(s)

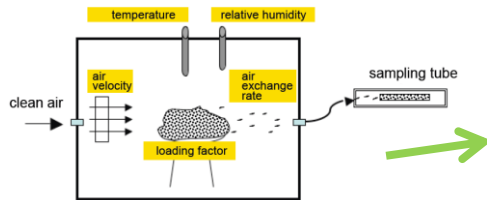
Abbreviation	Word or phrase	WHO – definition: Boiling point
VVOC	Very Volatile Organic Compounds	< 0 up to 50... 100 °C
VOC	Volatile Organic Compounds	50... 100 up to 240... 260 °C
SVOC	Semi-Volatile Organic Compounds	240... 260 up to 380... 400 °C
POM	Organic compound associated with particulate matter or particulate organic matter	> 380 °C



GC/MS



The Model Room Concept

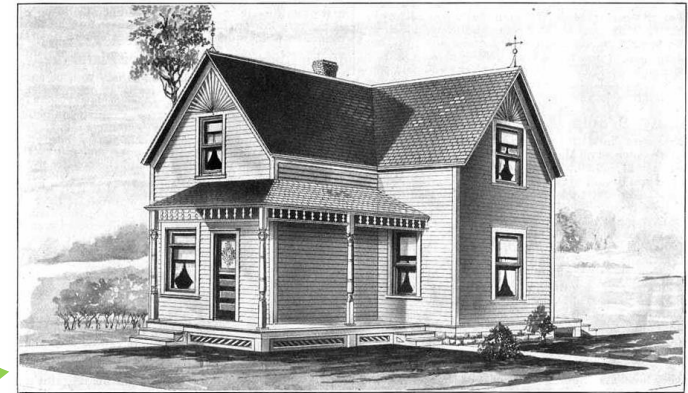


Test chamber
0,225 m³
(ISO 16000-6)



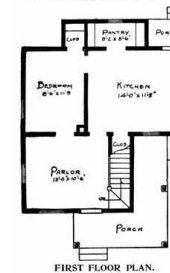
Model room
30 m³

(VOC Evaluation schemes like AgBB, Der Blaue Engel ect.)



MODERN HOME No. 115
With Wood Foundation, Not Excavated.

On the opposite page we illustrate a few of the materials we specify on this, our \$725.00 house.



The arrangement of this house is as follows:

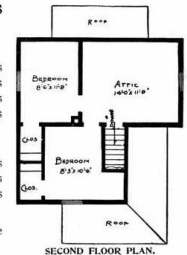
FIRST FLOOR.

- Parlor - - - 12 feet by 10 feet 6 inches
- Bedroom - - - 8 feet 6 inches by 11 feet 9 inches
- Kitchen - - - 14 feet by 11 feet 9 inches
- Pantry - - - 8 feet 2 inches by 3 feet 6 inches

SECOND FLOOR.

- Front Bedroom, 8 feet 3 inches by 10 feet 6 inches
- Rear Bedroom, 8 feet 6 inches by 11 feet 9 inches
- Large Attic - - - 14 feet by 11 feet 9 inches

All bedrooms have roomy closets.
Size: Width, 24 feet; length, 28 feet, exclusive of porch



Dwelling-place (or office)
>50 m³

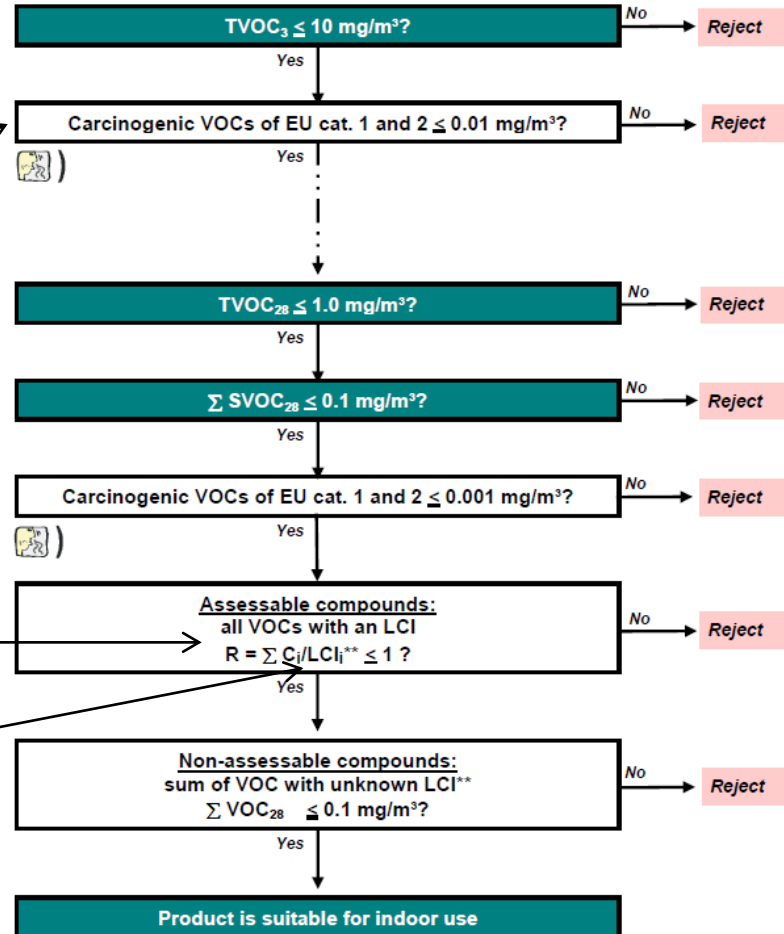
VOC Evaluating scheme - structure

Stakeholder participation

Structures based on tripartite models (government, industry and labor), with the addition of independent expertise¹

Test 1
after 3 days

To be checked:



Test 2
after 28 days

Hidden
safety
margin?

Over 200 volatile compounds

since 1980

till 1980

ECHA**

American Conference of
Governmental
Industrial Hygienists
(ACGIH)

OEL*

EU category 3 - Substances

non-mutagenic Substances

OEL / 1000

OEL / 100

LCI value

*.1 Occupational Exposure Limits - Do They Have a Future? - http://www.ioha.net/assets/files/OEL%20Green_Paper%2008%2019%2009.pdf

** ECHA - European Chemical Agency

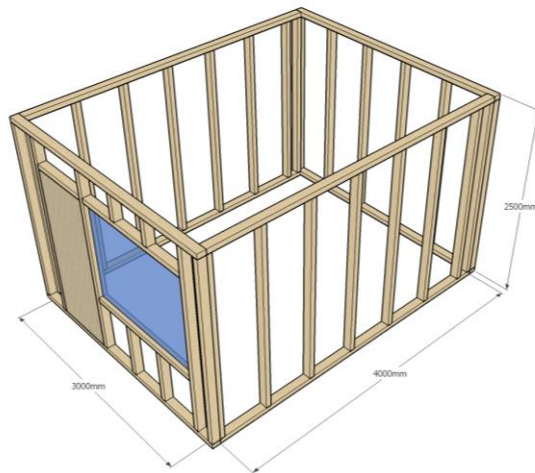
*** LCI - Lowest Concentration of Interest

Conducted experiments

- Part 1 – Quantification of the „hidden safety margins“ by the health assessment according AgBB (and derivative schemes)
- Part 2 – Numerical quantification of relevant European IAQ schemes' restrictiveness towards indoor related industrial production

Part 1 - Description

- Model rooms and newly constructed modular office containers used as campus offices have been examined
- Was there any emissions decline after day 28
 - The relative emissions decline would correspond to the safety margin



Part 1 - Description

Table 1: Characteristic parameters of the tested model rooms

Object*	Material	Volume	Ventilation	T, RH%*
MR ₁	OSB*	30 m ³	0,5 h ⁻¹	23°C, 50%
MR ₂	GKF/OSB*	30 m ³	0,5 h ⁻¹	23°C, 50%
C ₁	CLT*	69 m ³	0,4 h ⁻¹ **	~22°C
C ₂	Clay/Timber shell	69 m ³	0,4 h ⁻¹ **	~22°C
C ₃	Clay/Steel shell	68 m ³	manual	~22°C
C ₄	Steel	68 m ³	manual	~22°C

* MR_i- model rooms; C_i - office containers; T - temperature; RH% - relative humidity; OSB - oriented strand board; GKF/OSB - gypsum fibreboard in an OSB shell; CLT - cross laminated timber;

** Basic setting: Automatic ventilation with control system based on CO₂-concentrations.

Emissions modelling according EN 717-1

Intended for formaldehyde

Iterative nonlinear regression algorithm for calculating A, B, and D

$$c = A/(1 + Bt^D)$$

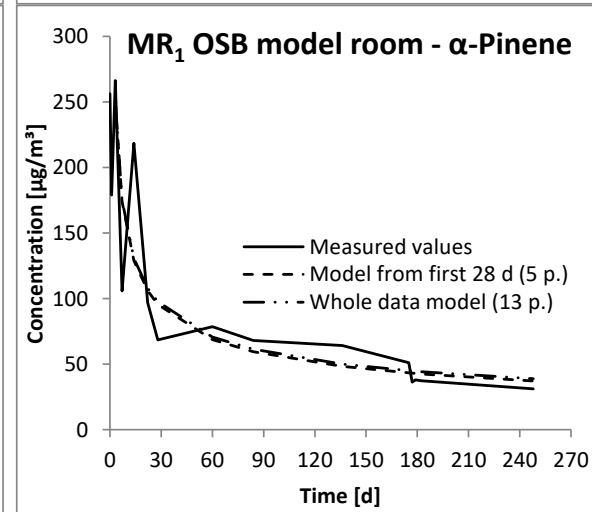
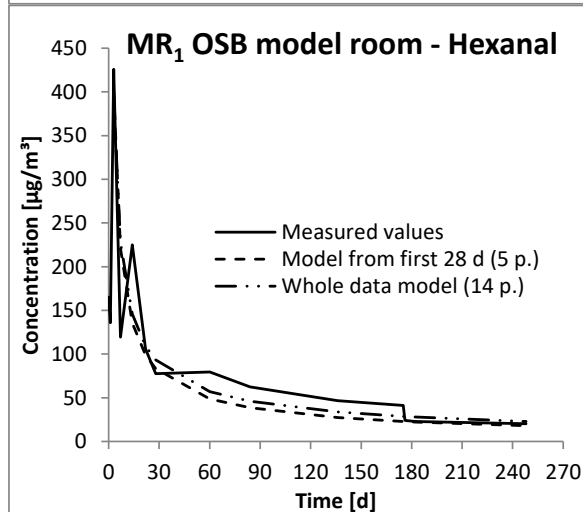
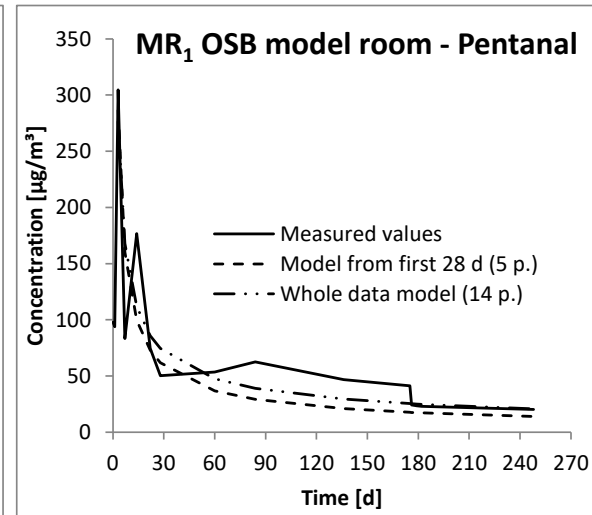
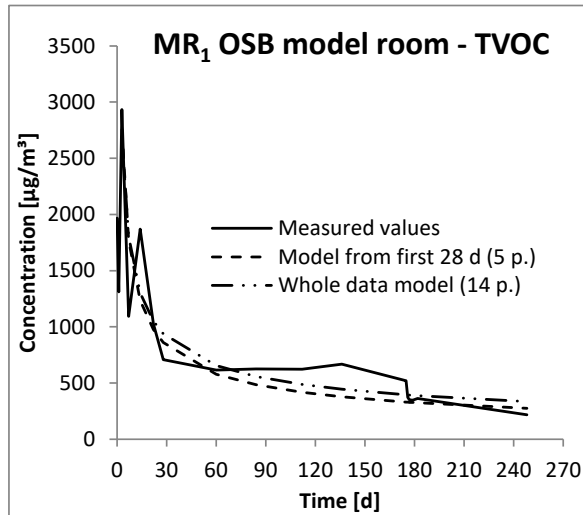
where:

c is the chamber concentration, in milligrams per cubic metre;

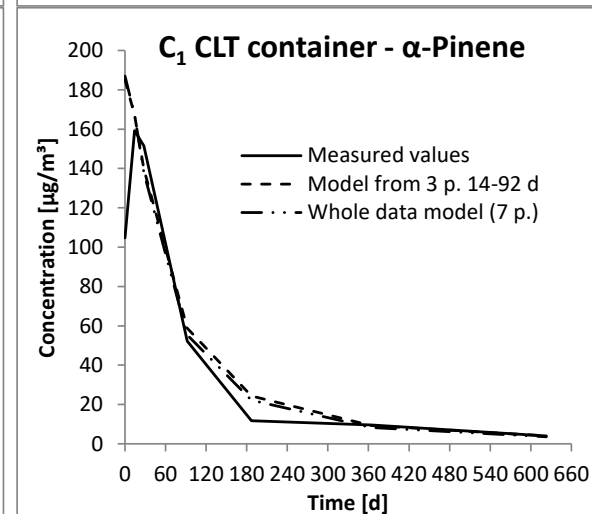
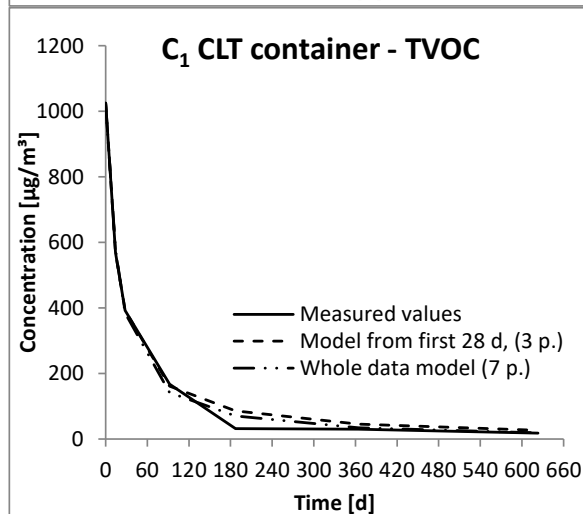
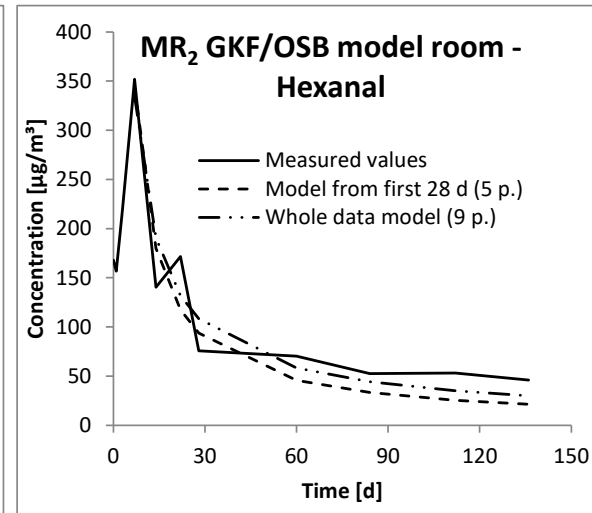
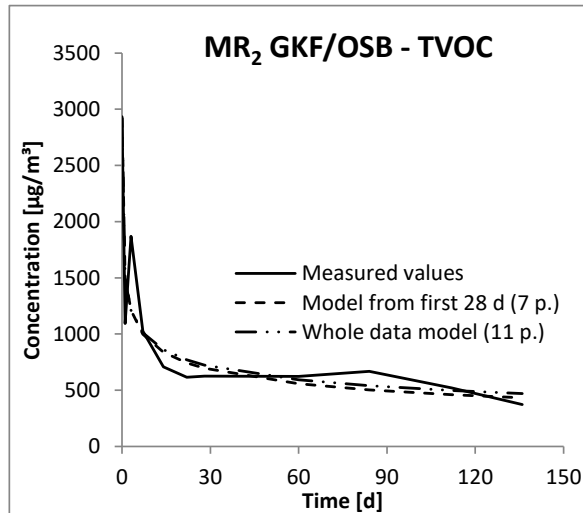
t is the time, in hours; and

A , B and D are positive constants.

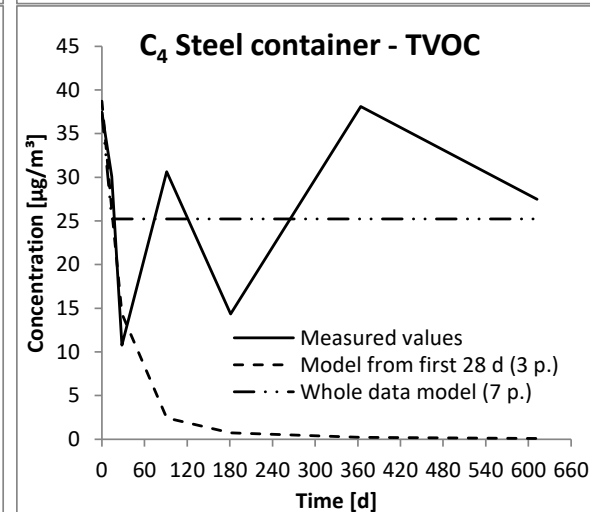
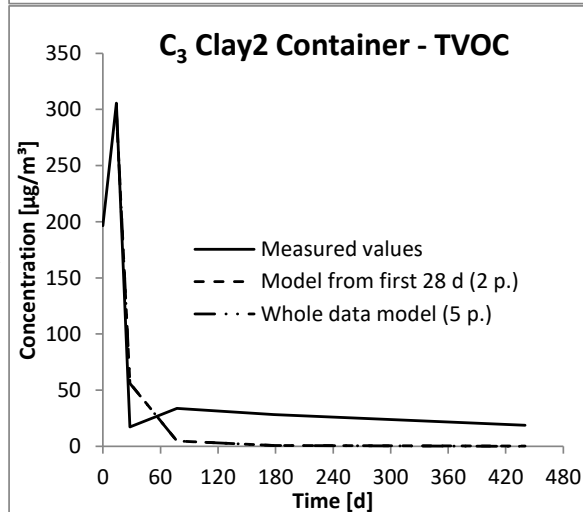
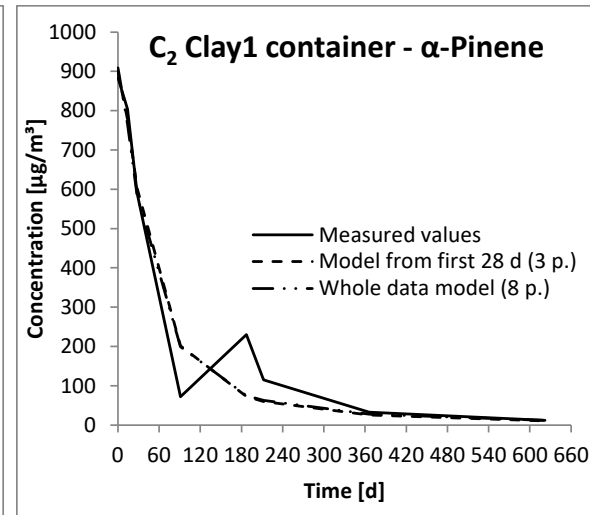
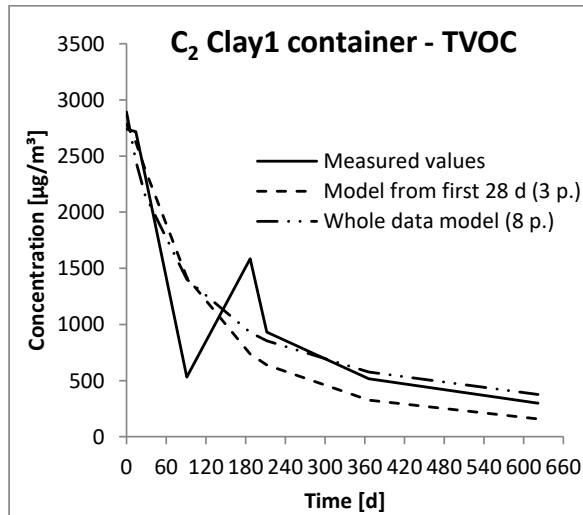
Part 1 – Results



Part 1 – Results



Part 1 – Results



Inorganic
Materials



Inorganic
materials



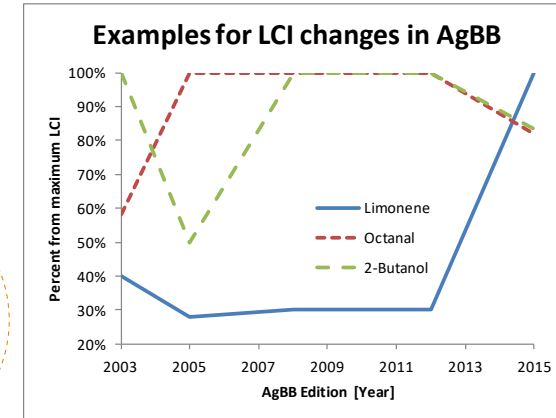
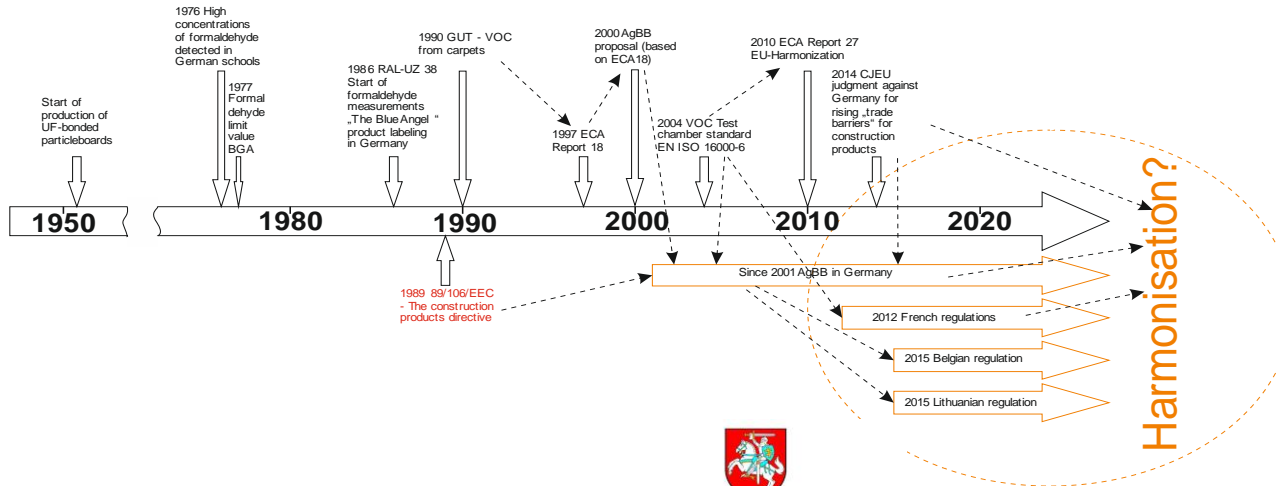
Part 1 – Conclusion

- Safety margins from 2 to 20 were detected for materials containing softwood

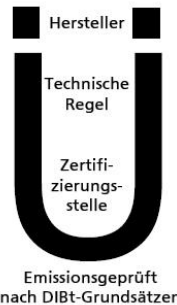
Model room or container	VOC	Safety margin for the period of the experiment					6 M safety margin	12 M safety margin	
		measured	model _{w.d.}	model ₂₈	error model ₂₈	period [months]			
MR ₁ -OSB	TVOC	3.3	2.8	3.1	3%	8.3	2.4	3.4	
	Pentanal	3.7	3.6	4.5	23%	8.3	3.0	4.5	
	Hexanal	5.2	4.1	4.6	0%	8.3	3.3	5.2	
	α-Pinene	3.1	2.5	2.6	-9%	8.3	2.2	3.0	
MR ₂ -GKF/OSB	TVOC	1.7	1.5	1.6	0%	4.5	1.7	2.1	
	Hexanal	1.7	3.6	4.4	68%	4.5	4.5	8.1	
	α-Pinene	1.3	1.6	1.6	13%	4.5	1.7	2.2	
C ₁ -CLT	TVOC	21.3	19.6	14.4	-30%	20.8	5.3	11.0	
	α-Pinene	37.7	38.2	34.4	-9%	20.8	5.9	16.7	
C ₂ -Clay/Timber	TVOC	7.8	5.7	14.9	121%	20.7	2.3	3.7	
	α-Pinene	50.3	48.0	56.5	15%	20.7	7.4	21.1	
C ₃ -Clay/Steel	TVOC	no safety margins detected							
C ₄ -Steel	TVOC								

- EN 717-1 Modelling for formaldehyde emissions gives adequate approximation for VOC emissions from softwood

Part 2 – Description



LIETUVOS RESPUBLIKOS
SVEIKATOS APSAUGOS MINISTERIJA



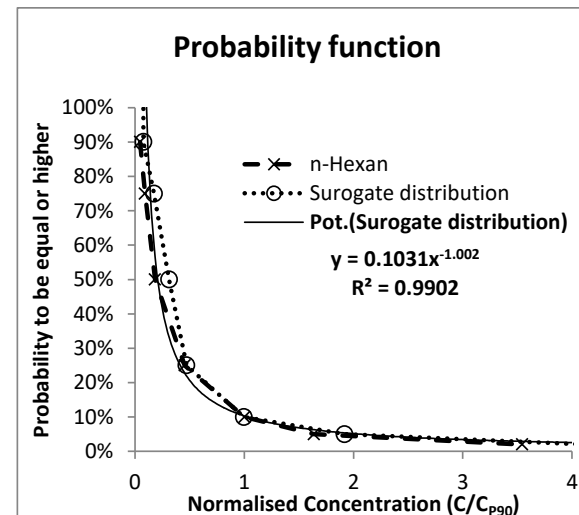
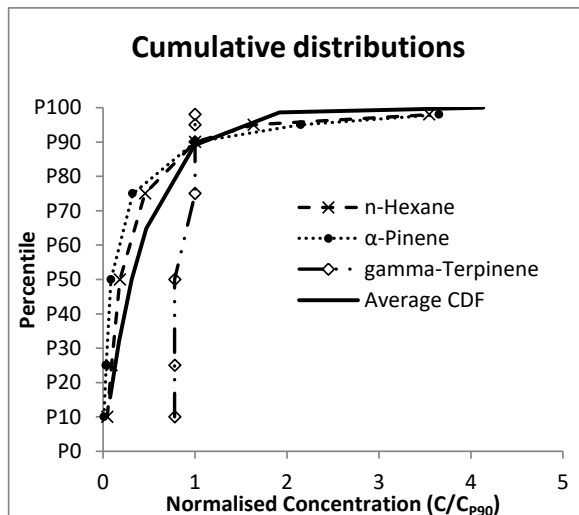
Part 2 - VOC Fingerprint of the Industrial Production

Hofmann, H. and Plieninger Peter (2008): Bereitstellung einer Datenbank zum Vorkommen von flüchtigen organischen Verbindungen in der Raumluft. WaBoLu-Hefte.

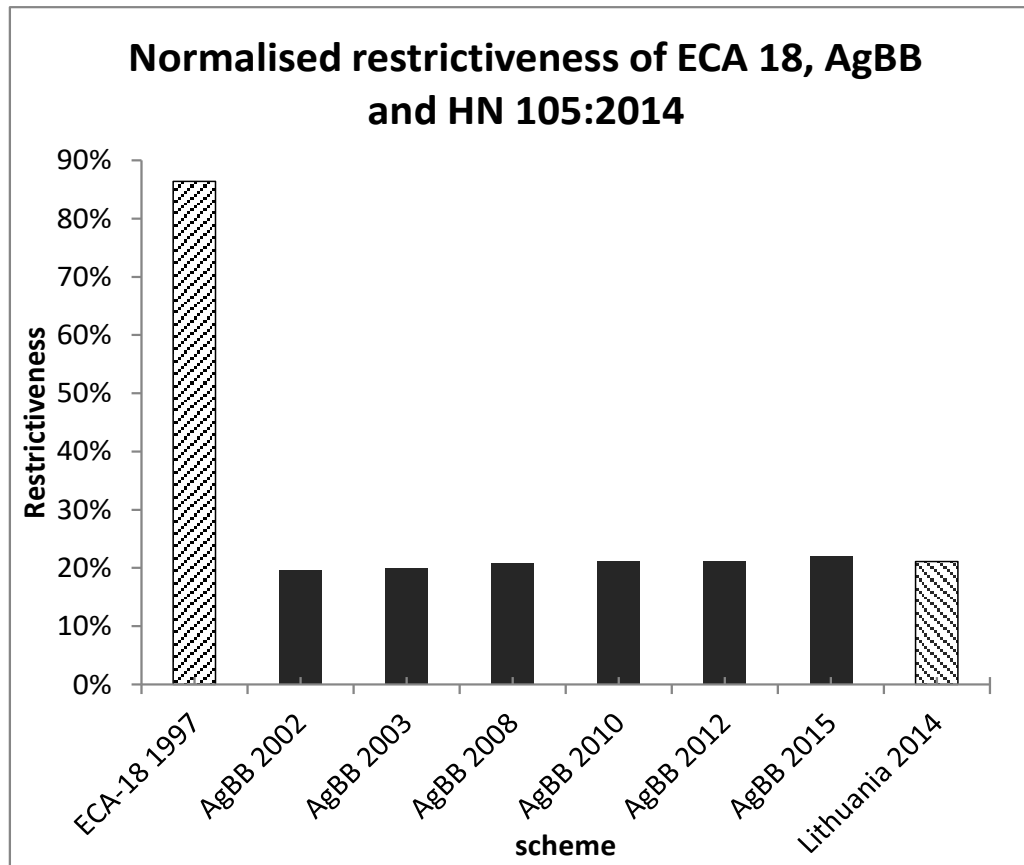
11.5 Kenndaten für Einzelstoffe

Tabelle 44: Kenndaten für Einzelstoffe; N = Stichprobenumfang; n>BG = Anzahl der Werte oberhalb der Bestimmungsgrenze; %<BG = prozentualer Anteil der Werte unterhalb der BG vom Gesamtstichprobenumfang; Max = Maximalwert in µg/m³, AM = arithmetischer Mittelwert in µg/m³; P = Perzentile der Verteilung in µg/m³; die Werte unterhalb der Bestimmungsgrenze wurden als BG/2 berücksichtigt; die Werte wurden jeweils auf die erste Nachkommastelle gerundet

CAS-Nr.	Name	N	n>BG	%<BG	Max	AM	P 10	P 25	P 50	P 75	P 90	P 95	P 98
SG 1	Alkane												
110-54-3	n-Hexan	2288	1495	34,7	4600	10,0	0,5	1,0	2,0	5,0	11,0	18,0	39,0
142-82-5	n-Heptan	2358	1866	20,9	1000	8,2	0,5	1,0	3,0	6,0	13,0	22,9	46,0
111-65-9	n-Octan	2343	1466	37,4	535	3,9	0,5	0,5	1,0	3,2	7,1	12,6	21,0
111-84-2	n-Nonan	2344	1425	39,2	1230	5,9	0,5	0,5	1,0	3,0	7,6	15,0	37,4
124-18-5	n-Decan	2349	1837	21,8	1401	12,8	0,5	1,0	2,0	6,0	20,1	41,0	93,7
1120-21-4	n-Undecan	2362	2043	13,5	3501	16,7	0,5	1,0	3,0	9,0	29,0	58,0	112,3
112-40-3	n-Dodecan	2363	1922	18,7	3501	10,5	0,5	1,0	2,0	6,0	16,0	30,9	66,7
629-50-5	n-Tridecan	2364	1595	32,5	1110	3,3	0,5	0,5	1,0	2,3	5,0	9,0	19,0
629-59-4	n-Tetradecan	2358	1632	30,8	407	2,7	0,5	0,7	1,1	2,9	5,0	7,0	12,0
629-62-9	n-Pentadecan	2352	1392	40,8	76	1,8	0,5	0,5	1,0	2,0	3,4	5,0	8,0
544-76-3	n-Hexadecan	1991	1008	49,4	32	1,4	0,5	0,5	1,0	2,0	3,0	4,0	5,2
629-78-7	n-Heptadecan	926	524	43,4	18	1,2	0,5	0,5	1,0	1,0	2,0	3,0	5,0
583-45-3	n-Octadecan	838	310	63,0	21	0,9	0,5	0,5	0,5	1,0	2,0	2,0	4,0

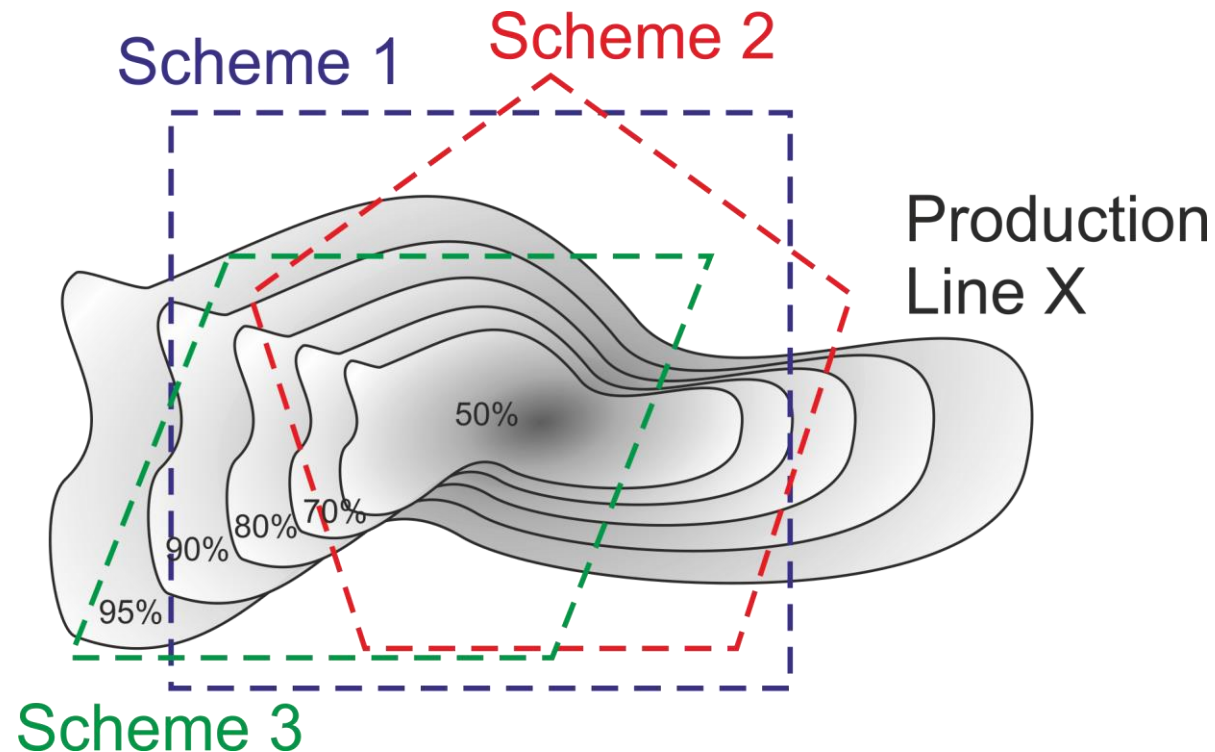


Part 2 – Results



Part 2 – Further Application

- Restrictiveness assessment of individual production
- Automatic assessment for several schemata



General Conclusions

- QBD (Quality By Design) approach could be applicable by the emissions health assessment of construction products

- Industry should be able to numerically quantify the impact of assessment schemata changes on its production
 - Rapid adaptation on regulative changes
 - Plausibility assessment of upcoming changes



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