

### Testing Specific Construction Products for Ecotoxicity

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1

### Motivation for Ecotoxicological Testing

- Huge variety of construction products
- Laboratory leaching tests CEN/TS 16637-2, -3, EN 16105
- Leached substances often unknown




2  
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2

### Bioassays Toolbox

- Minimum battery focusing on acute ecotoxicity (CEN/TR 17105)
  - Algae: Photosynthesis inhibition (short term) or growth rate (ISO 8692)
  - Daphnia: Mobility after 24 h or 48 h (ISO 6341)
  - Luminescent bacteria: Bioluminescence (EN ISO 11348-2)
- Results are expressed as Lowest Ineffective Dilution (LID)

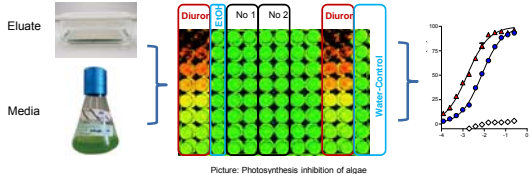


3  
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3

### Bioassays: General Procedure

- Eluate diluted with media step-by-step to derive dose-response curve
  - e.g. LID 2, 4, 8, 12, 16, 32, 64
- Limit values (DIBt concept, CEN/TR 17105)
  - LID > 4 for algae and daphnia
  - LID > 8 for luminescent bacteria

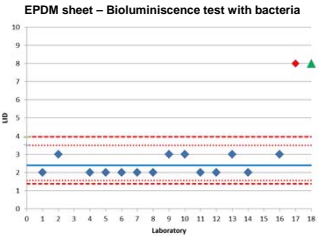


4  
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4

### Bioassays: Reproducibility

- Round robin test demonstrates reproducibility of bioassays
  - 12 Laboratories across Europe taken part (blue: geometric mean)




Gattiser et al. (2017). Results from a round robin test for the ecotoxicological evaluation of construction products using two leaching tests and an aquatic test battery. Chemosphere, 175:138-146.

5  
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5

### Three Examples of Ecotoxicological Evaluations

- Render with biocides used as film preservatives
  - Immersion test with 9 eluates (EN 16105)
- Corrosion protection coatings (epoxy resins, polyurethane)
  - Single samples with 7 days water contact
- Rooftop membranes – EPDM, PVC, FPO (flexible sheets)
  - DSLt with 8 eluates (CEN/TS 16637-2)



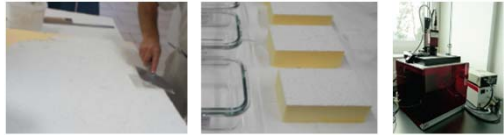
Funded by German EPA (UBA) and Swiss EPA (FOEN)

6  
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6

### Render

- Polymeric render containing free and encapsulated biocides
  - Initial amount 750 ppm Terbutryn, OIT, and DCOIT added
- Products applied on XPS substrate (100 cm<sup>2</sup>)
- Chemical analysis of biocides, transformation product M1, TOC
- Three bioassays with 1<sup>st</sup> and 9<sup>th</sup> eluates

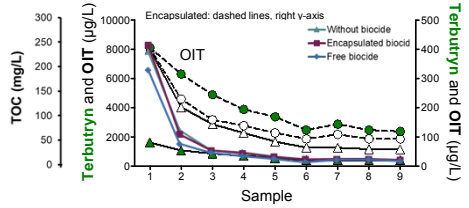


7  
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7

### Render: Leaching

- Substance properties influence the leaching (OIT > Terbutryn)
- Leaching of biocides is reduced by encapsulation
- TOC provides no insight to specific substances
  - Control without biocides shows similar TOC pattern

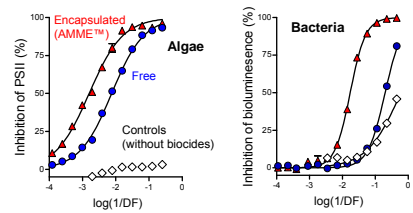


8  
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8

### Render: Bioassays

- Encapsulated biocides less toxic (e.g. Algae EC<sub>50</sub>: DF 630 vs. DF130)
- Control without biocides show no / small effect (but high TOC)
- Effects fits well with measured biocides concentrations
  - Concentrations and toxicity fell at 5-fold from 1<sup>st</sup> to 9<sup>th</sup> sample (not shown)




9  
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9

### Corrosion Protection Coatings

- 7 Epoxy and 1 PU resin prepared according to producer instructions
- Products applied onto glass plates (100 cm<sup>2</sup>) and leached for 7 d
- Chemical analysis of Bisphenol A (BPA), F (BPF), BADGE, TOC
- Three bioassays with a single water sample



10  
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10

### Corrosion Protection Coatings: Leaching

- BPA, BPF, transformation products BADGE were detected
  - A single product without substances of interest
- Hard to derive the environmental performance for this mixture

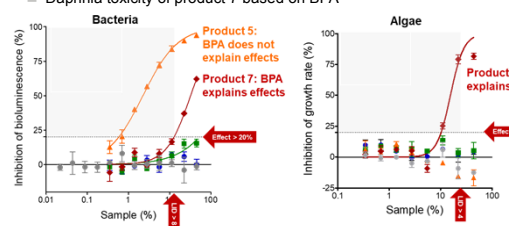
Product	EC [µS/cm]	TOC [mg/L]	BPA [µg/L]	BPF [µg/L]	BADGE [µg/L]	BADGE-H <sub>2</sub> O [µg/L]	BADGE-2H <sub>2</sub> O [µg/L]
1	3.1	1.8	<2	<1	83	153	62
2	2.7	1.5	<1	50	<1	1	1
3	22.1	30	<1	<1	1	2	13
4	3.4	7.5	<1	<1	<1	<1	<1
5	4.2	3.3	<1	<1	13	13	7
6	73.0	11.2	2	<1	5	10	9
7	46.7	37.1	10400	<100	<100	<100	<100
8	6.6	0.8	<10	<10	38	128	46

11  
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11

### Corrosion Protection Coatings: Bioassays

- 6 Products WITHOUT effects to bacteria and algae
  - Product 5: tox not related to measured substances, product 7 : BPA effects
- 4 Products WITHOUT effects to daphnia (not shown)
  - Daphnia toxicity of product 7 based on BPA



12  
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12

### Roof Membranes

- Professional market products of EPDM, PVC, and FPO membranes
- Surface leached in DSLT
- Chemical analysis of 172 organic additives and 17 phthalates (LC-MS/MS), 16 elements (ICP-MS), TOC
- Three bioassays with eluates 1+2 (24 hours) and eluate 8 (28 days)

13  
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13

### Roof Membranes: Leaching

- Small TOC concentration and slightly increasing for EPDM
- Identified in samples with 24 h (1) and 28 d (8) water contact time
  - EPDM: Zn, Ba, Mg, Hexamethyldiamine, Aniline, 1,3-Benzothiazole
  - PVC: Zn, Al, Sb, Diisononylphthalate
  - FPO: Zn, Al, Mg, 1,1,1-Trimethylolpropane

14  
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14

### Roof Membranes: Bioassays

- PVC shows no release of toxic substances, neither in bioassays nor in chemical analysis
- FPO released Trimethylolpropane and only algae show effects with LID<sub>A</sub> 24 and 192
- EPDM effects might be triggered by Benzothiazole and Zinc

Product	Sample	Algae LID <sub>A</sub>	Daphnia LID <sub>D</sub> 24 h	Daphnia LID <sub>D</sub> 48 h	Bacteria LID <sub>L</sub>
EPDM	1+2 (24 h)	12	12	16	128
EPDM	8 (28 d)	96	8	12	96
FPO	1+2 (24 h)	24	≤2	≤2	≤2
FPO	8 (28 d)	192	≤2	≤2	≤2
PVC	1+2 (24 h)	≤2	≤2	≤2	≤2
PVC	8 (28 d)	≤2	≤2	≤2	≤2

15  
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15

### Conclusions

- Toxicity-based approach delivers additional information to leachates
  - Insight to mixtures of leached substances using a test-battery
  - Fulfil lack of information for environmental performance
  - Variability of products easily evaluated
- Laboratory eluates can be used directly
  - CEN/TS 16637-2: Toxicity might increase with contact time
  - EN 16105: Toxicity decreases over nine immersion cycles
- Relevance of test results
  - Substance evaluation in unknown mixtures (good cost/benefit)
  - DF of eluates for declaration of performance (numbers, classes)
  - Guidance to product development (e.g. encapsulation)

16  
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16

Thank you for your attention !

17

17