

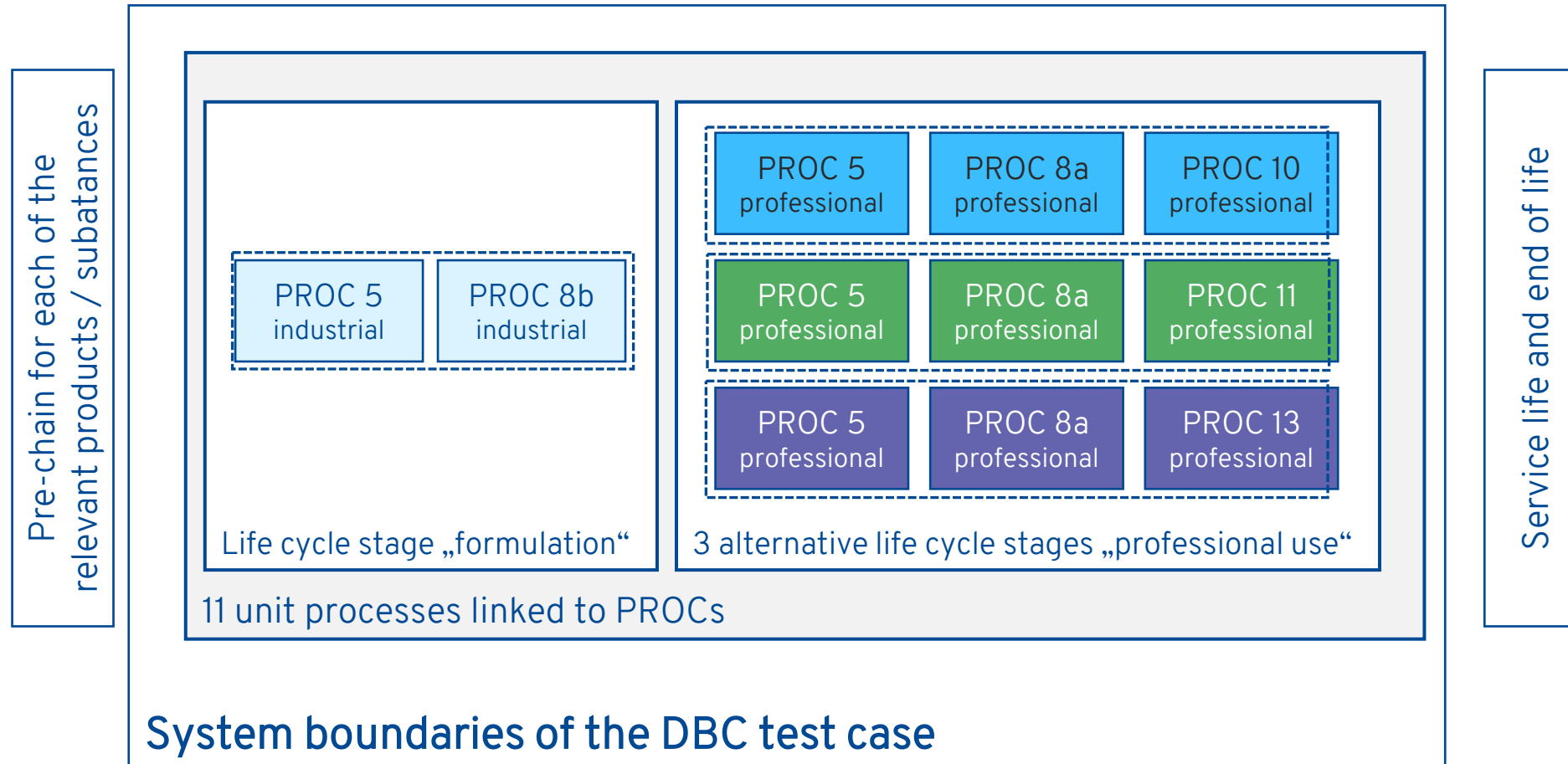


ProScale test cases for construction chemicals

Description of the test cases

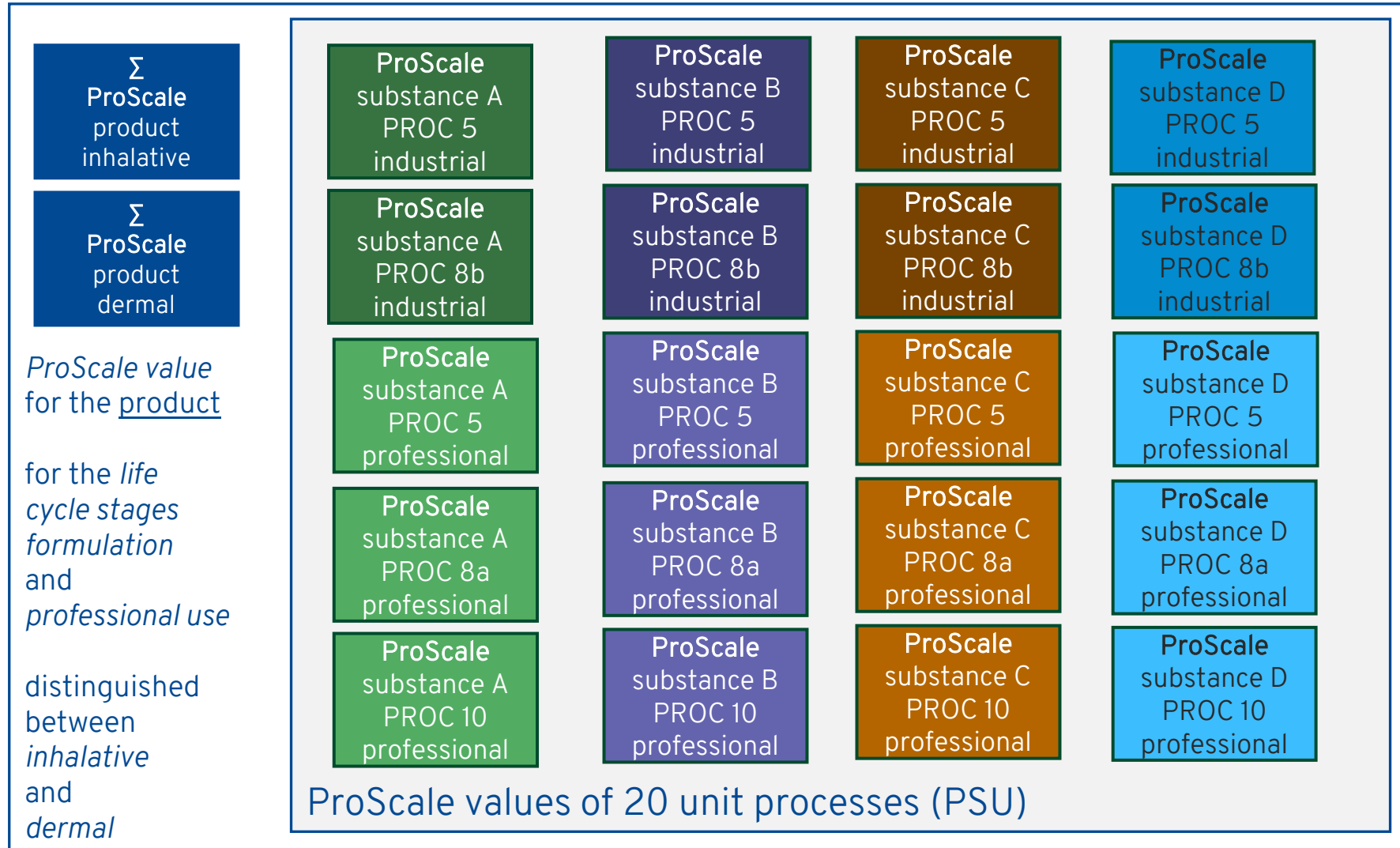
ProScale - test cases for construction chemicals

System boundaries and unit processes



ProScale - test cases for construction chemicals

From *ProScale process units* to *ProScale product*



ProScale - test cases for construction chemicals

List of relevant PROCs

ECHA Guidance R.12: Use description, vers. 3.0, Dec. 2015

Code	Name	industrial / professional
<i>PROC 5</i>	<i>Mixing or blending in batch processes</i>	<i>industrial</i>
<i>PROC 8b</i>	<i>Transfer of substance or mixture (charging and discharging) at dedicated facilities</i>	<i>industrial</i>
PROC 5	Mixing or blending in batch processes	professional
PROC 8a	Transfer of substance or mixture (charging and discharging) at non-dedicated facilities	professional
PROC 10	Roller application or brushing	professional
PROC 11	Non industrial spraying	professional
PROC 13	Treatment of articles by dipping and pouring	professional

ProScale - test cases for construction chemicals

„Dummy-mixtures Epoxy“ for the test cases

Ingredients of the mixture	ProScale test case EP I	ProScale test case EP II	ProScale test case EP III
Bisphenol A epoxy resin	54	54	54
Alkyl (C12-C14) glycidyl ether	6	6	6
Xylene mixture of isomers	15	-	15
Benzene	-	15	
Benzyl alcohol	12,5	12,5	12,5
Isophorone diamine	12,5	12,5	-
Isophorone diamine (MXDA)	-	-	12,5
Ratio A/B	75/25	75/25	75/25

ProScale - test cases for construction chemicals

Input parameter for the Epoxy-based product

Substance name	CAS No	H-phrases	OEL [mg/m ³]	Vapour pressure [kPa]
Bisphenol A epoxy resin	25068-38-6	H319, H315 H317, H411	not available default 0.001 mg/m ³	default for negligible 0.00001 kPa
Alkyl (C12-C14) glycidyl ether	68609-97-2	H315, H317	not available Default 0.001 mg/m ³	0,000018
Xylene mixture of isomers	1330-20-7	H312, H315 H320, H304 H335, H373	440 mg/m ³ TRGS 900	0,821 kPa
Benzene	71-43-2	H225, H350 H340, H372 H304, H319 H315	3.25 mg/m ³ EU-OEL	10 kPa
Benzyl alcohol	100-51-6	H332, H302	22 mg/m ³ TRGS 900	0,007 kPa
Isophorone diamine	2855-13-2	H312, H302 H314, H317 H412	0.073 mg/m ³ DNEL long-term worker	0.00258 kPa
m-Xylenediamine	1477-55-0	H302, H332 H314, H317	0.2 mg/m ³ DNEL long-term worker	0.0007 kPa

ProScale - test cases for construction chemicals

„Dummy-mixtures mortar“ for the test cases

Ingredients of a mixture	test recipe "Mortar A"	test recipe "Mortar B"
Portland cement	18	18
Calcium hydroxide	3	3
Calcium sulfate	4,5	4,5
Crystalline Silica flour	-	2
Quarz sand	54	52
Calcium carbonate	20	20
Hydroxypropyl methyl cellulose	0,5	0,5
Total	100	100

ProScale - test cases for construction chemicals

Input parameter for the mortar product

Substance name	CAS No	H-phrases	OEL [mg/m ³]	Vapour pressure [kPa]	Fugacity (dustiness)
Portland cement	65997-15-1	H315, H318 H335	5 mg/m ³ E TRGS 900	when powder in liquid: handled as liquid with default 0.000001 kPa	high
Calcium hydroxide	1305-62-0	H315, H318 H335	1 mg/m ³ E TRGS 900	when powder in liquid: handled as liquid with default 0.000001 kPa	medium
Calcium sulfate	7778-18-9	not classified	6 mg/m ³ A TRGS 900	when powder in liquid: handled as liquid with default 0.000001 kPa	high
Crystalline Silica flour	14808-60-7	H372	0,1 mg/m ³ EU-OEL	when powder in liquid: handled as liquid with default 0.000001 kPa	high

The rest of the ingredients (*Quarz sand, Calcium carbonate, Hydroxypropyl methyl cellulose*) are not relevant for the ProScale calculation because they are not classified as hazardous (no H-phrase) and no substances-related OELs are established.

The background is a complex, layered image. On the left, there is a historical map with a compass rose and the Latin text 'MARE SVETICVM'. In the center and right, there is a modern, detailed compass with a glowing lighthouse beam shining through its center. The entire image has a blue color scheme.

Results of the test cases

ProScale - test cases for construction chemicals

ProScaleProduct values for the Epoxy resin based product <i>test case EPI</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	1.01	1.89	2.32	3.2	0.99	1.87
dermal	0.76	29.57	4.49	115.02	0.34	19.77

ProScaleProduct values for the Epoxy resin based product <i>test case EPII</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	114.39	214.81	263.94	364.36	114.37	214.80
dermal	2.57	100.34	15.26	391.66	1.13	67.33

ProScaleProduct values for the Epoxy resin based product <i>test case EPIII</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	1.23	2.27	2.79	3.83	1.14	2.18
dermal	0,73	28.55	4.34	111.43	1.14	19.16

ProScale - test cases for construction chemicals

	ProScaleProduct values for the mortar product <i>test case mortar A</i>					
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	0.20	0.41	0.37	0.58	0.10	0.31
dermal	0.07	2.93	0.44	11.42	0.03	1.96

	ProScaleProduct values for the mortar product <i>test case mortar B</i>					
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	6.14	13.26	11.17	18.29	3.22	10.35
dermal	0.28	10.89	1.65	42.51	0.12	7.31



Analysis of results



Effect of considering Risk Management Measures (RMMs)

ProScale test case: Effect of Risk Management Measures

Effect of Risk Management Measures (RMM)

PROC	PROC 5	PROC 8b	PROC 5	PROC 8a	PROC 10	PROC 11	PROC 13
industrial or professional	industrial	industrial	professional	professional	professional	professional	professional
Local Exhaust Ventilation (LEV)	Indoors with LEV	Indoors with LEV	Indoors with LEV	Indoors with LEV	no	no	no
Respiratory protection (RP)	no	no	no	no	no	no	no
Consider LEV for dermal exposure	Yes	Yes	Yes	Yes	no	no	no
Dermal Personal Protective Equipment (PPE)	Gloves APF 10	Gloves APF 10	Gloves APF 10	Gloves APF 10	Gloves APF 10	Gloves APF 10	Gloves APF 10

ProScale test case: Effect of Risk Management Measures

Epoxy resin based product <i>ProScale test case EP I</i>			
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10	Industrial 5, 8b professional 5, 8a, 11	Industrial 5, 8b professional 5, 8a, 13
Effect of RMM in % (ProScale with RMM has been used as reference (100%))			
inhalative	87%	38%	89%
dermal	3791%	2462%	5715%
Epoxy resin based product <i>ProScale test case EP II</i>			
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10	Industrial 5, 8b professional 5, 8a, 11	Industrial 5, 8b professional 5, 8a, 13
Effect of RMM in % (ProScale with RMM has been used as reference (100%))			
inhalative	88%	38%	88%
dermal	3804%	2467%	5858%
Epoxy resin based product <i>ProScale test case EP III</i>			
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10	Industrial 5, 8b professional 5, 8a, 11	Industrial 5, 8b professional 5, 8a, 13
Effect of RMM in % (ProScale with RMM has been used as reference (100%))			
inhalative	85%	37%	91%
dermal	3811%	2468%	1581%

ProScale test case: Effect of Risk Management Measures

Mortar product <i>ProScale test case mortar A</i>			
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10	Industrial 5, 8b professional 5, 8a, 11	Industrial 5, 8b professional 5, 8a, 13
Effect of RMM in % (ProScale with RMM has been used as reference (100%))			
inhalative	105%	57%	210%
dermal	4086%	2495%	5992%

Mortar product <i>ProScale test case mortar B</i>			
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10	Industrial 5, 8b professional 5, 8a, 11	Industrial 5, 8b professional 5, 8a, 13
Effect of RMM in % (ProScale with RMM has been used as reference (100%))			
inhalative	116%	64%	221%
dermal	3789%	2476%	6008%

ProScale test case: Effect of Risk Management Measures

Effect of Risk Management Measures (RMM)

- **If RMM were not considered the ProScaleProduct value increases significantly**
 - For the selected mixtures, life cycle stages and activities
 - ProScaleProduct, inhalative: increase of 37% – 221% (average: 94%)
 - ProScaleProduct, dermal: increase of 1581% – 6008% (average: 3787%)
- **Recommendations**
 - RMM should be considered
 - If available the RMMs of the EFCC-UseMaps (source: ECHAs UseMap library) should be used



Difference between professional and industrial settings

ProScale test case: Effect of industrial vs. professional

Epoxy resin based product <i>ProScale test case EP I</i> with RMM			
PROCs ind./prof.	PROC 5 industrial	PROC 5 professional	Difference in % reference: ind. (100%)
inhalative	0.00704	0.18951	2592%
dermal	0.00117	0.03806	3153%

Epoxy resin based product <i>ProScale test case EP II</i> with RMM			
PROCs ind./prof.	PROC 5 industrial	PROC 5 professional	Difference in % reference: ind. (100%)
inhalative	0.81580	21.95979	2592%
dermal	0.00399	0.11044	2667%

Epoxy resin based product <i>ProScale test case EP III</i> with RMM			
PROCs ind./prof.	PROC 5 industrial	PROC 5 professional	Difference in % reference: ind. (100%)
inhalative	0.00793	0.21358	2593%
dermal	0.00322	0.02915	805%

ProScale test case: Effect of industrial vs. professional

Mortar product <i>ProScale test case mortar A</i> with RMM			
PROCs ind./prof.	PROC 5 industrial	PROC 5 professional	Difference in % reference: ind. (100%)
inhalative	0.00171	0.04463	2510%
dermal	0.00012	0.00299	2392%

Mortar product <i>ProScale test case mortar B</i> with RMM			
PROCs ind./prof.	PROC 5 industrial	PROC 5 professional	Difference in % reference: ind. (100%)
inhalative	0.06	1.54	2467%
dermal	0.00043	0.01	2226%

ProScale test case: Effect of industrial vs. professional

Effect of industrial vs. professional

- ProScale values for professional uses are significantly higher than the corresponding ProScale values for industrial settings.
- For the selected mixtures, life cycle stages and PROC 5 (mixing)
 - ProScale, PROC5, professional is 805% - 3153% (average 2400%) higher than ProScale, PROC5, industrial



Effect of substances with high hazard profile

ProScale test case: Effect of subst. with high hazard profile

ProScaleProduct values for the Epoxy resin based product <i>test case EPI</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	1.01	1.89	2.32	3.2	0.99	1.87
dermal	0.76	29.57	4.49	115.02	0.34	19.77

ProScaleProduct values for the Epoxy resin based product <i>test case EPII</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	114.39	214.81	263.94	364.36	114.37	214.80
dermal	2.57	100.34	15.26	391.66	1.13	67.33

Comparison between <i>EPI (15% Xylene) and EPII (15% Benzene)</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	EPII=EPI*113	EPII=EPI*114	EPII=EPI*114	EPII=EPI*114	EPII=EPI*116	EPII=EPI*115
dermal	EPII=EPI*3.38	EPII=EPI*3.39	EPII=EPI*3.40	EPII=EPI*3.41	EPII=EPI*3.32	EPII=EPI*3.41

ProScale test case: Effect of subst. with high hazard profile

ProScaleProduct values for the mortar product <i>test case mortar A</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	0.20	0.41	0.37	0.58	0.10	0.31
dermal	0.07	2.93	0.44	11.42	0.03	1.96

ProScaleProduct values for the mortar product <i>test case mortar B</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	6.14	13.26	11.17	18.29	3.22	10.35
dermal	0.28	10.89	1.65	42.51	0.12	7.31

Comparison between <i>mortar A and mortar B (+2% Silica flour (H372))</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	$mB=mA*30.7$	$mB=mA*32.3$	$mB=mA*30.2$	$mB=mA*31.5$	$mB=mA*32.2$	$mB=mA*33.4$
dermal	$mB=mA*4.00$	$mB=mA*3.72$	$mB=mA*3.75$	$mB=mA*3.72$	$mB=mA*4.00$	$mB=mA*3.73$

ProScale test case: Effect of subst. with high hazard profile

Effect of substances with high hazard profile

- **The substitution of 15% Xylene by 15% Benzene leads to an significantly increased ProScaleProduct value**
 - For the selected mixtures, life cycle stages and activities
 - ProScaleProduct, inhalative: increase by a factor of 113 to 116 (average: 114 times)
 - ProScaleProduct, dermal: increase by a factor of 3.32 – 3.41 (average: 3.39 times)
- **The substitution of 2% Quarz sand by 2% Crystalline Silica flour (H372) leads to an significantly increased ProScaleProduct value**
 - For the selected mixtures, life cycle stages and activities
 - ProScaleProduct, inhalative: increase by a factor of 30.2 to 33.4 (average: 31.7 times)
 - ProScaleProduct, dermal: increase by a factor of 3.72 – 4.00 (average: 3.82 times)



Differences between different product groups (EP vs. mortar)

ProScale - test case: Differences between product groups

ProScaleProduct values for the Epoxy resin based product <i>test case EPI</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	1.01	1.89	2.32	3.2	0.99	1.87
dermal	0.76	29.57	4.49	115.02	0.34	19.77

ProScaleProduct values for the mortar product <i>test case mortar A</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	0.20	0.41	0.37	0.58	0.10	0.31
dermal	0.07	2.93	0.44	11.42	0.03	1.96

Comparison between <i>EPI and mortar A</i>						
PROCs ind./prof.	Industrial 5, 8b professional 5, 8a, 10		Industrial 5, 8b professional 5, 8a, 11		Industrial 5, 8b professional 5, 8a, 13	
RMM	with	without	with	without	with	without
inhalative	$EPI=mA*5.05$	$EPI=mA*4.61$	$EPI=mA*6.27$	$EPI=mA*5.52$	$EPI=mA*9.9$	$EPI=mA*6.03$
dermal	$EPI=mA*10.9$	$EPI=mA*10.1$	$EPI=mA*10.2$	$EPI=mA*10.1$	$EPI=mA*11.3$	$EPI=mA*10.1$

ProScale - test case: Differences between product groups

Differences between different product groups (EP vs. mortar)

Comparison of ProScaleProduct values for a typical cementitious mortar and for an typical reactive Epoxy resin-based product

- As expected the ProScaleProduct value of the EP product is higher than the ProScaleProduct for the mortar.
 - ProScaleProduct inhalative *EP* is by a factor of 4.61 to 9.9 higher (average: 6.23 times) than the ProScaleProduct inhalative mortar
 - ProScaleProduct, dermal EP is by a factor of 10.1 to 11.3 higher (average: 10.5 times) than the ProScaleProduct dermal mortar



Differences between different application techniques (rolling vs. spraying vs. pouring)

ProScale test case: Differences between application techniques

Epoxy resin based product <i>ProScale test case EP I</i>						
PROCs ind./prof.	professional, PROC 10		professional, PROC11		professional PROC 13	
RMM	with	without	with	without	with	without
inhalative	0.61587	0.61587	1.92721	1.92721	0.59826	0.59826
dermal	0.69111	15.87366	4.41580	101.42360	0.26903	6.17926

Comparison of application techniques (PROCs 10, 11, 13)						
PROCs ind./prof.	professional PROC 10		professional PROC 11		professional PROC 13	
RMM	with	without	with	without	with	without
inhalative	$P10=P13*1.03$	$P10=P13*1.03$	$P11=P13*3.22$	$P11=P13*3.22$	$P13=P13*1$	$P13=P13*1$
dermal	$P10=P13*0.39$	$P10=P13*2.57$	$P11=P13*16.4$	$P11=P13*16.4$	$P13=P13*1$	$P13=P13*1$

ProScale test case: Differences between application techniques

Mortar product <i>ProScale test case mortar A</i>						
PROCs ind./prof.	professional PROC 10		professional PROC 11		professional PROC 13	
RMM	with	without	with	without	with	without
inhalative	0.10351	0.10351	0.27862	0.27862	0.00201	0.00201
dermal	0.06865	1.57673	0.43862	10.07439	0.02672	0.61378

Comparison of application techniques (PROCs 10, 11, 13)						
PROCs ind./prof.	professional PROC 10		professional PROC 11		professional PROC 13	
RMM	with	without	with	without	with	without
inhalative	$P10 = P13 * 5$ 1.5	$P10 = P13 * 5$ 1.5	$P11 = P13 * 13$ 8	$P11 = P13 * 13$ 8	$P13 = P13 * 1$	$P13 = P13 * 1$
dermal	$P10 = P13 * 2$.60	$P10 = P13 * 2$.60	$P11 = P13 * 16$.4	$P11 = P13 * 16$.4	$P13 = P13 * 1$	$P13 = P13 * 1$

ProScale test case: Differences between application techniques

Differences between different application techniques (rolling vs. spraying vs. pouring)

Comparison of ProScaleProduct values for the application techniques roller/brushing (PROC 10), spraying (PROC 11) and pouring (PROC 13)

- The results of this comparison depends on the selected mixtures.
- In all cases spray applications (PROC 11) leads to significantly higher ProScale than roller or pouring applications (PROC 10/13)
- Roller applications (PROC 10) and pouring applications (PROC 13) are on a similar level.
 - In most of the cases the ProScale for roller applications is slightly higher than the ProScale for pouring applications.



Overall assessment and comprehensive conclusions

ProScale - test cases for construction chemicals

Overall assessment and comprehensive conclusions

- Via the Excel tool and the Guidance document the ProScale method is easily to apply. The method can be applied without contracting a life cycle assessment expert.
- The required input parameter for an assessment of an mixture for the life cycle stages „formulation“ and „professional use“ are usually available or easily to obtain.
- The direction of the results are reasonable and as expected (qualitative)
- Maybe some effects are exaggerated and should be adopted by additional weighting factors (quantitative)
- The meaning of an ProScale value and the interpretation of an ProScale calculation should be better explained to prevent misunderstandings and misleading interpretations
- At present it is difficult to estimate if the ProScale method could be successfully established as an alternative method to USEtox. Currently it is not clear if ProScale will be accepted within PEF and EN 15804 over medium term.

ProScale - test cases for construction chemicals

Overall assessment and comprehensive conclusions

- A entire ProScale calculation (whole life cycle) requires a collaboration of the different actors in the supply chain. The formulators are depending on the support (pre-chain ProScale's) from their raw material suppliers
- The coverage of the life cycle stage „service life“ requires more effort
- How to cover the life cycle stage „end of life“ is not clear so far
- The direction of the results are reasonable and as expected (qualitative)
 - Significant difference between an cementitious mortar and an reactive EP-based product. Higher ProScale for the EP-based product.
 - Significant increase of ProScale by adding a substance with high hazard profile.
 - PROCs 10/11/13 have higher ProScale than PROCs 5/8a
 - PROC 11 has an higher ProScale than PROCs 10/13
 - Considering RMM leads to an significant decrease of ProScale values
 - ProScale values for professional uses are higher than ProScale for industrial uses.