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Assessment of the Environmental Behaviour of Polyurethane Foams
Baytherm C-45 F 125/W and Baytherm SP-42-F-9/W
according to the Requirements of DiBt (Deutsches Institut für Bautechnik)

Summary

Polyurethane foams may be applied in the environment thus having contact of soil and water. In principle, substances can be mobilised from the foam e.g. by washing off with rain water which then penetrates the soil. In order to quantify possible hazards for man and the environment, the DiBt (Deutsches Institut für Bautechnik) has developed a process in order to assess building materials. This process consists of mainly 2 steps:

Step 1: Determination and assessment of all components in educts and product .
Substances which are considered relevant, especially those which are known as hazardous substances are further analysed and assessed in step 2.

Step 2: Determination and assessment of mobilisable components.

1. Determination and assessment of general parameters
2. Analysis and assessment of mobilisable components in eluates from foams. In the current case the possible hydrolysis product Methylene dianiline (MDA), IUPAC Name: 4-[(4-Aminophenyl)methyl] aniline. CAS Nummer: 101-77-9 has been identified as a relevant substance.
3. Analysis and assessment of eluates from rigid foams for biological parameters according to the requirements of DiBt.

The analysis of the eluates showed that the foams "Baytherm C-45 F 125/W" and "Baytherm SP-42-F-9/W" do not release MDA and hazards for the environment are not expected:

Date: 2015-08-21
Page: 2 (5)

- MDA was analysed and found to be below the limit of quantification ($< 10 \mu\text{g/L}$ eluate) in both foams.
- Tests for ecotoxicity were waived as no effects were expected due to the assessment of step 1 and the substance specific analysis for MDA.

1. Step 1 according to DIBt (evaluation of possible harmful components)

The analysis and evaluation of the foam concerning chemical and biological parameters was performed according to the requirements of DIBt in a stepwise procedure. The first step consists of an evaluation of possible harmful components which could be released from the foam. Especially it is to be checked carcinogenicity (R 45), mutagenicity (R 46) or toxicity to reproduction (R 60, R 61) according to Directive 67/548/EWG. A complete overview over the substances used for the preparation of the foams is listed in the Annex. None of them falls under the requirements of DIBt. However, due to possible hydrolysis, the following substance was considered and evaluated:

Substance	IUPAC Name	CAS-Number
Methylene dianiline (MDA)	4-[(4-Aminophenyl)methyl]aniline.	101-77-9

The hydrolysis product MDA is classified for the environment as R51/53 according to Directive 67/548/EWG. Due to the environmental toxicity (labelling "N") it was decided to further assess the foams and the eluate according to the criteria of DIBt.

2. Step 2 according to DIBt: Analysis of mobilisable components

Basics:

The elution test according to DIN EN 12457-2 (01-2003) is a simulation test which comprises the following conservative assumptions:

- Elution with a rather high volume of water.
- Effective dissolution due to mechanical shaking.
- The test pieces (4 cm x 4 cm x 10 cm) have a rather high surface-volume relation which is higher than real polyurethane foams. Thus, mobilisable components are better extractable by water compared to real foams.
- The test pieces were produced by cutting. However, undisturbed polyurethane foams typically build an outer firm coat which is expected to be less permeable.

Date: 2015-08-21

Page: 3 (5)

Thus it is expected that more components can be released from such a test piece than from undisturbed foams.

Containers:

All vessels were rinsed with water and acetone and dried at 105°C before use. .

Eluates were produced 1-L-glas bottles with screw cap and alumina foil.

Aliquots for organic parameters: 250- -mL-glas bottles.

Preparation of eluates:

The eluates were prepared according to standard DIN EN 12457-2 (01-2003). The foam was cut manually into pieces of 4 cm x 4 cm x 10 cm. Due to the rather low density of the foam (about 50 g/Litre) the required ratio of solids and water of 1:10 by the standard could not be reached. Eluates were prepared and analysed in duplicate.

Sample	Mass of test pieces	Water volume	Solids-water ratio (mean)
Baytherm C-45 F 125/W	• 7.58 g • 7.72 g	1000 mL	1:130
Baytherm SP-42-F-9/W	• 7.59 g • 7.76 g	1000 mL	1:130
Control	0 g	1000 mL	0

Bottles were agitated in an overhead shaker for 24 hours at room temperature (about 23°C) with about 10 turns per minute. The eluates were filtered through a 0.45 µm-membrane filter.

2.1 Analysis and assessment of general paremeters:

The eluates were clear and colourless. Odour was not specifically tested but no signs of odour were recorded during the analytical procedure.

Date: 2015-08-21

Page: 4 (5)

2.2 Analysis and assessment of substances in the eluate

As a consequence of the manufacture and composition of the polyurethane rigid foam analysis for specific components was performed for MDA. A LC/MS/MS method was used in order to get quantitative results with a low limit of quantification. This method also allowed for separation of the isomers of MDA. The results are presented in the following table.

Sample	4,4- MDA (µg/L)	2,4-MDA (µg/L)	2,2-MDA (µg/L)
Baytherm C-45 F 125/W	<0.05	<0.05	<0.05
Baytherm SP-42-F-9/W	<0.05	<0.05	<0.05
Control	<0.05	<0.05	<0.05

2.3 Analysis and assessment of biological parameters in the eluate

Tests for ecotoxicity were waived as no effects were expected due to the assessment of step 1 and the substance specific analysis for MDA.

3. References

DIBt (2011), Deutsches Institut für Bautechnik, Grundsätze zur Bewertung der Auswirkungen von Bauprodukten auf Boden und Grundwasser, http://www.dibt.de/de/data/Aktuelles_Ref_II_6_5.pdf (dated 2015-05-27), Berlin 2011.

DIN EN 12457-4 (2003), Deutsches Institut für Normung, Einstufiges Schüttelverfahren mit einem Flüssigkeits-/Feststoffverhältnis von 10 L/kg und einer Korngröße unter 10 mm (01/2003).

Date: 2015-08-21
Page: 5 (5)

Annex: Substances used for the manufacture of Baytherm C-45 F 125/W and Baytherm SP-42-F-9/W

Baytherm C-45-F-125/W	Content [%]	HSE Classification	Reactive groups	HSE Assessment
PET 111 0	16,638	Xn	Y	
Polyether LP 112	18,719	Xn	Y	
Polyether S 440	37,438	-	Y	
Water	2,496	-	Y	
Dabco DMEA	0,666	C	Y	
Tegostab B8404	0,832	-	N	
Jeffcat ZF-10	0,166	C, Xn	Y	
Dabco K-15	0,166	Xn	Y	
PET 21AP27	20,799	-	Y	
Glycerin 99%	2,080	-	Y	

Baytherm SP-42-F-9/W	Content [%]	HSE Classification	Reactive groups	HSE Assessment
Polyether T 460	40,323	Xn	Y	
Polyether LP 112	15,233	Xn	Y	
PEG 400	13,441	-	Y	
Water	1,792	-	Y	
Dabco DMEA	2,688	C	Y	
Dabco DC 193	0,717	-	Y/N	
Jeffcat ZF-10	0,717	C, Xn	Y	
Dabco NE 1060	1,792	Xi	Y	
PET 1110	22,401	Xn	Y	
PET 4051 B	0,896	Xi	Y	