

## Background Information on the Substance Related Exposure Description for Benzyl Alcohol

### 1 INTRODUCTION

Benzyl alcohol is an important ingredient in chemical products used in the construction industry. It is used, e.g. in epoxy resin systems, paint strippers and cleaning agents with a stripping effect. Because of its relatively high boiling point of 205 °C, benzyl alcohol is one of the less volatile solvents. At 20 °C, vapour pressure is 0.03 hPa and saturation concentration is 130 mg/m<sup>3</sup>. In view of the importance of this material for epoxy resin coatings in the construction industry, the hazardous substance information system of the German legal accident insurance for the construction industry (BG BAU), GISBAU<sup>1</sup>, has determined the exposure to benzyl alcohol when applying these products at building sites. This exposure description therefore does not give the entire hazardous substance exposure ("Hazard Index") but examines only exposure to this specific substance. This allows a decision to be made on the safe use of benzyl alcohol, e.g. in the scope of REACH, but to stipulate protective measures to be taken when working with the products, further exposure to other substances through inhalation may need to be taken into consideration.

### 2 MEASURING METHOD

The concentration of benzyl alcohol is measured according to the IFA standard method. Sampling takes place by means of a PAS pump and type B activated charcoal test tubes. After extraction with methanol/dichloromethane/carbon disulfide (2 : 1 : 1), analysis is carried out by gas chromatography with a flame ionization detector.

### 3 DATA REPOSITORY

In the GISBAU database for measurements (all concluded reports of BG BAU by January 2011) there are 85 data sets for benzyl alcohol (CAS# 100-51-6, Hazard Substance Code 14734). An overview of the assignment of these measurements to the different product groups/activities is found in Table 1.

**Table 1:** Distribution of measurements to different product group areas. Areas that will not be further dealt with in this study are in italics.

Group	Number	Group	Number
Paint stripper	16	RE1 hot spraying	4
<i>EP/PU combination</i>	1	RE1 brush	28
Basic cleaners (strippers)	3	RE2 brush	6
<i>Panel production</i>	1	RE3 spraying	1
<i>Screen cleaning</i>	1	REX brush	12
<i>PU product</i>	1	RE1 - prior load	3
<i>Product unclear<sup>2</sup></i>	8		
Total	78	Evaluated here	73

<sup>1</sup> [www.gisbau.de](http://www.gisbau.de)

<sup>2</sup> Some of the measurements cannot be assigned for various reasons. It is possible that some of these measurements may still be assigned to the evaluated GISCODES after further investigations. If there is sufficient demand, investigations may be carried out. However, the relationship between benefit and expense must also be taken into account which under certain circumstances may be assessed differently, depending on the level of DNEL and the exposure levels determined.

The greater part of the measurements are for the application of epoxy resin systems (54 evaluated measurements). Of these, 12 could not be assigned to a GISCODE RE since it is not known which GISCODE the product belonged to at the time of the measurement (designated REX in the following). With 7 additional measurements it is unclear whether a sensible assignment to a GISCODE is even possible. GISBAU does not have any documents on these products and the measured values for benzyl alcohol are, as a rule, below the limit of quantitation. It is possible that these products do not even contain benzyl alcohol.

With 16 measurements for paint strippers, the next partial repository is much smaller. For cleaners with a stripping effect used for cleaning buildings there are 3 measurements (Product Code GG90). There are further selective measurements for PU and EP/PU systems as well as for the production of sandwich system panels and for cleaning printing screens but these individual values will not be dealt with in the following.

For statistical purposes, measured values less than the limit of quantitation are given as half the level of the limit of quantitation<sup>3</sup>. In one case a measured value was given at < 2 mg/m<sup>3</sup>, which was probably an error in transcription and therefore this value was taken as = 2 mg/m<sup>3</sup>.

In the following, 73 benzyl alcohol measurements will therefore be dealt with that were obtained with epoxy resin systems, paint strippers and cleaners with a stripping effect. Table 2 shows the overall statistics for these measurements. Since by far the greater part of the measured values are given in mg/m<sup>3</sup> without a decimal place, decimal places were not used in the following and thus no pretence of greater accuracy is made.

**Table 2:** Overall statistics.

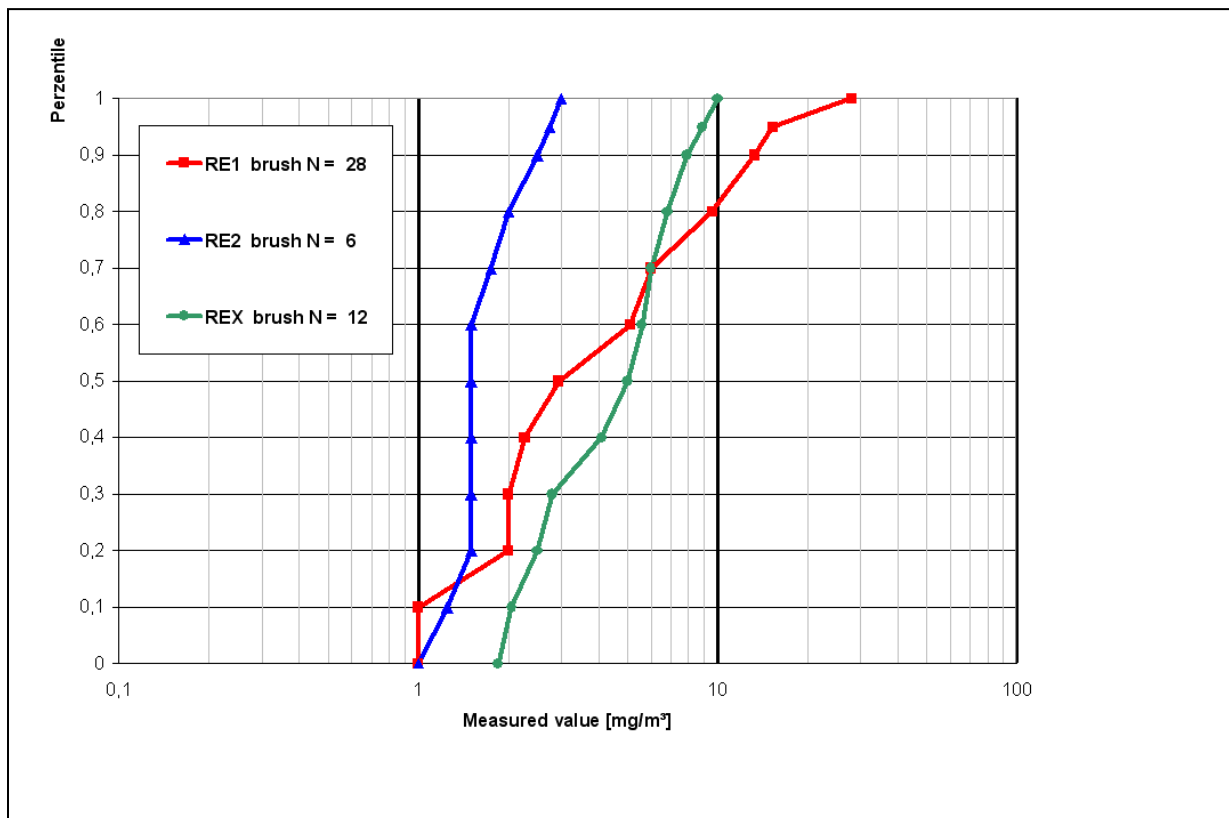
	P value	AI	Paint stripper	Stripping cleaner	RE1-hot-sprayed	RE1-brush	RE1-prior load	RE2-brush	RE3-sprayed	REX-brush
		N =	N =	N =	N =	N =	N =	N =	N =	N =
Number		73	16	3	4	28	3	6	1	12
Maximum	1	55	55	7	33	28	8	3	31	10
95% value	0.95	29	39	6	32	15	8	3	31	9
90% value	0.9	23	31	6	31	13	7	3	31	8
80% value	0.8	15	23	5	28	10	6	2	31	7
Upper quartile	0.75	10	22	4	27	9	6	2	31	6
70% value	0.7	9	19	4	26	6	6	2	31	6
60% value	0.6	6	16	3	25	5	5	2	31	6
Median	0.5	5	14	2	24	3	4	2	31	5
40% value	0.4	3	6	2	23	2	3	2	31	4
30% value	0.3	2	6	2	23	2	3	2	31	3
Lower quartile	0.25	2	5	2	22	2	3	2	31	3
20% value	0.2	2	4	2	22	2	2	2	31	3
10% value	0.1	2	3	2	21	1	2	1	31	2
5% value	0.05	1	2	2	20	1	1	1	31	2
Minimum	0	1	2	2	20	1	1	1	31	2
Arithmetic mean value		9	16	4	25	6	4	2	31	5
Standard deviation value		10	14	2	5	6	3	1	0	2
Geometric mean value		5	11	3	25	4	3	2	31	4
Number below LOQ		26	2	2	0	12	1	5	0	4
% "<LOQ"		36%	13%	67%	0%	43%	33%	83%	0%	33%

<sup>3</sup> In one case (200 g EP cement for natural stone was applied within 15 minutes), the limit of determination was rather high (< 27 mg/m<sup>3</sup>) for the short sampling period. This measurement was therefore assigned to the unclear products.

The 73 measured values in total range between  $< 2 \text{ mg/m}^3$  and  $55 \text{ mg/m}^3$ . In approximately one third of the cases, the measured value was less than the limit of quantitation. The interquartile range shows that half of the measured values range between  $< 4 \text{ mg/m}^3$  and  $10 \text{ mg/m}^3$ . Sampling was in principle carried out person-related; only 10 % of the cases were stationary. The duration of sampling was two hours as a rule; in 41 % of the cases the time was shorter due to the process involved. The measurements described here therefore show activity related exposures and are not mean values of a shift. However, it cannot be ruled out that some activities are carried out throughout an entire shift.

## 4 EVALUATION OF EPOXY RESIN SYSTEMS

There are 51 evaluated measurements for working epoxy resin systems containing benzyl alcohol: There are 46 measurements from 15 construction sites where **application was executed manually** (brush, trowel, roller, proportioning weigher). Of these, 28 (55 %) were carried out with RE1 products [solvent-free, sensitising] and 6 (12 %) with RE2 products [low solvent, sensitising]. For 12 of the measurements (24 %), no assignment to a GISCODE can be made yet. The distributions of these three sub-repositories are quite similar<sup>4</sup> (see fig. 1) so that these three sub-repositories can be examined together.



**Fig. 1:** Differentiation of measurements for epoxy resin systems applied manually.

<sup>4</sup> It might be worth while to investigate whether the 6 conspicuously low measured values for RE2 products are by chance or are because of a low benzyl alcohol content in low-solvent EP systems.

Of the 46 measured values for epoxy resin systems applied manually, 41 were obtained while coating industrial/hall floors at 12 construction sites. These will be dealt with in more detail in the following. Four measured values originate from two construction sites where coatings were applied to the interiors of tanks (5 - 7.5 kg of a RE1 product, benzyl alcohol content in the mixture about 5%) and show exposures of < 2 mg/m<sup>3</sup> to 28 mg/m<sup>3</sup>. One measured value (< 4 mg/m<sup>3</sup>) was determined while coating a balcony outdoors with 20 kg of an RE2 product (benzyl alcohol content in the mixture about 1%).

For sprayed applications there are five measured values from two construction sites for hydraulic steel structures. One measured value obtained while spraying 600 l of a RE3 product [solvent based, sensitising] in a tank with airless equipment shows an exposure of 32 mg/m<sup>3</sup>. Four measured values obtained during thermal spraying in a hot spraying facility (90 °C, 450 l of a RE1 product) show exposures of 20 mg/m<sup>3</sup> to 33 mg/m<sup>3</sup>.

## COATING INDUSTRIAL/HALL FLOORS

Most of the measured values were obtained while working with epoxy resin systems (floor coatings or screeds). The products used, which are 2-component as a rule, are mixed before they are applied by stirring or with mixing equipment, transported to the construction site if necessary and then applied. The mixed product is poured onto the floor and then distributed with a trowel, blade, rubber wiper or similar tool and smoothed. These coatings are often subsequently worked over with a spike roller and broadcast with (quartz) sand.

In Table 3 the measurements of the RE1, RE2 as well as the not yet assigned REX products are statistically evaluated together. All of the described activities are examined together since a subdivision in individual work steps would lead to data repositories that are too small. These activities may be carried out by the same person in one shift after the other or by several persons simultaneously. A comparison of the measured values for mixing work and transporting with those for application (compare with fig. 2) indicate that the exposures here are lower than while actually applying the coating.

**Table 3:** Exposures to benzyl alcohol [mg/m<sup>3</sup>]. The values marked with an asterisk are set values due to measured values below the limit of quantitation.

Activity	Number	< Detectable limit	Minimum	50 <sup>th</sup> percentile	75 <sup>th</sup> percentile	95 <sup>th</sup> percentile	Maximum
Industrial floor coating RE1, RE2, REX	41	18	1*	3	6	10	16

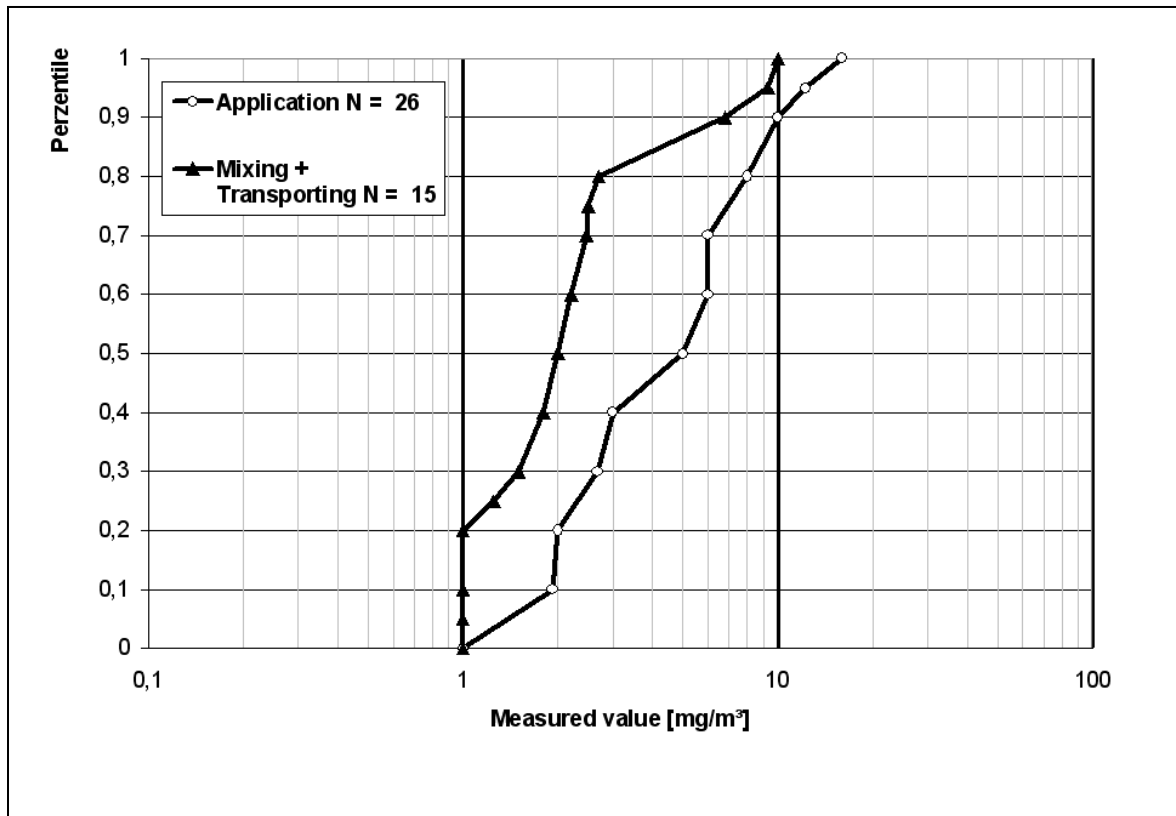


Fig. 2: Comparison of exposures for the activities 'mixing + transporting' with actual 'application'

Figures 3-7 show the measured benzyl alcohol concentrations depending on different basic parameters (data for all parameters are not available for all measured values). No compelling influence on exposure levels can be determined from the illustrations for the basic parameters quantity applied, room floor area, room volume and relative humidity. Only in regard to room temperature did the measurements below 15 °C show lower values compared to higher temperatures.

Data on the quantities applied range between 5 kg and 420 kg. Here it should be distinguished whether the quantity was applied by the respective person while the measurement was carried out or in total on this day by the entire team of workers. From the interquartile range it follows that half of the data on quantities applied range between 50 kg and 400 kg. This is certainly data that reflect the usual quantities applied at such construction sites.

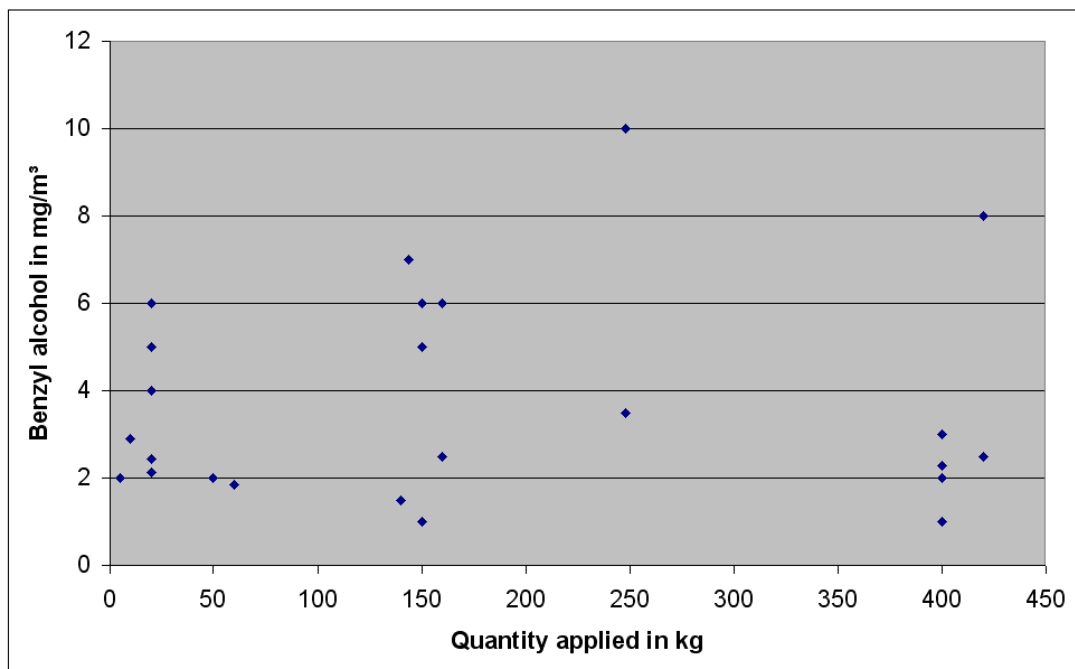


Fig. 3: Exposure compared to quantity applied

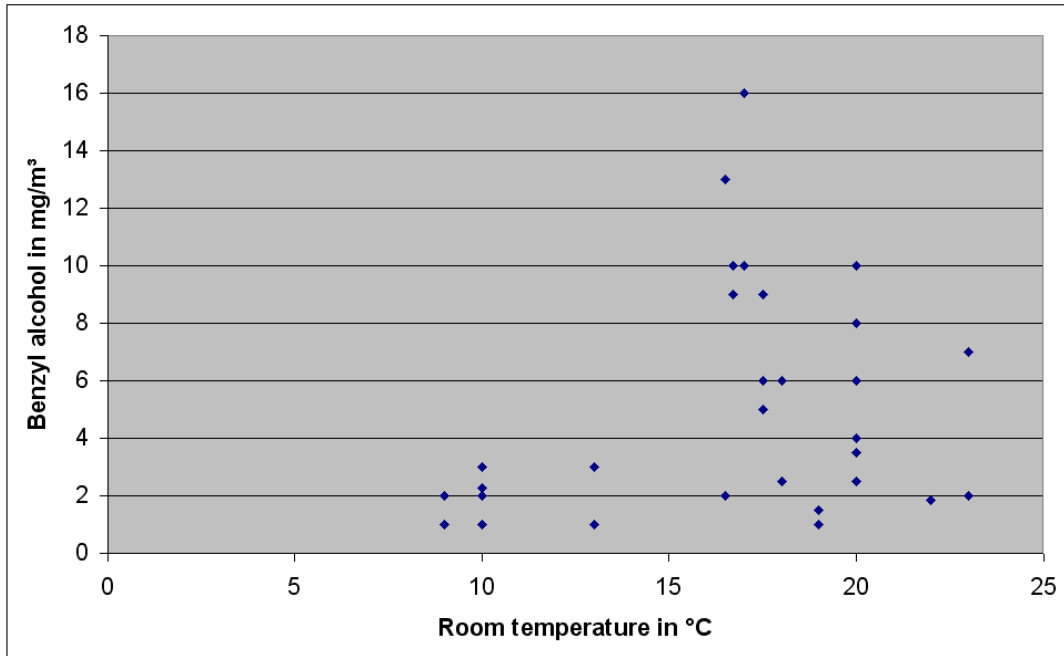


Fig. 4: Exposure compared to room temperature

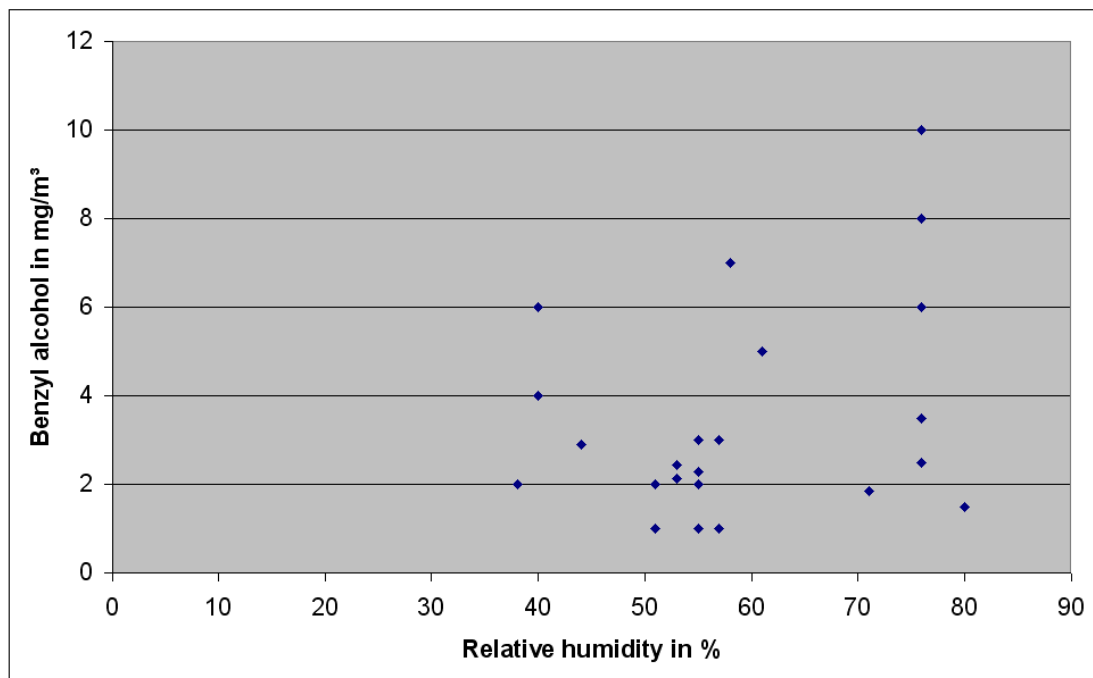


Fig. 5: Exposure compared to relative humidity

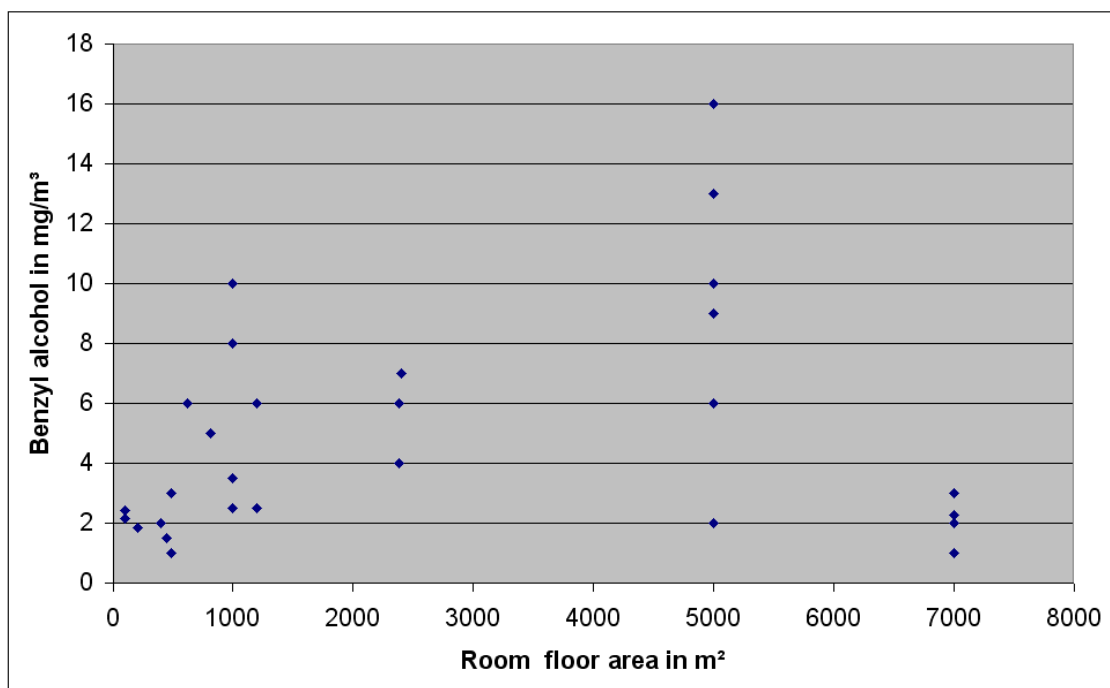


Fig. 6: Exposure compared to room floor area

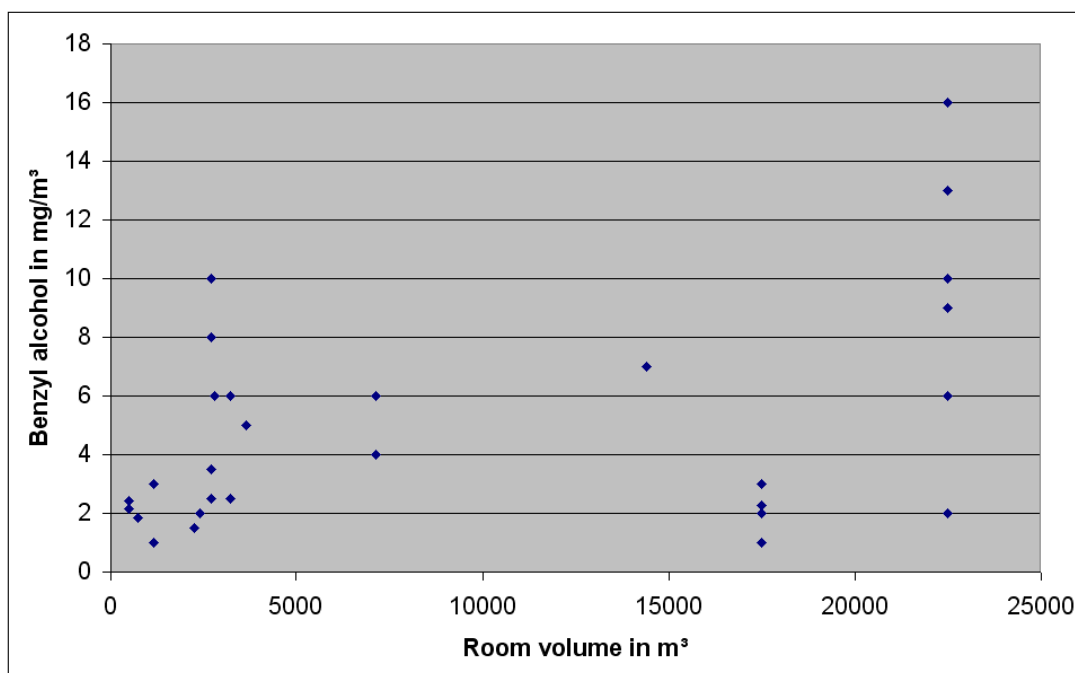


Fig. 7: Exposure compared to room volume

Table 4 presents the data on the benzyl alcohol content of the epoxy resin systems used. The content in the ready to use mixture (taking the mixing ratio into account) ranges between approx. 4 % and 16 %. The weighted mean value of the benzyl alcohol content related to the number of measured values for an EP system ranges at 12 %. If the exact content was given in the formulation, the value in the formulation was taken; otherwise data are oriented to the lower limit of the range given in the Safety Data Sheets.

Table 4: Data on benzyl alcohol (BA) content of the products in percent by weight. Formulation data are in bold print.

Product group	Product anonym	Number	Mixing ratio A:B	BA content in A component	BA content in B component	% in the mixture	SDB date	Year of measurement
REX brush	B1	1	3:1	0	25-50	6	25.04.2002	2001
REX brush	B2	3						1996
REX brush	B3	8						1996
RE1 brush	D2	2	3:1	5	0	3.8		1996
RE2 brush	D3	5	2:1	2	45	16.3		2010
REX brush	K1	1	2:1					1999
RE1 brush	M1	2	2:1	0	35	12.3		2002
REX brush	R1	4	ca. 6:1					1995
REX brush	R2	2	2:1					1995
REX brush	R3	1	2:1					1996
RE1 brush	S1	10	3:1	0	48	12.0		1996
RE1 brush	S2	2	2:1	0	37	12.3		1996



To be able to show the limits of generalising the measured results described here to some extent, the basic parameters for the highest measured exposures and the benzyl alcohol concentrations in the extreme values of the basic parameters have been compiled.

There are 9 measured values (7 mg/m<sup>3</sup> - 16 mg/m<sup>3</sup>) that lie above the 75<sup>th</sup> percentile of the measured value distribution. These originate from 3 construction sites from the years 1995 - 1996. Data on the quantities applied range between 144 kg and 420 kg. Room floor area ranged between 1,000 m<sup>2</sup> and 5,000 m<sup>2</sup>; room volume between 2,700 m<sup>3</sup> and 22,500 m<sup>3</sup>. Relative humidity varied between 58 % and 76 %; room temperature between 17 °C and 23 °C. There is no data on the content of benzyl alcohol in the products used here.

Data on the 10 largest quantities applied are 420 kg and 400 kg (the next being 248 kg); here the benzyl alcohol concentrations are in a range of < 2 - 8 mg/m<sup>3</sup>.

Data on the 18 largest room floor areas are 7,000 m<sup>2</sup> and 5,000 m<sup>2</sup> (the next being 2,400 m<sup>2</sup>); here the benzyl alcohol concentrations are in a range of < 2 - 3 mg/m<sup>3</sup> and 2 - 16 mg/m<sup>3</sup>. The data on the three smallest room floor areas are 100 m<sup>2</sup> and 210 m<sup>2</sup>; here the benzyl alcohol concentrations are in a range of < 4 mg/m<sup>3</sup>.

The data on the 19 largest room volumes are 22,500 m<sup>3</sup>, 17,500 m<sup>3</sup> and 14,400 m<sup>3</sup> (the next being 7,140 m<sup>3</sup>); benzyl alcohol concentrations here are in a range of 2 - 16 mg/m<sup>3</sup>, < 2 - 3 mg/m<sup>3</sup> and 7 mg/m<sup>3</sup>. Data on the 3 smallest room volumes are 500 m<sup>3</sup> and 735 m<sup>3</sup>; here the benzyl alcohol concentrations are in a range of < 4 mg/m<sup>3</sup> (the same values as for the smallest room floor areas).

The 9 highest values for relative humidity range at 76 % and 80 % (at room temperatures between 18 - 20 °C); the benzyl alcohol concentrations here are in a range of < 2 - 10 mg/m<sup>3</sup>. The four lowest values lie between 38 % and 44 % (at room temperatures between 20 - 23 °C); benzyl alcohol concentrations range here from 2 - 6 mg/m<sup>3</sup>.

A marked jump in the data on room temperature was not found; the 3 highest values lie at 22 °C and 23 °C; here the benzyl alcohol concentrations range from < 4 - 7 mg/m<sup>3</sup>.

Besides these basic parameters the products used the day before may influence worker's exposure. This effect, which under circumstances should not be overlooked, was observed at a construction site where a primer with a relatively high benzyl alcohol content (16 % of the ready to use mixture) was applied the first day and to which a benzyl alcohol-free coating was applied the following day. While the primer<sup>5</sup> that contained benzyl alcohol was applied, exposure was below the limit of quantitation but on the following day when the benzyl alcohol-free coating was applied, exposure ranged between 4 mg/m<sup>3</sup> and 8 mg/m<sup>3</sup>. The exchange of air during the night in the 90 x 5 x 5 m<sup>3</sup> room in the first basement storey was obviously so low that a benzyl alcohol concentration could be measured the following day. The release of this relatively low volatile substance must have mainly taken place with some delay after it was applied. Such 'follow-up measurements' are not carried out as a rule in the scope of our examinations. It is quite possible that the substance benzyl alcohol might be less a subject for measurements at the workplace during application than for interior room air evaluation<sup>6</sup>. If applicable, this 'prior load' effect must be taken into consideration for future measurements.

---

<sup>5</sup> At another construction site, while approx. three times the quantity of the same product was applied in a room 29 x 17 x 2.4 m<sup>3</sup>, an exposure of 3 mg/m<sup>3</sup> was measured. Exposure during mixing was less than the limit of quantitation as well.

<sup>6</sup> For benzyl alcohol there is an indoor room air guide value I of 0.4 mg/m<sup>3</sup> ("no impairment of health expected") and a guide value II of 4.0 mg/m<sup>3</sup> ("immediate intervention necessary if this value is exceeded").

## **5 EVALUATION OF PAINT STRIPPERS AND BASIC CLEANERS**

There are 16 evaluated measurements for paint strippers containing benzyl alcohol from between 1999 - 2010. They range from < 4 mg/m<sup>3</sup> to 55 mg/m<sup>3</sup>. Exposure is higher than for brushing of epoxy resin systems but with a 95-percentile of 39 mg/m<sup>3</sup> still clear below the DNEL value of 90 mg/m<sup>3</sup>.

The 3 measurement values for basic cleaning of floors show very low exposures of maximal 7 mg/m<sup>3</sup>.

---

This exposure description was compiled by the German legal accident insurance of the construction industry (Berufsgenossenschaft der Bauwirtschaft) in April 2011.

Contact persons:

Dr. Uwe Musanke, uwe.musanke@bgbau.de, Tel. 069 / 4705 - 283

Dr. Klaus Kersting, klaus.kersting@bgbau.de, Tel. 069 / 4705 - 281