Substance Related Exposure Description for Benzyl Alcohol in Epoxy Resin Coatings

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 130 mg/m³. 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[1], has determined the exposure to benzyl alcohol when applying these products at building sites.

This exposure description does **not** deal with the entire hazardous substance exposure ("Evaluation Index according to TRGS 402"); it only studies exposure to this one substance ("Substance Index according to TRGS 402"). This allows a decision to be made on the safe use of benzyl alcohol, e.g. in the framework of REACH, but to determine the 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 (BG Code 14734). 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 means of gas chromatography with a flame ionization detector. All data was obtained in context of the quality assured German MGU, the hazardous substances measurement system of the German legal accident insurances (formerly BGMG) [1, 2].

3 MEASURING STRATEGY

Person-related sampling was performed on principle; stationary sampling was only carried out in 2 % of the cases. As a rule, sampling was carried out for 2 hours; in 40 % of the cases the duration was less due to the process involved. The measurements described here therefore show **task related exposures** and are not mean values per shift. The advantage of a task relation approach instead of a shift relation for the variable conditions commonly found on construction sites is discussed in [3]. In general, it cannot be ruled out, of course, that some activities are carried out throughout an entire shift. In most cases the exposure duration in the measured shift was about 8 h.
The measurement values were obtained under normal construction site conditions.

4 DATA REPOSITORY

Most of the measured values originate from working with epoxy resin systems used as floor coatings or screeds, a few from coating the interiors of tanks or steel structures in hydraulic engineering . The 51 measured values in total for working with epoxy resin coatings range between < 2 mg/m³ and 33 mg/m³. The interquartile range shows that half of the measured values range between < 4 mg/m³ and 9 mg/m³. In 41 % of the cases, the measured value was less than the limit of quantitation; these values were taken into account in the statistics at one-half the limit of quantitation. A detailed description of the data repository for the benzyl alcohol measurements is found in the Annex to this exposure description.

[1] www.gisbau.de

There are 46 measurements from 15 construction sites where **application was executed manually** (brush, trowel, roller, proportioning weigher); 28 of these (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 (compare with Annex) so that these three sub-repositories can be examined together.

Of the 46 measured values for epoxy resin systems applied manually, 41 were obtained while coating industrial/hall floors at 12 construction sites between 1995 and 2010. 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) and show exposures of < 2 mg/m³ to 28 mg/m³. One measured value (< 4 mg/m³) was determined while coating a balcony outdoors with 20 kg of an RE2 product.

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/m³. Four measured values obtained during thermal spraying in a hot spraying facility (90 °C, 450 l of a RE1 product) showed exposures of 20 mg/m³ to 33 mg/m³.

5 EXPOSURE WHEN COATING INDUSTRIAL/HALL FLOORS

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. When coating industrial and hall floors, 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.

The measurements of the RE1, RE2 and the not yet assigned REX products are statistically evaluated together in Table 1. All of the described activities are examined together since subdivision into 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 as well as by several persons simultaneously. A comparison of the measured values for **mixing work + transporting** with those for **application** (compare with fig. 1) show that the exposures here are lower than while actually applying the coating.

Table 1: Exposures to benzyl alcohol [mg/m³]. The values marked with an asterisk are set values due to measured values below the limit of quantitation.

Activity	Number	< Limit of detection	Minimum	50th percentile	75th percentile	95th percentile	Maximum
Industrial floor coating RE1, RE2, REX	41	18	1*	3	6	10	16

No compelling influence on exposure levels can be detected for the **basic parameters** quantity applied, room 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 (see Annex).

Data on the **quantities applied** range between 5 kg and 420 kg with an mean value of 195 kg. 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.

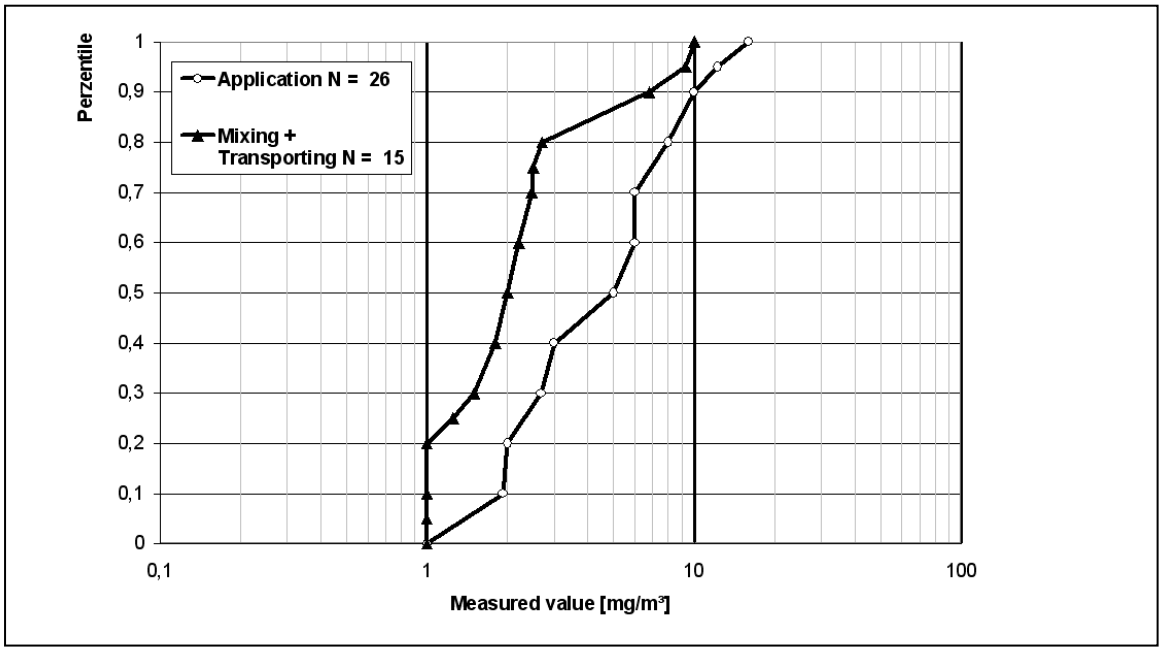

Fig. 1: Comparison of exposures for the activities 'mixing + transporting' with actual 'application'

Application was predominately carried out in medium to larger size rooms or halls. The **floor area** of the rooms ranged from 100 m² to 7,000 m², with a mean value of 3,300 m². **Room volume** ranged from 500 m³ to 22,500 m³ with a mean volume of 10,900 m³. Normally, the rooms only had natural ventilation (doors, windows open). Exhaust / artificial ventilation was not present in any case. In about a third of the cases the natural ventilation was rather poor (doors, windows closed).

Relative **humidity** measured in the work area varied between 38 % and 80 % with a mean relative humidity of 60 % which are generally quite normal values for interior spaces at our latitude.

The **air temperature** measured in the work area ranged between 9 °C and 23 °C with a mean air temperature of 16 °C. From the interquartile range it follows that half of all measurements were carried out at room air temperatures between 10 °C and 19 °C. As fig. 5 in the Annex shows, lower exposures were determined throughout at temperatures below 15 °C. However, the span of the measured values at room temperatures at 16 °C to 18 °C ranges from < 5 mg/m³ to 16 mg/m³ so that a dependence on temperature compared with other influencing factors (at least in this data repository which is rather small for such reflections) seems to be of secondary importance.

Data on the **benzyl alcohol content** in the products used are found in the Annex. If the exact content was known from the formulation, the value given in the formulation was taken; otherwise data are oriented to the lower limit of the range given in the Safety Data Sheets. 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 %.

To be able to show the limits of generalising the results of measuring described here to some extent, the basic parameters for the highest measured exposures are compiled in the Annex and the benzyl alcohol concentrations for the extreme values of the basic parameters examined. In conclusion it can be ascertained that the exposures described here are based on representative examples of the conditions normally found at construction sites.

One 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[2] 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/m³ and 8 mg/m³. The exchange of air during the night in the 90 x 5 x 5 m³ room in the first basement storey was obviously so low that a benzyl alcohol concentration could only 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[3]. If applicable, this 'prior load' effect must be taken into consideration for future measurements.

6 SUMMARY

Based on 41 measurements at the workplace for benzyl alcohol from 12 construction sites while coating industrial/hall floors with epoxy resin systems, it could be shown that exposure to benzyl alcohol while mixing, transporting and application of the coatings lies at 10 mg/m³ (95th percentile of the measured value distribution). Sampling was practically always carried out person-related and the measured values reflect activity related exposure. The basic spatial and climatic conditions during the measurements correspond to the conditions that are usually found at such construction sites. The mean quantities applied ranged around 200 kg, the mean content of benzyl alcohol in the mixed and ready to use systems was 12 % (span: 4 % to 16 %).

Since no workplace limit value has been set for benzyl alcohol and no other limit value is found in the GESTIS International Limit Values database, assessment of exposure is carried out based on the DNEL value of 90 mg/m³ (long-term, systemic effects, inhalation). Since the determined exposure level of 10 mg/m³ is very clearly below the DNEL value, it can be assumed in the sense of REACH that benzyl alcohol can be safely applied during these activities. Dermal exposure was not determined here. When working with these products, gloves that provide protection against chemicals must always be worn and therefore dermal exposure is only expected to play a subordinate role.

Since this exposure description deals only with exposure to benzyl alcohol, it cannot be used alone to stipulate protective measures to be taken when working with epoxy resin systems. Further information for assessing risks is found, for example, in the corresponding product group information (RE1, RE2 etc.) found in the GISCODE for epoxy resin systems (www.wingis-online.de).

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

[2] 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 m³, an exposure of 3 mg/m³ was measured. Exposure during mixing was less than the limit of quantitation as well.

[3] For benzyl alcohol there is an indoor room air guide value I of 0.4 mg/m³ ("no impairment of health expected") and a guide value II of 4.0 mg/m³ ("immediate intervention necessary if this value is exceeded").

Literature

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