Exposure to vapours and aerosols during laying of mastic asphalt („Gussasphalt“) using temperature reducing organic additives

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Gussasphalt (also called mastic asphalt) has been applied at reduced temperatures for many years by various companies. This special type of asphalt can be used for roads as a wearing course, bridge deck water proofing but also for indoor flooring (screeds). The addition of organic additives such as Fischer-Tropsch Wax, Montan or Amide Wax allows a significant reduction of the application temperatures of asphalt. The BITUMEN Forum supports and promotes the application of Gussaphalt at reduced temperatures by publishing articles and various presentations (Musanke et al., 2006).

The German institutions for statutory accident insurance and prevention for the construction industry (BG BAU) has been measuring vapours and aerosols arising from bitumen during the application of Gussasphalt at reduced and conventional temperatures. Often these measurements were carried out on construction sites where paving companies applied temperature reduced asphalt for the very first time. Obviously this includes trials and experiments to fully understand the technology, and explains application temperatures below 200°C as well as above 250°C (figure 1). Usually the application temperature of Gussasphalt using organic additives is today between 220-230°C. It can be expected that this application temperature will be achieved more often once more companies gain experience, most likely the temperature may be reduced even further.

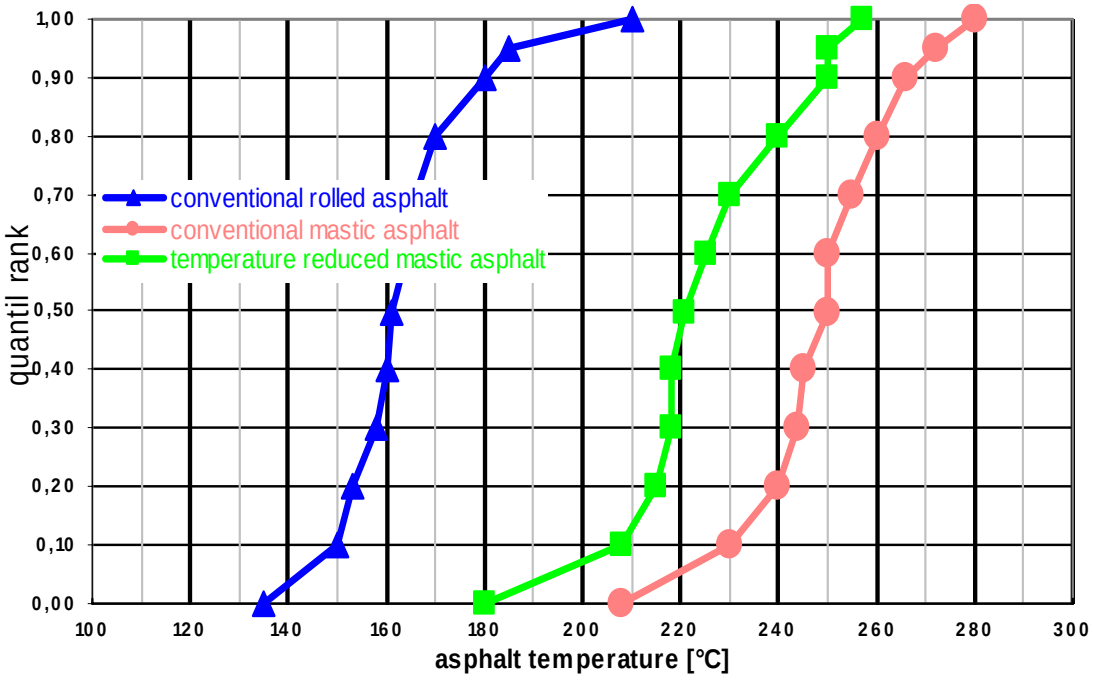

Figure 1: Temperature distribution for conventional and temperature reduced asphalt on construction sites

Since 1999 the BG BAU carried out 219 measurements on 48 construction sites where Gussasphalt containing additives was applied at reduced temperatures.

Measuring Emissions of hot Bitumen

The measurements were carried out by BG BAU and analysed in BGIA predominantly since 2001. The German method for measuring emissions from working with hot bitumen uses the GGP. The GGP is a modification of the sampler for inhalable aerosols GSP with an additional cartridge for vapour sampling. The aerosols are collected on a glass fibre filter (diameter 37 mm); the vapour is adsorbed on 3 g Amberlite™ XAD-2. The flow rate is 3.5 L/min. Filter and XAD-2 are extracted with tetrachloroethylen and analysed by infrared spectroscopy (calibration with mineral oil for spectroscopy) (BGIA 1997; Kenny et al. 1997). Ekström et al. (2001) gave a comparison of different sampling methods for vapours and aerosols of bitumen based on laboratory examinations.

Usually personal-air-sampling is used: Workers carry the test equipment or it is fixed at the paver close to the head of the worker using a pole. During working breaks without exposure to vapours or aerosols the measurements are stopped.

The measurements usually cover periods of two hours. Exposure data presented in this status report refer to the job tasks, which often last for a full 8-hour shift. The 2-h-values obtained were considered to be representative for the job tasks and therefore no modifications (e.g. concerning time weighting) were made. If the measured value is below the detection limit a value of half the detection limit is applied.

During the measurements a large variety of parameters possibly influencing level of exposure were collected, such as date, location, performed job, product/bitumen name, bitumen/asphalt temperature and amount, machines in use. Additionally, environmental conditions such as weather (e.g. temperature, direction and force of wind, type of weather), room dimensions and conditions, exposure control measures etc. were documented.

Exposure during application of temperature reduced Gussasphalt containg additives

On construction sites exposure naturally depends very strongly on wind force and direction as well as on other local conditions. This explains the partly very large ranges of the exposure at individual jobs. Nevertheless, representative exposure data were received by performing a large multiplicity of measurements on different construction sites.

The results of the measurements for the various job tasks of laying Gussasphalt at reduced temperatures are listed in Table 1 (laying temperatures 180 - 256°C). 180°C were achieved on a construction site where a combination of organic additives and zeolithes was used. The high temperature of 256°C was measured during an initial first trial of organic additives. The measured exposures were most of the time below 10 mg/m³.

Table 1: Exposure (mg/m³) to vapour and aerosols of bitumen for temperature reduced Gussasphalt containing additives (temperature 180 - 256°C)

	N	arithmetric mean	geometric mean	50 %	95 %	Range
All	219	3.63	2.24	2.90	9.32	0.25-12.80
Mechanical laying of Gussasphalt (road paving)						
Charger on the mixer, outdoors	43	3.40	2.47	2.40	7.71	0.25-11.98
Screed operator, outdoors	57	3.90	2.83	2.90	8.97	0.25-11.91
Smoother, outdoors	31	0.90	0.53	0,26	3.30	0.25-5.79
Gritter, outdoors	10	0.74	0.46	0.27	2.37	0.25-3.00
Roller driver, outdoors	2	-	-	-	-	0.25-0.25

	N	arithmetric mean	geometric mean	50 %	95 %	Range
Manual work with Gussasphalt (flooring)						
Charger on the mixer, outdoors	2	-	-	-	-	0.25-3.20
Charger on the mixer, indoors	27	5.22	4.40	5.00	11.12	0.52-12.80
Transporting in a barrow, outdoors	1	-	-	-	-	1.00
Transporting in a barrow, indoors	1	-	-	-	-	3.60
Transporting in a bucket, indoors	2	-	-	-	-	2.30-7.30
Smoothing, outdoors	3	-	-	-	-	0.46-1.00
Smoothing, indoors	32	5.88	5.19	5.35	9.82	0.60-10.80
Gritter, indoors	8	-	-	-	-	3.50-10.20

Exposure during application of Gussasphalt at paving temperatures below 230°C
The following examination only considers construction sites where Gussasphalt containing additives was applied at reduced temperatures (max. 230°C) by using organic additives (Table 2).

Table 2: Exposure (mg/m³) to vapours and aerosols of bitumen for temperature reduced Gussasphalt containing additives (temperature max. 230°C)

	N	arithmetric mean	geometric mean	50 %	95 %	Range
All	161	2.92	1.66	2.10	8.60	0.25 – 11.98
Mechanical laying of Gussasphalt (road paving)						
Charger on the mixer, outdoors	43	3.40	2.47	2.40	7.71	0.25 – 11.98
Screed operator, outdoors	57	3.90	2.83	2.90	8.97	0.25 – 11.91
Smoother, outdoors	31	0.90	0.53	0.26	3.30	0.25 – 5.79
Gritter, outdoors	10	0.74	0.46	0.27	2.37	0.25 – 3.30
Roller driver, outdoors	2	-	-	-	-	0.25 – 0.25
Manual work with Gussasphalt (flooring)						
Charger on the mixer, outdoors	1	-	-	-	-	0.50
Charger on the mixer, indoors	3	-	-	-	-	0.50 – 8.60
Transporting in a barrow, outdoors	1	-	-	-	-	1.00
Transporting in a barrow, indoors	1	-	-	-	-	3.6
Transporting in a bucket, indoors	2	-	-	-	-	2.3-7.3
Smoothing, outdoors	3	-	-	-	-	0.46 – 1.00
Smoothing, indoors	7	-	-	-	-	1.90 – 9.50

Figure 2 shows the statistical distribution of exposures during application of rolled asphalt at application temperatures up to 200°C and of Gussasphalt containing additives at application temperatures up to 230°C compared to exposures during application of conventional Gussasphalt.

Details of the exposure data gained during application of conventional rolled asphalt are presented in the paper ‚Einbau von konventionellem Walzasphalt im Straßenbau' (Laying conventional rolled asphalt at road paving) published by BG BAU (www.gisbau.de/bitumen.html, Link Anwendungsbereiche).

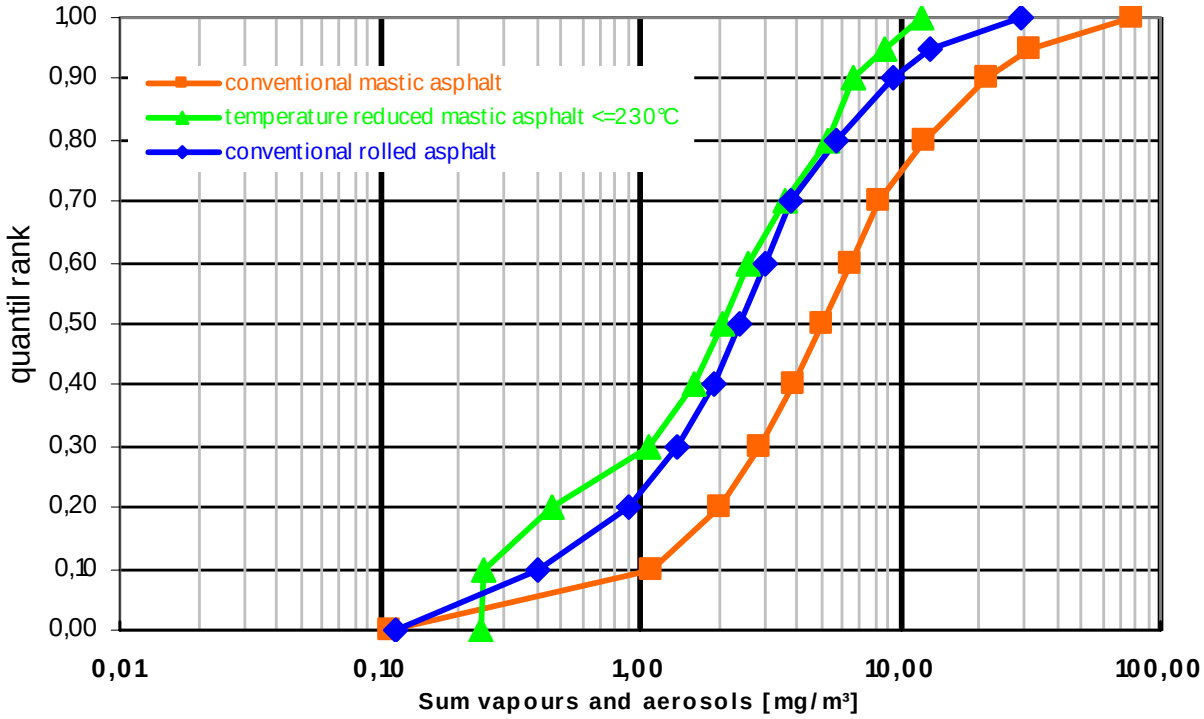

Figure 2: Comparison of exposures resulting from application of rolled asphalt at paving temperatures up to 200°C and from Gussasphalt containing additives at reduced (≤230°C) and conventional temperatures

It is very obvious that exposures resulting from application of conventional rolled asphalt (paving temperature ≤200°C) and exposures resulting from application of temperature reduced Gussasphalt containing additives (paving temperature ≤230°C) are very similar.

Literature

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Dr. Reinhold Rühl, Frankfurt (reinhold.ruehl@bgbau.de)