Zinc Exposure in the Metal Working Industry

Dorothea Koppisch, Stefan Gabriel

Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), Sankt Augustin, Germany

IFA
Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung

Background and Methods

Zinc is widespread in workplaces in the metal working industry during the production of zinc-coated iron/steel and alloys. Another important source of zinc dust is the processing of these materials especially during welding, soldering and grinding/polishing.

Metal fume fever is one health effect that can be caused by zinc oxide fumes. Currently an occupational shift limit value of 0.1 mg/m³ Zn in the respirable fraction is discussed in Germany. This study describes the height of exposure against zinc in the respirable fraction in the German metal working industry and tries to identify critical working areas where more preventive action is needed.

Exposure data from the German exposure database MEGA were analysed. They were sampled within the MGU Measurement system for exposure assessment of the German Social Accident Insurance Institutions (Gabriel et al. 2010). Shift related data with an exposure time of ≥ 8h and a sampling time of ≥2h within the period 2000-2011 were selected. Only representative measurements from normal working situations were considered.

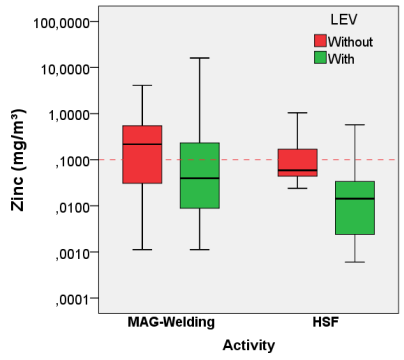
For zinc in the inhalable fraction 2467 measurements are documented in the MEGA database and 1198 for zinc in the respirable fraction. A report about all these zinc measurements will be published by IFA together with the German Social Accident Insurances. In this poster samples of the respirable fraction will be presented.

Results

About 1200 measurements of zinc in the respirable fraction are documented within the exposure database MEGA between 2000 and 2011. For personal sampling the median (50th percentile) of zinc exposures is 0.03 mg/m³ and the 95th percentile 1.12 mg/m³ (Table 1).

The median exposure to zinc in the respirable fraction is below 0.05 mg/m³ Zn in electroplating, steelworks and the construction of motor vehicles (Table 2). For hot dip galvanization, non-ferrous-metal foundries and iron/steel foundries the median exposure is between 0.1 and 0.3 mg/m³. The 95th percentile is about 0.2 mg/m³ in steelworks and electroplating, but it reaches over 6 mg/m³ in non-ferrous-metal foundries.

Figure 1: Influence of local exhaust ventilation (LEV) on zinc exposure during metal active gas welding (MAG-Welding) and hard soldering with a flame (HSF).
OEL is shown at 0.1 mg/m³, Whisker length: 1.5 Inter-quartile range



Looking at different working techniques highest exposures were documented for welding, especially metal active gas welding (Table 3 a and b). The exposure can be reduced by local exhaust ventilation, but still the 75th percentile is above 0.1 mg/m³ (Figure 1). The exposure during soldering depends strongly on the technique used with highest exposure occurring during hard soldering with a flame (Table 3 c and d). While grinding shows high zinc exposures, exposure using other abrasive techniques are comparatively low (Table 3 e and f).

Table 1: Influence of the sampling type (personal and static) on the exposure to zinc in the respirable dust fraction, 2000-2011
N=number of samples, Nc=number of companies, LOD=analytical quantification limit, %≤OEL=percentage of values below the proposed exposure limit of 0.1 mg Zn/m³

Sampling type	N	Nc	Values <LOD N (%)	%≤OEL	50th percentile (mg/m³)	90th percentile (mg/m³)	95th percentile (mg/m³)
a) Static sampling	537	296	92 (17)	84.2	0.00884	0.233	0.524
b) Personal sampling	661	328	81 (12)	67.2	0.0305	0.570	1.124

Table 2: Exposure to zinc in the respirable dust fraction in different industrial sectors, 2000-2011
1) personal sampling, 2) joint analysis of static and personal sampling, N=number of samples, Nc=number of companies, LOD=analytical quantification limit, %≤OEL=percentage of values below the proposed exposure limit of 0.1 mg Zn/m³

Industrial sector	N	Nc	Values <LOD N (%)	% ≤OEL	50th percentile (mg/m³)	90th percentile (mg/m³)	95th percentile (mg/m³)
a) Iron/steel foundries 1)	12	4	0	8.3	0.273	2.01	2.35
b) Non-ferrous-metal foundries 1)	22	12	2 (9)	27.3	0.289	3.82	6.18
c) Hot dip galvanization 1)	36	21	0	44.4	0.104	0.349	0.506
d) Construction of motor 1) vehicles	72	30	12 (17)	70.8	0.0161	0.406	1.22
e) Steelworks 2)	12	3	0	83.3	0.0426	0.131	0.238
f) Electroplating 2)	12	9	6 (50)	83.3	0.00175	0.123	0.188

Table 3: Influence of the activity on the exposure to zinc in the respirable dust fraction, personal sampling, 2000-2011
N=number of samples, Nc=number of companies, LOD=analytical quantification limit, %≤OEL=percentage of values below the proposed exposure limit of 0.1 mg Zn/m³

Activity	N	Nc	Values <LOD N (%)	%≤OEL	50th percentile (mg/m³)	90th percentile (mg/m³)	95th percentile (mg/m³)
a) Metal active gas welding	167	79	11 (7)	53,9	0,0606	1,03	1,58
b) Welding (other types)	162	72	16 (10)	71,6	0,0345	0,347	0,592
c) Hard soldering with a flame	31	20	5 (16)	83,9	0,0221	0,186	0,429
d) Soldering (other types)	14	13	7 (50)	92,9	0,00257	0,0386	0,0945
e) (Dry) Grinding	25	21	5 (20)	80,0	0,0149	0,278	0,501
f) Sawing, turning, planing, polishing	15	13	6 (40)	100	0,00370	0,0340	0,0384

Discussion

If the discussed shift limit value of 0.1 mg/m³ Zn in the respirable fraction should be introduced exposures have to be reduced in many sectors of the metal working industry. One possibility for reducing exposures is the use of adequate local exhaust ventilation.

References

Gabriel S, Koppisch D, Range D (2010) The MGU – a monitoring system for the collection and documentation of valid workplace exposure data. Gefahrstoffe - Reinhalt. Luft 70 (2010) Nr. 1/2, S. 43-49