

Toxicity and Risk of DCM and alternative solvents in paint strippers

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Tasks of BAuA

- Support the ministry of labour (BMA)
- Implementation and transfer of knowledge
- Research
- Implementation of laws (risk assessments, OEL)
- Advising people interested in OSH
- German occupational safety and health exhibition

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What's the problem ? Dichloromethane as solvent in paint strippers

- More than **30 fatalities** as a consequence of very high exposure (probably far above the OEL)
- **100 ppm (max. OEL in EU) is considerably exceeded** in many countries (incl. retardants): Rühl et al. 2004
- In Germany **MAK-value (100 ppm) was deleted** (carcinogenicity and germ cell effects); no new value !
- The **risk is not acceptable**
- Protective measures are obviously **not sufficient**

What about the substitutes ??

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Dichloromethane and alternative solvents

- **Dichloromethane:** (CAS-Nr. 75-09-2)

Selected alternatives:

- **Dibasic esters:**
 - 15 % - 25 % Dimethyl succinate (CAS-Nr. 106-65-0)
 - 55 % - 65 % Dimethyl glutarate (CAS-Nr. 1119-40-0)
 - 10 % - 25 % Dimethyl adipate (CAS-Nr. 627-93-0)
- **2-(2-Ethoxyethoxy) ethanol:** (CAS-Nr. 111-90-0)
- **Benzyl alcohol:** (CAS-Nr. 100-51-6)

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Dichloromethane

Toxicity:

- acute: narcotic, generation of carbon monoxide, death
- genotoxic in vivo and in vitro
- tumors in mice, relevance for humans ?
- **D-MAK-commission: tumor risk in humans cannot be assessed finally, further studies needed !**

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Dichloromethane

- OELs between 15 ppm (N) and 100 ppm (e. g. UK, NL)
- In Germany **MAK-value (100 ppm) was deleted** (carcinogenicity and germ cell effects); no new value !
- No EU-OEL
- EU-classification: Xn, R40 (**Carc. Cat. 3**)
limited evidence of a carcinogenic effect

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Dibasic esters

Dibasic esters:

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55 % - 65 % Dimethyl glutarate (CAS-Nr. 1119-40-0)

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no classification

no OEL

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Dibasic esters

	DBE	DMS	DMG	DMA
Repeated, oral	X	-	-	-
Repeated, inhalation	X	X¹	X	X¹
Mutagenicity in vitro	X	X	X	-
Mutagenicity in vivo	X	X	X	X
Reprotox (dev tox)	X	-	-	X
Reprotox (fertility)	X	-	-	-
Carcinogenicity	-	-	-	-

DBE: Dibasic esters

DMS: Dimethyl succinate

DMG: Dimethyl glutarate

DMA: Dimethyl adipate

1: one dose

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Dibasic esters (mixture)

Repeated, inhalation: nose, olfactory epithelium, acid effect

Reproductive toxicity: body weight change of minor relevance

Mutagenicity: in vivo negative (one positive in vitro)

Carcinogenicity: no study (no need of a study because of lacking mutagenicity and no alerts from the structure)

Acute, inhalation: blurred vision ??

- Database sufficient for an OEL of the mixture (key effect: toxicity in the nose)

- BAUA submitted an OEL-document to German UA III

Dimethyl glutarate

Repeated, inhalation: nose, olfactory epithelium, acid effect

Reproduction: no relevant effects (increase of sperm count and change of hormonal parameter)

Mutagenicity: no effects

Carcinogenicity: no study (no need of a study because of lacking mutagenicity and no alerts from the structure)

Dimethyl succinate and Dimethyl adipate

Repeated, inhalation: nose, olfactory epithelium, acid effect, one dose

Reproduction: no relevant effects (hormonal parameters)

Mutagenicity: no effects

Carcinogenicity: no study (no need of a study because of lacking mutagenicity and no alerts from the structure)

- single esters show similar properties as the mixture

- OEL can be set for the mixture

2-(2-Ethoxyethoxy) ethanol Benzyl alcohol

	2-(2-Ethoxyethoxy) ethanol	Benzyl alkohol
Repeated, oral	X	X
Repeated, inhalation	X	-
Mutagenicity in vitro	X	X
Mutagenicity in vivo	X	X
Reprotox (dev tox)	X	X
Reprotox (fertility)	X	-
Carcinogenicity	X	X

2-(2-Ethoxyethoxy) ethanol

Repeated, inhalation: Larynx/Nose ?

Reproduction:	no effect
Mutagenicity:	no effect
Carcinogenicity:	no effect

- Database sufficient for an OEL (key effect: effects in larynx/nose ?)
- BAUA submitted an OEL-document to German UA III

Benzyl alcohol

Repeated, oral: brain, muscles, kidney at very high doses

Reproduction:	no effect
Mutagenicity:	positive in vitro, negative in vivo
Carcinogenicity:	no effect

OEL difficult because of missing inhalation study

Quality of database Setting of an OEL

Dibasic esters	sufficient toxicity in nose
2-(2-Ethoxyethoxy) ethanol	sufficient toxicity in nose and larynx ?
Benzyl alkohol	limited no inhalation study

Dichloromethane	limited (German MAK) cancer, death ?

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Risk comparison

- Assuming similar working practise, the **vapour pressure** determines the exposure level
- The **saturation concentration** depends on the vapour pressure roughly by the formula
1000 x vapour pressure (hPa) \approx saturation conc. (ppm)

$$\text{Relative Risk level} = \frac{\text{Saturation concentration}}{\text{OEL}}$$

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Risk comparison of DCM with alternative solvents

	saturation conc. (ppm)	OEL (ppm)	Relative risk level = saturation conc./ OEL
Dichloromethane	465200	10 - 100 ¹	4650 - 46500
DBE (v p = 27 Pa, 20°C)	270	0,2 - 2 ²	135 - 1350
DBE (v p = 8 Pa, 20°C)	80	0,2 - 2 ²	40 - 400
2-(2-Ethoxyethoxy) eth.	190	10 ³	19
Benzyl alcohol		--	

1: range of OELs; consideration of cancer might decrease the OEL

2: range, in which the OEL is probably situated

3: BAuA-proposal

A higher relative risk level means a higher risk

Risk comparison of DCM with alternative solvents

	Relative risk level	effect	database
DCM	4650 - 46500	cancer, death	limited (D-MAK)
DBE	40 - 1350	nose	sufficient
EEE	19	nose, larynx	sufficient
BA	no information		

Risk comparison of DCM with alternative solvents

Conclusion:

Two out of three selected alternative solvents are better than DCM, because

- lower risk level
- key effect is less important
- database is better (at least in D)

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