BENOMYL

CAS number:	17804-35-2
Synonyms:	Benlate, methyl-1-(butylcarbamoyl)-2-benzimidazole-carbamate
Chemical formula:	$C_{14}H_{18}N_4O_3$

Workplace exposure standard (amended)

TWA:	**1 mg/m^3**
STEL:	**—**
Peak limitation:	**—**
Notations:	**DSEN**
IDLH:	**—**
Sampling and analysis:	The recommended value is readily quantifiable through currently available sampling and analysis techniques.

Recommendation and basis for workplace exposure standard

A TWA of 1 mg/m^3 is recommended to protect for upper respiratory tract irritation in exposed workers. It is also considered protective for potential developmental and reproductive effects reported in animals.

Discussion and conclusions

Benomyl is a systemic fungicide with adverse effects in animals following exposure including upper respiratory tract irritation and male reproductive system and foetal damage.

An inhalational study in rats have reported a NOAEL of 10 mg/m^3 for degeneration of the olfactory epithelium (males only) and greater than 200 mg/m^3 for reduced sperm development.

The recommended TWA is derived by dividing the NOAEL of 10 mg/m^3 rats by an uncertainty factor of 10 for interspecies variation. When converted to a daily intake this TWA is also considered protective for possible developmental and reproductive effects in exposed workers.

Recommendation for notations

Not classified as a carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Classified as a skin sensitiser and not a respiratory sensitiser according to the GHS.

A skin notation is not recommended based on the available evidence.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	***1991***	***TWA: 10 mg/m³ (0.84 ppm)***
ACGIH	***2014***	***TLV-TWA 1 mg/m³***
TLV-TWA recommended to protect for potential upper respiratory tract and reproductive toxic effects in exposed workers. Benomyl is a systemic fungicide Summary of data: Human data: • Reported eye irritation and contact dermatitis in workers • Reports of dermal sensitisation • Suggested increase in childhood leukaemia associated with prenatal parental exposure to certain pesticides including benomyl ○ results not conclusive. Animal data: • Reported low acute toxicity • Acute dermal LD_{50}: >10,000 mg/kg (rabbit) • Inhalation study NOEL: 10 mg/m³ (male rat); 50 mg/m³ (female rat); olfactory epithelium degeneration and decreased gains in body weight; 6 h/d, 5 d/wk for 60 d • Rat inhalation study reported reduced sperm development in some exposed animals with a NOEL of >200 mg/m³ (4 h) • Rat feeding study reported decreased testicular weights and lowered fertility index at all doses (<1 ppm, 6.3 ppm and 203 ppm; daily for 70 d) • Multiple rat oral studies reported decreased testicular weights, decreased sperm counts, and other reproductive organ changes • Fetotoxicity and teratogenicity demonstrated in mice in a 10 d oral study; same study reported foetal growth retardation in rats at 505 mg/kg • Reported as genotoxic in a variety of studies.		
DFG	***2015***	***NA***
No recommended TWA. Summary of additional data: • Dermal sensitiser notation based on reported sensitising properties in case reports and positive results in studies with occupationally exposed persons • Aneuploidy in the female germ cells of mice; no mutagenic effects in male germ cells.		
SCOEL	***NA***	***NA***
No report		
OARS/AIHA	***NA***	***NA***
No report		

Source	Year set	Standard
HCOTN	***2004***	***TWA: 1 mg/m^3***

TWA considered sufficient to protect for respiratory irritation and reproductive effects in exposed workers.

Summary of additional data:

- NOAEL: 15 mg/kg/d for developmental and male reproduction toxicity in rats (oral; 0, 1, 5, 15, or 45 mg/kg/d for 62 d)
- TWA extrapolated from the NOAEL of 10 mg/m^3 (same study as ACGIH, 2018) via application of an overall assessment factor of 8 to account for intra- and interspecies variation and critical effect
- Conversion of TWA to a daily intake (assuming 70 kg, 10 m^3 inhalation, 8 h/d, and 100% retention) results in 0.15 mg/kg/d, 100 times lower than the NOAEL, justifying protection against reproductive effects.

Secondary source reports relied upon

NIL

Carcinogenicity — non-threshold based genotoxic carcinogens

Is the chemical mutagenic?	Insufficient data
Is the chemical carcinogenic with a mutagenic mechanism of action?	No

The chemical is not a non-threshold based genotoxic carcinogen.

Notations

Source	Notations
SWA	Sen
HCIS	Skin sensitisation – category 1
NICNAS	NA
EU Annex	NA
ECHA	NA
ACGIH	Carcinogenicity – A3; DSEN
DFG	Sh (dermal sensitiser)
SCOEL	NA
HCOTN	—
IARC	—
US NIOSH	NA

NA = not applicable (a recommendation has not been made by this Agency); — = the Agency has assessed available data for this chemical but has not recommended any notations

Skin notation assessment

Calculation	
Adverse effects in human case study:	no
Dermal LD_{50} ≤1000 mg/kg:	no
Dermal repeat-dose NOAEL ≤200 mg/kg:	
Dermal LD_{50}/Inhalation LD_{50} <10:	
In vivo dermal absorption rate >10%:	
Estimated dermal exposure at WES >10%:	
	a skin notation is not warranted

IDLH

Is there a suitable IDLH value available?	No

Additional information

Molecular weight:	290.4
Conversion factors at 25°C and 101.3 kPa:	1 ppm = Number mg/m^3; 1 mg/m^3 = Number ppm
This chemical is used as a pesticide:	✓
This chemical is a biological product:	☐
This chemical is a by-product of a process:	☐
A biological exposure index has been recommended by these agencies:	☐ ACGIH ☐ DFG ☐ SCOEL

Workplace exposure standard history

Year	Standard
Click here to enter year	

References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7th Edition Documentation, CD-ROM, Single User Version. Copyright 2018. Reprinted with permission. See the *TLVs® and BEIs® Guidelines section* on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2015) Benomyl – MAK value documentation.

Health Council of the Netherlands (HCOTN) (2004) Benomyl. Health-based calculated occupational cancer risk values. The Hague: Health Council of the Netherlands; publication no. 2000/15OSH/094.