

Toluene

Cite

Download

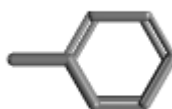
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PubChem CID 1140

Structure



2D



3D



Crystal

Primary Hazards



Flammable



Irritant



Health
Hazard

[Laboratory Chemical Safety Summary \(LCSS\)
Datasheet](#)

Molecular Formula

C_7H_8
 $C_6H_5CH_3$

Synonyms

toluene
methylbenzene
108-88-3
toluol
Phenylmethane

[View More...](#)

Molecular Weight

92.14 g/mol

Computed by PubChem 2.2 (PubChem release 2025.04.14)

Dates

Create: 2004-09-16
Modify: 2025-08-12

Description

Toluene is a clear, colorless liquid with a distinctive smell. Toluene occurs naturally in crude oil and in the

tolu tree. It is also produced in the process of making gasoline and other fuels from crude oil and making coke from coal. Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes.

▶ [Agency for Toxic Substances and Disease Registry \(AT...](#)

Toluene can cause developmental toxicity according to an independent committee of scientific and health experts. It can cause female reproductive toxicity according to California Labor Code.

▶ [California Office of Environmental Health Hazard Asse...](#)

Toluene appears as a clear colorless liquid with a characteristic aromatic odor. Flash point 40 °F. Less dense than [water](#) (7.2 lb / gal) and insoluble in [water](#). Hence floats on [water](#). Vapors heavier than air. May be toxic by inhalation, ingestion or skin contact. Used in aviation and automotive fuels, as a solvent, and to make other chemicals.

▶ [CAMEO Chemicals](#)

[View More...](#)



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See also: [Xylene](#) (related).

Contents

Title and Summary	
1 Structures	▼
2 Names and Identifiers	▼
3 Chemical and Physical Properties	▼
4 Spectral Information	▼
5 Related Records	▼
6 Chemical Vendors	
7 Drug and Medication Information	▼
8 Food Additives and Ingredients	▼

9 Pharmacology and Biochemistry	∨
10 Use and Manufacturing	∨
11 Identification	∨
12 Safety and Hazards	∨
13 Toxicity	∨
14 Associated Disorders and Diseases	
15 Literature	∨
16 Patents	∨
17 Interactions and Pathways	∨
18 Biological Test Results	∨
19 Taxonomy	
20 Classification	∨
21 Information Sources	



1 Structures



1.1 2D Structure



Chemical Structure Depiction

+

-

The image shows a software interface for displaying a chemical structure. The title is "Chemical Structure Depiction". The main area contains a 2D skeletal structure of toluene, which is a benzene ring with a methyl group attached. The structure is centered in the view. In the top right corner of the interface, there are icons for search, image, and download. In the bottom right corner, there are zoom in (+) and zoom out (-) buttons. A full-screen icon is also present in the top right of the structure area.

1.2 3D Conformer



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1.3 Crystal Structures

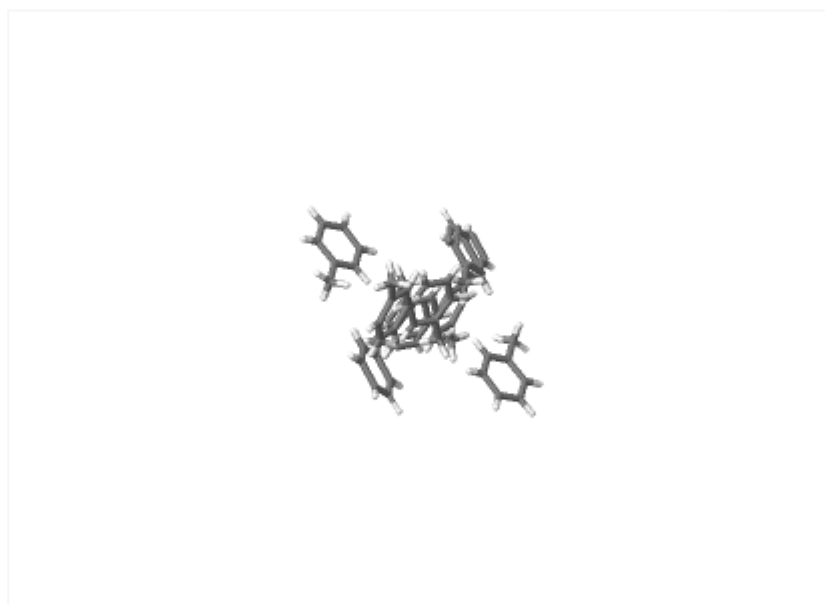


1 of 2 items

View All

CCDC Number	725245
Associated Article	DOI:10.1039/c001190h
Crystal Structure Data	DOI:10.5517/ccsbp0s

Crystal Structure Depiction



2 Names and Identifiers



2.1 Computed Descriptors



2.1.1 IUPAC Name



toluene

Computed by Lexichem TK 2.7.0 (PubChem release 2025.04.14)

▶ [PubChem](#)



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2.1.2 InChI



InChI=1S/C7H8/c1-7-5-3-2-4-6-7/h2-6H,1H3

Computed by InChI 1.07.2 (PubChem release 2025.04.14)

▶ [PubChem](#)

2.1.3 InChIKey



YXFVVABEGXRONW-UHFFFAOYSA-N

Computed by InChI 1.07.2 (PubChem release 2025.04.14)

▶ [PubChem](#)

2.1.4 SMILES



CC1=CC=CC=C1

Computed by OEChem 2.3.0 (PubChem release 2025.04.14)

▶ [PubChem](#)

2.2 Molecular Formula



C₇H₈

Computed by PubChem 2.2 (PubChem release 2025.04.14)

▶ [Australian Industrial Chemicals Introduction Scheme \(AICIS\)](#); [CAMEO Chemicals](#); [PubChem](#)

C₆H₅CH₃

C₇H₈

- ▶ ILO-WHO International Chemical Safety Cards (ICSCs)

2.3 Other Identifiers



2.3.1 CAS



108-88-3

- ▶ Australian Industrial Chemicals Introduction Scheme (AICIS); CAMEO Chemicals; CAS Co...



2.3.2 Related CAS



25013-04-1

Compound: Benzene, methyl-, homopolymer

- ▶ CAS Common Chemistry

2.3.3 Deprecated CAS



1053657-77-4, 1202864-97-8

- ▶ ChemIDplus; EPA Chemicals under the TSCA; EPA DSSTox

2.3.4 European Community (EC) Number



203-625-9

- ▶ European Chemicals Agency (ECHA)

946-198-0

- ▶ European Chemicals Agency (ECHA)

2.3.5 UNII



3FPU23BG52

- ▶ FDA Global Substance Registration System (GSRS)

2.3.6 UN Number



1294 (TOLUENE)

- ▶ CAMEO Chemicals; Emergency Response Guidebook (ERG)

1294

- ▶ ILO-WHO International Chemical Safety Cards (ICSCs); The National Institute for Occupat...

2.3.7 ChEBI ID



CHEBI:17578

- ▶ ChEBI



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2.3.8 ChEMBL ID



CHEMBL9113

- ▶ ChEMBL

2.3.9 DEA Code Number



6594 (DEA list II chemical)

21 CFR Section 1310.02(a) <https://www.ecfr.gov/current/title-21/chapter-II/part-1310/section-1310.02>

- ▶ Drug Enforcement Administration (DEA)

2.3.10 DrugBank ID



DB11558

- ▶ DrugBank

2.3.11 DSSTox Substance ID



DTXSID7021360

- ▶ EPA DSSTox

2.3.12 HMDB ID



HMDB0034168

- ▶ Human Metabolome Database (HMDB)

2.3.13 ICSC Number



0078

- ▶ ILO-WHO International Chemical Safety Cards (ICSCs)



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2.3.14 KEGG ID



C01455

- ▶ KEGG

2.3.15 Metabolomics Workbench ID



46394

- ▶ Metabolomics Workbench

2.3.16 NCI Thesaurus Code



C77930

- ▶ NCI Thesaurus (NCIt)

2.3.17 Nikkaji Number



J2.245.009C

- ▶ Japan Chemical Substance Dictionary (Nikkaji)

J2.868A

- ▶ Japan Chemical Substance Dictionary (Nikkaji)

2.3.18 NSC Number



406333

▶ DTP/NCI

2.3.19 Pharos Ligand ID



M374NYX7BH24

▶ Pharos

2.3.20 RTECS Number



XS5250000

▶ The National Institute for Occupational Safety and Health (NIOSH)

2.3.21 Wikipedia



Toluene

▶ Wikipedia

2.4 Synonyms



2.4.1 MeSH Entry Terms



Toluene

▶ Medical Subject Headings (MeSH)

2.4.2 Depositor-Supplied Synonyms



toluene	tolu-sol	Caswell No. 859	Methyl
methylbenzene	monomethyl benzene	NCI-C07272	CHEBI:3
108-88-3	Methane, phenyl-	CP 25	203-625
toluol	Tolueen	NSC 406333	946-198
Phenylmethane	Toluolo	EPA Pesticide Chemical Code 080601	methyl-
Benzene, methyl-	phenyl methane	NSC-406333	p-tolue
methacide	1-Methylbenzene	3FPU23BG52	4-methy
methylbenzol	RCRA waste number U220	DTXSID7021360	Benzen
antisal 1a	Tolueno	CHEBI:17578	UN 129



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Toluen

methyl benzene

DTXCID501360

TOLUEN

[▶ PubChem](#)

3 Chemical and Physical Properties



3.1 Computed Properties



Property Name	Property Value	Reference
Molecular Weight	92.14 g/mol	Computed by PubChem 2.2 (PubChem release 2025.04.14)
XLogP3	2.7	Computed by XLogP3 3.0 (PubChem release 2025.04.14)
Hydrogen Bond Donor Count	0	Computed by Cactvs 3.4.8.18 (PubChem release 2025.04.14)
Hydrogen Bond Acceptor Count	0	Computed by Cactvs 3.4.8.18 (PubChem release 2025.04.14)
Rotatable Bond Count	0	Computed by Cactvs 3.4.8.18 (PubChem release 2025.04.14)
Exact Mass	92.062600255 Da	Computed by PubChem 2.2 (PubChem release 2025.04.14)
Monoisotopic Mass	92.062600255 Da	Computed by PubChem 2.2 (PubChem release 2025.04.14)
Topological Polar Surface Area	0 Å ²	Computed by Cactvs 3.4.8.18 (PubChem release 2025.04.14)
Heavy Atom Count	7	Computed by PubChem
Formal Charge	0	Computed by PubChem
Complexity	42	Computed by Cactvs 3.4.8.18 (PubChem release 2025.04.14)



Isotope Atom Count	0	Computed by PubChem
Defined Atom Stereocenter Count	0	Computed by PubChem
Undefined Atom Stereocenter Count	0	Computed by PubChem
Defined Bond Stereocenter Count	0	Computed by PubChem
Undefined Bond Stereocenter Count	0	Computed by PubChem
Covalently-Bonded Unit Count	1	Computed by PubChem
Compound Is Canonicalized	Yes	Computed by PubChem (release 2025.04.14)

▶ [PubChem](#)



3.2 Experimental Properties



3.2.1 Physical Description



Toluene appears as a clear colorless liquid with a characteristic aromatic odor. Flash point 40 °F. Less dense than [water](#) (7.2 lb / gal) and insoluble in [water](#). Hence floats on [water](#). Vapors heavier than air. May be toxic by inhalation, ingestion or skin contact. Used in aviation and automotive fuels, as a solvent, and to make other chemicals.

▶ [CAMEO Chemicals](#)

Liquid; Liquid, Other Solid; Other Solid; NKRA; Pellets or Large Crystals, Liquid

▶ [EPA Chemical Data Reporting \(CDR\)](#)

Colorless liquid with a sweet, pungent, [benzene](#)-like odor; [NIOSH]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

Liquid

▶ [Human Metabolome Database \(HMDB\)](#)

COLOURLESS LIQUID WITH CHARACTERISTIC ODOUR.

- ▶ ILO-WHO International Chemical Safety Cards (ICSCs)

Colorless liquid with a sweet, pungent, **benzene**-like odor.

- ▶ Occupational Safety and Health Administration (OSHA); The National Institute for Occup...

3.2.2 Color / Form



Colorless liquid

NIOSH. NIOSH Pocket Guide to Chemical Hazards. Department of Health & Human Services, Centers for Disease Control & Prevention. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2010-168 (2010). Available from: <https://www.cdc.gov/niosh/npg>

- ▶ Hazardous Substances Data Bank (HSDB)



3.2.3 Odor



Sweet, pungent, **benzene**-like odor

NIOSH. NIOSH Pocket Guide to Chemical Hazards. Department of Health & Human Services, Centers for Disease Control & Prevention. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2010-168 (2010). Available from: <https://www.cdc.gov/niosh/npg>

- ▶ Hazardous Substances Data Bank (HSDB)

3.2.4 Boiling Point



231.1 °F at 760 mmHg (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

- ▶ CAMEO Chemicals

110.6 °C

PhysProp

- ▶ DrugBank

110.6 °C

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 3-514

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

110.00 to 111.00 °C. @ 760.00 mm Hg

The Good Scents Company Information System

- ▶ [Human Metabolome Database \(HMDB\)](#)

111 °C

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

232 °F

- ▶ [Occupational Safety and Health Administration \(OSHA\); The National Institute for Occup...](#)



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3.2.5 Melting Point



-139 °F (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

- ▶ [CAMEO Chemicals](#)

-94.9 °C

PhysProp

- ▶ [DrugBank](#)

-94.9 °C

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 3-514

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

-95 °C

- ▶ [Human Metabolome Database \(HMDB\); ILO-WHO International Chemical Safety Cards \(I...](#)

-139 °F

- ▶ [Occupational Safety and Health Administration \(OSHA\); The National Institute for Occup...](#)

3.2.6 Flash Point



40 °F (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

▶ CAMEO Chemicals

4.4 °C

▶ Haz-Map, Information on Hazardous Chemicals and Occupational Diseases

4.0 °C (39.2 °F) - closed cup

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ Hazardous Substances Data Bank (HSDB)

4.4 dec C (closed cup)

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250

▶ Hazardous Substances Data Bank (HSDB)

40 °F (4 °C) (Closed cup)

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 325-108

▶ Hazardous Substances Data Bank (HSDB)

4 °C c.c.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

40 °F

▶ Occupational Safety and Health Administration (OSHA); The National Institute for Occup...

3.2.7 Solubility



less than 1 mg/mL at 64 °F (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

▶ CAMEO Chemicals

526 mg/L (at 25 °C)

SANEMASA, I ET AL. (1982)



▶ DrugBank

In water, 526 mg/L at 25 °C

Sanemasa I et al; Bull Chem Soc Japan 55: 1054-62 (1982)

▶ Hazardous Substances Data Bank (HSDB)

Miscible with alcohol, chloroform, ether, acetone, glacial acetic acid, carbon disulfide

O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Cambridge, UK: Royal Society of Chemistry, 2013., p. 1765

▶ Hazardous Substances Data Bank (HSDB)

Soluble in ethanol, benzene, diethyl ether, acetone, chloroform, glacial acetic acid and carbon disulfide

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47: 79 (1989)

▶ Hazardous Substances Data Bank (HSDB)

0.526 mg/mL at 25 °C

▶ Human Metabolome Database (HMDB)

Solubility in water: none

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

(74 °F): 0.07%

▶ The National Institute for Occupational Safety and Health (NIOSH)

3.2.8 Density



0.867 at 68 °F (USCG, 1999) - Less dense than water; will float

U.S. Coast Guard. 1999. Chemical Hazard Response Information System (CHRIS) - Hazardous Chemical Data. Commandant Instruction 16465.12C. Washington, D.C.: U.S. Government Printing Office.

▶ CAMEO Chemicals

0.8623 g/cm³ at 20 °C

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 3-514



- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Relative density (water = 1): 0.87

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

0.87

- ▶ [Occupational Safety and Health Administration \(OSHA\); The National Institute for Occup...](#)

3.2.9 Vapor Density



3.14 (NTP, 1992) - Heavier than air; will sink (Relative to Air)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

- ▶ [CAMEO Chemicals](#)

3.1 (Air = 1)

Infante PF, Bingham E; Aromatic Hydrocarbons - Benzene and Other Alkylbenzenes. Patty's Toxicology. 6th ed. (1999-2016). New York, NY: John Wiley & Sons, Inc. On-line Posting Date: 17 Aug 2012

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Relative vapor density (air = 1): 3.1

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

3.14

- ▶ [Occupational Safety and Health Administration \(OSHA\)](#)

3.2.10 Vapor Pressure



10 mmHg at 43.5 °F ; 20 mmHg at 65.1 °F; 40 mmHg at 89.2 °F (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

- ▶ [CAMEO Chemicals](#)

28.4 [mmHg]

- ▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

28.4 mm Hg at 25 °C

Daubert, T.E., R.P. Danner. Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, D.C.: Taylor and Francis, 1989.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Vapor pressure, kPa at 25 °C: 3.8

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

21 mmHg

▶ [Occupational Safety and Health Administration \(OSHA\); The National Institute for Occup...](#)



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3.2.11 LogP



2.73

HANSCH, C ET AL. (1995)

▶ [DrugBank](#)

log Kow = 2.73

Hansch, C., Leo, A., D. Hoekman. Exploring QSAR - Hydrophobic, Electronic, and Steric Constants. Washington, DC: American Chemical Society, 1995., p. 31

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

2.73

▶ [Human Metabolome Database \(HMDB\)](#)

2.69

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

3.2.12 LogS



-2.21

ADME Research, USCD

▶ [DrugBank](#)

3.2.13 Henry's Law Constant



Henry's Law constant = 6.64×10^{-3} atm-cu m/mole @ 25 °C

Mackay D et al; *Environ Sci Technol* 13: 333-6 (1979)

▶ Hazardous Substances Data Bank (HSDB)

3.2.14 Stability / Shelf Life



Stable under recommended storage conditions.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ Hazardous Substances Data Bank (HSDB)



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3.2.15 Autoignition Temperature



896 °F (USCG, 1999)

U.S. Coast Guard. 1999. Chemical Hazard Response Information System (CHRIS) - Hazardous Chemical Data. Commandant Instruction 16465.12C. Washington, D.C.: U.S. Government Printing Office.

▶ CAMEO Chemicals

896 °F (480 °C)

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 49-144

▶ Hazardous Substances Data Bank (HSDB)

480 °C

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

3.2.16 Decomposition



Can react vigorously with oxidizing materials.

Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ Hazardous Substances Data Bank (HSDB)

When heated to decomposition it emits acrid smoke and irritating fumes.

Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.17 Viscosity



1.165 mPa-s at -25 °C; 0.778 mPa-s at 0 °C; 0.560 mPa-s at 25 °C; 0.424 mPa-s at 50 °C; 0.333 mPa-s at 75 °C; 0.270 mPa-s at 100 °C

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 6-234

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

0.68 mm²/s at 20 °C

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)



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3.2.18 Corrosivity



Noncorrosive liquid.

USEPA; Ambient Water Quality Doc: Toluene p.A-1 (1980) EPA 440/5-80-075

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.19 Heat of Combustion



3910.3 KJ/mol

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 5-68

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.20 Heat of Vaporization



38.01 KJ/mol at 25 °C

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 6-144

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.21 Surface Tension



29.46 mN/m at 10 °C; 27.73 mN/m at 25 °C; 24.85 mN/m at 50 °C; 21.98 mN/m at 75 °C; 19.10 mN/m at 100 °C

Haynes, W.M. (ed.). *CRC Handbook of Chemistry and Physics. 95th Edition.* CRC Press LLC, Boca Raton: FL 2014-2015, p. 6-184

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.22 Ionization Potential



8.82 eV

▶ [Occupational Safety and Health Administration \(OSHA\); The National Institute for Occup...](#)



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3.2.23 Odor Threshold



Odor Threshold Low: 0.16 [ppm]

Odor Threshold High: 37.0 [ppm]

Detection odor threshold from AIHA (mean = 1.6 ppm)

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

2.14 ppm (8 mg/cu m). Odor recognition level is reported as 1.03 to 140 ug/cu m.

Cleland, J.G., G.L. Kingsbury. Multimedia Environmental Goals for Environmental Assessment. Volume 1. EPA-600/7-77-136a. Research Triangle Park, NC: EPA, Nov. 1977., p. E-146

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Odor in air= $1.30 \times 10^{+11}$ mol/cu cm

Fazzalari, F.A. (ed.). Compilation of Odor and Taste Threshold Values Data. ASTM Data Series DS 48A (Committee E-18). Philadelphia, PA: American Society for Testing and Materials, 1978., p. 158

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.24 Refractive Index



Index of refraction: 1.4967 @ 20 °C/D

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 3-514

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

3.2.25 Kovats Retention Index



Standard non-polar

755.4 , 747.02 , 747.41 , 744 , 752 , 756.5 , 761 , 751.5 , 754 ,
765.3 , 742 , 746.5 , 747.1 , 750.1 , 753.2 , 751 , 751 , 748.39 ,
749.03 , 762 , 744 , 751 , 754 , 748.65 , 749 , 749 , 775 , 764 ,
752.8 , 753.4 , 756.8 , 763 , 763 , 746.99 , 749.29 , 750.81 , 764
, 754.08 , 755.27 , 751.88 , 752 , 748 , 730 , 754 , 781 , 751.6 ,
752.6 , 754.8 , 755.2 , 755.3 , 759.7 , 760.9 , 786 , 751.72 ,
753.79 , 756.18 , 758.31 , 760.55 , 763.41 , 765.53 , 767.08 ,
769.68 , 773.08 , 774.96 , 777.86 , 758 , 776 , 773.24 , 750.1 ,
754.9 , 786.91 , 756.97 , 756.97 , 766.3 , 754 , 767 , 758 , 752 ,
746 , 779 , 780 , 761.8 , 763 , 765.5 , 768.4 , 748 , 755 , 757.5 ,
764.5 , 777.1 , 786.9 , 756.2 , 756.5 , 756.5 , 756.6 , 756.7 , 755
, 771.6 , 749 , 756 , 756 , 766 , 766 , 757 , 766 , 771.4 , 766 ,
753.6 , 756.6 , 758.4 , 759.9 , 766 , 759 , 760 , 753 , 757 , 762 ,
767 , 754 , 756.1 , 758 , 759.8 , 788 , 753 , 788 , 780 , 771 , 762
, 764 , 764 , 766 , 766 , 751 , 753 , 755 , 757 , 759 , 761 , 756.2
, 756.7 , 759.9 , 767 , 754 , 761 , 774 , 766 , 772 , 782 , 748 ,
756 , 756 , 766.4 , 771.5 , 781.5 , 758 , 764 , 765 , 761.4 , 770 ,
773 , 776 , 778 , 772 , 776 , 778 , 781 , 785 , 757.7 , 757.7 ,
757.7 , 757.7 , 757.7 , 757.6 , 755 , 756 , 759 , 767 , 756 , 751 ,
765 , 766 , 756 , 760 , 763 , 766 , 746 , 757 , 746 , 761 , 766 ,
771 , 776 , 753 , 746 , 746 , 750 , 750 , 750 , 772 , 772 , 756 ,
759 , 746 , 756 , 753 , 753 , 752 , 745 , 748 , 753.8 , 771 , 760 ,
760.3 , 744.5 , 753 , 757 , 741 , 742 , 767 , 772 , 746.6 , 744.2 ,
751.2 , 756 , 766 , 761 , 751.9 , 751.13 , 753.5 , 753 , 754 ,
749.4 , 758.1 , 751 , 755 , 756 , 751 , 754 , 763 , 760 , 764 , 760
, 766 , 760 , 760 , 764 , 766 , 766 , 766 , 767 , 752 , 760 , 749 ,
754.9 , 758 , 749 , 744 , 748 , 752 , 766 , 766 , 770 , 772 , 756 ,
743 , 746 , 746 , 763 , 768 , 758 , 758 , 759 , 760 , 760 , 762 ,
763 , 752 , 752 , 756 , 756 , 760.7 , 768 , 768.5 , 769 , 748 , 748
, 749 , 753 , 760 , 765 , 745 , 766 , 739 , 748 , 748.7 , 763 , 752
, 750 , 764 , 748 , 734 , 745 , 748 , 751 , 752 , 753 , 761 , 764 ,
767 , 754 , 758 , 756 , 748 , 748 , 749 , 770 , 753 , 761 , 750 ,
742.9 , 770 , 770 , 768

Semi-standard non-polar

771 , 771 , 769 , 762 , 779.2 , 796.8 , 762 , 765 , 784 , 779 , 773
, 784 , 769 , 775 , 776 , 750 , 760 , 758.9 , 761.3 , 761.7 , 770.8 ,
773 , 762 , 766 , 768 , 776 , 771 , 760 , 771 , 778 , 756 , 770 ,
760 , 757 , 777 , 771 , 768 , 756 , 756 , 760 , 762.9 , 767.6 ,
758.9 , 761.3 , 761.7 , 761 , 759 , 761.89 , 764.46 , 766.26 ,
774.14 , 778.14 , 785.29 , 792.81 , 782.2 , 787.7 , 767.72 ,
770.81 , 772.35 , 774.88 , 776.58 , 779.16 , 781.85 , 784.33 ,
787.46 , 790.83 , 793.44 , 797.35 , 769 , 743.7 , 746.2 , 748.7 ,
751.2 , 753.5 , 756.2 , 758.8 , 784 , 759 , 788.2 , 763 , 746 , 757
, 784 , 786 , 771.9 , 775.4 , 758 , 752 , 744.1 , 749 , 753 , 758 ,
744 , 746 , 748 , 772.3 , 774.4 , 776.7 , 779 , 781.5 , 784.2 , 755
, 757 , 755 , 757.1 , 750 , 791 , 757 , 745.2 , 750 , 744.2 , 749.3 ,
749.8 , 751.2 , 754 , 754.7 , 755 , 755 , 755.3 , 755.5 , 749.2 ,
749.4 , 755 , 757.1 , 760 , 731.4 , 731.4 , 746 , 766.8 , 786.5 ,
747 , 750 , 751.68 , 760 , 756 , 763 , 745 , 750 , 758 , 753 , 757
, 760 , 763 , 764 , 767 , 773 , 747 , 746.8 , 776 , 758 , 763 ,
754.7 , 758 , 761.1 , 754.2 , 760.7 , 788 , 740.6 , 747 , 751 , 756



, 753, 756, 763, 769, 783, 789, 796, 756.4, 756, 738, 739, 742, 750, 752, 757, 787, 744, 747, 748, 748, 748, 749, 749, 750, 751, 751, 751, 751, 752, 752, 752, 753, 753, 755, 755, 756, 756, 756, 757, 758, 759, 761, 761, 768, 772, 776, 759, 757, 760, 771, 776, 759, 764, 762, 763, 769, 766, 759, 772, 761, 771, 773, 750, 769, 764, 763, 770, 765, 758, 776, 756, 767, 770, 770, 756, 773, 780, 780, 780, 766, 766.1, 766, 769.8, 773, 776, 774, 769, 772, 772, 776, 768.3, 772, 777.4, 766, 764, 773.1, 773, 771.9, 766.2, 773, 767, 768, 764, 772.6, 766, 761, 770, 776, 769, 766, 780, 769, 770, 769, 753.2, 770, 769, 772.6, 771, 773, 756, 756, 760, 767.4, 778, 758.7, 762.8, 779, 768, 770, 752, 765, 771.2, 757, 763, 767, 750, 765, 765, 763, 769, 771, 771, 772, 773, 774, 776, 725, 771, 774, 764.1, 774, 764, 757.6, 771, 751, 755, 771, 760, 734, 746, 759, 792, 755, 755, 743, 769, 106.1, 106.1, 111.93, 114.3, 112.43, 112.62



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Standard polar

1035, 1035, 1035, 1035, 1040, 1043, 1036, 1027, 1034, 1017, 1029, 1046, 1075, 1058, 1073, 1033, 1014, 1047, 1038, 1056, 1029, 1028, 1041, 1034, 1033, 1041, 1033, 1040, 1039, 1033, 1040, 1043, 1049, 1031, 1024, 1041, 1033, 1044, 1058, 1042, 1040, 1028, 1039, 1036, 1049, 1040, 1037, 1042, 1070, 1035, 1050, 1051, 1019, 1015, 1025, 1042, 1040, 1043, 1022, 1027, 1061, 1077.5, 1088.3, 1043.09, 1049.5, 1057.61, 1068.53, 1076.25, 1084.2, 1042, 1026, 1030, 1039.5, 1052.3, 1054.2, 1037, 1042, 1057, 1042, 1037, 1040, 1041, 1041, 1019, 1038, 1053.89, 1057.98, 1062.76, 1067.04, 1071.62, 1076.1, 1066, 1055, 1049.5, 1068.2, 1073.3, 1078.4, 1083.4, 1088.5, 1054, 1054, 1069.7, 1069.7, 1072.9, 1073.4, 1090.9, 1043.2, 1027.1, 1077, 1077, 1093, 1064, 1071, 1078, 1085, 1066, 1028, 1039, 1040, 1022, 1059, 1040, 1040, 1042, 1069, 1026, 1030, 1043, 1081, 1061, 1061, 1040, 1043, 1029, 1042, 1043, 1026, 1047, 1023, 1023, 1043, 1051, 1051, 1051, 1043, 1027, 1052, 1062, 1073, 1083, 1033, 1036, 1026, 1067.3, 1023, 1065, 1041, 1020, 1050, 1029, 1035.7, 1057.9, 1030.1, 1059, 1065, 1034, 1037, 1030, 1026, 1059, 1017, 1019, 1040, 1031, 1034.1, 1027, 1040, 1036.9, 1055, 1041, 1041, 1048, 1056, 1058, 1068, 1077, 1043, 1037, 1031, 1037.6, 1038, 1045.6, 1049.1, 1036, 1011, 1012, 1029, 1043, 1054.5, 1027, 1033, 1034, 1047, 1058, 1051, 1038, 1050, 1060, 1031, 1038, 1032, 1047, 1017, 1035, 1024, 1017, 1043, 1051, 1038, 1070, 1093, 1032, 1035, 1035, 1055, 1027, 1027, 1037, 1054, 1035, 1049.3, 1050.2

► [NIST Mass Spectrometry Data Center](#)

Conversion factors: 1 ppm = 3.77 mg/cu m at 1 atmosphere

Infante PF, Bingham E; Aromatic Hydrocarbons - Benzene and Other Alkylbenzenes. Patty's Toxicology. 6th ed. (1999-2016). New York, NY: John Wiley & Sons, Inc. On-line Posting Date: 17 Aug 2012

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Ratio of Specific Heats of Vapor (Gas): 1.089; floats on [water](#)

U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Partition coefficients at 37 °C for toluene into blood = 15.6; into oil = 1,470

[PMID:3299685](#)

Sato A, Nakajima T; Scand J Work Environ Health 13: 81-93 (1987)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

[Hydroxyl](#) radical rate constant = 5.96×10^{-12} cu cm/molecule-sec @ 25 °C

Atkinson R; J Phys Chem Ref Data Monograph No. 2 (1994)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



3.3 SpringerMaterials Properties



13C nuclear magnetic resonance spectrum	Chemical shift	Diffusive flu
Schoenflies notation	Composition	Dispersion
Absorbance	Compressibility	Electron co
Acentric factor	Corrosion	Enthalpy
Activity	Critical point	Exaltation c
Angular frequency	Density	Excess enth
Azeotropes	Diamagnetic susceptibility	Excess volu
Boiling point	Diamagnetic susceptibility exaltation	External qu
Chemical bond	Dielectric constant	Fluorescenc
Chemical diffusion	Diffusion	Fusion tem

▶ [SpringerMaterials](#)

3.4 Chemical Classes



Hazardous Air Pollutants (HAPs)

- ▶ EPA Air Toxics

Teratogens

Flammable agents - 3rd degree

- ▶ NJDOH RTK Hazardous Substance List

Volatile Organic Compound (VOC)

- ▶ USGS Health-Based Screening Levels for Evaluating Water-Quality Data

3.4.1 Drugs



Pharmaceuticals -> Listed in ZINC15

S55 | ZINC15PHARMA | Pharmaceuticals from ZINC15 | DOI:10.5281/zenodo.3247749

- ▶ NORMAN Suspect List Exchange

3.4.1.1 Animal Drugs



Active Ingredients (Toluene) -> FDA Greenbook

- ▶ FDA Approved Animal Drug Products (Green Book)

3.4.2 Cosmetics



Cosmetics ingredient -> Base; Fragrance; Solvent

- ▶ California Safe Cosmetics Program (CSCP) Product Database

Cosmetic ingredients ([Toluene](#)) -> CIR (Cosmetic Ingredient Review)

Journal of the American College of Toxicology 6(1):77-120, 1987

International Journal of Toxicology 25(Suppl. 2) :1-89,2006

- ▶ Cosmetic Ingredient Review (CIR)

Solvent

S13 | EUCOSMETICS | Combined Inventory of Ingredients Employed in Cosmetic Products (2000) and Revised Inventory (2006) | DOI:10.5281/zenodo.2624118

- ▶ NORMAN Suspect List Exchange

3.4.3 Endocrine Disruptors



Potential endocrine disrupting compound

S109 | PARCEDC | List of 7074 potential endocrine disrupting compounds (EDCs) by PARC T4.2
| DOI:10.5281/zenodo.10944198

- ▶ NORMAN Suspect List Exchange

3.4.4 Food Additives



SOLVENT OR VEHICLE -> FDA Substance added to food

- ▶ FDA Substances Added to Food



3.4.5 Food Contact Substances



FCS -> FDA Inventory of Food Contact Substances Listed in 21 CFR

- ▶ FDA Packaging & Food Contact Substances (FCS)

3.4.6 Fragrances



Fragrance substance (Toluene) -> IFRA amendment 38

- ▶ International Fragrance Association (IFRA)

3.4.7 Solvents



Solvents -> Aromatic Solvents

- ▶ Haz-Map, Information on Hazardous Chemicals and Occupational Diseases

4 Spectral Information



4.1 1D NMR Spectra



1 of 2 items

1D NMR Spectra

1H NMR: 157 (Varian Associates NMR Spectra Catalogue)

- ▶ Hazardous Substances Data Bank (HSDB)

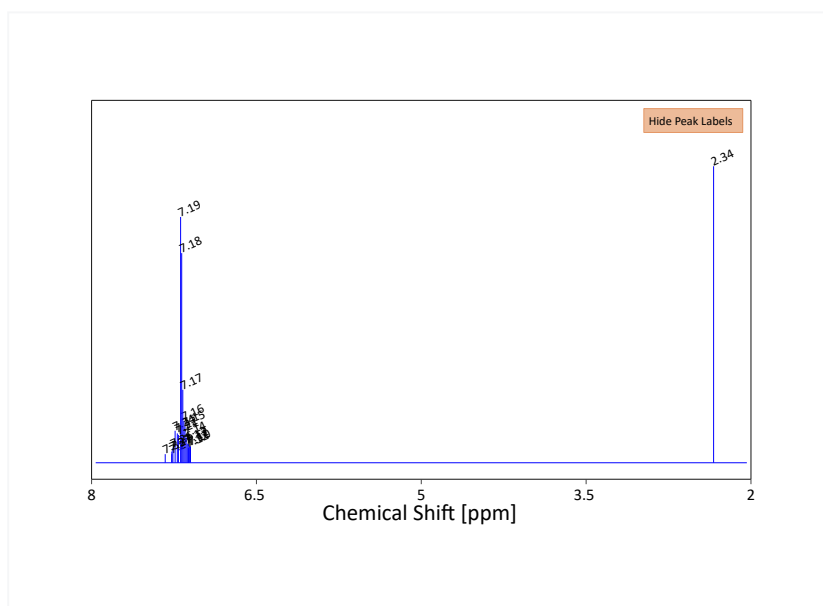
2 of 2 items

[▶ NMRShiftDB](#)4.1.1 ¹H NMR Spectra

1 of 2 items

Spectra ID	2126
Instrument Type	JEOL
Frequency	90 MHz
Solvent	CDCl ₃
Shifts [ppm]:Intensity	7.16:141.00, 7.24:108.00, 7.15:122.00, 7.11:55.00, 7.19:829.00, 7.27:29.00, 7.12:50.00, 7.18:707.00, 7.21:94.00, 7.10:55.00, 7.17:246.00, 7.13:65.00, 7.22:99.00, 2.34:1000.00, 7.12:62.00, 7.26:50.00, 7.14:85.00, 7.33:29.00, 7.27:38.00

Thumbnail

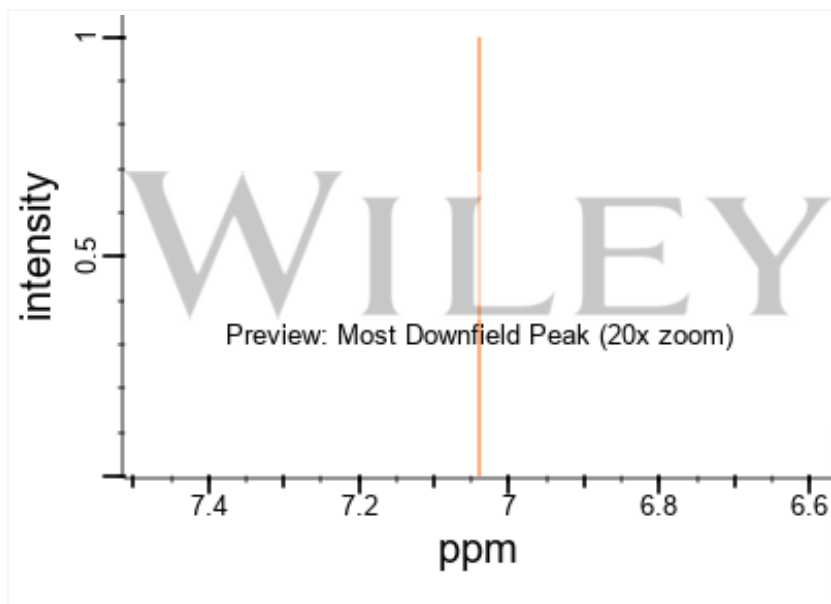
[▶ Human Metabolome Database \(HMDB\)](#)

2 of 2 items

Instrument Name	Varian A-60
Copyright	Copyright © 2009-2025 John Wiley & Sons, Inc. All Rights Reserved.



Thumbnail



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► [SpectraBase](#)

4.1.2 ¹³C NMR Spectra



1 of 3 items

[View All](#)

13C NMR Spectra

13C NMR: 243 (Johnson and Jankowski, [Carbon-13 NMR Spectra](#), John Wiley & Sons, New York)

► [Hazardous Substances Data Bank \(HSDB\)](#)

2 of 3 items

[View All](#)

Spectra ID

[3445](#)

Instrument Type

Varian

Frequency

25.16 MHz

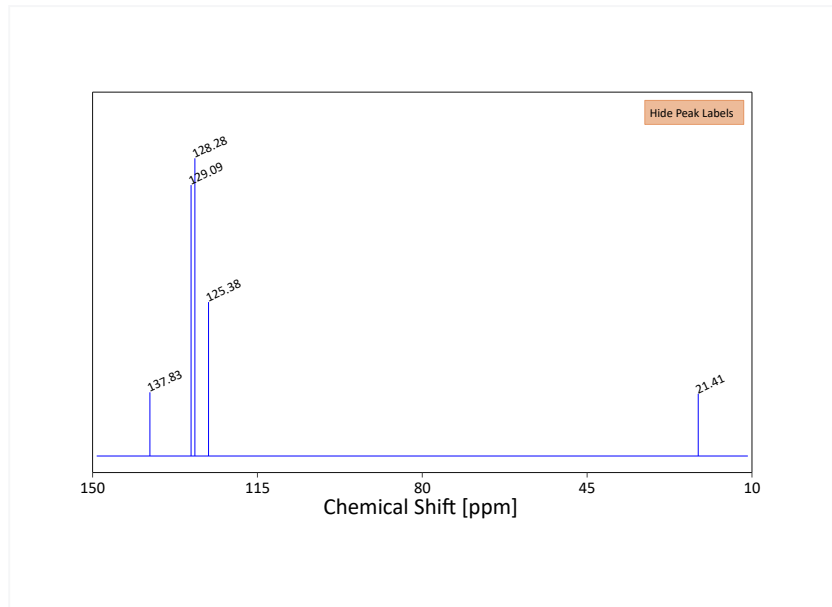
Solvent

CDCl₃

Shifts [ppm]:Intensity

128.28:1000.00, 137.83:214.00, 125.38:517.00, 21.41:209.00, 129.09:910.00

Thumbnail



► [Human Metabolome Database \(HMDB\)](#)

4.2 Mass Spectrometry



4.2.1 GC-MS

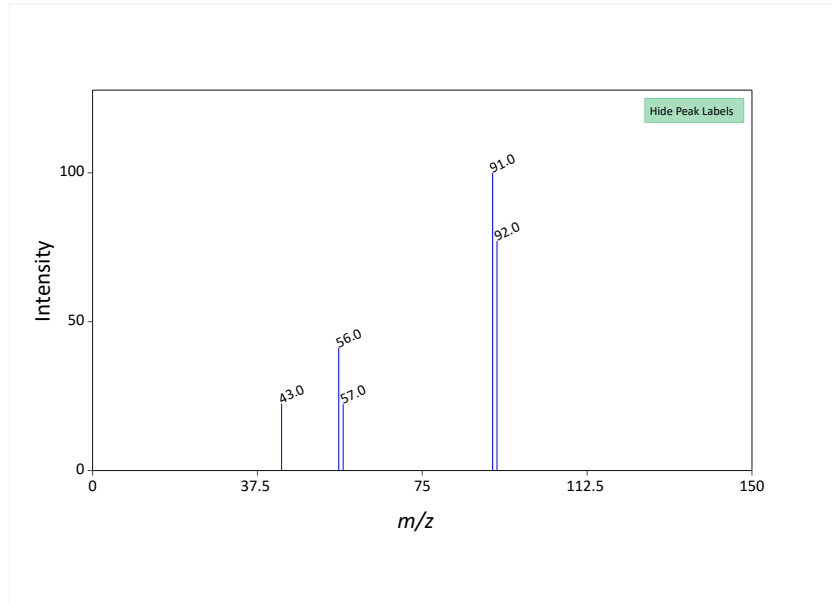


1 of 17 items

[View All](#)

Spectra ID	101542
Instrument Type	EI-B
Ionization Mode	positive
SPLASH	splash10-0006-9000000000-21366c9a473a72238c27
Top 5 Peaks	91.0 99.99 92.0 77.10 56.0 41.30 43.0 22.50 57.0 22.30

Thumbnail



Notes

instrument=JEOL JMS-01-SG-2

► [Human Metabolome Database \(HMDB\)](#)

2 of 17 items

[View All](#)

Spectra ID [101544](#)

Instrument Type EI-B

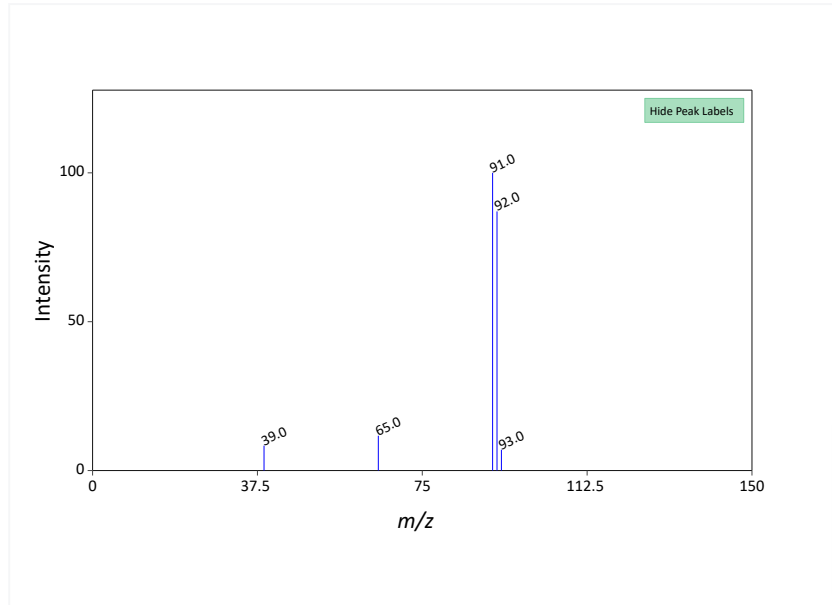
Ionization Mode positive

SPLASH [splash10-0006-9000000000-9484aa3a95c9d0168f91](#)

Top 5 Peaks

91.0	99.99
92.0	87.04
65.0	11.69
39.0	8.37
93.0	6.98

Thumbnail



Notes

instrument=HITACHI RMU-7M

▶ [Human Metabolome Database \(HMDB\)](#)



4.2.2 Other MS



1 of 5 items

[View All](#)

Other MS

MASS: 61278 (NIST/EPA/MSDC Mass Spectral Database 1990 version)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

2 of 5 items

[View All](#)

Accession ID

[MSBNK-Fac_Eng_Univ_Tokyo-JP003417](#)

Authors

KOGA M, UNIV. OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH

Instrument

JEOL JMS-01-SG-2

Instrument Type

EI-B

MS Level

MS

Ionization Mode

POSITIVE

Ionization

ENERGY 75 eV

Top 5 Peaks

91 999

92 771

56 413

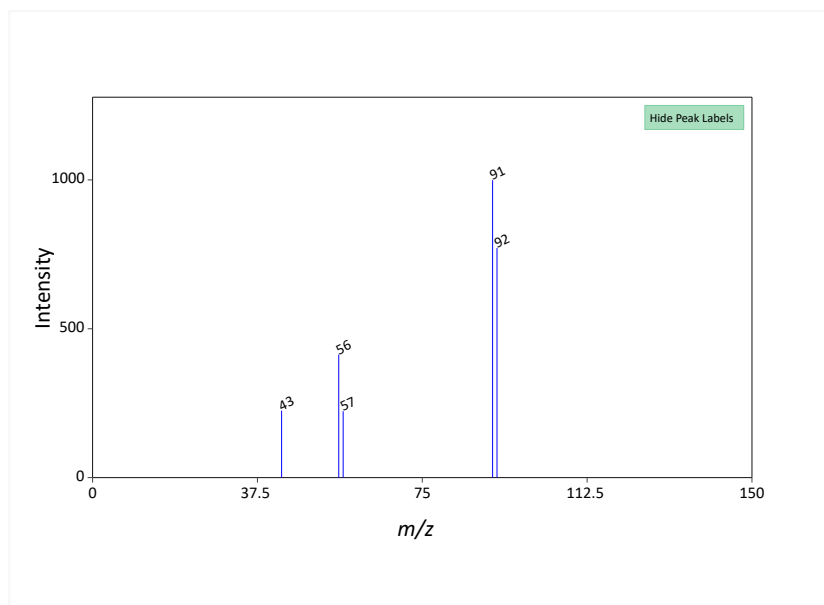
43 225

57 223

SPLASH

splash10-0006-9000000000-21366c9a473a72238c27

Thumbnail



License

CC BY-NC-SA

▶ [MassBank Europe](#)

4.3 UV Spectra



SADTLER REF NUMBER: 419 (IR, PRISM); 119 (IR, GRATING); MAX ABSORPTION (ALCOHOL): 207 NM (LOG E= 3.97); 260 NM LOG E= 2.48)

Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979., p. C-518

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

UV max = 276 nm

NIST; Chemistry WebBook. National Institute of Standards and Technology Standard Reference Database. Number 69 - Feb 2015 Release. Available from, as of Mar 4, 2016: <https://webbook.nist.gov/chemistry>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

UV: 155 (Sadtlar Research Laboratories Spectral Collection)

Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V2: 1082

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



4.4 IR Spectra



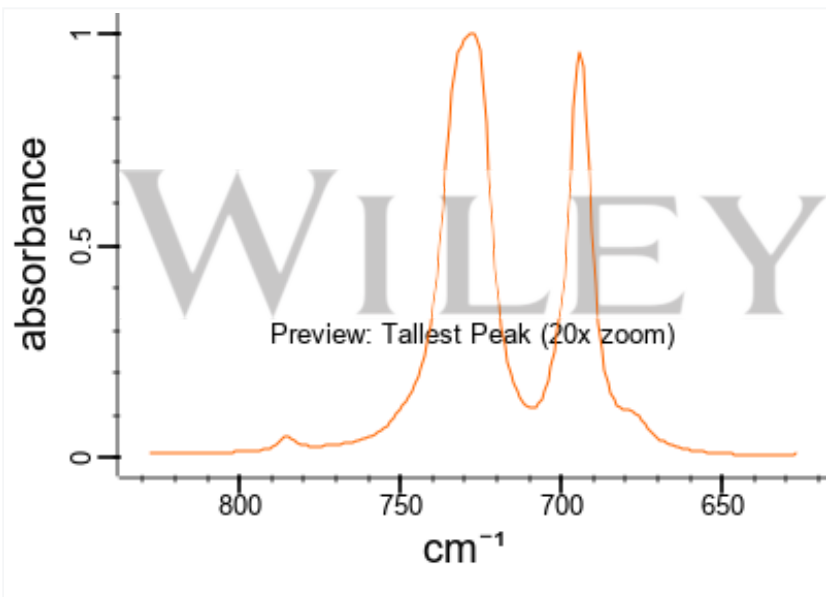
IR Spectra

IR: 3574 (Coblentz Society Spectral Collection)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

4.4.1 FTIR Spectra



Technique	NEAT
Source of Sample	J. T. Baker Chemical Company
Copyright	Copyright © 1980, 1981-2025 John Wiley & Sons, Inc. All Rights Reserved.
Thumbnail	



▶ [SpectraBase](#)

4.4.2 ATR-IR Spectra



Instrument Name	Bruker Tensor 27 FT-IR
Technique	ATR-Neat (DuraSamplIR II)
Source of Spectrum	Bio-Rad Laboratories, Inc.
Source of Sample	Acros Organics
Catalog Number	424555000
Lot Number	A0250823

Copyright	Copyright © 2018-2025 John Wiley & Sons, Inc. All Rights Reserved.
Thumbnail	



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▶ SpectraBase

4.4.3 Near IR Spectra



Instrument Name	INSTRUMENT PARAMETERS=INST=BRUKER,RSN=10710,REO=2,CNM=HEI,Z FF=2
Technique	NIR Spectrometer= BRUKER IFS 88
Source of Spectrum	Prof. Buback, University of Goettingen, Germany
Copyright	Copyright © 1989, 1990-2025 Wiley-VCH GmbH. All Rights Reserved.
Thumbnail	

▶ SpectraBase

4.4.4 Vapor Phase IR Spectra



Instrument Name	Bruker IFS 85
Technique	Gas-GC
Copyright	Copyright © 1989, 1990-2025 Wiley-VCH GmbH. All Rights Reserved.
Thumbnail	



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▶ SpectraBase

4.5 Raman Spectra

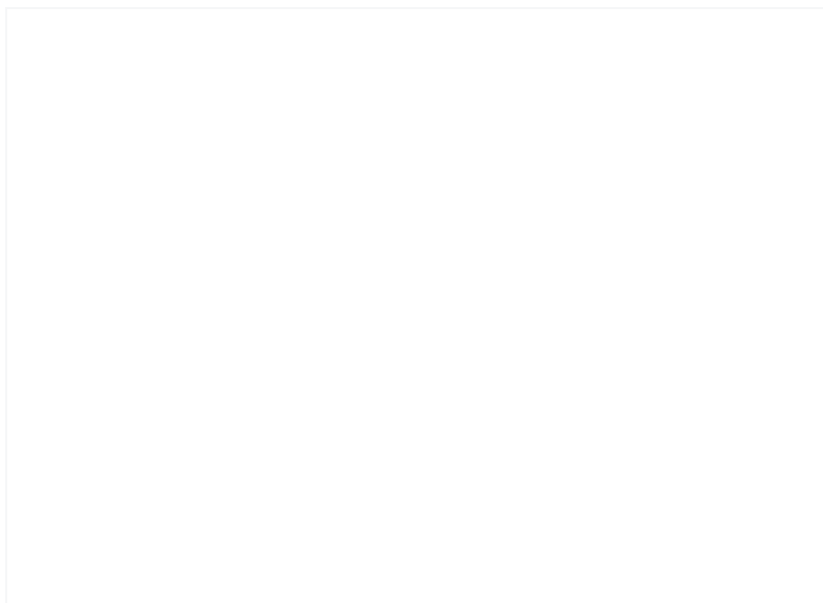


1 of 2 items	
Raman Spectra	Raman: 67 (Dollish et al., Characteristic Raman Frequencies of Organic Compounds, John Wiley & Sons, New York)

▶ Hazardous Substances Data Bank (HSDB)

2 of 2 items	
Instrument Name	Bio-Rad FTS 175C with Raman accessory
Technique	FT-Raman
Source of Sample	NI Industries, Inc.

Thumbnail

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▶ [SpectraBase](#)

4.6 Other Spectra



Intense mass spectral peaks: 65 m/z, 91 m/z, 92 m/z

Pfleger, K., H. Maurer and A. Weber. Mass Spectral and GC Data of Drugs, Poisons and their Metabolites. Parts I and II. Mass Spectra Indexes. Weinheim, Federal Republic of Germany. 1985., p. 104

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

5 Related Records



5.1 Related Compounds with Annotation



Follow these links to [do a live 2D search](#) or [do a live 3D search](#) for this compound, sorted by annotation score. This section is deprecated (see [the neighbor discontinuation help page](#) for details), but these live search links provide equivalent functionality to the table that was previously shown here.

▶ [PubChem](#)

5.2 Related Compounds



Same Connectivity Count 55

Same Parent, Connectivity Count	1295
Same Parent, Exact Count	1230
Mixtures, Components, and Neutralized Forms Count	45366
Similar Compounds (2D)	View in PubChem Search
Similar Conformers (3D)	View in PubChem Search

▶ [PubChem](#)



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5.3 Substances



5.3.1 PubChem Reference Collection SID



[481108034](#)

▶ [PubChem](#)

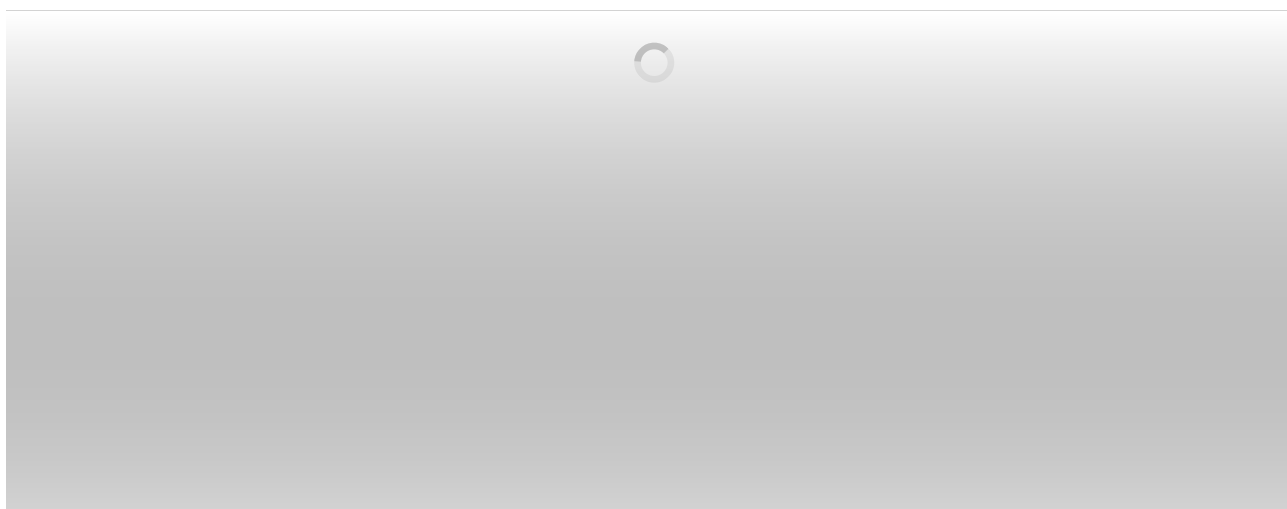
5.3.2 Related Substances



All Count	53078
Same Count	1071
Mixture Count	52007

▶ [PubChem](#)

5.3.3 Substances by Category



▶ PubChem

5.4 Other Relationships



Xylene (related)

▶ PubChem



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5.5 Entrez Crosslinks



PubMed Count	14595
Protein Structures Count	26
Taxonomy Count	8
OMIM Count	1
Gene Count	999

▶ PubChem

5.6 NCBI LinkOut



▶ NCBI



C
笔记

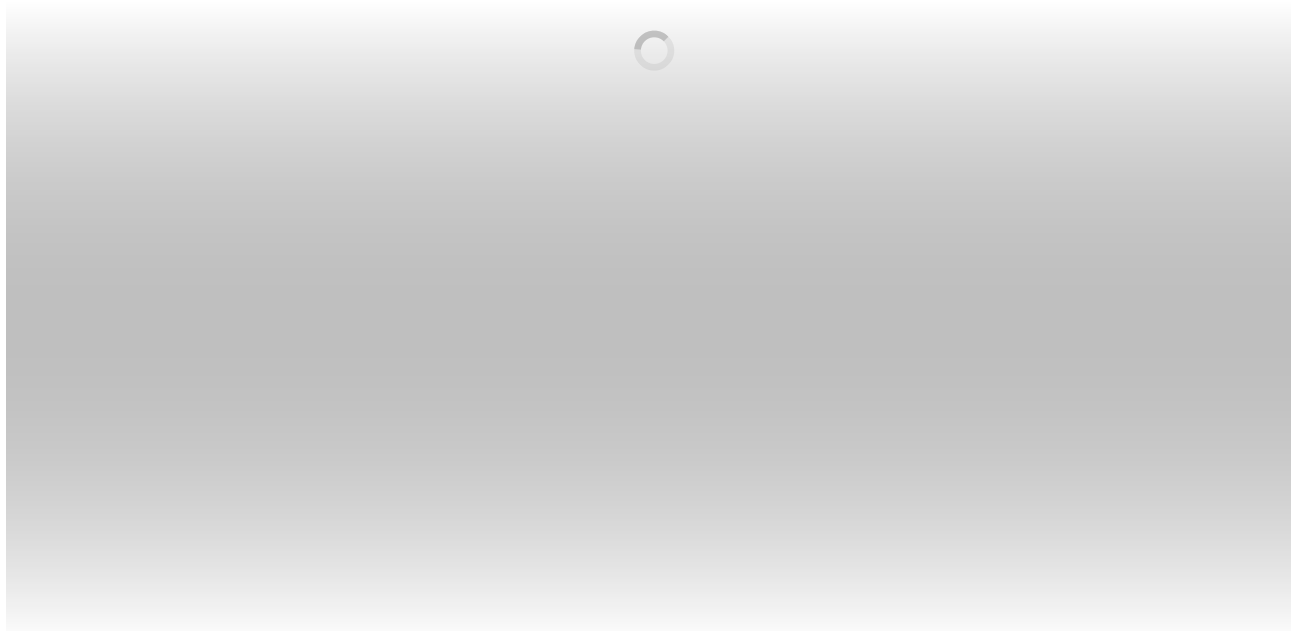
▶ [PubChem](#)

7 Drug and Medication Information

7.1 Drug Indication

Used for the removal of ascarids (*Toxocara canis* and *Toxascaris leonina*) and hookworms (*Ancylostoma caninum* and *Uncinaria stenocephala*) and as an aid in removing tapeworms (*Taenia pisiformis*, *Dipylidium caninum*, and *Echinococcus granulosus*) from dogs and cats.

▶ [DrugBank](#)



▶ Open Targets

7.2 FDA Green Book

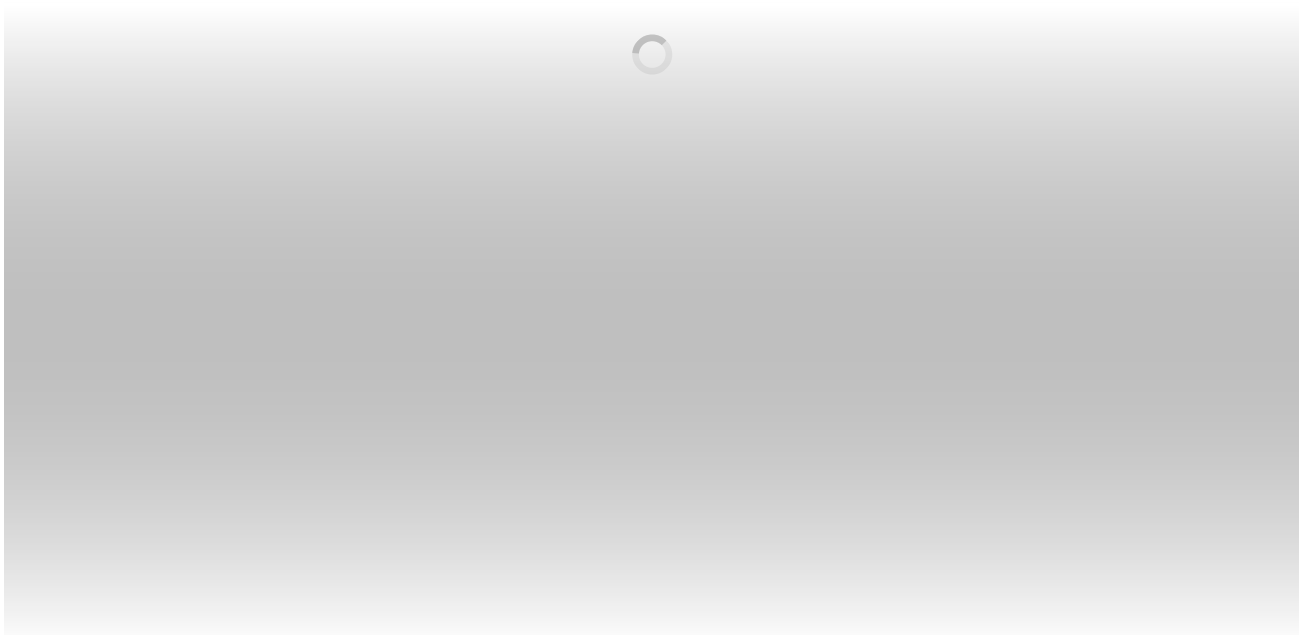


▶ FDA Approved Animal Drug Products (Green Book)

7.3 Drug Labels



Active ingredient and drug



▶ DailyMed

7.4 Reported Fatal Dose



Lethal levels 1.0 mg%; 10.0 ug/ml

Winek, C.L. Drug and Chemical Blood-Level Data 1985. Pittsburgh, PA: Allied Fischer Scientific, 1985.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Ingestion of approximately 60 mL (625 mg/kg) of toluene proved fatal for a white male mental patient.

Ameno K et al; Forensic Sci Int 41: 255-60 (1989)

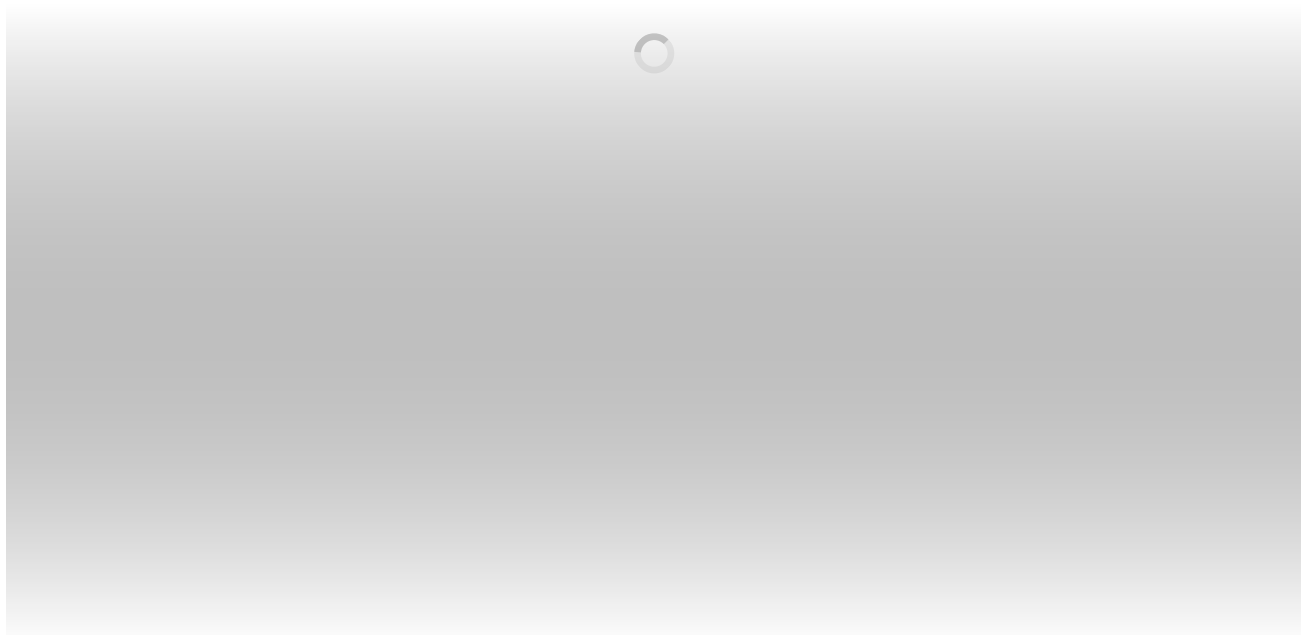
▶ [Hazardous Substances Data Bank \(HSDB\)](#)

50 mg/kg for an adult human. (T26)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)



7.5 Biomarker Information



▶ [MarkerDB](#)

8 Food Additives and Ingredients



8.1 Food Additive Classes



JECFA Functional Classes

Food Additives -> EXTRACTION_SOLVENT;

▶ [Joint FAO/WHO Expert Committee on Food Additives \(JECFA\)](#)

8.2 FDA Substances Added to Food



Substance	toluene
Used for (Technical Effect)	SOLVENT OR VEHICLE
Document Number (21 eCFR)	172.736

▶ [FDA Substances Added to Food](#)

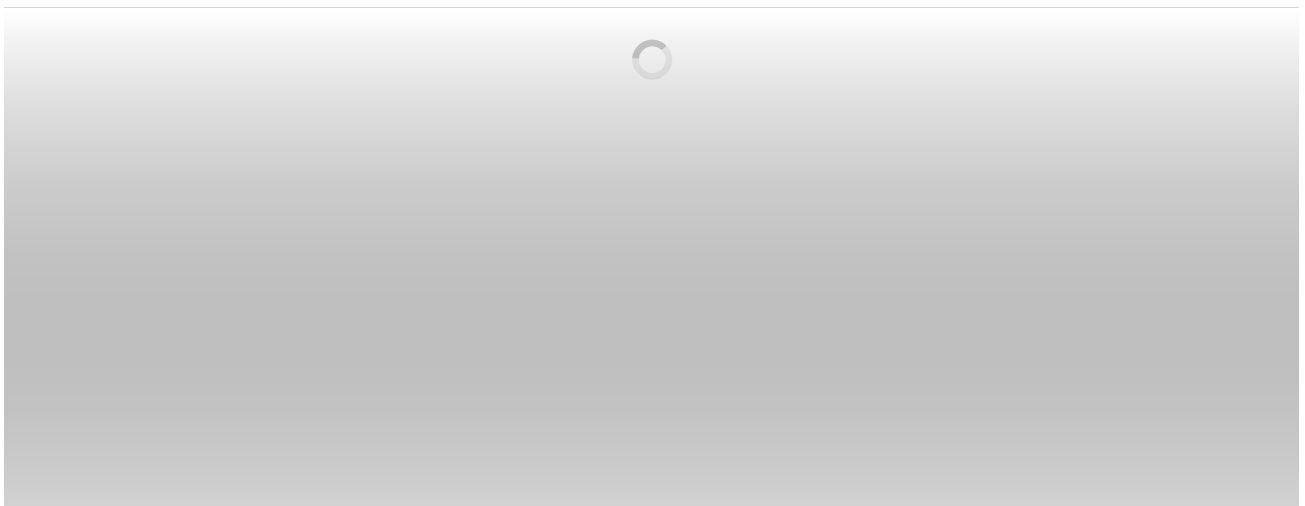
8.3 FDA Food Contact Substances (FCS)



Substance	TOLUENE
Document Number (21 eCFR)	172.723 175.105 175.320 176.180 177.1010 177.1200 177.1440 177.1580 177.1585 177.1650 177.2460 177.2600 178.3010

▶ [FDA Packaging & Food Contact Substances \(FCS\)](#)

8.4 Associated Foods



► FooDB

8.5 Evaluations of the Joint FAO / WHO Expert Committee on Food Additives - JECFA



Chemical Name	PHENYLMETHANE
Evaluation Year	1981
ADI	NOT SPECIFIED
Comments	Residues of toluene occurring in food when this solvent is used in accordance with good manufacturing practice would not pose any toxicological problems
Report	TRS 669-JECFA 25/30
Tox Monograph	FAS 16-JECFA 25/214



► [Joint FAO/WHO Expert Committee on Food Additives \(JECFA\)](#)

9 Pharmacology and Biochemistry



9.1 MeSH Pharmacological Classification



Solvents

Liquids that dissolve other substances (solutes), generally solids, without any change in chemical composition, as, water containing sugar. (Grant & Hackh's; Chemical Dictionary, 5th ed)

► [Medical Subject Headings \(MeSH\)](#)

9.2 Absorption, Distribution and Excretion



In a group of 37 rotogravure printers a close correlation ($r_s = 0.78$) was found between the time weighted toluene exposure during a five day working week (range 8-416 mg/cu m, median 75) and the concentration of toluene in subcutaneous adipose tissue (range 1.1-20.7 mg/kg, median 3.8). After exposure ceased, the elimination of toluene was followed up in 11 subjects. The toluene concentration in venous blood decreased non-linearly and the elimination curves contained at least

three exponential components. The first two had median estimated half times of nine minutes and two hours respectively. The third component, with a median half time of 90 hours, reflected the decline in adipose tissue, which had a median half time of 79 hours (range 44-178). The study showed protracted endogenous toluene exposure from adipose tissue depots long after the end of exogenous exposure. The observations also suggest that the blood toluene concentrations on Monday mornings might be used as an index of the exposure in the previous week.

PMID:2818975

Full text: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1009794>

Nise G et al; *Br J Ind Med* 46 (6): 407-11 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Studies quantifying oral absorption of toluene are limited but have demonstrated nearly 100% absorption following a single oral exposure. In volunteers exposed to an infusion of 2 mg toluene/minute for 3 hours (~5 mg/kg) via a gastric tube, absorption of toluene, measured by monitoring exhaled air for toluene and urine for toluene metabolites, was found to be complete. /Another study/ reported that greater than 99% of a single gavage dose of radiolabeled toluene in rats was eliminated in the urine or expired air, indicating near-total absorption of the exposure dose.

USEPA; Toxicology Review of Toluene (CAS No. 108-88-3) p. 4 (September 2005). Available from, as of February, 2016: <https://www.epa.gov/iris/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is absorbed through human skin slowly, with absorption rates ranging from 14 to 23 mg/sq cm-hour.

USEPA; Toxicology Review of Toluene (CAS No. 108-88-3) p. 4 (September 2005). Available from, as of February, 2016: <https://www.epa.gov/iris/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Studies in both humans and animals have shown that the majority of toluene in the body is eliminated in the urine, mainly as metabolites.

USEPA; Toxicology Review of Toluene (CAS No. 108-88-3) p. 4 (September 2005). Available from, as of February, 2016: <https://www.epa.gov/iris/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Absorption, Distribution and Excretion (Complete) data for TOLUENE (28 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



Toluene is well metabolized, but a portion is exhaled unchanged. Hepatic P450s catalyze metabolism of toluene primarily to [benzyl alcohol](#) and lesser amounts of cresols. [Benzyl alcohol](#) is converted by ADH and aldehyde dehydrogenase (ALDH) to [benzoic acid](#), which is primarily conjugated with [glycine](#) and eliminated in the urine as [hippuric acid](#).

Klaassen, C.D. (ed). Casarett and Doull's Toxicology. The Basic Science of Poisons. 7th ed. New York, NY: McGraw-Hill, 2008., p. 1010

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is metabolized to [benzoic acid](#), followed by hepatic cytochrome P-450 catalyzed [glycine](#) conjugation to form [hippuric acid](#). Approximately 75% to 80% of the absorbed toluene is metabolized to [benzoic acid](#), and 62% to 72% is eliminated by humans in the urine as [hippuric acid](#). As the amount of absorbed toluene is increased, the relative importance of the glucuronide conjugated increased. Relatively small amounts appear in urine as the [o-cresol](#) (0.12%-0.43%) and [p-cresol](#) where they occur as glucuronide and [sulfate](#) derivatives. Less than 2% of the absorbed toluene is eliminated in feces.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 3

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

In rats, approx 0.5%-1.1% of the dose is converted to [o-cresol](#) and [p-cresol](#) and is excreted as glucuronide and [sulfate](#) conjugates.

Bakke OM, Scheline RR; Tox Appl Pharm 16: 691-700 (1970) as cited in NRC; Alkyl Benzenes p.221 (1981)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

In mammalian species, acidic metabolites are conjugated with [glycine](#) to form [hippuric acid](#) and [phenylacetic acid](#). In humans, the [phenylacetic acid](#) metabolite is also conjugated with [glutamine](#) to form phenacetylglutamine.

James MO et al; Proc R Soc Lond Ser B 182: 25-35 (1972) as cited in NRC; Alkyl Benzenes p.219 (1981)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene has known human metabolites that include [o-Cresol](#), [Benzyl alcohol](#), and [4-Methylphenol](#).

S73 | METXBIODB | Metabolite Reaction Database from BioTransformer | DOI:10.5281/zenodo.4056560

▶ [NORMAN Suspect List Exchange](#)

Inhalation and ingestion are the primary routes of exposure, though toluene may also be absorbed through the skin. It accumulates rapidly in the brain and is subsequently deposited in other tissues according to their lipid content, with the highest levels attained in adipose tissue. The primary initial steps in toluene metabolism is side-chain hydroxylation catalyzed predominately by the cytochrome P450 isozyme CYP2E1, followed by oxidation to [benzoic acid](#). Most of the [benzoic acid](#) is then conjugated with [glycine](#) to form [hippuric acid](#), but a small portion can be conjugated with [UDP-glucuronate](#) to form the acyl-glucuronide. A very small portion of absorbed toluene can be converted by CYP1A2, CYP2B2, or CYP2E1 to ortho- or [para-cresol](#). These metabolites are excreted in the urine, and the remaining toluene is exhaled unchanged. (T10, L174)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)



9.4 Biological Half-Life



Blood: 0.5 hours (can range up to 90 hours depending upon fat deposition); for [hippuric acid](#) in urine: 1.5 hours; [TDR, p. 1145]

TDR - Ryan RP, Terry CE, Leffingwell SS (eds). Toxicology Desk Reference: The Toxic Exposure and Medical Monitoring Index, 5th Ed. Washington DC: Taylor & Francis, 1999., p. 1145

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

In mice, toluene is eliminated from alveolar air with a biologic half-life of 2.6 hours; elimination from blood and brain occurs with a half-life of 1 hour. In rats, the mean half-time for toluene uptake from air at 1000 to 3000 ppm was 34 minutes and the half-times for the rapid and slow elimination phases were 6 and 90 minutes, respectively. Alveolar and circulating toluene concentrations decrease as a direct function of respiratory and cardiac rates after exposure ceases. The elimination half-time for toluene from human tissue is 0.5 to 2.7 days after inhaling 70 ppm for 2 hours.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 3-4

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

After exposure ceased, the elimination of toluene was followed up in 11 /rotogravure printers/. The toluene concentration in venous blood decreased non-linearly and the elimination curves contained at least three exponential components. The first two had median estimated half times of nine minutes and two hours respectively. The third component, with a median half time of 90 hours,

reflected the decline in adipose tissue, which had a median half time of 79 hours (range 44-178).

[PMID:2818975](#)

Full text: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1009794>

Nise G et al; *Br J Ind Med* 46 (6): 407-11 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

0.083 days (Inhaled as environmental air)

Cleland, J.G., G.L. Kingsbury. *Multimedia Environmental Goals for Environmental Assessment. Volume 1. EPA-600/7-77-136a. Research Triangle Park, NC: EPA, Nov. 1977., p. E-146*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



9.5 Mechanism of Action



The present study demonstrates reductions of [dopamine](#) (DA) turnover in various areas of the anterior nucleus caudate of rat by toluene at concentrations lower than the current OSHA threshold limit value (100 ppm). Thus, toluene at low concentrations may produce disturbances in dopaminergic mechanisms of the basal ganglia probably leading to functional changes in sensory-motor integration. The increases in DA turnover in the cholecystinin (CCK)-DA terminals of the subcortical limbic system induced by high concentrations of toluene may be part of the neurochemical basis for its abuse as a euphoric agent in man.

[PMID:7112606](#)

Fuxe K et al; *Toxicol Lett* 12 (2-3): 115-23 (1982)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Exposure to toluene causes both reversible and irreversible changes in the central nervous system. The effects of toluene inhalation on some specific enzymes and [glutamate](#) and [GABA](#) receptor binding in defined parts of the rat brain were studied following several exposure schemes. The activities of the transmitter synthesizing enzymes [glutamic acid](#) decarboxylase (GAD), [choline](#) acetyltransferase (ChAT) and aromatic amino-acid decarboxylase (AAD) were used as markers for permanent loss of neuronal activity. Catecholaminergic neurons showed a 50% reduction in the brain stem after 4 weeks exposure to 250 and 1000 ppm toluene. Following 500 ppm of toluene, 16 hr/day for 3 months, a general increase in the activities was seen. This is most probably due to a reduction in total protein content, to which the activities were related. The neurotransmitters [glutamate](#) and [GABA](#) had their specific receptor binding increased in most of the brain areas studied, but decreased in some areas. The glial enzyme, [glutamine](#) synthetase, has its activity increased in the cerebellar hemisphere following 4 weeks exposure to 1000 ppm. This suggests that

glial cells in the area may have proliferated, a frequent phenomenon following CNS damage.

Bjornaes S, Naalsund Lu; Toxicol 49 (2-3): 367-74 (1988)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The effect on energetic metabolism of rat liver mitochondria (RLM) of [styrene](#) and other aliphatic benzene derivatives, i.e. toluene, [ethylbenzene](#), [alpha-methylstyrene](#) and [butylbenzene](#), is studied. It is shown that these compounds uncouple oxidative phosphorylation and this effect is connected with the stimulation of passive entry of protons into mitochondria. The relationship between hydrophobicity of these compounds and their biological activity and mechanism of uncoupling effect are discussed.

PMID:2904817

Mickiewicz W, Rzeczycki W; Biochem Pharmacol 37 (23): 4439-44 (1988)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



9.6 Human Metabolite Information



9.6.1 Cellular Locations



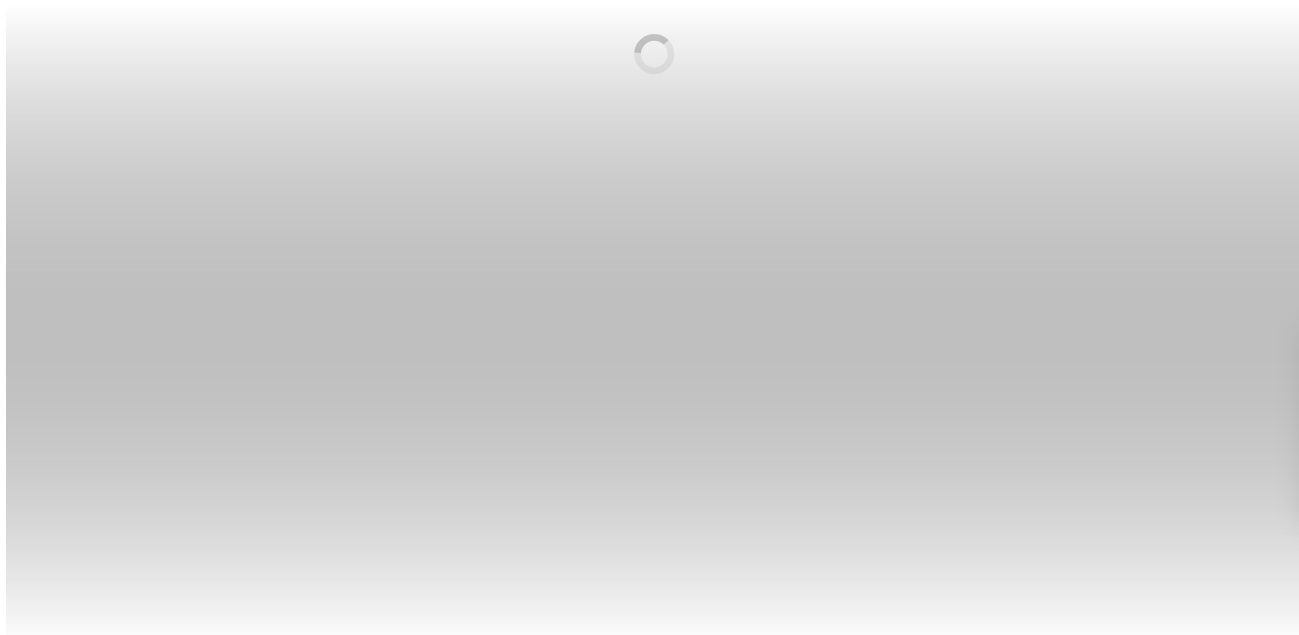
Membrane

▶ [Human Metabolome Database \(HMDB\)](#)

9.7 Biochemical Reactions



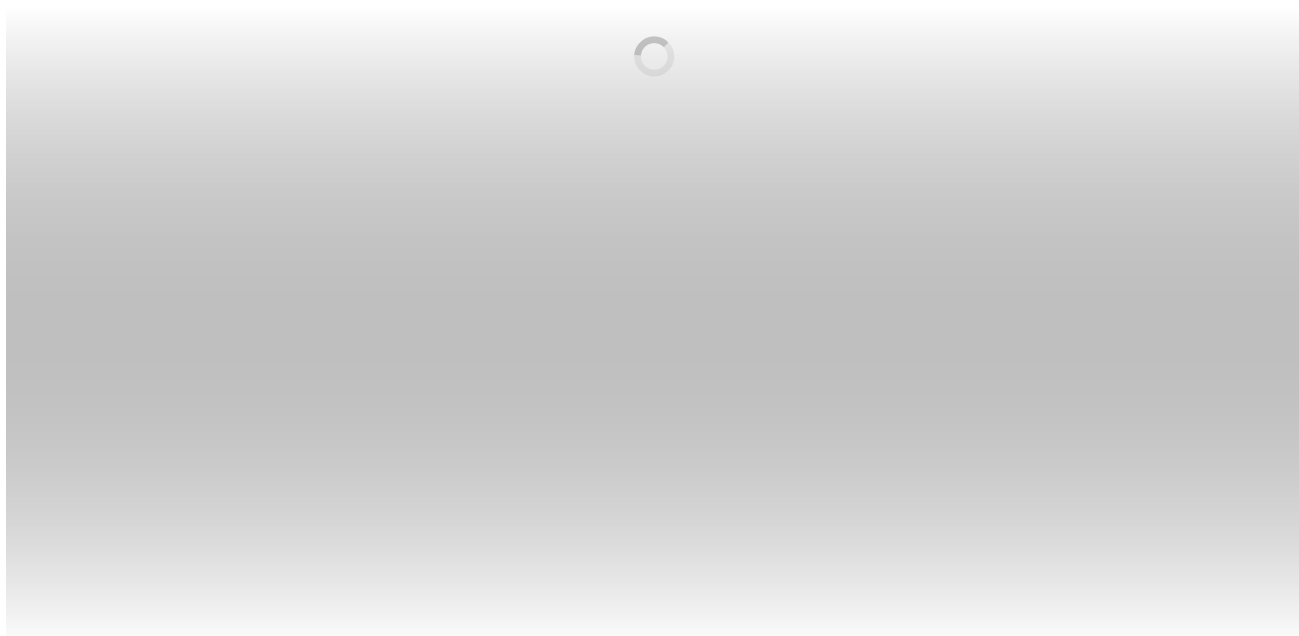
▶ Rhea - Annotated Reactions Database



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▶ PubChem

9.8 Transformations



▶ NORMAN Suspect List Exchange

10 Use and Manufacturing



10.1 Uses



Cosmetic Ingredient Review Link

CIR ingredient: Toluene

Journal of the American College of Toxicology 6(1):77-120, 1987

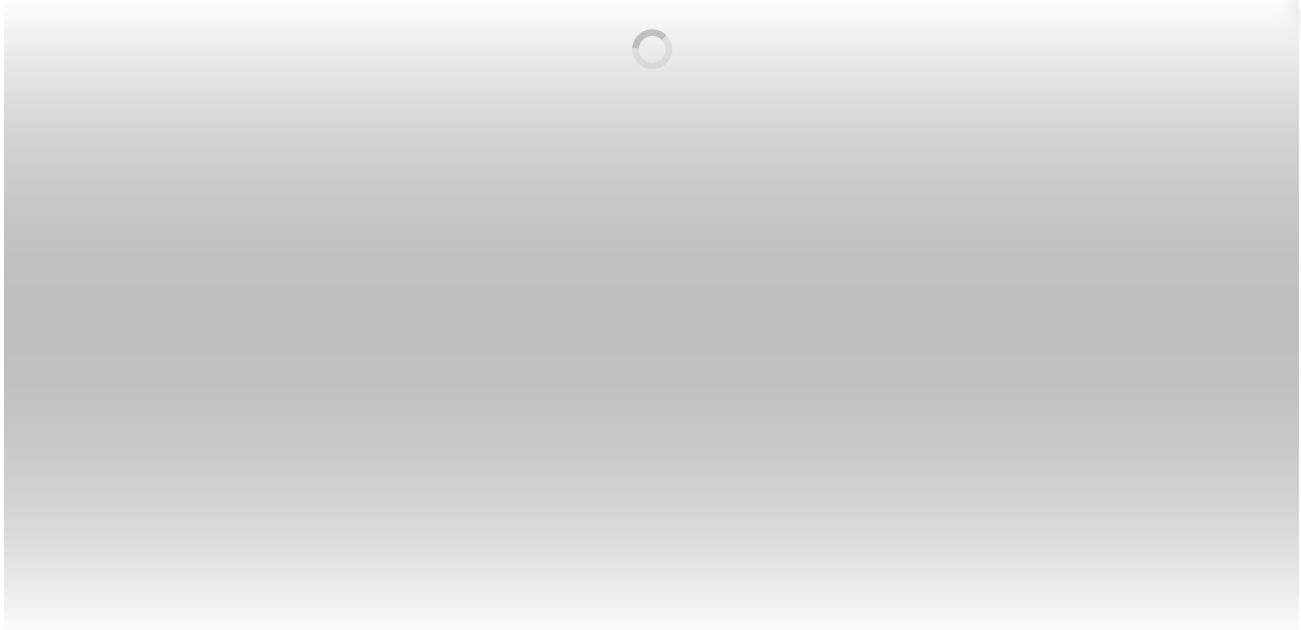
International Journal of Toxicology 25(Suppl. 2) :1-89,2006

▶ [Cosmetic Ingredient Review \(CIR\)](#)

The major use of toluene is as a mixture added to gasoline to improve [octane](#) ratings. Toluene is also used to produce [benzene](#) and as a solvent in paints, coatings, synthetic fragrances, adhesives, inks, and cleaning agents.

▶ [EPA Air Toxics](#)

EPA CPDat Chemical and Product Categories



The Chemical and Products Database, a resource for exposure-relevant data on chemicals in consumer products, Scientific Data, volume 5, Article number: 180125 (2018), DOI:10.1038/sdata.2018.125

▶ [EPA Chemical and Products Database \(CPDat\)](#)

Sources/Uses

Derived from petroleum, toluene is used as a solvent and chemical intermediate. Purified toluene contains about 0.01% [benzene](#), but crude toluene may contain as much as 25% [benzene](#). Rotogravure printers were exposed to high concentrations of toluene (decreasing from about 1710 ppm in 1969 to about 43-157 ppm in 1980). [ACGIH] Used in photography (color retouching); [www.ci.tucson.az.us/arthazards/medium.html]

ACGIH - Documentation of the TLVs and BEIs, 7th Ed. Cincinnati: ACGIH Worldwide, 2020.

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

Industrial Processes with risk of exposure

[Semiconductor Manufacturing](#) [Category: Industry]

[Painting \(Solvents\)](#) [Category: Paint]

[Working with Glues and Adhesives](#) [Category: Other]

[Leather Tanning and Processing](#) [Category: Industry]

[Photographic Processing](#) [Category: Other]

[Silk-Screen Printing](#) [Category: Other]

- ▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

Activities with risk of exposure

[Painting](#) [Category: Hobbies]

[Woodworking](#) [Category: Hobbies]

[Preparing and mounting animal skins \(taxidermy\)](#) [Category: Hobbies]

- ▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

For toluene (USEPA/OPP Pesticide Code: 080601) there are 0 labels match. /SRP: Not registered for current use in the U.S., but approved pesticide uses may change periodically and so federal, state and local authorities must be consulted for currently approved uses./

National Pesticide Information Retrieval System's Database on Toluene (108-88-3). Available from, as of February 19, 2016: <https://npirpublic.ceris.purdue.edu/ppis/>

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is a component of gasoline, paints, inks, lacquers, paint thinners, adhesives, fingernail polish, cleaning agents, and rubber. BTX (a mixture of [benzene](#), toluene, and xylene) is added to gasoline to improve [octane](#) ratings. Toluene is used to produce [benzene](#), [trinitrotoluene \(TNT\)](#), nylon, plastics, and polyurethanes.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 1-2

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Aviation gasoline and high-[octane](#) blending stock; [benzene](#), [phenol](#), and [caprolactam](#); solvent for paints and coatings, gums, resins, most oils, rubber, vinyl organosols; diluent and thinner in nitrocellulose lacquers; adhesive solvent in plastic toys and model airplanes; chemicals ([benzoic acid](#), benzyl and benzoyl derivatives, [saccharin](#), medicines, dyes, perfumes); source of toluenediisocyanates (polyurethane resins); explosives ([TNT](#)); toluene sulfonates (detergents); scintillation counters.

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250



▶ [Hazardous Substances Data Bank \(HSDB\)](#)

In manufacture [benzoic acid](#), [benzaldehyde](#), explosives, dyes, and many other organic compounds; as a solvent for paints, lacquers, gums, resins; thinner for inks, perfumes, dyes; in the extraction of various principles from plants; as gasoline additive.

O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Cambridge, UK: Royal Society of Chemistry, 2013., p. 1765

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Uses (Complete) data for TOLUENE (13 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is used in paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes. Gasoline, which contains 5 to 7 percent toluene by weight, is the largest source of atmospheric emissions and exposure of the general populace. (T10, L174)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)

10.1.1 Use Classification



Chemical Classes -> Hydrocarbons (contain [hydrogen](#) and [carbon](#) atoms), Volatile organic compounds

▶ [Agency for Toxic Substances and Disease Registry \(ATSDR\)](#)

Animal Drugs -> FDA Approved Animal Drug Products (Green Book) -> Active Ingredients

▶ [FDA Approved Animal Drug Products \(Green Book\)](#)

Food Additives -> EXTRACTION_SOLVENT; -> JECFA Functional Classes

▶ [Joint FAO/WHO Expert Committee on Food Additives \(JECFA\)](#)

Cosmetics -> Solvent

S13 | EUCOSMETICS | Combined Inventory of Ingredients Employed in Cosmetic Products (2000) and Revised Inventory (2006) | DOI:10.5281/zenodo.2624118

▶ [NORMAN Suspect List Exchange](#)

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10.1.2 DEA Listed Chemicals



Name	Toluene
List II Chemical	A chemical, other than a List I chemical, specified by regulation that, in addition to legitimate uses, is used in manufacturing a controlled substance in violation of the Act. (21 eCFR 1310.02)

▶ Drug Enforcement Administration (DEA)



10.1.3 Industry Uses



Plasticizers	Fuels and fuel additives
Solvents (which become part of product formulation or mixture)	Anti-adhesive/cohesive
Defoamer	Adhesives and sealant chemi
Laboratory chemicals	Intermediates
Surface modifier	Fuel
Opacifer	Fuel agents
Lubricants and lubricant additives	Not Known or Reasonably As
Solvents (for cleaning or degreasing)	Sealant (barrier)
Adhesion/cohesion promoter	Corrosion inhibitors and anti
Other (specify)	Solvent

<https://www.epa.gov/chemical-data-reporting>

▶ EPA Chemical Data Reporting (CDR)

10.1.4 Consumer Uses



Paint additives and coating additives not described by other categories	Adhesives and sealant
Catalyst	Intermediates
Monomers	Fuel
Plasticizer	Fuel agents
Processing aids, specific to petroleum production	Not Known or Reason
Diluent	Sealant (barrier)
Corrosion inhibitor	Solvent
Fuels and fuel additives	Intermediate
Dispersing agent	Solvents (which becor

<https://www.epa.gov/chemical-data-reporting>

▶ [EPA Chemical Data Reporting \(CDR\)](#)

10.1.5 Household Products



California Safe Cosmetics Program (CSCP)

Cosmetics product ingredient: Toluene

Source: Toluene occurs naturally in crude oil. It can also be manufactured in the process of making gasoline. Toluene is one of the thinners used in nail polish, fingernail glue, and other nail products. It helps to maintain uniform color in the product and to form a smooth finish across the nail.

Potential health impacts: People are mainly exposed to toluene by inhalation. Studies of people who have inhaled toluene have shown neurological (nervous system) impacts such as dizziness, sensory confusion, appetite loss, tremors, hearing loss, and slurred speech. Studies of women exposed to toluene at work have reported negative reproductive effects, including spontaneous abortion, reduced fertility, premature delivery, and menstrual disturbance. Studies of rats that inhaled toluene found signs of lung irritation and increases in liver and kidney weights, as well as reduced sperm count in male rats. California Proposition 65 lists toluene as a reproductive toxin.

Product count: 113

▶ [California Safe Cosmetics Program \(CSCP\) Product Database](#)

Household & Commercial/Institutional Products

Information on 642 consumer products that contain Toluene in the following categories is provided:

- Auto Products
- Commercial / Institutional
- Hobby/Craft
- Home Maintenance
- Inside the Home
- Landscaping/Yard
- Pesticides
- Pet Care

▶ [Consumer Product Information Database \(CPID\)](#)



It is possible to synthesize toluene industrially by alkylation of [benzene](#) with [methanol](#), and by cyclization of [n-heptane](#) with subsequent aromatization. However, for economic reasons toluene is extracted from ... reformates from crude petroleum distillates; liquid products from the pyrolysis of hydrocarbons (steam cracking) /and/ liquid products from the gasification or coking (pyrolysis) of coal, lignite, etc. ... An important aspect of the extraction of toluene is the fact that the pyrolysis products (from steam cracking, coking, etc.) must be hydrogenated before pure toluene can be extracted. The unsaturated components are converted to saturated ones and the heteroatoms such as [sulfur](#), [nitrogen](#), and [oxygen](#) are removed. In the case of reformates such pretreatment is usually unnecessary. For the separation of toluene from other components within the same boiling range several methods are available, depending on quality requirements. Fine fractionation is now suitable only for the production of toluene with lower purity, and involves significant losses in fores and tails. Azeotropic distillation uses entrainers, such as [methanol](#), to separate toluene from nonaromatics; a nonaromatics - [methanol](#) fraction with a lower bp than the [methanol](#) - toluene azeotrope distills at the column head, while pure toluene is removed from its base. [Methanol](#) is recovered from the distillate by washing with [water](#). For economic reasons, extractive distillation is now used only for the separation of toluene from nonaromatics. Technical grade solvents with higher bp than toluene have proved to be suitable extraction agents, e.g., [N-methylpyrrolidone](#) (Distapex process, Lurgi Ol-Gas-Chemie), and [morpholine](#) (Morphylane process, Krupp-Koppers). Extractive distillation essentially involves two distillation columns between which the extraction agent is circulated. The toluene-containing material is charged to the extraction column; the extraction agent is charged to the column head. The extraction agent - toluene mixture leaves the column at the bottom, and is separated into pure toluene and extraction agent in a second recovery column. The product obtained at the distillation head of the extraction column contains the nonaromatic components of the starting material and the extraction agent. This fraction is separated in the recovery column into raffinate (nonaromatics) and extraction agent. The latter is then combined with the main portion of extraction agent from the recovery column, and fed back into the extraction column.

Fabri J et al; Toluene. Ullmann's Encyclopedia of Industrial Chemistry 7th ed. (1999-2016). NY, NY: John Wiley & Sons. Online Posting Date: October 15, 2011

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Unrecovered component of gasoline

SRI

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Catalytic reforming of petroleum steams accounts for 87% of total toluene production. An additional 9% is separated from pyrolysis gasoline produced in steam crackers during manufacture of [ethylene](#) and [propylene](#) ... coal-tar separation from coke ovens produces 1% of total toluene ... up to 2% of the toluene produced is obtained as a by-product from [styrene](#) manufacture.

DCE/NCI; Monograph On Human Exposure To Chemicals In The Workplace: Toluene p.2-1 (1985)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

(1) By catalytic reforming of petroleum. (2) By fractional distillation of coal tar light oil.

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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10.3 IFRA Fragrance Standards



IFRA Substance	Toluene
Synonyms	Toluol; Methylbenzol; Methylbenzene
Document	IFRA_STD_182.pdf
Amendment	38
Guidance	IFRA 51st Amendment - Guidance for the use of IFRA Standards
IFRA Standard type	Prohibition: This material should not be used as a fragrance ingredient Specification: This material should be used only if it meets the criteria stated in the Standard
Intrinsic property driving the risk management measure	LIVER TOXICITY
Prohibited fragrance ingredients: notes	This material should not be used as a fragrance ingredient.
Specified ingredients: notes	The level of Toluene has to be kept as low as practicable and should never exceed 100 ppm in the fragrance compound/mixture or fragrance oil.

▶ [International Fragrance Association \(IFRA\)](#)

10.4 Impurities



... Commercial grades /of toluene/ usually contain small amounts of **benzene** as an impurity.

Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Technical grades (90-120 °C boiling range) are less pure and may contain up to 25% **benzene** as well as other hydrocarbons.

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at:

<https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 80 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Commercial grades /of toluene/ can ... contain polynuclear aromatic hydrocarbons (PAHs), including **pyrene**, fluoranthrene, and **benzo[ghi]perylene**.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 1

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

10.5 Formulations / Preparations



Grades: Research 99.99%; Pure 99.98%

Flick, E.W. Industrial Solvents Handbook. 3rd ed. Park Ridge, NJ: Noyes Publications, 1985., p. 48

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Grades: 1st degree nitration; 2nd degree commercial; 90% solvent

DCE/NCI; Monograph On Human Exposure To Chemicals In The Workplace: Toluene p.1-1 (1985)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Grade: (Usually defined in terms of boiling ranges) Pure, commercial, straw-colored, nitration, scintillation, industrial.

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



10.6 Consumption Patterns



Chem int for **benzene**, 55.3%; solvent, 25.7%; chem int for **toluene diisocyanate**, 7.3%; chem int for **benzoic acid**, 2.5%; chem int for **benzyl chloride**, 1.5%; other, 7.7% (1981 non-gasoline use)

SRI

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Benzene, 46%; gasoline blending, 37%; solvent, 8%; **toluene diisocyanate**, 7%; miscellaneous chemicals, 2% (1985) /estimate/

CHEMICAL PRODUCTS SYNOPSIS: Toluene, 1985

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

In the USA in 1981, the use of toluene as a solvent was second only to its use in **benzene** production via hydrodemethylation and accounted for about 26% of nonfuel consumption.

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 82 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Of the estimated 3.3 million tons of toluene produced in the USA in 1980, 44% was used to make **benzene**, 34% to make gasoline, 10% in solvents, 6% to make **toluene diisocyanate**, and 6% for miscellaneous use.

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 82 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

10.7 U.S. Production



Aggregated Product Volume

2019: 20,000,000,000 - <30,000,000,000 lb

2018: 20,000,000,000 - <30,000,000,000 lb

2017: 20,000,000,000 - <30,000,000,000 lb

2016: 20,000,000,000 - <30,000,000,000 lb

<https://www.epa.gov/chemical-data-reporting>



▶ EPA Chemical Data Reporting (CDR)

(1981) 4.68X10+12 g (all uses, 93% chem grade)

US INTERNATIONAL TRADE COMMISSION, WASH, DC 20436; SOC SERIES C/P-82-1

▶ Hazardous Substances Data Bank (HSDB)

(1977) 1.50X10+12 g

SRI

▶ Hazardous Substances Data Bank (HSDB)

(1982) 1.54X10+12 g

SRI

▶ Hazardous Substances Data Bank (HSDB)

(1985) 2.30X10+12 g

USITC. SYN ORG CHEM-U.S. PROD/SALES 1985 p.19

▶ Hazardous Substances Data Bank (HSDB)

For more U.S. Production (Complete) data for TOLUENE (10 total), please visit the [HSDB record page](#).

▶ Hazardous Substances Data Bank (HSDB)

10.8 U.S. Imports



(1978) 1.92X10+11 g

SRI

▶ Hazardous Substances Data Bank (HSDB)

(1983) 2.73X10+11 g

SRI

▶ Hazardous Substances Data Bank (HSDB)

(1985) 1.57X10+8 gal

BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1985 p.1-547

▶ Hazardous Substances Data Bank (HSDB)



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10.9 U.S. Exports



(1978) 3.65X10+11 g

SRI

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

(1983) 1.15X10+11 g

SRI

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

(1985) 2.82X10+7 gal

BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1985 p.2-70

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



10.10 General Manufacturing Information



Industry Processing Sectors

Miscellaneous Manufacturing	Agriculture, Forestry, Fishing
Wholesale and Retail Trade	Pesticide, Fertilizer, and Other
Textiles, apparel, and leather manufacturing	Transportation Equipment M
Asphalt Paving, Roofing, and Coating Materials Manufacturing	All other Petroleum and Coal
Petroleum Refineries	Paper Manufacturing
Other (requires additional information)	Plastics Product Manufacturi
Adhesive Manufacturing	Rubber Product Manufacturi
Paint and Coating Manufacturing	Fabricated Metal Product Ma
Electrical Equipment, Appliance, and Component Manufacturing	Non-metallic Mineral Product
All Other Basic Organic Chemical Manufacturing	gypsum, and other non-met

▶ [EPA Chemical Data Reporting \(CDR\)](#)

EPA TSCA Commercial Activity Status

Benzene, methyl-: ACTIVE

▶ [EPA Chemicals under the TSCA](#)

10.11 Sampling Procedures



A new passive monitor for organic vapors has been developed for the determination of the time-weighted average (TWA) concentration of contaminants in air. This personal dosimeter type badge monitor collects the organic vapors through the mechanism of molecular diffusion and adsorption onto an activated [carbon](#) collection element. After exposure, the activated [carbon](#) is removed from the device and analyzed using gas chromatographic techniques outlined in NIOSH Physical and Chemical Analysis Method (P&CAM) 127. Current NIOSH standards for measuring the concentration of organic vapors in the atmosphere involve the use of [charcoal](#) tubes and sampling pumps for collection, desorption by [carbon disulfide](#) and subsequent analysis using gas chromatographic techniques. In comparative testing, the new passive monitor has demonstrated that its overall accuracy is at least equivalent to the [charcoal](#) tube method in determining ambient contaminant concentration. Several organic compounds were sampled over the range of 0.5 ppm - 1100 ppm exposure levels. Both field and laboratory tests were conducted and the results were compared. Environmental parameters such as temperature, relative humidity, and air movement were among the factors examined. Other factors considered were desorption efficiencies, sampling rates, sampling range, bias, and precision. /organic vapors/

[PMID:7435378](#)

Lautenberger WJ et al; Am Ind Hyg Assoc J 41 (10): 737-47 (1980)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NIOSH Method 1500. Analyte: Toluene. Matrix: Air. Sampler: Solid sorbent tube (coconut shell [charcoal](#), 100 mg/50 mg). Flow Rate: 0.20 l/min. Sample Size: 8 liters. Shipment: No special precautions. Sample Stability: At least 2 weeks.

U.S. Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, 3rd ed. Volumes 1 and 2 with 1985 supplement, and revisions. Washington, DC: U.S. Government Printing Office, February 1984., p. 1500-1

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NIOSH Method 4000. Analyte: Toluene. Sampler: Passive (activated [carbon](#)). Shipment: Transfer sorbent to septum-capped vial; otherwise routine. Sample Stability: At least 2 weeks @ 25 °C if stored in septum-capped vial.

U.S. Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, 3rd ed. Volumes 1 and 2 with 1985 supplement, and revisions. Washington, DC: U.S. Government Printing Office, February 1984., p. 4000-1

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NIOSH Method 8002. Analyte: Toluene. Specimen: Venous blood, after 2 or more hrs of exposure. Shipment: Air express @ 4 °C. Sample Stability: Stable @ 4 °C for 3

weeks.

U.S. Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, 3rd ed. Volumes 1 and 2 with 1985 supplement, and revisions. Washington, DC: U.S. Government Printing Office, February 1984., p. 8002-1

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NIOSH Method 1501. Analyte: Toluene. Matrix: Air. Sampler: Solid sorbent tube (coconut shell [charcoal](#), 100 mg/50 mg). Flow Rate: Less or equal to 0.20. Sample Size: 8-liters. Shipment: No special precautions. Sample Stability: Not determined.

U.S. Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, 3rd ed. Volumes 1 and 2 with 1985 supplement, and revisions. Washington, DC: U.S. Government Printing Office, February 1984., p. 1501-1

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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11 Identification



11.1 Analytic Laboratory Methods



Method: NIOSH 1501, Issue 3; Procedure: gas chromatography with flame ionization detection; Analyte: toluene; Matrix: air; Detection Limit: 0.7 ug/sample.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Method: NIOSH 2549, Issue 1; Procedure: thermal desorption, gas chromatography, mass spectrometry; Analyte: toluene; Matrix: air; Detection Limit: 100 ng per tube or less.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Method: NIOSH 3800, Issue 1; Procedure: extractive fourier transform infrared spectrometry; Analyte: toluene; Matrix: air; Detection Limit: 1.16 ppm at 10-meter absorption pathlength.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Method: NIOSH 4000, Issue 2; Procedure: gas chromatography with flame ionization detection; Analyte: toluene vapor; Matrix: air; Detection Limit: 0.01 mg/sample.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Analytic Laboratory Methods (Complete) data for TOLUENE (28 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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11.2 Clinical Laboratory Methods

Method: NIOSH 8002, Issue 2; Procedure: gas chromatography with flame ionization detection; Analyte: toluene; Matrix: blood; Detection Limit: 1 to 600 ug/mL.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Method: NIOSH 8007, Issue 1; Procedure: headspace/gas chromatography with flame ionization detection; Analyte: toluene; Matrix: whole blood; Detection Limit: 0.006 ug/mL.

CDC; NIOSH Manual of Analytical Methods, 4th ed. Toluene (108-88-3). Available from, as of February 19, 2016: <https://www.cdc.gov/niosh/docs/2003-154/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Urinary [hippuric acid](#) levels have generally been used as a biomarker of exposure to toluene. However, because of its short half-life, [hippuric acid](#) levels correlate best to acute exposure situations. Blood concentrations of toluene have been reported as the most reliable measure of toluene exposure. ... Blood toluene /was found/ to be highly correlated to toluene in air at levels approximating 1 ppm, where [hippuric acid](#) measurements as a marker of exposure are no longer useful.

USEPA; Toxicology Review of Toluene (CAS No. 108-88-3) p. X (September 2005). Available from, as of February, 2016: <https://www.epa.gov/iris/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

A procedure for the determination of toluene in blood by the purge and trap method is described ... has a linear range which extends up to at least 1500 ug/L ... detection limit ... is estimated to be less than 7.5 ug/L ...

Cocheo V et al; Am Ind Hyg Assoc 43 (12): 938-41 (1982)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

An automated high performance liquid chromatographic method (HPLC) for the direct determination of urinary concentrations of [hippuric acid](#) (HA), and o-, m- and p-methyl hippuric acids (MHAs), metabolites of toluene and o-, m-, and p-xylenes, and of urinary phenyl glyoxylic acid (PGA) and [mandelic acid](#) (MA), metabolites of [styrene](#) or [ethylbenzene](#), is described. [Methanol](#) was added to urine, the mixture was centrifuged and the supernatant was injected into HPLC. A stainless-steel column packed with octadecyl silanized [silicate](#) was used and the mobile phase was a mixed solution of 5 mM [potassium phosphate monobasic/acetonitrile](#) (90/10). The method is simple and specific...

PMID:3570490

Ogata M, Taguchi T; Int Arch Occup Environ Health 59 (3): 263-72 (1987)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



11.3 NIOSH Analytical Methods



HYDROCARBONS, AROMATIC 1501

▶ [NIOSH Manual of Analytical Methods](#)

VOLATILE ORGANIC COMPOUNDS (SCREENING) 2549

▶ [NIOSH Manual of Analytical Methods](#)

ORGANIC AND INORGANIC GASES BY EXTRACTIVE FTIR SPECTROMETRY 3800

▶ [NIOSH Manual of Analytical Methods](#)

TOLUENE (diffusive sampler) 4000

▶ [NIOSH Manual of Analytical Methods](#)

METHYL ETHYL KETONE, ETHANOL, and TOLUENE in blood 8002

▶ [NIOSH Manual of Analytical Methods](#)

12 Safety and Hazards



12.1 Hazards Identification



12.1.1 GHS Classification



Pictogram(s)



Flammable



Irritant

Health
Hazard

Signal

Danger

GHS Hazard Statements

H225: Highly Flammable liquid and vapor [Danger Flammable liquids]H304: May be fatal if swallowed and enters airways [Danger Aspiration hazard]H315: Causes skin irritation [Warning Skin corrosion/irritation]H336: May cause drowsiness or dizziness [Warning Specific target organ toxicity, single exposure; Narcotic effects]H361d ***: Suspected of damaging the unborn child [Warning Reproductive toxicity]H373 **: May causes damage to organs through prolonged or repeated exposure [Warning Specific target organ toxicity, repeated exposure]

Precautionary Statement Codes

P203, P210, P233, P240, P241, P242, P243, P260, P261, P264, P271, P280, P301+P316, P302+P352, P303+P361+P353, P304+P340, P318, P319, P321, P331, P332+P317, P362+P364, P370+P378, P403+P233, P403+P235, P405, and P501

(The corresponding statement to each P-code can be found at the [GHS Classification](#) page.)

► [Regulation \(EC\) No 1272/2008 of the European Parliament and of the Council](#)

12.1.2 Hazard Classes and Categories



Flam. Liq. 2 (98.5%)

Asp. Tox. 1 (99.8%)

Skin Irrit. 2 (98.5%)

STOT SE 3 (98.3%)

Repr. 2 (95.3%)

STOT RE 2 (98.4%)

Aquatic Chronic 3 (16.5%)


► [European Chemicals Agency \(ECHA\)](#)

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[View More...](#)

12.1.3 NFPA Hazard Classification



1 of 2 items		View All
NFPA 704 Diamond	 2-3-0	
NFPA Health Rating	2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.	
NFPA Fire Rating	3 - Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions.	
NFPA Instability Rating	0 - Materials that in themselves are normally stable, even under fire conditions.	



▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.1.4 Health Hazards



Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration. (USCG, 1999)

U.S. Coast Guard. 1999. Chemical Hazard Response Information System (CHRIS) - Hazardous Chemical Data. Commandant Instruction 16465.12C. Washington, D.C.: U.S. Government Printing Office.

▶ [CAMEO Chemicals](#)

ERG 2024, Guide 130 (Toluene)

- May cause toxic effects if inhaled or absorbed through skin.
- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire will produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or asphyxiation, especially when in closed or confined areas.

· Runoff from fire control or dilution [water](#) may cause environmental contamination.

▶ [Emergency Response Guidebook \(ERG\)](#)

12.1.5 Fire Hazards



Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. (USCG, 1999)

U.S. Coast Guard. 1999. Chemical Hazard Response Information System (CHRIS) - Hazardous Chemical Data. Commandant Instruction 16465.12C. Washington, D.C.: U.S. Government Printing Office.

▶ [CAMEO Chemicals](#)



ERG 2024, Guide 130 (Toluene)

- HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along the ground and collect in low or confined areas (sewers, basements, tanks, etc.).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids will float on [water](#).

▶ [Emergency Response Guidebook \(ERG\)](#)

Highly flammable. Vapour/air mixtures are explosive. Risk of fire and explosion on contact with strong oxidants.

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.1.6 Hazards Summary



Toluene is a clear, colorless liquid with a distinctive smell. Toluene occurs naturally in crude oil and in the tolu tree. It is also produced in the process of making gasoline and other fuels from crude oil and making coke from coal. Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes.

▶ [Agency for Toxic Substances and Disease Registry \(ATSDR\)](#)

Toluene is added to gasoline, used to produce [benzene](#), and used as a solvent. Exposure to toluene may occur from breathing ambient or indoor air affected by such sources. The central nervous system (CNS) is the primary target organ for toluene toxicity in both humans and animals for acute (short-term) and chronic (long-term) exposures. CNS dysfunction and narcosis have been frequently observed in humans acutely exposed to elevated airborne levels of toluene; symptoms include fatigue, sleepiness, headaches, and nausea. CNS depression has been reported to occur in chronic abusers exposed to high levels of toluene. Chronic inhalation exposure of humans to toluene also causes irritation of the upper respiratory tract and eyes, sore throat, dizziness, and headache. Human studies have reported developmental effects, such as CNS dysfunction, attention deficits, and minor craniofacial and limb anomalies, in the children of pregnant women exposed to high levels of toluene or mixed solvents by inhalation. EPA has concluded that that there is inadequate information to assess the carcinogenic potential of toluene.



▶ [EPA Air Toxics](#)

Chronic abuse from glue sniffing causes permanent cerebral and cerebellar dysfunction. Liver injury has been reported in glue sniffers. [ATSDR Case Studies: Toluene Toxicity] Toluene abuse may induce acute renal failure with rhabdomyolysis documented as the precipitating event in some cases. [Rosenstock, p. 577] Birth defects similar to the fetal alcohol syndrome occur when mothers abuse toluene during pregnancy. A study of women occupationally exposed to toluene showed an increased incidence of spontaneous abortions. [Frazier, p. 184-5] TLV Basis is impairment (CNS, visual, and hearing), female reproductive toxicity, and pregnancy loss. [ACGIH] The probability of cognitive deficits due to toluene exposure below a TLV of 50 ppm remains extremely low. [PMID 14598174]

Rosenstock - Rosenstock L, Cullen MR, Brodtkin CA, Redlich CA (eds). Textbook of Clinical Occupational and Environmental Medicine, 2nd Ed. Philadelphia: Elsevier Saunders, 2004., p. 577

Frazier - Frazier LM, Hage ML (eds). Reproductive Hazards of the Workplace. New York: John Wiley & Sons, 1998., p. 184-5

ACGIH - Documentation of the TLVs and BEIs, 7th Ed. Cincinnati: ACGIH Worldwide, 2020.

[PMID:14598174](#)

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

12.1.7 Fire Potential



Flammable liquid. A very dangerous fire hazard when exposed to heat, flame, or oxidizers.

Lewis, R.J. Sr. (ed) *Sax's Dangerous Properties of Industrial Materials*. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.1.8 Skin, Eye, and Respiratory Irritations



A human eye irritant.

Lewis, R.J. Sr. (ed) *Sax's Dangerous Properties of Industrial Materials*. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



Irritating to skin, eyes, and respiratory system.

National Fire Protection Association; *Fire Protection Guide to Hazardous Materials*. 14TH Edition, Quincy, MA 2010, p. 49-144

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Vapors of toluene cause noticeable sensation of irritation to human eyes at 300-400 ppm in air

Grant, W.M. *Toxicology of the Eye*. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986., p. 927

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Acute effects in humans following exposure to toluene: ... 200 ppm: mild throat and eye irritation; ... 400 ppm: lacrimation and irritation to the eyes and throat /From table/

Zenz, C., O.B. Dickerson, E.P. Horvath. *Occupational Medicine*. 3rd ed. St. Louis, MO., 1994, p. 724

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Eye and upper airway irritation occurred after a 6.5 hr exposure to an air level of 100 ppm (377 mg/cu m) toluene, and lachrymation was seen at 500 mg/cu m.

IARC. *Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 101 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.1.9 EPA Hazardous Waste Number



U220; A toxic waste when a discarded commercial chemical product or manufacturing chemical intermediate or an off-specification commercial chemical product or manufacturing chemical intermediate.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

F005; A hazardous waste from nonspecific sources when a spent solvent.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.2 Safety and Hazard Properties



12.2.1 Acute Exposure Guideline Levels (AEGLs)



12.2.1.1 AEGLs Table



AEGLs	10 min	30 min	60 min	4 hr	8 hr
AEGL 1: Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure (Unit: ppm)	67	67	67	67	67
AEGL 2: Irreversible or other serious, long-lasting adverse health effects or an impaired ability to	1,400*	760	560	310	250

escape (Unit: ppm)					
AEGL 3: Life-threatening health effects or death (Unit: ppm)	** 10,000 ppm	5,200*	3,700*	1,800*	1,400*

▶ EPA Acute Exposure Guideline Levels (AEGLs)

12.2.1.2 AEGLs Notes



Lower Explosive Limit (LEL) = 14,000 ppm * = > 10% LEL; ** = > 50% LEL AEGL 3 - 10 min = **10,000 ppm For values denoted as * safety considerations against the hazard(s) of explosion(s) must be taken into account. For values denoted as ** extreme safety considerations against the hazard(s) of explosion(s) must be taken into account.

AEGLs Status: Final

▶ EPA Acute Exposure Guideline Levels (AEGLs)

12.2.2 Flammable Limits



Flammable, dangerous fire risk

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250

▶ Hazardous Substances Data Bank (HSDB)

Lower flammable limit: 1.1% by volume; Upper flammable limit: 7.1% by volume

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 325-108

▶ Hazardous Substances Data Bank (HSDB)

Flammability

Class IB Flammable Liquid: Fl.P. below 73 °F and BP at or above 100 °F.

▶ The National Institute for Occupational Safety and Health (NIOSH)

12.2.3 Lower Explosive Limit (LEL)



1.27 % (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

▶ CAMEO Chemicals

1.1%

▶ Occupational Safety and Health Administration (OSHA); The National Institute for Occup...

12.2.4 Upper Explosive Limit (UEL)



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7.1 % (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

▶ CAMEO Chemicals

7.1%

▶ Occupational Safety and Health Administration (OSHA); The National Institute for Occup...

12.2.5 Critical Temperature & Pressure



Critical temperature: 591.75 K; critical pressure: 4.108 MPa

Haynes, W.M. (ed.). CRC Handbook of Chemistry and Physics. 95th Edition. CRC Press LLC, Boca Raton: FL 2014-2015, p. 6-73

▶ Hazardous Substances Data Bank (HSDB)

12.2.6 Physical Dangers



The vapour mixes well with air, explosive mixtures are easily formed. As a result of flow, agitation, etc., electrostatic charges can be generated.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

12.2.7 Explosive Limits and Potential



Explosive in the form of vapor when exposed to heat or flame.

Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ Hazardous Substances Data Bank (HSDB)

1.27-7%.

Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 15th Edition. John Wiley & Sons, Inc. New York, NY 2007., p. 1250

▶ Hazardous Substances Data Bank (HSDB)

Explosive limits , vol% in air: 1.1-7.1

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

12.2.8 OSHA Standards



Permissible Exposure Limit: Table Z-2 8-hr Time Weighted Avg: 200 ppm.

29 CFR 1910.1000 (USDOL); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ Hazardous Substances Data Bank (HSDB)

Permissible Exposure Limit: Table Z-2 Acceptable Ceiling Concentration: 300 ppm.

29 CFR 1910.1000 (USDOL); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ Hazardous Substances Data Bank (HSDB)

Permissible Exposure Limit: Table Z-2 Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift. Concentration: 500 ppm.
Maximum Duration: 10 minutes.

29 CFR 1910.1000 (USDOL); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ Hazardous Substances Data Bank (HSDB)

Vacated 1989 OSHA PEL TWA 100 ppm (375 mg/cu m); STEL 150 ppm (560 mg/cu m) is still enforced in some states.

NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997., p. 372

▶ Hazardous Substances Data Bank (HSDB)

12.2.9 NIOSH Recommendations



Recommended Exposure Limit: 10 Hour Time-Weighted Average: 100 ppm (375 mg/cu m).

NIOSH. NIOSH Pocket Guide to Chemical Hazards. Department of Health & Human Services, Centers for Disease Control & Prevention. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2010-168 (2010). Available from: <https://www.cdc.gov/niosh/npg>

▶ Hazardous Substances Data Bank (HSDB)

Recommended Exposure Limit: 15 Minute Short-Term Exposure Limit: 150 ppm (560 mg/cu m).

NIOSH. NIOSH Pocket Guide to Chemical Hazards. Department of Health & Human Services, Centers for Disease Control & Prevention. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2010-168 (2010). Available from: <https://www.cdc.gov/niosh/npg>

▶ Hazardous Substances Data Bank (HSDB)



12.3 First Aid Measures



Inhalation First Aid

Fresh air, rest. Refer immediately for medical attention.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

Skin First Aid

First rinse with plenty of **water** for at least 15 minutes, then remove contaminated clothes and rinse again. Rinse and then wash skin with **water** and soap. Refer for medical attention .

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

Eye First Aid

First rinse with plenty of **water** for several minutes (remove contact lenses if easily possible), then refer for medical attention.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

Ingestion First Aid

Rinse mouth. Give nothing to drink. Do NOT induce vomiting. Refer immediately for medical attention.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

12.3.1 First Aid



EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with [water](#) or [normal saline](#) solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

SKIN: IMMEDIATELY flood affected skin with [water](#) while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and [water](#). If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.

INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of [water](#) to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING.

IMMEDIATELY transport the victim to a hospital. (NTP, 1992)

National Toxicology Program, Institute of Environmental Health Sciences, National Institutes of Health (NTP). 1992. National Toxicology Program Chemical Repository Database. Research Triangle Park, North Carolina.

▶ [CAMEO Chemicals](#)

ERG 2024, Guide 130 (Toluene)

General First Aid:

- Call 911 or emergency medical service.
- Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and avoid contamination.
- Move victim to fresh air if it can be done safely.
- Administer [oxygen](#) if breathing is difficult.
- If victim is not breathing:
 - DO NOT perform mouth-to-mouth resuscitation; the victim may have ingested or inhaled the substance.



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- If equipped and pulse detected, wash face and mouth, then give artificial respiration using a proper respiratory medical device (bag-valve mask, pocket mask equipped with a one-way valve or other device).
- If no pulse detected or no respiratory medical device available, provide continuous compressions. Conduct a pulse check every two minutes or monitor for any signs of spontaneous respirations.
- Remove and isolate contaminated clothing and shoes.
- For minor skin contact, avoid spreading material on unaffected skin.
- In case of contact with substance, remove immediately by flushing skin or eyes with running [water](#) for at least 20 minutes.
- For severe burns, immediate medical attention is required.
- Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.
- Keep victim calm and warm.
- Keep victim under observation.
- For further assistance, contact your local Poison Control Center.
- Note: Basic Life Support (BLS) and Advanced Life Support (ALS) should be done by trained professionals.

Specific First Aid:

- Wash skin with soap and [water](#).
- In case of burns, immediately cool affected skin for as long as possible with cold [water](#). Do not remove clothing if adhering to skin.

▶ [Emergency Response Guidebook \(ERG\)](#)

(General first aid procedures)

Eye: Irrigate immediately - If this chemical contacts the eyes, immediately wash (irrigate) the eyes with large amounts of [water](#), occasionally lifting the lower and upper lids. Get medical attention immediately.

Skin: Soap wash promptly - If this chemical contacts the skin, promptly wash the contaminated skin with soap and [water](#). If this chemical penetrates the clothing, promptly remove the clothing and wash the skin with soap and [water](#). Get medical attention promptly.

Breathing: Respiratory support

Swallow: Medical attention immediately - If this chemical has been swallowed, get medical attention immediately.

▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)

Excerpt from ERG Guide 130 [Flammable Liquids (Water-Immiscible / Noxious)]:

CAUTION: The majority of these products have a very low flash point. Use of water spray when fighting fire may be inefficient.

SMALL FIRE: Dry chemical, CO₂, water spray or regular foam. If regular foam is ineffective or unavailable, use alcohol-resistant foam.

LARGE FIRE: Water spray, fog or regular foam. If regular foam is ineffective or unavailable, use alcohol-resistant foam. Avoid aiming straight or solid streams directly onto the product. If it can be done safely, move undamaged containers away from the area around the fire.

FIRE INVOLVING TANKS, RAIL TANK CARS OR HIGHWAY TANKS: Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out.

Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks in direct contact with flames.

For massive fire, use unmanned master stream devices or monitor nozzles; if this is impossible, withdraw from area and let fire burn. (ERG, 2024)

2024 Emergency Response Guidebook,

<https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg>

▶ CAMEO Chemicals

Use foam, powder, carbon dioxide, water spray. In case of fire: keep drums, etc., cool by spraying with water.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

12.4.1 Fire Fighting Procedures



Suitable extinguishing media: Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ Hazardous Substances Data Bank (HSDB)

Advice for firefighters: Wear self-contained breathing apparatus for firefighting if necessary.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ Hazardous Substances Data Bank (HSDB)

Use [water](#) spray to cool unopened containers.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

To fight fire, use foam, CO₂, dry chemical.

Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3481

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Fire Fighting Procedures (Complete) data for TOLUENE (7 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



12.4.2 Firefighting Hazards



Poisonous gases may be produced in fire.

Pohanish, R.P. (ed). Sittig's Handbook of Toxic and Hazardous Chemical Carcinogens 6th Edition Volume 1: A-K, Volume 2: L-Z. William Andrew, Waltham, MA 2012, p. 2588

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Vapors are heavier than air and may travel to a source of ignition and flash back. Liquid floats on [water](#) and may travel to a source of ignition and spread fire.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 49-144

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Flame speed equals 37 cm/sec.

Environment Canada; Tech Info for Problem Spills: Toluene (Draft) p.3 (1979)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.5 Accidental Release Measures



Public Safety: ERG 2024, Guide 130 (Toluene)

· CALL 911. Then call emergency response telephone number on shipping paper. If shipping paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.

- Keep unauthorized personnel away.
- Stay upwind, uphill and/or upstream.
- Ventilate closed spaces before entering, but only if properly trained and equipped.
 - ▶ [Emergency Response Guidebook \(ERG\)](#)

Spill or Leak: ERG 2024, Guide 130 (Toluene)

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames) from immediate area.
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor-suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean, non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- **Water** spray may reduce vapor, but may not prevent ignition in closed spaces.
 - ▶ [Emergency Response Guidebook \(ERG\)](#)

12.5.1 Isolation and Evacuation



Excerpt from ERG Guide 130 [Flammable Liquids (**Water**-Immiscible / Noxious)]:
IMMEDIATE PRECAUTIONARY MEASURE: Isolate spill or leak area for at least 50 meters (150 feet) in all directions.

LARGE SPILL: Consider initial downwind evacuation for at least 300 meters (1000 feet).

FIRE: If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. (ERG, 2024)

2024 Emergency Response Guidebook,

<https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg>

▶ [CAMEO Chemicals](#)

Evacuation: ERG 2024, Guide 130 (Toluene)

Immediate precautionary measure

- Isolate spill or leak area for at least 50 meters (150 feet) in all directions.

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail tank car or highway tank is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

- ▶ [Emergency Response Guidebook \(ERG\)](#)

12.5.2 Spillage Disposal



Evacuate danger area! Consult an expert! Personal protection: chemical protection suit and self-contained breathing apparatus. Ventilation. Remove all ignition sources. Do NOT wash away into sewer. Do NOT let this chemical enter the environment. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent. Then store and dispose of according to local regulations.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.5.3 Cleanup Methods



ACCIDENTAL RELEASE MEASURES: Personal precautions, protective equipment and emergency procedures: Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas; Environmental precautions: Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided; Methods and materials for containment and cleaning up: Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Evacuate and restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete. Remove all ignition sources. Establish forced ventilation to keep levels below explosive limit. Absorb liquids in vermiculite, dry sand, earth, peat, [carbon](#), or a similar material and deposit in sealed containers. Keep this chemical out of a confined space, such as a sewer, because of the

possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations. It may be necessary to contain and dispose of this chemical as a hazardous waste. If material or contaminated runoff enters waterways, notify downstream users of potentially contaminated waters.

Pohanish, R.P. (ed). Sittig's Handbook of Toxic and Hazardous Chemical Carcinogens 6th Edition Volume 1: A-K, Volume 2: L-Z. William Andrew, Waltham, MA 2012, p. 2588

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Eliminate all ignition sources. Stop or control the leak, if this can be done without undue risk. Use [water](#) spray to cool and disperse vapors and protect personnel. Absorb in noncombustible material for proper disposal. Control runoff and isolate discharged material for proper disposal.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 49-144

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

1. Remove all ignition sources. 2. Ventilate area of spill or leak. 3. For small quantities, absorb on paper towels. Evaporate in safe place (such as fume hood). Allow sufficient time for evaporating vapors to completely clear hood ductwork. Burn paper in suitable location away from combustible materials.

Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication No. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981., p. 4

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Cleanup Methods (Complete) data for TOLUENE (10 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.5.4 Disposal Methods



Product: Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material; Contaminated packaging: Dispose of as unused product.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016: <https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Generators of waste (equal to or greater than 100 kg/mo) containing this contaminant, EPA hazardous waste numbers U220, and F005 must conform with USEPA regulations in storage, transportation, treatment and disposal of waste.

40 CFR 240-280, 300-306, 702-799 (7/1/90)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is a waste chemical stream constituent which may be subjected to ultimate disposal by controlled incineration.

USEPA; Engineering Handbook for Hazardous Waste Incineration p.2-9 (1981) EPA 68-03-3025

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

A good candidate for liquid injection incineration at a temperature range of 650 to 1,600 °C and a residence time of 0.1 to 2 seconds. A good candidate for rotary kiln incineration at a temperature range of 820 to 1,600 °C and residence times of seconds for liquids and gases, and hours for solids. A good candidate for fluidized bed incineration at a temperature range of 450 to 980 °C and residence times of seconds for liquids and gases, and longer for solids.

USEPA; Engineering Handbook for Hazardous Waste Incineration p.3-16 (1981) EPA 68-03-3025

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Disposal Methods (Complete) data for TOLUENE (11 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.5.5 Preventive Measures



Precautions for safe handling: Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Use explosion-proof equipment. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Appropriate engineering controls: Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Drench-type showers, eye-wash fountains should be installed and maintained to provide prompt, immediate access.

NIOSH; Criteria Document: Toluene p.9 (1973) DHEW Pub. NIOSH 73-11023

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Preventive Measures (Complete) data for TOLUENE (11 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.6 Handling and Storage



12.6.1 Nonfire Spill Response



Excerpt from ERG Guide 130 [Flammable Liquids ([Water](#)-Immiscible / Noxious)]:
ELIMINATE all ignition sources (no smoking, flares, sparks or flames) from immediate area. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor-suppressing foam may be used to reduce vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean, non-sparking tools to collect absorbed material.

LARGE SPILL: Dike far ahead of liquid spill for later disposal. [Water](#) spray may reduce vapor, but may not prevent ignition in closed spaces. (ERG, 2024)

2024 Emergency Response Guidebook,

<https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg>

▶ [CAMEO Chemicals](#)

12.6.2 Safe Storage



Well closed. Fireproof. Separated from strong oxidants. Store in an area without drain or sewer access. Store only in original container.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.6.3 Storage Conditions



Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Handle and store under inert gas.

*Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:
<https://www.sigmaaldrich.com/safety-center.html>*

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Store in a flammable liquid storage area or approved cabinet away from ignition sources and corrosive and reactive materials. ... Before entering confined space where this chemical may be present, check to make sure that an explosive concentration does not exist. Toluene must be stored to avoid contact with strong oxidizers (such as [chlorine](#), [bromine](#), and [fluorine](#)), since violent reactions occur. Protect storage containers from physical damage. Sources of ignition, such as smoking and open flames, are prohibited where toluene is used, handled, or stored in a manner that could create a potential fire or explosion hazard. Metal containers involving the transfer of 5 gallons or more of toluene should be grounded and bonded. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arresters. Use only nonsparking tools and equipment, especially when opening and closing containers of toluene.

Pohanish, R.P. (ed). Sittig's Handbook of Toxic and Hazardous Chemical Carcinogens 6th Edition Volume 1: A-K, Volume 2: L-Z. William Andrew, Waltham, MA 2012, p. 2587-8

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage warehouse, room, or cabinet. Separate from oxidizing materials.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 49-144

- ▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.7 Exposure Control and Personal Protection



Protective Clothing: ERG 2024, Guide 130 (Toluene)

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing provides thermal protection but only limited chemical protection.

▶ [Emergency Response Guidebook \(ERG\)](#)

Exposure Summary

Biological Exposure Indices (BEI) [ACGIH] - [o-Cresol](#) in urine = 0.3 mg/g [creatinine](#) (end of shift); Toluene in blood = 0.02 mg/L (prior to last shift of workweek); Toluene in urine = 0.03 mg/L (end of shift); [ACGIH]

ACGIH - Documentation of the TLVs and BEIs, 7th Ed. Cincinnati: ACGIH Worldwide, 2020.

ACGIH - Documentation of the TLVs and BEIs, 7th Ed. Cincinnati: ACGIH Worldwide, 2020.

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

RD50 (Exposure concentration producing a 50% respiratory rate decrease)

5300.0 [ppm]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

Maximum Allowable Concentration (MAK)

50.0 [ppm]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

12.7.1 Recommended Exposure Limit (REL)



REL-TWA (Time Weighted Average)

100 ppm (375 mg/m³)

▶ [Occupational Safety and Health Administration \(OSHA\)](#)

REL-STEL (Short Term Exposure Limit)

150 ppm (560 mg/m³)

▶ [Occupational Safety and Health Administration \(OSHA\)](#)

TWA 100 ppm (375 mg/m³) ST 150 ppm (560 mg/m³)

▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)

12.7.2 Permissible Exposure Limit (PEL)



200.0 [ppm], Ceiling(OSHA) = 300 ppm(500 ppm for 10-min peak per 8-hr shift)

- ▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

PEL-TWA (8-Hour Time Weighted Average)

200 ppm

- ▶ [Occupational Safety and Health Administration \(OSHA\)](#)

PEL-C (Ceiling)

300 ppm; 500 ppm (Peak) [10 min maximum in an 8 hr shift]

- ▶ [Occupational Safety and Health Administration \(OSHA\)](#)

TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak) [See Appendix G](#)

- ▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)



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12.7.3 Immediately Dangerous to Life or Health (IDLH)



500 ppm (NIOSH, 2024)

- ▶ [CAMEO Chemicals](#)

500.0 [ppm]

Excerpts from Documentation for IDLHs: Human data: It has been reported that extreme fatigue, mental confusion, exhilaration, nausea, headache and dizziness resulted from exposures to 600 ppm by the end of 3 hours [von Oettingen et al. 1942]. In addition, the following observations have been made: Some workers will tolerate concentrations ranging up to 200 ppm for 6 to 8 hours daily with no demonstrable ill effects; 200 to 500 ppm for 6 to 8 hours will cause tiredness and lassitude in most workers; and concentrations over 500 ppm for 1 to 3 hours are definitely dangerous and will cause symptoms attributable to depression of the central nervous system and the bone marrow [Wilson 1943]. It has also been reported that exposure to concentrations greater than 4,000 ppm for more than 5 minutes might limit self rescue ability [ANSI 1973]. After 20 minutes, exposures to concentrations at 300, 500, or 700 ppm resulted in significant increases in reaction times; a significant decrease in perceptual speed resulted after a 20 minute exposure to 700 ppm [Gamberale and Hultengren 1972].

- ▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

500 ppm

NIOSH. NIOSH Pocket Guide to Chemical Hazards. Department of Health & Human Services, Centers for Disease Control & Prevention. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2010-168 (2010). Available from: <https://www.cdc.gov/niosh/npg>

▶ [Hazardous Substances Data Bank \(HSDB\); Occupational Safety and Health Administratio...](#)

500 ppm

See: [108883](#)

▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)



12.7.4 Threshold Limit Values (TLV)

20.0 [ppm]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

8 Hr Time Weighted Avg (TWA): 20 ppm.

American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH 2015, p. 57

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.

American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH 2015, p. 5

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

A4; Not classifiable as a human carcinogen.

American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH 2015, p. 57

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Biological Exposure Index (BEI): Determinant: [o-Cresol](#) in urine (with hydrolysis); Sampling Time: end of shift; BEI: 0.3 mg/g [creatinine](#). Notations: The determinant may be present in biological specimens collected from subjects who have not been

occupationally exposed, at a concentration which could affect interpretation of the result. Such background concentrations are incorporated in the BEI value.

American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH 2015, p. 110

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Threshold Limit Values (TLV) (Complete) data for TOLUENE (6 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

20 ppm as TWA; (OTO); A4 (not classifiable as a human carcinogen); BEI issued.

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

TLV-TWA (Time Weighted Average)

20 ppm [2006]

▶ [Occupational Safety and Health Administration \(OSHA\)](#)

12.7.5 Occupational Exposure Limits (OEL) 🔍 📄

EU-OEL

192 mg/m

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.7.6 Emergency Response Planning Guidelines 🔍 📄

Emergency Response: ERG 2024, Guide 130 (Toluene)

CAUTION: The majority of these products have a very low flash point. Use of [water](#) spray when fighting fire may be inefficient.

Small Fire

· Dry chemical, CO₂, [water](#) spray or regular foam. If regular foam is ineffective or unavailable, use alcohol-resistant foam.

Large Fire

· [Water](#) spray, fog or regular foam. If regular foam is ineffective or unavailable, use alcohol-resistant foam.

· Avoid aiming straight or solid streams directly onto the product.

· If it can be done safely, move undamaged containers away from the area around the fire.



Fire Involving Tanks, Rail Tank Cars or Highway Tanks

- Fight fire from maximum distance or use unmanned master stream devices or monitor nozzles.
- Cool containers with flooding quantities of **water** until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks in direct contact with flames.
- For massive fire, use unmanned master stream devices or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

▶ [Emergency Response Guidebook \(ERG\)](#)

ERPG-1: 50 ppm - one hour exposure limit: 1 = mild transient health effects or objectionable odor [AIHA]

ERPG-2: 300 ppm - one hour exposure limit: 2 = impaired ability to take protective action [AIHA]

ERPG-3: 1,000 ppm - one hour exposure limit: 3 = life threatening health effects [AIHA]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)



12.7.7 Other Standards Regulations and Guidelines



Australia: 100 ppm, STEL 150 ppm (substance under review) (1990); Federal Republic of Germany: 100 ppm, short-term level 500 ppm, 30 min, twice per shift, Pregnancy group B, a risk of damage to the developing embryo or fetus must be considered to be probable (1992); Sweden: 80 ppm, short-term value 100 ppm, 15 min, planning of new plants or alterations of old ones, 50 ppm (1990); United Kingdom: 50 ppm, 10-min STEL 150 ppm, skin (1991).

American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I, II, III. Cincinnati, OH: ACGIH, 1991., p. 1577

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Emergency Response Planning Guidelines (ERPGs) for toluene:

ERPG / LEL	Airborne Concentration	Notations
ERPG-1: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing more than mild,	50 ppm	Odor should be detectable near ERPG-1

transient adverse health effects or without perceiving a clearly defined objectionable odor.	
ERPG-2: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.	300 ppm
ERPG-3: The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.	1000 ppm
LEL (Lower Explosive Limit): The minimum concentration in air of a flammable gas or vapor at which ignition can occur.	None

2015 Emergency Response Planning Guidelines (ERPG) & Workplace Exposure Level (WEEL). American Industrial Hygiene Association, Falls Church, VA 2015, p. 30

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.7.8 Inhalation Risk



A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20 °C.

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.7.9 Effects of Short Term Exposure



The substance is irritating to the skin. The substance is mildly irritating to the eyes. The substance may cause effects on the central nervous system. If this liquid is

swallowed, aspiration into the lungs may result in chemical pneumonitis. Exposure at high levels could cause cardiac dysrhythmia and unconsciousness.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)

12.7.10 Effects of Long Term Exposure



The substance defats the skin, which may cause dryness or cracking. The substance may have effects on the central nervous system. Exposure to the substance may increase noise-induced hearing loss. Animal tests show that this substance possibly causes toxicity to human reproduction or development. May cause colour vision impairment.

▶ ILO-WHO International Chemical Safety Cards (ICSCs)



12.7.11 Personal Protective Equipment (PPE)



Excerpt from NIOSH Pocket Guide for Toluene:

Skin: PREVENT SKIN CONTACT - Wear appropriate personal protective clothing to prevent skin contact.

Eyes: PREVENT EYE CONTACT - Wear appropriate eye protection to prevent eye contact.

Wash skin: WHEN CONTAMINATED - The worker should immediately wash the skin when it becomes contaminated.

Remove: WHEN WET (FLAMMABLE) - Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e., for liquids with a flash point <100 °F).

Change: No recommendation is made specifying the need for the worker to change clothing after the workshift. (NIOSH, 2024)

▶ CAMEO Chemicals

Eye/face protection: Face shield and safety glasses. Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:
<https://www.sigmaaldrich.com/safety-center.html>

▶ Hazardous Substances Data Bank (HSDB)

Skin protection: Handle with gloves.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Body Protection: Complete suit protecting against chemicals. Flame retardant antistatic protective clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Respiratory protection: Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Personal Protective Equipment (PPE) (Complete) data for TOLUENE (12 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.7.12 Respirator Recommendations



NIOSH

Up to 500 ppm:

(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*

(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister

(APF = 10) Any supplied-air respirator*

(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:



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(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister

Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

- ▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)



12.7.13 Preventions



Fire Prevention

NO open flames, NO sparks and NO smoking. Closed system, ventilation, explosion-proof electrical equipment and lighting. Prevent build-up of electrostatic charges (e.g., by grounding). Do NOT use compressed air for filling, discharging, or handling. Use non-sparking handtools. NO contact with strong oxidizing agents.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Exposure Prevention

AVOID ALL CONTACT!

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Inhalation Prevention

Use ventilation, local exhaust or breathing protection.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Skin Prevention

Protective gloves.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Eye Prevention

Wear safety goggles.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Ingestion Prevention

Do not eat, drink, or smoke during work.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.8 Stability and Reactivity



12.8.1 Air and Water Reactions



Highly flammable. Insoluble in [water](#).

- ▶ [CAMEO Chemicals](#)



12.8.2 Reactive Group



Hydrocarbons, Aromatic

- ▶ [CAMEO Chemicals](#)

12.8.3 Reactivity Alerts



Highly Flammable

- ▶ [CAMEO Chemicals](#)

12.8.3.1 CSL Reaction Information



CSL No	CSL00194
Reactants/Reagents	Nitrous oxide + Nitric oxide + Sodium + Hydrogen + Sodium formate + Toluene
Warning Message	"A safety letter from Merck & Co. chemists titled " Nitric Oxide at High Pressure " (C&EN, Jan. 30, page 6) described two explosions during depressurization of a reaction between NO and methanol under basic conditions. The products in a model system with sodium methoxide were described as nitrous oxide and formic acid , presumably as sodium formate . A potential danger in this system should be pointed out: Sodium formate undergoes thermal decomposition to give hydrogen gas (J. Am. Chem. Soc.,DOI: 10.1021/ja02245a004), which explodes spontaneously in the presence of nitrous oxide above critical limits (J. Am. Chem. Soc., DOI: 10.1021/ja01179a036), even in the absence of a catalyst or source of ignition. The presence of hydrogen and nitrous



[oxide](#) above a reaction mixture was undoubtedly the cause of an explosion and fire in my laboratory in 1981 during workup of a reaction between [sodium](#) and [nitric oxide](#). The major product of the reaction is cis-sodium hyponitrite, which decomposes immediately in [water](#) to form [sodium hydroxide](#) and [nitrous oxide](#). The employee, a biology major who was badly burned, had carried out the reaction a number of times without incident. This time he tried twice and failed to disperse about 30 g of [sodium](#) in toluene and, without consulting me, decided to continue the reaction. The explosion occurred as he was attempting to destroy the unreacted [sodium](#), a lump too large to remove from the flask, by dropwise addition of [water](#). Most of the [sodium](#) had reacted at the time of the explosion, and there was no indication of mechanical failure. At the time, I was unaware of the extreme incompatibility of the two gases, and the accident was extremely puzzling. The reaction mixture was close to room temperature and was stirred rapidly while the headspace was flushed with a stream of [nitrogen](#). When I arrived at the laboratory a few minutes after the accident, [nitrogen](#) was still flowing from the burned-off end of the plastic tubing. Since that time, I noticed a reference to the "hydrogen explosion" in the ancient chemical literature as a way to identify [nitrous oxide](#)." (reprint of the full-text)

GHS Category	Explosive
Reaction Scale	Medium (up to 100g)
DOI Link	10.1021/cen-09013-letters
Reference Source	Literature Reference
Modified Date	10/15/2022
Create Date	10/14/2022

▶ [Pistoia Alliance Chemical Safety Library](#)

12.8.4 Reactivity Profile



TOLUENE reacts vigorously with [allyl chloride](#) or other alkyl halides even at -70 °C in the presence of ethyl aluminum dichloride or ethyl aluminum sesquichloride. Explosions have been reported [NFPA 491M 1991]. Incompatible with strong oxidizing agents. When added to a tank of [sulfur dichloride](#), the tank overpressurized and ruptured in a reaction thought to be catalyzed by [iron](#) or [iron\(III\) chloride](#) [Chem. Eng. News, 1988, 66(32), 2].

▶ [CAMEO Chemicals](#)

Incompatible materials: Strong oxidizing agents

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016:

<https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

If conditions are not properly controlled, the reaction of toluene with [nitric acid](#) is extremely violent especially in the presence of [sulfuric acid](#), which takes up the [water](#) formed. Part of the hazard is from the formation of nitrocresols, which react and decompose violently on further nitration.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 491-127

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

A mixture of /[nitrogen tetroxide](#) and toluene/ caused an explosion at an industrial plant in Zschornewitz.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 491-130

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Shock-sensitive solvated salts are ... formed with [silver perchlorate](#) and ... toluene.

National Fire Protection Association; Fire Protection Guide to Hazardous Materials. 14TH Edition, Quincy, MA 2010, p. 491-172

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Hazardous Reactivities and Incompatibilities (Complete) data for TOLUENE (14 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.9 Transport Information

12.9.1 DOT Emergency Guidelines

/GUIDE 130 FLAMMABLE LIQUIDS (Non-Polar/[Water](#)-Immiscible/Noxious)/ Fire or Explosion: HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and

collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Those substances designated with a (P) may polymerize explosively when heated or involved in a fire. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than [water](#).

U.S. Department of Transportation. 2012 Emergency Response Guidebook. Washington, D.C. 2012

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/GUIDE 130 FLAMMABLE LIQUIDS (Non-Polar/[Water](#)-Immiscible/Noxious)/ Health: May cause toxic effects if inhaled or absorbed through skin. Inhalation or contact with material may irritate or burn skin and eyes. Fire will produce irritating, corrosive and/or toxic gases. Vapors may cause dizziness or suffocation. Runoff from fire control or dilution [water](#) may cause pollution.

U.S. Department of Transportation. 2012 Emergency Response Guidebook. Washington, D.C. 2012

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/GUIDE 130 FLAMMABLE LIQUIDS (Non-Polar/[Water](#)-Immiscible/Noxious)/ Public Safety: CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover. As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering.

U.S. Department of Transportation. 2012 Emergency Response Guidebook. Washington, D.C. 2012

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/GUIDE 130 FLAMMABLE LIQUIDS (Non-Polar/[Water](#)-Immiscible/Noxious)/ Protective Clothing: Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.

U.S. Department of Transportation. 2012 Emergency Response Guidebook. Washington, D.C. 2012

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more DOT Emergency Guidelines (Complete) data for TOLUENE (8 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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12.9.2 DOT ID and Guide



1294 130

- ▶ The National Institute for Occupational Safety and Health (NIOSH)

12.9.3 Shipping Name / Number DOT/UN/NA/IMO



UN 1294; Toluene

- ▶ Hazardous Substances Data Bank (HSDB)

IMO 3; Toluene

- ▶ Hazardous Substances Data Bank (HSDB)



12.9.4 Standard Transportation Number



49 093 05; Toluene

- ▶ Hazardous Substances Data Bank (HSDB)

49 093 56; Toluene (toluol), reclaimed solvents, derived from the use of printing inks, consisting of 70% recycled toluol and not more than 30% lactol spirits, textile spirits and mineral spirits

- ▶ Hazardous Substances Data Bank (HSDB)

49 060 10; Toluene (toluol), mixed with **aluminum** alkyls, not to exceed 20% (**aluminum** alkyl)

- ▶ Hazardous Substances Data Bank (HSDB)

12.9.5 Shipment Methods and Regulations



No person may /transport,/ offer or accept a hazardous material for transportation in commerce unless that person is registered in conformance ... and the hazardous material is properly classed, described, packaged, marked, labeled, and in condition for shipment as required or authorized by ... /the hazardous materials regulations (49 CFR 171-177)./

49 CFR 171.2 (USDOT); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 19, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The International Air Transport Association (IATA) Dangerous Goods Regulations are published by the IATA Dangerous Goods Board pursuant to IATA Resolutions 618 and 619 and constitute a manual of industry carrier regulations to be followed by all IATA Member airlines when transporting hazardous materials. Toluene is included on the dangerous goods list.

International Air Transport Association. Dangerous Goods Regulations. 55th Edition. Montreal, Quebec Canada. 2014., p. 315

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The International Maritime Dangerous Goods Code lays down basic principles for transporting hazardous chemicals. Detailed recommendations for individual substances and a number of recommendations for good practice are included in the classes dealing with such substances. A general index of technical names has also been compiled. This index should always be consulted when attempting to locate the appropriate procedures to be used when shipping any substance or article. Toluene is included on the dangerous goods list.

International Maritime Organization. IMDG Code. International Maritime Dangerous Goods Code Volume 2 2012, p. 58

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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12.9.6 DOT Label



Flammable Liquid

▶ [CAMEO Chemicals](#)

12.9.7 UN Classification



UN Hazard Class: 3; UN Pack Group: II

▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

12.10 Regulatory Information



The Australian Inventory of Industrial Chemicals

Chemical: [Benzene, methyl-](#)

▶ [Australian Industrial Chemicals Introduction Scheme \(AICIS\)](#)

California Safe Cosmetics Program (CSCP) Reportable Ingredient

Hazard Traits - Cardiovascular Toxicity; Developmental Toxicity; Hepatotoxicity and Digestive System Toxicity; Immunotoxicity; Nephrotoxicity and Other Toxicity to the Urinary System; Neurotoxicity; Ocular Toxicity; Ototoxicity; Respiratory Toxicity

Authoritative List - ATSDR Neurotoxicants; CA MCLs; CA TACs; CWA 303(c); CWA 303(d); IRIS Neurotoxicants; OEHHA RELs; Prop 65

Report - regardless of intended function of ingredient in the product

- ▶ [California Safe Cosmetics Program \(CSCP\) Product Database](#)

DEA Listed Chemicals

List II Chemical: A chemical, other than a List I chemical, specified by regulation that, in addition to legitimate uses, is used in manufacturing a controlled substance in violation of the Act. (21 eCFR 1310.02)

21 CFR Section 1310.02(a) <https://www.ecfr.gov/current/title-21/chapter-II/part-1310/section-1310.02>

- ▶ [Drug Enforcement Administration \(DEA\)](#)

REACH Registered Substance

Status: Active Update: 02-05-2023 <https://echa.europa.eu/registration-dossier/-/registered-dossier/15538>

Status: Cease Manufacture Update: 15-04-2018 <https://echa.europa.eu/registration-dossier/-/registered-dossier/24071>

- ▶ [European Chemicals Agency \(ECHA\)](#)

REACH Restricted Substance

Restricted substance: Toluene

EC: 203-625-9

Restriction condition document: [PDF link](#)

<https://echa.europa.eu/substances-restricted-under-reach>

- ▶ [European Chemicals Agency \(ECHA\)](#)

New Zealand EPA Inventory of Chemical Status

[Benzene, methyl-](#): [HSNO](#) Approval: HSR001227 Approved with controls

- ▶ [New Zealand Environmental Protection Authority \(EPA\)](#)

New Jersey Worker and Community Right to Know Act

The New Jersey Worker and Community Right to Know Act requires public and private employers to provide information about hazardous substances at their



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workplaces. (N.J.S.A. 34:5A-1 et. seq.)

▶ NJDOH RTK Hazardous Substance List



12.10.1 Atmospheric Standards

This action promulgates standards of performance for equipment leaks of Volatile Organic Compounds (VOC) in the Synthetic Organic Chemical Manufacturing Industry (SOCMI). The intended effect of these standards is to require all newly constructed, modified, and reconstructed SOCMI process units to use the best demonstrated system of continuous emission reduction for equipment leaks of VOC, considering costs, non air quality health and environmental impact and energy requirements. Toluene is produced, as an intermediate or a final product, by process units covered under this subpart.



40 CFR 60.489 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ Hazardous Substances Data Bank (HSDB)

Listed as a hazardous air pollutant (HAP) generally known or suspected to cause serious health problems. The Clean Air Act, as amended in 1990, directs EPA to set standards requiring major sources to sharply reduce routine emissions of toxic pollutants. EPA is required to establish and phase in specific performance based standards for all air emission sources that emit one or more of the listed pollutants. Toluene is included on this list.

Clean Air Act as amended in 1990, Sect. 112 (b) (1) Public Law 101-549 Nov. 15, 1990

▶ Hazardous Substances Data Bank (HSDB)



12.10.2 Federal Drinking Water Standards

EPA 1000 ug/L

USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC). Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present

▶ Hazardous Substances Data Bank (HSDB)



12.10.3 Federal Drinking Water Guidelines

EPA 1000 ug/L

USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC). Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.10.4 State Drinking Water Standards



(CA) CALIFORNIA 150 ug/L

*USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC).
Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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12.10.5 State Drinking Water Guidelines



(AZ) ARIZONA 2000 ug/L

*USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC).
Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

(ME) MAINE 1400 ug/L

*USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC).
Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

(MN) MINNESOTA 1000 ug/L

*USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC).
Summary of State and Federal Drinking Water Standards and Guidelines (11/93) To Present*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.10.6 Clean Water Act Requirements



Toxic pollutant designated pursuant to section 307(a)(1) of the Federal [Water Pollution Control Act](#) and is subject to effluent limitations.

40 CFR 401.15 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is designated as a hazardous substance under section 311(b)(2)(A) of the Federal [Water Pollution Control Act](#) and further regulated by the Clean [Water Act](#) Amendments of 1977 and 1978. These regulations apply to discharges of this

substance. This designation includes any isomers and hydrates, as well as any solutions and mixtures containing this substance.

40 CFR 116.4 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Maximum contaminant levels (MCL) for organic contaminants apply to community and non-transient, non-community [water](#) systems: Chemical, MCL 1 mg/L.

40 CFR 141.61(a) (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



12.10.7 CERCLA Reportable Quantities



Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its reportable quantity of 1000 lb or 454 kg. The toll free number of the NRC is (800) 424-8802. The rule for determining when notification is required is stated in 40 CFR 302.4 (section IV.D.3.b).

40 CFR 302.4 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.10.8 TSCA Requirements



Pursuant to section 8(d) of [TSCA](#), EPA promulgated a model Health and Safety Data Reporting Rule. The section 8(d) model rule requires manufacturers, importers, and processors of listed chemical substances and mixtures to submit to EPA copies and lists of unpublished health and safety studies. Toluene is included on this list. Effective date: 10/4/82; Sunset date: 10/4/92.

40 CFR 716.120 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.10.9 RCRA Requirements



U220; As stipulated in 40 CFR 261.33, when toluene, as a commercial chemical product or manufacturing chemical intermediate or an off-specification commercial chemical product or a manufacturing chemical intermediate, becomes a waste, it

must be managed according to Federal and/or State hazardous waste regulations. Also defined as a hazardous waste is any residue, contaminated soil, [water](#), or other debris resulting from the cleanup of a spill, into [water](#) or on dry land, of this waste. Generators of small quantities of this waste may qualify for partial exclusion from hazardous waste regulations (40 CFR 261.5).

40 CFR 261.33 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

F005; When toluene is a spent solvent, it is classified as a hazardous waste from a nonspecific source (F005), as stated in 40 CFR 261.31, and must be managed according to State and/or Federal hazardous waste regulations.

40 CFR 261.31 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



12.10.10 FDA Requirements



Toluene is an indirect food additive for use only as a component of adhesives.

21 CFR 175.105 (USEPA); U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from, as of February 16, 2016: <https://www.ecfr.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

12.11 Other Safety Information



Chemical Assessment

IMAP assessments - [Benzene](#), [methyl-](#): Human health tier II assessment

▶ [Australian Industrial Chemicals Introduction Scheme \(AICIS\)](#)

12.11.1 Toxic Combustion Products



Special hazards arising from the substance or mixture: Carbon oxides

Sigma-Aldrich; Safety Data Sheet for Toluene. Product Number: 244511, Version 5.7 (Revision Date 12/10/2015). Available from, as of January 28, 2016: <https://www.sigmaaldrich.com/safety-center.html>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The wreck of the MV Ariadne, a Panamanian flag container ship, is examined as a case study of a hazardous substance emergency response in a third world country. /The ship/, carrying a cargo of heavy fuel oil, tetraethyl lead, xylene, toluene, [methyl isobutyl ketone](#), [butyl acetate](#), [ethyl acetate](#), and [acetone](#) was grounded while departing the harbor of Mogadishu, Somalia. The Somali government requested a team of technical advisors to help respond appropriately to the emergency. The major issues addressed by the advisory team were the need for additional salvage equipment and expertise, the danger of toxic fumes from the fire and explosions aboard the ship, the presence and possible release of tetraethyl lead, possible port blockage by the wreck, recovery of the chemical drums, and the extent of environmental damage caused by the release of oil, pesticides, and tetraethyl lead into the harbor. ...

Heare SF et al; 1986 Hazard Matl Spill Conf p.12-18 (1986)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



12.11.3 Special Reports

Review: Benignus VA; Neurotoxicology (Park Forest South, IL) 2 (3): 567 (1981).
Review on health effects of toluene, particularly with respect to its neurotoxic effects in humans and lab animals.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NIOSH; Criteria Document: Toluene (1973) DHEW Pub. NIOSH 73-11023

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

USEPA; Ambient [Water](#) Quality Doc: Toluene (1980) EPA 440/5-80-075

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

NAS/NRC; The Alkyl Benzenes 384 pp (1981)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Special Reports (Complete) data for TOLUENE (10 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1 Toxicological Information



CDC-ATSDR Toxicological Profile

- ▶ Agency for Toxic Substances and Disease Registry (ATSDR)

13.1.1 Toxicity Summary



Cosmetic Ingredient Review Finding(s)

Safe in the present practices of use and concentration. Ingredient, concentration, and use information are available in documents discoverable at <https://cir-reports.cir-safety.org>

Journal of the American College of Toxicology 6(1):77-120, 1987

International Journal of Toxicology 25(Suppl. 2) :1-89,2006

- ▶ Cosmetic Ingredient Review (CIR)

IDENTIFICATION AND USE: Toluene is a colorless liquid. It is not registered for current pesticide use in the U.S., but approved pesticide uses may change periodically and so federal, state and local authorities must be consulted for currently approved uses. Toluene is a component of gasoline, paints, inks, lacquers, paint thinners, adhesives, fingernail polish, cleaning agents, and rubber. BTX (a mixture of **benzene**, toluene, and xylene) is added to gasoline to improve **octane** ratings. Toluene is used to produce **benzene**, **trinitrotoluene (TNT)**, nylon, plastics, and polyurethanes. It is also used in production of drugs of abuse. Toluene is a favorite of solvent abusers, who intentionally inhale high concentrations to achieve a euphoric effect. HUMAN EXPOSURE AND TOXICITY: Eye and upper airway irritation occurred after a 6.5 hr exposure to an air level of 100 ppm (377 mg/cu m) toluene, and lacrymation was seen at 500 mg/cu m. Volunteers exposed to 100 ppm (377 mg/cu m) toluene for 6 hr/day for four days suffered from subjective complaints of headache, dizziness and a sensation of intoxication. In subjects exposed to 750 mg/cu m for 8 hr, fatigue, muscular weakness, confusion, impaired coordination, enlarged pupils and accommodation disturbances were experienced; at about 3000 mg/cu m, severe fatigue, pronounced nausea, mental confusion, considerable incoordination with staggering gait and strongly affected pupillary light reflexes were observed. After exposure at the high level, muscular fatigue, nervousness and insomnia lasted for several days. Heavy accidental exposure leads to coma. Studies of women exposed to toluene have shown menstrual disturbances, principally associated with abnormal bleeding. In a case study of two adult white males who suffered from toluene intoxication cardiac arrhythmias were noted. Response seemed to be highly variable among individuals. One person exposed for 2 hr to less than 1890 ppm toluene exhibited a rapid heartbeat (sinus tachycardia),



while the second person, exposed for 3 hr, exhibited a slow heartbeat (bradycardia). Severe renal tubular acidosis was observed in five pregnant women who were chronic abusers of paints containing toluene. A 27-year-old male developed cerebral and cerebellar atrophy over a period of five years of extensive glue sniffing. He also developed bilateral optic atrophy with blindness and severe sensorineural hearing loss. CYP2E1 is a versatile phase I drug-metabolizing enzyme responsible for the biotransformation of most volatile organic compounds, including toluene. Human toluene exposure increases CYP2E1 mRNA and modifies its activity in leucocytes. A study of Finnish individuals monitored in an occupational database during the years 1978 to 1983 showed that there was no increase in cancer risk with individuals exposed to toluene with average blood levels of 0.18 mg/L. Chromosome studies on peripheral blood lymphocytes of 34 rotogravure workers in Italy showed no changes when compared with the control group. Several case series have demonstrated that high exposure to toluene through sniffing during pregnancy induces a syndrome that closely resembles the fetal alcohol syndrome, with pre- and postnatal growth deficiency, microcephaly and developmental delay, typical craniofacial features including micrognathia, small palpebral fissures, and ear anomalies.

ANIMAL STUDIES: Rats were studied to assess the effects of acute binge-like toluene inhalations (15 or 30 min; ~5,000 ppm) on tasks that examine locomotion, exploration, balance, gait, and neurological functioning for adolescent (1 month), young adult (2-3 months), adult (5-6 months), and older adult (10-12 months) rats. Both motor and neurological functions were impaired following acute toluene inhalation at all ages. However, only the duration to recover from deficits in motor functions differed among age groups, with adolescent and young adult rats requiring notably longer recovery times than older rats. When 0.25, 0.5, or 2.0 mL toluene were applied to 0.7% of the total body surface of guinea pigs, none of the animals died, but reduced body-weight gain occurred. Inhalation of 1400 to 2000 ppm toluene by male rats, 8 hours/day for as little as 3 days resulted in reversible, high-frequency hearing loss. Subcutaneous injection of 50 and 500 mg/kg once a day for 10 days caused decreased sperm counts and serum [testosterone](#) in male rats. Rats were dosed with 1.3 g/kg toluene subcutaneously during either week 2 (8-15 days) or week 3 (14-20 days) of pregnancy and evaluated for malformations, development of the skeleton, prenatal growth of the brain and liver, postnatal growth, and behavioral effects. The only toluene-induced change was low birth weight and was found in the rats dosed in the third week of pregnancy. Rabbits exposed 24 hours/day at 1000 mg/cu m (265 ppm) from day 6 to 15 of pregnancy showed increased spontaneous abortions. Mice exposed 24 hours/day at 1000 mg/cu m (265 ppm) on days 6 to 15 of pregnancy and rats exposed to 2400 mg/cu m (636 ppm) on days 7 to 15 of pregnancy showed growth and skeletal retardation. Mice exposed 24 hours/day at 133 ppm toluene on days 6 to 13 of pregnancy and rats exposed 24 hours/day at 399 ppm on days 1 to 8 of pregnancy and on days 9 to 14 of pregnancy showed fetal growth retardation and an increase in skeletal anomalies. There was maternal mortality in these groups. Mice exposed 6 hours/day



at 100 ppm toluene during days 1 to 17 of pregnancy showed no significant differences in number of implantation sites, number of fetuses, or mean fetal body weight when compared with control. When toluene was applied to shaved interscapular skin of male mice 3 times per week for 4 weeks, followed by a secondary treatment of 3 times per week for up to 112 weeks, no tumors were observed. Groups of 60 male and female mice that were exposed 6.5 hours/day, 5 days/week for 2 years via inhalation at inhaled 0, 120, 600, or 1200 ppm toluene showed no biologically relevant increases for any non-neoplastic or neoplastic tissue changes. When groups of 60 rats of each sex were exposed via inhalation 6.5 hours/day, 5 days/week for 2 years to atmospheres containing 0, 600, or 1200 ppm toluene, nephropathy occurred in nearly all of the rats. The olfactory and respiratory epithelia showed signs of degeneration with nasal inflammation and metaplasia of the olfactory epithelium (principally in the females). No treatment-related neoplasms occurred in the male rats. and the few scattered tumors found in the females were considered not associated with toluene inhalation. Toluene did not induce gene mutations in *Salmonella typhimurium* strain TA98, TA100, TA1535, or TA1537 with or without exogenous metabolic activation. In the mouse lymphoma assay, toluene gave an equivocal response with and without exogenous metabolic activation. Toluene did not induce sister chromatid exchanges or chromosomal aberrations in Chinese hamster ovary cells in the presence or absence of exogenous metabolic activation. ECOTOXICITY STUDIES: The toluene contamination significantly reduced the mass of the cell wall material in the alfalfa roots. Furthermore, the toluene pollution can change the alfalfa root cell wall properties by reducing the cell wall functional groups. These functional groups are probably related to the proteins and polysaccharides in the cell wall.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is a cholinesterase or acetylcholinesterase (AChE) inhibitor. A cholinesterase inhibitor (or 'anticholinesterase') suppresses the action of acetylcholinesterase. Because of its essential function, chemicals that interfere with the action of acetylcholinesterase are potent neurotoxins, causing excessive salivation and eye-watering in low doses, followed by muscle spasms and ultimately death. Nerve gases and many substances used in insecticides have been shown to act by binding a [serine](#) in the active site of [acetylcholine](#) esterase, inhibiting the enzyme completely. [Acetylcholine](#) esterase breaks down the neurotransmitter [acetylcholine](#), which is released at nerve and muscle junctions, in order to allow the muscle or organ to relax. The result of [acetylcholine](#) esterase inhibition is that [acetylcholine](#) builds up and continues to act so that any nerve impulses are continually transmitted and muscle contractions do not stop. Among the most common acetylcholinesterase inhibitors are [phosphorus](#)-based compounds, which are designed to bind to the active site of the enzyme. The structural requirements are a [phosphorus](#) atom bearing two lipophilic groups, a leaving group (such as a halide or [thiocyanate](#)), and a terminal [oxygen](#).

13.1.2 EPA IRIS Information



Substance	Toluene
Toxicity Summary	EPA IRIS Summary PDF (Update: Sep-23-2005)
Critical Effect Systems	Nervous Urinary
Reference Dose (RfD), chronic	8×10^{-2} mg/kg-day
Reference Concentration (RfC), chronic	5 mg/m^3



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▶ [EPA Integrated Risk Information System \(IRIS\)](#)

13.1.3 EPA Provisional Peer-Reviewed Toxicity Values



Chemical Substance	Toluene
Reference Dose (RfD), Subchronic	8×10^{-1} mg/kg-day
Reference Concentration (RfC), Subchronic	5 mg/m^3
PPRTV Assessment	PDF Document
Last Revision	2009

▶ [EPA Provisional Peer-Reviewed Toxicity Values \(PPRTVs\)](#)

13.1.4 RAIS Toxicity Values



Inhalation Acute Reference Concentration (RfCa) (mg/m^3)	7.6
Inhalation Acute Reference Concentration Reference	ATSDR Final
Inhalation Chronic Reference Concentration (RfC) (mg/m^3)	5

Inhalation Chronic Reference Concentration Reference	IRIS Current
Inhalation Subchronic Reference Concentration (RfCs) (mg/m ³)	5
Inhalation Subchronic Reference Concentration Reference	PPRTV Current
Oral Acute Reference Dose (RfDoa)(mg/kg-day)	0.8
Oral Acute Reference Dose Reference	ATSDR Final
Oral Chronic Reference Dose (RfDoc) (mg/kg-day)	0.08
Oral Chronic Reference Dose Reference	IRIS Current
Oral Subchronic Chronic Reference Dose (RfDos) (mg/kg-day)	0.8
Oral Subchronic Chronic Reference Dose Reference	PPRTV Current
Short-term Oral Reference Dose (RfDot) (mg/kg-day)	0.2
Short-term Oral Reference Dose Reference	ATSDR Final

▶ [Risk Assessment Information System \(RAIS\)](#)

13.1.5 USGS Health-Based Screening Levels for Evaluating Water-Quality



Chemical	Toluene
USGS Parameter Code	34010
Chemical Classes	Volatile Organic Compound (VOC)
MCL (Maximum Contaminant Levels)[μg/L]	1000
Reference	Smith, C.D. and Nowell, L.H., 2024. Health-Based Screening Levels for evaluating water-quality data (3rd ed.).

- ▶ USGS Health-Based Screening Levels for Evaluating Water-Quality Data

13.1.6 NIOSH Toxicity Data



- ▶ The National Institute for Occupational Safety and Health (NIOSH)

13.1.7 Evidence for Carcinogenicity



Evaluation: There is inadequate evidence for the carcinogenicity of toluene in humans. There is evidence suggesting lack of carcinogenicity of toluene in experimental animals. Overall evaluation: Toluene is not classifiable as to its carcinogenicity to humans (Group 3).

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V71 855 (1999)

- ▶ Hazardous Substances Data Bank (HSDB)

Under the Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005), there is inadequate information to assess the carcinogenic potential of toluene because studies of humans chronically exposed to toluene are inconclusive, toluene was not carcinogenic in adequate inhalation cancer bioassays of rats and mice exposed for life, and increased incidences of mammary cancer and leukemia were reported in a lifetime rat oral bioassay at a dose level of 500 mg/kg-day but not at 800 mg/kg-day.

U.S. Environmental Protection Agency's Integrated Risk Information System (IRIS). Summary on Toluene (108-88-3; September 2005). Available from, as of February 12, 2016: <https://www.epa.gov/iris/>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

A4; Not classifiable as a human carcinogen.

American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH 2015, p. 57

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



13.1.8 Carcinogen Classification



1 of 3 items	
IARC Carcinogenic Agent	Toluene
IARC Carcinogenic Classes	Group 3: Not classifiable as to its carcinogenicity to humans
IARC Monographs	<p>Volume 47: (1989) Some Organic Solvents, Resin Monomers and Related Compounds, Pigments and Occupational Exposures in Paint Manufacture and Painting</p> <p>Volume 71: (1999) Re-evaluation of Some Organic Chemicals, Hydrazine and Hydrogen Peroxide (Part 1, Part 2, Part 3)</p>

▶ [International Agency for Research on Cancer \(IARC\)](#)

2 of 3 items	
Substance	Toluene
NTP Technical Report	TR-371 : Toxicology and Carcinogenesis Studies of Toluene (CASRN 108-88-3) in F344/N Rats and B6C3F1 Mice (Inhalation Studies) (1990)
Peer Review Date	03/13/89
Conclusion for Male Rat	No Evidence
Conclusion for Female Rat	No Evidence
Conclusion for Male Mice	No Evidence
Conclusion for Female Mice	No Evidence

Summary

Under the conditions of these 2-year inhalation studies, there was no evidence of carcinogenic activity for male or female F344/N rats exposed to toluene at concentrations of 600 or 1,200 ppm. There was no evidence of carcinogenic activity for male or female B6C3F1 mice exposed by inhalation to toluene at concentrations of 120, 600, or 1,200 ppm for 2 years.

▶ [NTP Technical Reports](#)

3 of 3 items

Carcinogen Classification 3, not classifiable as to its carcinogenicity to humans. (L135)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)



13.1.9 Health Effects



Acute exposure to cholinesterase inhibitors can cause a cholinergic crisis characterized by severe nausea/vomiting, salivation, sweating, bradycardia, hypotension, collapse, and convulsions. Increasing muscle weakness is a possibility and may result in death if respiratory muscles are involved. Accumulation of ACh at motor nerves causes overstimulation of nicotinic expression at the neuromuscular junction. When this occurs symptoms such as muscle weakness, fatigue, muscle cramps, fasciculation, and paralysis can be seen. When there is an accumulation of ACh at autonomic ganglia this causes overstimulation of nicotinic expression in the sympathetic system. Symptoms associated with this are hypertension, and hypoglycemia. Overstimulation of nicotinic [acetylcholine](#) receptors in the central nervous system, due to accumulation of ACh, results in anxiety, headache, convulsions, ataxia, depression of respiration and circulation, tremor, general weakness, and potentially coma. When there is expression of muscarinic overstimulation due to excess [acetylcholine](#) at muscarinic [acetylcholine](#) receptors symptoms of visual disturbances, tightness in chest, wheezing due to bronchoconstriction, increased bronchial secretions, increased salivation, lacrimation, sweating, peristalsis, and urination can occur. Certain reproductive effects in fertility, growth, and development for males and females have been linked specifically to organophosphate pesticide exposure. Most of the research on reproductive effects has been conducted on farmers working with pesticides and insecticides in rural areas. In females menstrual cycle disturbances, longer pregnancies, spontaneous abortions, stillbirths, and some developmental effects in offspring have been linked to organophosphate pesticide exposure. Prenatal exposure has been linked to impaired fetal growth and development. Neurotoxic effects have also been linked to poisoning with OP pesticides causing four neurotoxic effects in humans: cholinergic syndrome, intermediate syndrome,

organophosphate-induced delayed polyneuropathy (OPIDP), and chronic organophosphate-induced neuropsychiatric disorder (COPIND). These syndromes result after acute and chronic exposure to OP pesticides.

- ▶ [Toxin and Toxin Target Database \(T3DB\)](#)



13.1.10 Exposure Routes

The substance can be absorbed into the body by inhalation, through the skin and by ingestion.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

inhalation, skin absorption, ingestion, skin and/or eye contact

- ▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)

Oral (L174) ; inhalation (L174) ; dermal (L174)

- ▶ [Toxin and Toxin Target Database \(T3DB\)](#)



13.1.11 Signs and Symptoms

Inhalation Exposure

Sore throat. Cough. Dizziness. Drowsiness. Headache. Nausea. Unconsciousness.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Skin Exposure

Redness. Dry skin.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Eye Exposure

Redness. Pain.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

Ingestion Exposure

Aspiration hazard! Burning sensation. Abdominal pain. Vomiting. Further see Inhalation.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage

- ▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)

The central nervous system is the primary target organ of toluene and other alkylbenzenes. Manifestations of exposure range from slight dizziness and headache to unconsciousness, respiratory depression and death. Other symptoms include tiredness, confusion, weakness, memory loss, nausea, loss of appetite, and hearing and color vision loss. These symptoms usually disappear when exposure is stopped. (T10, L174)

- ▶ [Toxin and Toxin Target Database \(T3DB\)](#)



13.1.12 Target Organs



Cardiovascular (Heart and Blood Vessels), Developmental (effects while organs are developing), Immunological (Immune System), Neurological (Nervous System), Respiratory (From the Nose to the Lungs)

- ▶ [Agency for Toxic Substances and Disease Registry \(ATSDR\)](#)

Nervous

Urinary

- ▶ [EPA Integrated Risk Information System \(IRIS\)](#)

Eyes, skin, respiratory system, central nervous system, liver, kidneys

- ▶ [The National Institute for Occupational Safety and Health \(NIOSH\)](#)

13.1.13 Acute Toxicity Link



Chemical: TOLUENE

- ▶ [USGS Columbia Environmental Research Center](#)

13.1.14 Adverse Effects



Neurotoxin - Acute solvent syndrome

Occupational hepatotoxin - Secondary hepatotoxins: the potential for toxic effect in the occupational setting is based on cases of poisoning by human ingestion or animal experimentation.

Nephrotoxin - The chemical is potentially toxic to the kidneys in the occupational setting.

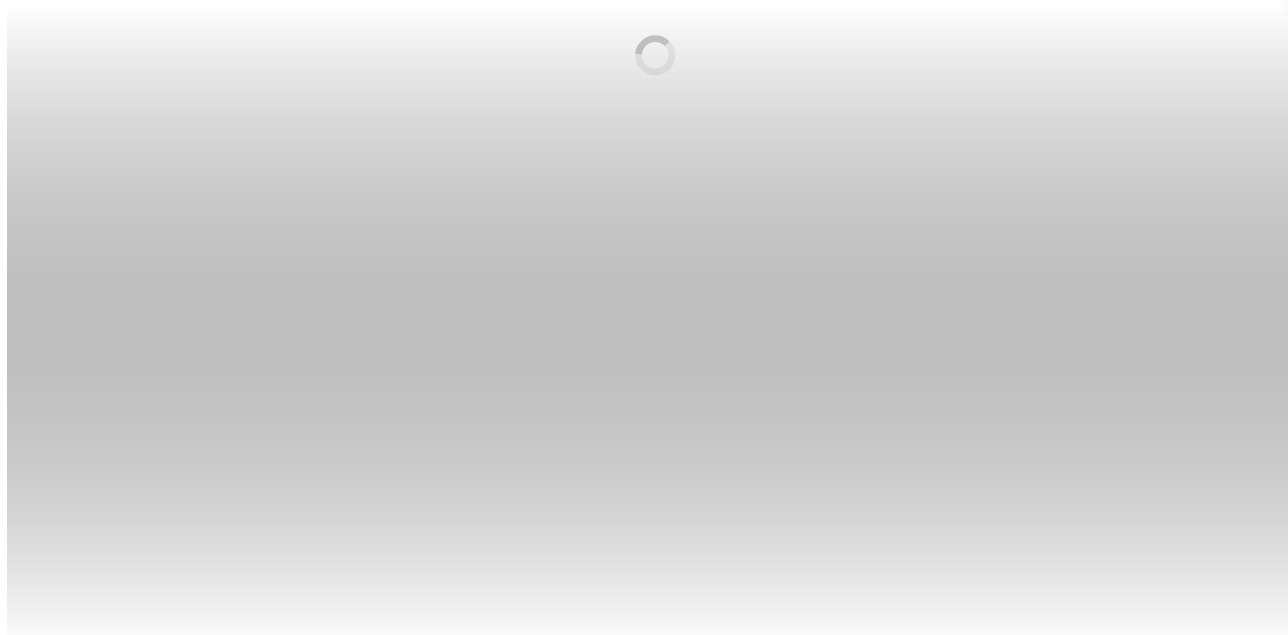
Reproductive Toxin - A chemical that is toxic to the reproductive system, including defects in the progeny and injury to male or female reproductive function.

Reproductive toxicity includes developmental effects. See Guidelines for Reproductive Toxicity Risk Assessment.

ACGIH Carcinogen - Not Classifiable.

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

13.1.15 Acute Effects



▶ [ChemIDplus](#)

13.1.16 Toxicity Data



LC50 (rat) = 8000 ppm/4H

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

LD50: 5000 mg/kg (Oral, Rat) (T14) LD50: 1332 mg/kg (Intraperitoneal, Rat) (T14)
LD50: 1960 mg/kg (Intravenous, Rat) (T14) LD50: 2250 mg/kg (Subcutaneous, Mouse) (T14)
LD50: 12 124 mg/kg (Dermal, Rabbit) (T14) LC50: 400 ppm over 24 hours (Inhalation, Mouse) (T14)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)

13.1.17 Minimum Risk Level



Acute Inhalation: 1 ppm (L134) Chronic Inhalation: 0.08 ppm (L134) Acute Oral: 0.8 mg/kg/day (L134) Intermediate Oral: 0.02 mg/kg/day (L134)

▶ [Toxin and Toxin Target Database \(T3DB\)](#)

13.1.18 Treatment



If the compound has been ingested, rapid gastric lavage should be performed using 5% [sodium bicarbonate](#). For skin contact, the skin should be washed with soap and [water](#). If the compound has entered the eyes, they should be washed with large quantities of isotonic saline or [water](#). In serious cases, [atropine](#) and/or [pralidoxime](#) should be administered. Anti-cholinergic drugs work to counteract the effects of excess [acetylcholine](#) and reactivate AChE. [Atropine](#) can be used as an antidote in conjunction with [pralidoxime](#) or other pyridinium oximes (such as [trimedoxime](#) or [obidoxime](#)), though the use of '-oximes' has been found to be of no benefit, or possibly harmful, in at least two meta-analyses. [Atropine](#) is a muscarinic antagonist, and thus blocks the action of [acetylcholine](#) peripherally.



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▶ [Toxin and Toxin Target Database \(T3DB\)](#)

13.1.19 Interactions



The exposure intensity during a shift and the metabolite levels in the shift-end urine were examined in male workers exposed to either [benzene](#) (65 subjects; the [benzene](#) group), toluene (35 subjects; the toluene group), or a mixture of both (55 subjects; the mixture group). In addition, 35 non-exposed male workers (the control group) were similarly examined for urinary metabolites to define background levels. A linear relationship was established between the intensity of solvent exposure and the corresponding urinary metabolite levels (i.e. [phenol](#), [catechol](#) and [quinol](#) from [benzene](#), and [hippuric acid](#) and [o-cresol](#) from toluene) in each case when one of the three exposed groups was combined with the control group for calculation. Comparison of regression lines in combination with regression analysis disclosed that urinary levels of [phenol](#) and [quinol](#) (but not [catechol](#)) were lower in the mixture group than in the [benzene](#) group when the intensities of exposure to [benzene](#) were comparable, indicating that the biotransformation of [benzene](#) to phenolic compounds (excluding [catechol](#)) in man is suppressed by co-exposure to toluene. Conversely, metabolism of toluene to [hippuric acid](#) was suppressed by [benzene](#) co-exposure. Conversion of toluene to [o-cresol](#) was also reduced by [benzene](#), but to a lesser extent. The significance of the present findings on the mutual suppression of metabolism between [benzene](#) and toluene is discussed in relation to solvent toxicology and biological monitoring of exposure to the solvents.

PMID:3350599

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

As toluene is metabolized by CYPs, ADH, and ALDH, the chemical can interact with other xenobiotics metabolized by these enzymes. Concurrent exposure to solvents metabolized by the same CYP isoforms can result in competitive metabolic inhibition. /It has been observed/ that [benzene](#) and toluene suppressed one another's metabolism in humans. ... /A study/ found that toluene greatly reduced manifestations of peripheral neuropathy caused by [n-hexane](#) in rats. Although no interaction between toluene and xylenes were seen in humans inhaling low levels of each, simultaneous exposure to higher levels results in mutual metabolic suppression. Prior exposure to P450 inducers can result in increased rates of toluene metabolism/elimination and more rapid recovery from toluene-induced CNS depression. /Another study/ observed that high concentrations of inhaled toluene moderately induced four of the six P450 isoforms that metabolize it, but inhibited the other two in rat liver.

Klaassen, C.D. (ed). Casarett and Doull's Toxicology. The Basic Science of Poisons. 7th ed. New York, NY: McGraw-Hill, 2008., p. 1011

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Voluntary inhalation of organic solvents, such as toluene, is particularly prevalent in adolescent populations and is considered to be a contributing factor to substance use and dependence later in life. While inhalants are often the initial "drug" experienced during this period, alcohol is another substance readily abused by adolescent populations. Although both substances are thought to have similar actions within the brain, our understanding of the implications of adolescent inhalant abuse upon subsequent exposure to alcohol remains to be investigated. Thus, this study aimed to assess locomotor responses to acute [ethanol](#) and voluntary [ethanol](#) consumption following a period of toluene inhalation throughout adolescence/early adulthood. Adolescent male Wistar rats (postnatal day [PN] 27) inhaled air or toluene (3000 ppm) for 1 hr/day, 3 days/week for 4 (PN 27-52) or 8 weeks (PN 27-80) to mimic the patterns observed in human inhalant abusers. Following the exposure period, cross-sensitization to acute [ethanol](#) challenge (0.5 g/kg, intra-peritoneally [i.p.]), and voluntary consumption of 20% [ethanol](#) in a chronic intermittent 2-bottle choice paradigm, were assessed. Hepatic [ethanol](#) and [acetaldehyde](#) metabolism and liver histopathology were also investigated. Chronic intermittent toluene (CIT) exposure throughout adolescence for up to 8 weeks did not alter the behavioral response to acute [ethanol](#) or voluntary consumption of [ethanol](#) in adulthood, although an age-dependent effect on [ethanol](#) consumption was observed ($p < 0.05$). Both liver function and pathology did not differ between treatment groups. Thus, in the paradigm employed, CIT exposure throughout



adolescence and early adulthood did not predispose rats to subsequent locomotor sensitivity or voluntary consumption of ethanol in adulthood.

[PMID:25212750](#)

Dick AL et al; Alcohol 48 (6): 561-9 (2014)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Caffeic acid phenethyl ester (CAPE) has antioxidant and anti-inflammatory properties. The aim of this study is to examine the negative effects of toluene on kidney tissues and functions and to investigate the protective effects of CAPE against toluene-induced nephrotoxicity in rats. A total of 21 male Wistar rats were divided into three groups of equal number in each. The rats in group I were the controls. Toluene was intraperitoneally injected into the rats in group II with a dose of 500 mg/kg. Rats in group III received CAPE daily while exposed to toluene. After 14 days of experimental period, all rats were killed by decapitation. Enzymatic activities of superoxide dismutase (SOD), **glutathione peroxidase (GSH-Px)**, and catalase (CAT) and **malondialdehyde (MDA)** levels were studied in the rat kidneys. Blood **urea nitrogen (BUN)** and serum **creatinine** levels were measured for renal function. The CAT and SOD enzyme activities and serum **creatinine** levels were significantly increased in rats treated with toluene when compared with the controls. But **GSH-Px** activity, MDA, and BUN levels showed statistically nonsignificant changes. However, increased CAT and SOD enzyme activities and decreased serum **creatinine** levels were detected in the rats that received CAPE while exposed to toluene. The **GSH-Px** activity and MDA and BUN levels in the same group did not show statistically significant changes. The results of our study demonstrated that toluene damages kidney tissue and is a nephrotoxic substance. CAPE was able to prevent the renal damage as antioxidant, antitoxic, and nephroprotective agent.

[PMID:23858052](#)

Meydan S et al; Toxicol Ind Health 32 (1): 15-21 (2016)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Interactions (Complete) data for TOLUENE (23 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1.20 Antidote and Emergency Treatment



Immediate First Aid: Ensure that adequate decontamination has been carried out. If patient is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask, as trained. Perform CPR if necessary. Immediately flush contaminated eyes with gently flowing **water**. Do not



induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration. Keep patient quiet and maintain normal body temperature. Obtain medical attention.

/Aromatic hydrocarbons and related compounds/

Currance, P.L. Clements, B., Bronstein, A.C. (Eds.); Emergency Care For Hazardous Materials Exposure. 3rd revised edition, Elsevier Mosby, St. Louis, MO 2007, p. 209

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Basic treatment: Establish a patent airway (oropharyngeal or nasopharyngeal airway, if needed). Suction if necessary. Watch for signs of respiratory insufficiency and assist ventilations if necessary. Administer **oxygen** by nonrebreather mask at 10 to 15 L/min. Monitor for pulmonary edema and treat if necessary Monitor for shock and treat if necessary Anticipate seizures and treat if necessary. ... For eye contamination, flush eyes immediately with **water**. Irrigate each eye continuously with 0.9% saline (NS) during transport Do not use emetics. For ingestion, rinse mouth and administer 5 mL/kg up to 200 L of **water** for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated **charcoal** /Aromatic hydrocarbons and related compounds/

Currance, P.L. Clements, B., Bronstein, A.C. (Eds.); Emergency Care For Hazardous Materials Exposure. 3rd revised edition, Elsevier Mosby, St. Louis, MO 2007, p. 209-10

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Advanced treatment: Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious, has severe pulmonary edema, or is in severe respiratory distress. Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial. Consider drug therapy for pulmonary edema Consider administering a beta agonist such as **albuterol** for severe bronchospasm Monitor cardiac rhythm and treat arrhythmias if necessary Start IV administration of D5W TKO /SRP: "To keep open", minimal flow rate/. Use 0.9% saline (NS) or lactated Ringer's (LR) if signs of hypovolemia are present. For hypotension with signs of hypovolemia, administer fluid cautiously. Watch for signs of fluid overload Treat seizures with **diazepam (Valium)** or **lorazepam (Ativan)** Use **proparacaine hydrochloride** to assist eye irrigation /Aromatics hydrocarbons and related compounds/

Currance, P.L. Clements, B., Bronstein, A.C. (Eds.); Emergency Care For Hazardous Materials Exposure. 3rd revised edition, Elsevier Mosby, St. Louis, MO 2007, p. 210

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene sniffing, frequently described under the generic category of "glue sniffing," is a potential cause of normal anion gap metabolic acidosis due to distal renal tubular acidosis. Urine anion gap is used to diagnose metabolic acidosis of a normal anion gap variety; however, pitfalls exist when using urine anion gap in the setting



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of toluene sniffing. We present the case of a young woman who had a normal anion gap metabolic acidosis due to toluene sniffing and an unexpectedly low urine anion gap. In such a scenario, the urine anion gap will underestimate the rate of ammonia excretion when the conjugate bases of acids other than HCl are excreted in large quantities. Estimation of the urine osmolal gap will provide a more accurate ammonia excretion rate in these circumstances. The challenges in interpretation of the urine anion gap and ammonia excretion in the setting of distal renal tubular acidosis due to toluene toxicity are discussed.

PMID:23778000

Tuchscherer J, Rehman H; CJEM 15 (4): 249-52 (2013)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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13.1.21 Medical Surveillance



/EPIDEMIOLOGY STUDIES/ Auditory, cognitive, and visual evoked potentials were investigated in 49 printing press workers who had been exposed to toluene for an average of 22 years and compared to 59 workers not known to be exposed to anything. The level of exposure was assessed by determination of toluene in peripheral blood, and the exposure was estimated to be 40 to 60 ppm, based on hippuric acid in urine after the workshift. /The study/ discovered changes in amplitude and latencies of the evoked potentials in the toluene-exposed group in each of the tests.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 5

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Yearly physical examinations of exposed personnel, with special attention to the eyes and central nervous system, including complete blood count and liver function tests.

ITII. Toxic and Hazardous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1988., p. 526

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1.22 Human Toxicity Excerpts



/HUMAN EXPOSURE STUDIES/ The solvent toluene has neurotoxic properties that are especially relevant in the working environment. Short-term exposure limits (STELs) vary from 50 ppm up to 300 ppm across countries but their acute effects remain elusive in humans. Several in vitro and in vivo studies elucidated that toluene

acutely acts by perturbations of different neurotransmitter systems. More specifically visual evoked potentials (VEPs) of rats are decreased after acute toluene exposure, leading to the assumption that particularly visual attention processes might be a target of toluene in humans. Therefore a visual change detection task was applied to measure both neurobehavioral and neurophysiological effects by using electroencephalography (EEG) after a single peak exposure to 200 ppm toluene. Performance and event-related components of the EEG were examined before and after exposure in a toluene-exposed and a control group. Thirty-three young healthy volunteers participated in this study. The behavioral results of the experiment indicate that toluene impairs the rate of correct responses especially in task conditions in which an irrelevant distractor is given, while the response times did not differ between both groups. The neurophysiological findings hint toward a less efficient visual processing of behaviorally relevant stimuli and an increased distractibility by irrelevant distractors. Thus the present results are a promising starting point for further research specifically targeting visual attention after toluene exposure and the reconsideration of the presently very heterogeneous STELs.

[PMID:25770824](#)

Kobald SO et al; Neurotoxicology 48: 50-9 (2015)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/HUMAN EXPOSURE STUDIES/ The nasal mucus flow, lung function, subjective response, and psychometric performance of 16 young healthy subjects was studied during 6-hr exposures to clean air and to 10, 40 or 100 ppm of toluene under controlled conditions. The toluene exposures did not affect nasal mucus flow or lung function. At 100 ppm irritation was experienced in the eyes and in the nose. There was a significant deterioration in the perceived air quality and a significant increased odor level during all exposures to toluene. The test battery investigated visual perception, vigilance, psychomotor functions, and higher cortical functions and comprised five-choice, rotary pursuit, screw-plate, Landolt's rings, Bourdon Wiersma, multiplication, sentence comprehension, and word memory tests. In these eight tests measuring 20 parameters, no statistically significant effects of the toluene exposure occurred. For three tests (multiplication errors, Landolt's rings, and the screw plate test) there was a borderline significance (0.05% less than p less than 0.10%). The subjects felt that the tests were more difficult and strenuous during the 100-ppm exposure, for which headache, dizziness, and feeling of intoxication were significantly more often reported. The exposures to 10 and 40 ppm did not result in any adverse effects.

[PMID:6673099](#)

Andersen I et al; Scand J Work Environ Health 9 (5): 405-18 (1983)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/HUMAN EXPOSURE STUDIES/ Controlled exposure effects on volunteers were studied at toluene concentrations of 40, 60, or 100 ppm. The exposed individuals experienced ocular and respiratory irritation along with a perceived deterioration of air quality, enhanced odor, headache, and dizziness at 100 ppm. Also at exposures of 100 ppm psychologic measurements indicated decrements in vigilance, visual perception, motor performance, and ability to carry out functions.

Sullivan, J.B., Krieger G.R. (eds). Clinical Environmental Health and Toxic Exposures. Second edition. Lippincott Williams and Wilkins, Philadelphia, Pennsylvania 1999., p. 1148

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/HUMAN EXPOSURE STUDIES/ Volunteers exposed to 100 ppm (377 mg/cu m) toluene for 6 hr/day for four days suffered from subjective complaints of headache, dizziness and a sensation of intoxication. In subjects exposed to 750 mg/cu m for 8 hr, fatigue, muscular weakness, confusion, impaired coordination, enlarged pupils and accommodation disturbances were experienced; at about 3000 mg/cu m, severe fatigue, pronounced nausea, mental confusion, considerable incoordination with staggering gait and strongly affected pupillary light reflexes were observed. After exposure at the high level, muscular fatigue, nervousness and insomnia lasted for several days. Heavy accidental exposure leads to coma.

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 101 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Human Toxicity Excerpts (Complete) data for TOLUENE (66 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1.23 Non-Human Toxicity Excerpts



/LABORATORY ANIMALS: Acute Exposure/ Toluene is a psychoactive chemical found in many household products including adhesives and thinners. Inhalation of these vapors can cause euphoria and impairments in motor control and neurological functioning. Misuse and abuse of toluene is most common in children, which may in part be due to an age-dependent neurobehavioral sensitivity to toluene. Here we assessed the effects of acute binge-like toluene inhalations (15 or 30 min; ~5,000 ppm) on tasks that examine locomotion, exploration, balance, gait, and neurological functioning for adolescent (1 month), young adult (2-3 months), adult (5-6 months), and older adult (10-12 months) rats. Both motor and neurological functions were impaired following acute toluene inhalation at all ages. However, only the duration

to recover from deficits in motor functions differed among age groups, with adolescent and young adult rats requiring notably longer recovery times than older rats. Our results are suggestive of an age-dependent vulnerability to the intoxicating effects of toluene.

[PMID:23765908](#)

Samuel-Herter SR et al; Dev Psychobiol 56 (4): 657-73 (2014)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/LABORATORY ANIMALS: Acute Exposure/ Toluene is an organic solvent that is used in various industrial applications. Despite its usefulness, toluene has toxic effects on the brain and is a substance that is commonly abused. Toluene causes behavioral and functional abnormalities such as decreased memory capacity, cognitive impairment, and depression-like symptoms. However, the target sites and toxic mechanisms of inhaled toluene in the brain are poorly understood. In this study, we subjected Sprague-Dawley (SD) rats to acute high-level toluene exposure (7000 ppm) to investigate its neuronal toxicity, and in particular, its effect on neurogenesis in the hippocampus. In order to assay the effects of inhaled toluene on hippocampal neurogenesis, we measured the levels of neurogenesis markers Ki-67 and doublecortin (DCX) in the hippocampus 1, 2, 5, and 8 days after cessation of toluene exposure. In addition to assaying clinical signs, body weight, and bronchoalveolar lavage fluid, the liver, lungs, and kidneys were subjected to histopathological examination to investigate the toxic effects of high-level toluene exposure. Although abnormal neurological signs were observed after toluene exposure, these disappeared within 24 hr and no toluene-related toxicological effects were observed in the liver, lungs, or kidneys. The animals exposed to toluene showed significantly decreased hippocampal neurogenesis, which persisted until the 8th and final day of measurement. Thus, acute high-level toluene exposure inhibited hippocampal neurogenesis and produced transient abnormal neurological signs, but did not produce toxicity in the other organs studied.

[PMID:26475279](#)

Yoon JH et al; Toxicol Ind Health pii: 0748233715599087 (2015) (Epub ahead of print)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/LABORATORY ANIMALS: Acute Exposure/ Differential susceptibility to environmental exposures across life stages is an area of toxicology about which little is known. We examined the effects of toluene on transcriptomic changes and oxidative stress (OS) parameters (e.g., NQO1 and GPX) in the rat brain at different life stages to elucidate key molecular pathways responsible for toluene-induced neurotoxicity, as well as possible age-related interactions. Changes in assessed end points following acute oral toluene (0, 0.65, and 1.0 g/kg) were examined 4 h after exposure in hippocampi of Brown Norway Rats at 4, 12, and 24 months of age. Genomic data were analyzed by two-way ANOVA to identify the effects of age,



toluene, and interactions between the two factors. Analysis by one-way ANOVA identified 183 genes whose expression changed /greater than or equal to/ 1.25-fold with age. The majority of the genes were upregulated between life stages (> 79%). Similar analysis for toluene-related genes found only two sequences to vary significantly with dose. Fifty-six genes were identified to have expression changes due to an age-toluene interaction. Expression of genes with roles in immune response, cytoskeleton, protein, and energy metabolism was changed with advancing life stage, indicating changes in basic cellular homeostasis. Toluene affected similar cell functions, enhancing the effects of aging. OS parameters also indicated age-related changes in response mechanisms, evidence of toluene damage, and supported an age-toluene interaction. The data indicate that life stage can alter the toxicity of acute toluene exposure in various and complex ways, highlighting the need for further investigation into the role of aging in susceptibility.

[PMID:22166486](#)

Royland JE et al; Toxicol Sci 126 (1): 193-212 (2012)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

/LABORATORY ANIMALS: Acute Exposure/ When 0.25, 0.5, or 2.0 mL toluene were applied to 0.7% of the total body surface of guinea pigs (and held in contact by a cover glass), none of the animals died, but reduced body-weight gain occurred.

American Conference of Governmental Industrial Hygienists. Documentation of the TLVs and BEIs with Other World Wide Occupational Exposure Values. 7th Ed. CD-ROM Cincinnati, OH 45240-1634 2013., p. 2

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

For more Non-Human Toxicity Excerpts (Complete) data for TOLUENE (57 total), please visit the [HSDB record page](#).

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1.24 Human Toxicity Values



Ingestion of approximately 60 mL (625 mg/kg) of toluene proved fatal for a white male mental patient.

Ameno K et al; Forensic Sci Int 41: 255-60 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Lethal /blood/ levels 1.0 mg%; 10.0 ug/ml

Winek, C.L. Drug and Chemical Blood-Level Data 1985. Pittsburgh, PA: Allied Fischer Scientific, 1985.



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▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.1.25 Non-Human Toxicity Values



LD50 Rat oral 2.6 to 7.5 g/kg

DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Gavage Studies) p.16 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

LD50 Rabbit dermal 14.1 mL/kg

DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Gavage Studies) p.16 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

LD50 Rat (female) ip 1.64 g/kg

DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Inhalation Studies) p.16 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



[View More...](#)

13.1.26 Ongoing Test Status



EPA has released the Interactive Chemical Safety for Sustainability (iCSS) Dashboard. The iCSS Dashboard provides an interactive tool to explore rapid, automated (or in vitro high-throughput) chemical screening data generated by the Toxicity Forecaster (ToxCast) project and the federal Toxicity Testing in the 21st century (Tox21) collaboration. /The title compound was tested by ToxCast and/or Tox21 assays/[USEPA; ICSS Dashboard Application; Available from, as of December 17, 2015: <http://actor.epa.gov/dashboard/>]

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The following link will take the user to the National Toxicology Program (NTP) Testing Status of Agents page for toluene, which displays the studies performed for this chemical regarding Short-Term Toxicity, Long-Term Toxicity, Special Studies, Genetic Toxicology, and Organ Systems Toxicity. Clicking on a subject heading will provide more in-depth information about how such studies are conducted.

[Available from, as of February 16, 2016:

<http://ntp.niehs.nih.gov/testing/status/agents/ts-10009-v.html>]

13.1.27 National Toxicology Program Studies



Toluene did not induce gene mutations in *Salmonella typhimurium* strain TA98, TA100, TA1535, or TA1537 with or without exogenous metabolic activation. In the mouse lymphoma assay, toluene gave an equivocal response with and without exogenous metabolic activation. Toluene did not induce sister chromatid exchanges or chromosomal aberrations in Chinese hamster ovary cells in the presence or absence of exogenous metabolic activation.

DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Inhalation Studies) p.4 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826

Long-term studies were conducted by exposing groups of 60 rats /F344/N/ of each sex to 0, 600, or 1,200 ppm toluene by inhalation, 6.5 hours per day, 5 days per week. Groups of 60 /B6C3F1/ mice of each sex were exposed at 0, 120, 600, or 1,200 ppm on the same schedule. ... Animals were exposed to toluene for 103 weeks. Nephropathy was seen in almost all rats, and the severity was somewhat increased in exposed rats. A rare renal tubular cell carcinoma in a female rat and an equally uncommon sarcoma of the kidney in another female rat were seen in the 1,200 ppm exposure group. Erosion of the olfactory epithelium and degeneration of the respiratory epithelium were increased in exposed rats. Inflammation of the nasal mucosa and metaplasia of the olfactory epithelium were increased in exposed female rats. A rare squamous cell carcinoma of the nasal mucosa was seen in one female rat at 1,200 ppm. A squamous cell papilloma of the forestomach was observed in one female rat at 1,200 ppm, and a squamous cell carcinoma was observed in a second female rat at 1,200 ppm. No chemically related neoplasms were found in male rats, and the one nasal, two kidney, and two forestomach neoplasms observed in female rats were considered not to be associated with inhalation exposure to toluene. For mice, no biological important increases were observed for any nonneoplastic or neoplastic lesions.

DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Inhalation Studies) p.4 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826

13.1.28 TSCA Test Submissions



Neurotoxicity was determined in groups of rats (4 male and 4 female, strain not reported) exposed by inhalation to 0,100, or 1500 ppm toluene (purity not reported) 6 hrs/day, 5 days/week for periods up to 27 weeks. Histological sections of selected areas of the brainstem were made for the upper medulla oblongata (including dorsal and ventral cochlear and vestibular nuclei), lower metencephalon (including superior olivary nuclei, trapezoid body and ventral cochlear nuclei), upper metencephalon (including the lateral lemniscus, superior olivary nuclei, cochlear and vestibular nuclei, and inferior colliculus) and the mesencephalon-diencephalon junction (including the medial geniculate). The investigators reported that the "vast majority" of sections from animals exposed to toluene were indistinguishable from controls. Shrunken and darkly stained neurons were observed in the corpus trapezoid of one animal exposed to 100 ppm and another exposed to 1500 ppm toluene; these were present in only one section and not in sufficient quantity to be considered a positive response by the investigators. Statistical analysis of the results was not reported.

American Petroleum Inst.; Effects of Toluene Exposure on Auditory Pathways, Final Report. (1979), EPA Document No. 40-8450019, Fiche No. OTS0507495

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Chronic toxicity was evaluated in male and female Sprague Dawley rats (15/sex/group) exposed to toluene via inhalation at 0, 100 and 1500 ppm for 6 hrs/day, 5 days/week for 26 weeks. There were significant increases in the hematocrit and hemoglobin levels in females at 1500 ppm in the 13th week. There were significant differences in females at week 26 in the following: decreased mean blood clotting time and increased mean serum glutamic pyruvic transaminase at 100 ppm level, and decreases in [glucose](#) levels at 1500 ppm. There were no significant differences between treated and control animals in urinalysis.

American Petroleum Institute; 26 Week Inhalation Toxicity Study in the Rat (1980), EPA Document No. FYI-AX-1081-0136, Fiche No. 0136-0

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Teratogenicity was evaluated in mated female CRL:COBS CD (SD) BR rats (27/group) exposed to toluene by inhalation at nominal concentrations of 0, 100 or 400 ppm on gestation days (GD) 6-15 for 6 hrs/day. The adult female rats were sacrificed on GD 20 and examined. There were no significant differences observed between treated and control animals in the following: maternal mortality, body weights, food consumption, examination of tissues and organs at necropsy (except an insignificant number of observations of mottled lungs in 4 high-dose group rats), pregnancy rate, live litters, implantation sites, resorptions, litters with resorptions, dead pups, litters with dead pups, live pups/implantation site, mean live litter size, average pup weights, fetal sex ratio, examination of soft tissues of the head, thoracic and visceral organs, and skeletal abnormalities.

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

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13.1.29 Populations at Special Risk



Preclude individuals from exposure to toluene who have central nervous system or liver diseases.

ITII. Toxic and Hazardous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1988., p. 526

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



13.2 Ecological Information



13.2.1 Ecotoxicity Values



EC50; Species: *Scenedesmus subspicatus* (Green Algae) Exponential Growth Phase; Conditions: freshwater, static, 24 °C, pH 8.0-9.3; Concentration: 160000 ug/L for 48 hr; Effect: population, decreased biomass /formulation/

Kuhn R, Pattard M; Water Res 24 (1): 31-38 (1990) as cited in the ECOTOX database. Available from, as of February 15, 2016

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

EC50; Species: *Scenedesmus subspicatus* (Green Algae) Exponential Growth Phase; Conditions: freshwater, static, 24 °C, pH 8.0-9.3; Concentration: 125000 ug/L for 48 hr; Effect: population changes, general /formulation/

Kuhn R, Pattard M; Water Res 24 (1): 31-38 (1990) as cited in the ECOTOX database. Available from, as of February 15, 2016

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

EC50; Species: *Pseudokirchneriella subcapitata* (Green Algae) Exponential Growth Phase; Conditions: freshwater, static; Concentration: 9400 ug/L for 8 days; Effect: growth, general /formulation/

Herman DC et al; Aquat Toxicol 18 (2): 87-100 (1990) as cited in the ECOTOX database. Available from, as of February 15, 2016

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

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13.2.2 Ecotoxicity Excerpts



/PLANTS/ The influence of toluene pollution on the chemical properties and swelling coefficient of root cell walls in alfalfa (*Medicago sativa* L.) was investigated. Two sets of alfalfa seedlings were selected and one set was treated with 450 mg/L toluene in the nutrient solution under hydroponic culture. Thirty days after treatment with toluene, alfalfa plants were harvested and the root cell walls were isolated. Fourier-transform infrared (FTIR) spectroscopy was carried out for the characterization of the root cell walls composition. The cation exchange capacity (CEC) and the swelling coefficient of the root cell walls (K_{cw}) were estimated at various pH values. The toluene contamination significantly reduced the mass of the cell wall material in the alfalfa roots. According to the FTIR spectra, the toluene pollution can change the alfalfa root cell wall properties by reducing the cell wall functional groups. These functional groups are probably related to the proteins and polysaccharides in the cell wall. Also, toluene pollution strongly reduced CEC and K_{cw} of the root cell walls. The results show that the decrease in the active sites of adsorption on the root cell walls as a response to toluene pollution can affect the [water](#) flow rate and the mineral nutrients uptake by roots.



[PMID:26728292](#)

Sharifi M et al; Environ Sci Pollut Res Int (2016) (Epub ahead of print)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.3 US EPA Regional Screening Levels for Chemical Contaminants



Resident Soil (mg/kg)	4.90e+03
Industrial Soil (mg/kg)	4.70e+04
Resident Air (ug/m ³)	5.20e+03
Industrial Air (ug/m ³)	2.20e+04
Tapwater (ug/L)	1.10e+03
MCL (ug/L)	1.00e+03
Risk-based SSL (mg/kg)	7.60e-01
MCL-based SSL (mg/kg)	6.90e-01
Chronic Oral Reference Dose (mg/kg-day)	8.00e-02

Chronic Inhalation Reference Concentration (mg/m ³)	5.00e+00
Volatile	Volatile
Mutagen	Mutagen
Fraction of Contaminant Absorbed in Gastrointestinal Tract	1
Soil Saturation Concentration (mg/kg)	8.18e+02

▶ [EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites](#)

13.2.4 US EPA Regional Removal Management Levels for Chemical Contaminants



Resident Soil (mg/kg)	1.50e+04
Industrial Soil (mg/kg)	1.40e+05
Resident Air (ug/m ³)	1.60e+04
Industrial Air (ug/m ³)	6.60e+04
Tapwater (ug/L)	3.30e+03
MCL (ug/L)	1.00e+03
Chronic Oral Reference Dose (mg/kg-day)	8.00e-02
Chronic Inhalation Reference Concentration (mg/m ³)	5.00e+00
Volatile	Volatile
Mutagen	Mutagen
Fraction of Contaminant Absorbed in Gastrointestinal Tract	1
Soil Saturation Concentration (mg/kg)	8.18e+02

▶ [EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites](#)

13.2.5 ICSC Environmental Data



The substance is toxic to aquatic organisms. The substance may cause long-term effects in the aquatic environment. It is strongly advised not to let the chemical enter into the environment.

- ▶ [ILO-WHO International Chemical Safety Cards \(ICSCs\)](#)

13.2.6 Environmental Fate / Exposure Summary



Toluene's production and use as an intermediate in the production of [benzoic acid](#), [benzaldehyde](#), explosives and many other organic compounds may result in toluene's release to the environment through various waste streams. Toluene is released into the atmosphere principally from the volatilization of petroleum fuels and toluene-based solvents and thinners and from motor vehicle exhaust. Toluene has been detected in emissions from volcanos, forest fires and crude oil and naturally occurs in some flora. If released to air, a vapor pressure of 28.4 mm Hg at 25 °C indicates toluene will exist solely as a vapor in the atmosphere. Vapor-phase toluene will be degraded in the atmosphere by reaction with photochemically-produced [hydroxyl](#) radicals; the half-life for this reaction in air is estimated to be 2 days. Toluene may also be degraded in the atmosphere by reaction with [nitrate](#) radicals and [ozone](#) molecules, but these reactions are too slow to be environmentally important. Toluene does not absorb light at wavelengths >290 nm and, therefore, is not expected to be susceptible to direct photolysis by sunlight. If released to soil, toluene is expected to have high to moderate mobility based upon Koc values in the range of 37-178. Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 6.64×10^{-3} atm-cu m/mole. Toluene may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation is expected to occur rapidly in soil surfaces, with half-lives in the range of several hours to 71 days. If released into [water](#), toluene is not expected to adsorb to suspended solids and sediment based upon a Koc of 166 measured in lake sediment. Half-lives of 4 and 56 days in aerobic and anaerobic [water](#), respectively, indicate that biodegradation is an important environmental fate process in [water](#). Volatilization from [water](#) surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hour and 4 days, respectively. Measured BCF values of 13 and 90 in fish suggest bioconcentration in aquatic organisms is low to moderate. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions (pH 5 to 9). Occupational exposure to toluene may occur through inhalation and dermal contact with this compound at workplaces where toluene is produced or used, particularly as a solvent or in



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gasoline. Monitoring data indicate that the general population may be exposed to toluene via inhalation of ambient air, cigarette smoke, ingestion of food and drinking [water](#), and dermal contact with consumer products, such as gasoline, containing toluene. (SRC)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.7 Natural Pollution Sources



Toluene has been detected in emissions from volcanos, forest fires and crude oil(1). It also occurs naturally in some plants(2).

(1) Graedel TE; *Chemical Compounds in the Atmosphere*, New York, NY: Academic Press p. 108 (1978)

(2) USDA; *Dr. Duke's Phytochemical and Ethnobotanical Databases. Codeine*. Washington, DC: US Dept Agric, Agric Res Service. Available from, as of Mar 4, 2016: <https://phytochem.nal.usda.gov/phytochem/search>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene occurs in nature in ... natural gas deposits ...

IARC. *Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at: <https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47 82 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.8 Artificial Pollution Sources



Toluene's production and use as an intermediate in the production of [benzoic acid](#), [benzaldehyde](#), explosives and many other organic compounds; as a solvent for paints, lacquers, gums, and resins; as a thinner for inks, perfumes; in the extraction of various principles from plants; and as gasoline additive(1) may result in its release to the environment through various waste streams(SRC). Toluene is released into the atmosphere principally from the volatilization of petroleum fuels and toluene-based solvents and thinners and from motor vehicle exhaust(2,3).

(1) O'Neil MJ, ed; *The Merck Index. 15th ed*. Cambridge, UK: The Royal Society of Chemistry. p. 1765 (2013)

(2) Graedel TE; *Chemical Compounds in the Atmosphere*. New York, NY: Academic Press p. 108 (1978)

(3) Walker P; *Air Pollution Assessment of Toluene*. TR-7215 Mitre Corp, McLean VA, pp. 1-22, 46-92 (1976)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



Toluene is a major constituent (20-60 ug/cigarette) of the gas phase of the mainstream smoke of unfiltered cigarettes. /From table/

Rom, W.N. (ed.). *Environmental and Occupational Medicine*. 2nd ed. Boston, MA: Little, Brown and Company, 1992., p. 1212

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.9 Environmental Fate



TERRESTRIAL FATE: Based on a classification scheme(1), Koc values of 37-178 measured in soil(2,3) indicate that toluene is expected to have high to moderate mobility in soil(SRC). Volatilization of toluene from moist soil surfaces is expected to be an important fate process(SRC) given a Henry's Law constant of 6.64×10^{-3} atm-cu m/mole(4). Toluene is expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 28.4 mm Hg at 25 °C(5). Complete biodegradation of toluene was observed in lab microcosm tests during a 40 hour incubation period using soils previously exposed to toluene(6). The biodegradation half-life in various soils was reported as several hours to 71 days(7). These tests suggest that biodegradation is an important environmental fate process in soil(SRC).



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(1) Swann RL et al; *Res Rev* 85: 17-28 (1983)

(2) Wilson JT et al; *J Environ Qual* 10: 501-6 (1981)

(3) Nathwani JS, Phillips CR; *Chemosphere* 6: 157-62 (1977)

(4) Mackay D et al; *Environ Sci Technol* 13: 333-36 (1979)

(5) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals Data Compilation* Washington, DC: Taylor and Francis (1989)

(6) Allen-King RM et al; *Environ Toxicol Chem* 13: 693-705 (1994)

(7) Aronson D et al; *Aerobic biodegradation of organic chemicals in environmental media*. Washington, DC: US EPA (1999). Available from, as of Mar 3, 2016:

<https://www3.epa.gov/epawaste/hazard/wastetypes/wasteid/hwirwste/pdf/risk/reports/s0549.pdf>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

AQUATIC FATE: Based on a classification scheme(1), a Koc value of 166 measured in lake sediment(2) indicates that toluene is not expected to adsorb to suspended solids and sediment(SRC). Volatilization from water surfaces is expected(3) based upon a Henry's Law constant of 6.64×10^{-3} atm-cu m/mole(4). Using this Henry's Law constant and an estimation method(3), volatilization half-lives for a model river and model lake are 1 hour and 4 days, respectively(SRC). According to a classification scheme(5), BCF values of 13(6) and 90(7) measured in fish suggest the potential for bioconcentration in aquatic organisms is low to moderate(SRC). The half-life of toluene in aerobic and anaerobic water was reported as 4 and 56 days(8),

respectively, suggesting that biodegradation is an important environmental fate process in [water](#)(SRC).

(1) Swann RL et al; *Res Rev* 85: 17-28 (1983)

(2) Kan AT et al; *Environ Sci Technol* 32: 892-902 (1998)

(3) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods*. Washington, DC: Amer Chem Soc pp. 15-1 to 15-29 (1990)

(4) Mackay D et al; *Environ Sci Technol* 13: 333-36 (1979)

(5) Franke C et al; *Chemosphere* 29: 1501-14 (1994)

(6) Ogata M, Miyake Y; *Water Res* 12: 1041-4 (1978)

(7) Freitag D et al; *Chemosphere* 14: 1589-1616 (1985)

(8) Capel PD, Larson SL; *Chemosphere* 30: 1097-1107 (1995)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), toluene, which has a vapor pressure of 28.4 mm Hg at 25 °C(2), is expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase toluene is degraded in the atmosphere by reaction with photochemically-produced [hydroxyl](#) radicals, [nitrate](#) radicals and [ozone](#) molecules(SRC). The half-life for the reaction with [hydroxyl](#) radicals is estimated to be 2 days(SRC), calculated from its rate constant of 5.93×10^{-12} cu cm/molecule-sec at 25 °C(3). The half-life for the nighttime reaction with [nitrate](#) radicals is estimated as 491 days(SRC) calculated from its rate constant of 6.8×10^{-17} cu cm/molecule-sec at 25 °C(4). The half-life for the reaction with [ozone](#) is estimated as 27,950 days(SRC) calculated from its rate constant of 4.1×10^{-22} cu cm/molecule-sec at 25 °C(4). Toluene does not absorb light at wavelengths >290 nm(5) and, therefore, is not expected to be susceptible to direct photolysis by sunlight(SRC).

(1) Bidleman TF; *Environ Sci Technol* 22: 361-367 (1988)

(2) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals Data Compilation* Washington, DC: Taylor and Francis (1989)

(3) Atkinson R, Arey J; *Chem Rev* 103: 4605-38 (2003)

(4) Atkinson R; *J Phys Chem Ref Data Monograph* 2 (1994)

(5) NIST Standard Reference Database No. 69, Sept 2013 Release. Washington, DC: US Sec Commerce. Available from, as of Mar 4, 2016: <https://webbook.nist.gov>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.10 Environmental Biodegradation



AEROBIC: Toluene is readily degradable in a variety of standard biodegradability tests using sewage seed or sludge inoculums(1-7). Degradation has been observed in several die-away tests using seawater or estuarine [water](#)(9-12). The degradation

rate is much faster in systems which have been contaminated by oil(9,10). Complete degradation has been observed in 4 days and 22 days in a marine mesocosm with summer and spring conditions, respectively(12), and 10 days in a 1% gas oil mixture in a North Sea coast **water** inoculum(8). A 90 day half-life in uncontaminated estuarine **water** was reduced to 30 days in oil-polluted **water**(10). The half-life in **water** collected near Port Valdez, Alaska was 12 days(9). 1.5 mM and 3 mM Ring-labeled toluene added to a methanogenic inoculum originally enriched from sewage sludge and incubated at 35 °C for 60 days resulted in 3.6 and 4.5% ¹⁴C final activity respectively(13). Toluene, present at 100 mg/L, reached 123% of its theoretical BOD in 2 weeks using an activated sludge inoculum at 30 mg/L in the Japanese MITI test(14).

(1) Tabak HH et al; *J Water Pollut Control Fed* 53: 1503-8 (1981)

(2) Davis EM et al; *Water Res* 15: 1125-7 (1981)

(3) Bridie AL et al; *Water Res* 13: 627-30 (1979)

(4) Kawasaki M; *Ecotox Environ Safety* 4: 444-54 (1980)

(5) Malaney GW, McKinney RE; *Water Sewage Works* 113: 302-9 (1966)

(6) Price KS et al; *J Water Pollut Control Fed* 46: 63-77 (1974)

(7) Matsui S et al; *Prog Water Technol* 7: 645-59 (1975)

(8) Van der Linden AC; *Dev Biodegrad Hydrocarbons* 1: 165-200 (1978)

(9) Button DK et al; *Appl Environ Microbiol* 42: 708-19 (1981)

(10) Lee RF; *1977 Oil Spill Conf Amer Petrol Inst* p 611-6 (1977)

(11) Reichardt PB et al; *Environ Sci Technol* 15: 75-9 (1981)

(12) Wakeham SG et al; *Environ Sci Technol* 17: 611-7 (1983)

(13) Grbic-Galic D, Vogel TM; *Appl Environ Microbiol* 53: 254-60 (1987)

(14) NITE; *Chemical Risk Information Platform (CHRIP). Biodegradation and Bioconcentration*. Tokyo, Japan: Natl Inst Tech Eval. Available from, as of January 25, 2016: <https://www.safe.nite.go.jp/english/db.html>

► **Hazardous Substances Data Bank (HSDB)**

AEROBIC: Toluene completely degraded in groundwater in 8 days including a lag of 3-4 days while microbial populations became acclimated(1). Other investigators found that only 1-2% of toluene degraded in the subsurface environment(2) and >90% degraded in 4 weeks in soil cores at various depths both above and below the **water** table(3,5). Microbial attack proceeds via immediate hydroxylation of the **benzene** ring followed by ring-cleavage or oxidation of the side chain followed by hydroxylation and ring-cleavage(4).

(1) Kappeler T, Wuhrmann K; *Water Res* 12: 327-33 (1978)

(2) Wilson JT et al; *Devel Indust Microbiol* 24: 225-33 (1983)

(3) McNabb JF et al; *81st Ann Mtg Amer Soc Microbiology* p.213 (1981)

(4) Fewson CA; *FEMS Symp 12 (Microb Deg Xenobiotics Recalcitrant Cmpds):* 141-79 (1981)



(5) Wilson JT et al; *Ground Water* 21: 134-42 (1983)

▶ Hazardous Substances Data Bank (HSDB)

Complete biodegradation of toluene was observed in lab microcosm tests during a 40 hour incubation period using soils previously exposed to toluene(1). Toluene was rapidly degraded in soil column experiments using acclimated soil at a rate of 8-35 mg/kg-day, and the rate followed zero-order kinetics(2). First-order degradation rate constants of 0.0005 to 0.0063 day⁻¹ were measured for toluene in a gasoline-contaminated aquifer zone(3). These rate constants correspond to half-lives of 100-1,386 days(3). A first-order biodegradation rate constant of 0.045 day⁻¹ was reported for toluene in an anaerobic petroleum contaminated aquifer, corresponding to a biodegradation half-life of 15 days(4). Toluene was rapidly biodegraded by indigenous mixed cultures in sandy aquifer material and pure cultures isolated from the aquifer(5). The zero-order rate constant for the aquifer material was 23 mg/L-day and had a lag period of 2 days(5). The half-life of toluene in aerobic and anaerobic water was reported as 4 and 56 days, respectively(6). The biodegradation half-life in various soils was reported as several hours to 71 days(7).

(1) Allen-King RM et al; *Environ Toxicol Chem* 13: 693-705 (1994)

(2) Allen-King RM et al; *J Environ Qual* 25: 287-95 (1996)

(3) Borden RC et al; *Water Resour Res* 33: 1105-15 (1997)

(4) Borden RC et al; *Anaerobic Biodegradation of BTEX in Aquifer Material USEPA/600/S-97/003. National Risk Management Laboratory, Ada, OK. pp. 9 (1997)*

(5) Alvarez PJJ, Vogel TM; *Appl Environ Microbiol* 57: 2981-85 (1991)

(6) Capel PD, Larson SL; *Chemosphere* 30: 1097-1107 (1995)

(7) Aronson D et al; *Aerobic biodegradation of organic chemicals in environmental media. Washington, DC: US EPA (1999). Available from, as of Mar 3, 2016:*

<https://www3.epa.gov/epawaste/hazard/wastetypes/wasteid/hwirwste/pdf/risk/reports/s0549.pdf>

▶ Hazardous Substances Data Bank (HSDB)



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13.2.11 Environmental Abiotic Degradation



The rate constant for the vapor-phase reaction of toluene with photochemically-produced hydroxyl radicals has been measured as 5.96×10^{-12} cu cm/molecule-sec at 25 °C(1). This corresponds to an atmospheric half-life of about 2 days at an atmospheric concentration of 5×10^5 hydroxyl radicals per cu cm(2). The rate constant for the vapor-phase reaction of toluene with nitrate radicals has been measured as 6.8×10^{-17} cu cm/molecule-sec at 25 °C(3). This corresponds to an atmospheric half-life of about 491 days at an atmospheric concentration of 2.4×10^8 nitrate radicals per cu cm(4). The rate constant for the vapor-phase reaction of toluene with ozone has been measured as 4.1×10^{-22} cu cm/molecule-

sec at 25 °C(3). This corresponds to an atmospheric half-life of about 27,950 days at an atmospheric concentration of 7×10^{11} ozone molecules per cu cm(5). In a study of the effect of nitrite concentration on the formation of 3-nitrotoluene from the gas phase reaction of toluene with hydroxyl radicals, it was reported that at a NO₂ mixing ratio of approximately 3.3 ppmV, the OH-toluene adduct reactions with oxygen and nitrite are of equal importance(6). There was a decrease in the yield of 3-nitrotoluene with decreasing NO₂ concentrations, indicating that the hydroxyl radical reaction with toluene in the atmosphere leading to the formation of 3-nitrotoluene is dependent on the NO₂ concentration(6). Toluene is not expected to undergo hydrolysis in the environment due to the lack of hydrolyzable functional groups(7). The compound does not absorb light at wavelengths >290 nm(8) and, therefore, is not expected to be susceptible to direct photolysis by sunlight(SRC).

(1) Atkinson R, Arey J; *Chem Rev* 103: 4605-38 (2003)

(2) Meylan WM, Howard PH; *Chemosphere* 26: 2293-99 (1993)

(3) Atkinson R; *J Phys Chem Ref Data Monograph* 2 (1994)

(4) Atkinson R et al; *Atmos Environ* 24: 2647-54 (1990)

(5) Atkinson R, Carter WPL; *Chem Rev* 84: 437-70 (1984)

(6) Nishino N et al; *Environ Sci Technol* 42: 9203-9209 (2008)

(7) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods*. Washington, DC: Amer Chem Soc pp. 7-4, 7-5 (1990)

(8) NIST; *NIST Chemistry WebBook*. Toluene (108-88-3). NIST Standard Reference Database No. 69, Sept 2013 Release. Washington, DC: US Sec Commerce. Available from, as of Mar 4, 2016: <https://webbook.nist.gov>

► Hazardous Substances Data Bank (HSDB)



13.2.12 Environmental Bioconcentration



The BCF of toluene in eels (*Anguilla japonica*) was reported as 13(1) and the BCF in golden ide (*Leuciscus idus melanotus*) was reported as 90(2). According to a classification scheme(3), these BCF values suggest the potential for bioconcentration in aquatic organisms is low to moderate(SRC).

(1) Ogata M, Miyake Y; *Water Res* 12: 1041-4 (1978)

(2) Freitag D et al; *Chemosphere* 14: 1589-1616 (1985)

(3) Franke C et al; *Chemosphere* 29: 1501-14 (1994)

► Hazardous Substances Data Bank (HSDB)

13.2.13 Soil Adsorption / Mobility



The Koc of toluene was reported as 178 in a sandy soil(1) and as 37 (Wendover silty loam), 160 (Grimsby silt loam), 160 (Vaudreuil sandy loam) and 46 (sandy soil)(2). The Koc of toluene in lake sediment was measured as 166(3). According to a classification scheme(4), these measured Koc values suggest that toluene is expected to have high to moderate mobility in soil.

(1) Wilson JT et al; *J Environ Qual* 10: 501-6 (1981)

(2) Nathwani JS, Phillips CR; *Chemosphere* 6: 157-62 (1977)

(3) Kan AT et al; *Environ Sci Technol* 32: 892-902 (1998)

(4) Swann RL et al; *Res Rev* 85: 17-28 (1983)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

In association with clay minerals, toluene's adsorption is inversely proportional to the pH of the soil. Approximately 40-70% of toluene applied to the surface of sandy soils is volatilized.

IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work). Available at:

<https://monographs.iarc.fr/ENG/Classification/index.php>, p. V47: 90 (1989)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.14 Volatilization from Water / Soil



The Henry's Law constant for toluene is 6.64×10^{-3} atm-cu m/mole(1). This Henry's Law constant indicates that toluene is expected to volatilize from [water](#) surfaces(2). Based on this Henry's Law constant, the volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec)(2) is estimated as 2.9 hours(SRC). The volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec)(2) is estimated as 3.8 days(SRC). Toluene's Henry's Law constant indicates that volatilization from moist soil surfaces may occur(SRC). Toluene is expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 28.4 mm Hg(3). The air-[water](#) interface equilibrium partitioning coefficient for toluene, at a concentration of 0.47 mg/L, has been reported to be 0.223, 0.226, 0.273, and 0.336 at 26.9, 31.9, 36.9, and 41.9 °C, respectively(4). A first-order volatilization rate calculated for toluene from [water](#) using an inverse reactive simulation was reported as 6.62×10^{-6} /sec(5). The volatilization half-life of toluene from a [water](#) column of one meter depth was estimated to be 5.18 hours(6). Toluene was reported to have a disappearance half-life of <2 days due to volatilization in two different soil types, a Captina silt loam and a McLaurin sandy loam(7).

(1) Mackay D et al; *Environ Sci Technol* 13: 333-6 (1979)

(2) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods*. Washington, DC: Amer Chem Soc pp. 15-1 to 15-29 (1990)

(3) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals Data Compilation*. Washington, DC: Taylor and Francis (1989)

(4) Cheng W-H et al; *Atmos Environ* 37: 4807-4815 (2003)

(5) Keefe SH et al; *Environ Sci Technol* 38: 2209-2216 (2004)

(6) Mackay D, Leinonen PJ; *Environ Sci Technol* 9: 1178-80 (1975)

(7) Anderson TA et al; *J Environ Qual* 20:420-4 (1991)

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13.2.15 Environmental Water Concentrations

GROUNDWATER: Toluene was detected in groundwater near contaminated wells from gasoline storage tanks at concentrations of 0.55-6400 ppb(1,2) and groundwater underlying 2 rapid infiltration sites at 0.2 ppb(3). Groundwater under a gasification site 15 months after gasification contained toluene at 170-740 ppb(4). In a cluster well study under an old industrial site, mean levels of toluene in bedrock wells were 90 ppb while shallow and deep glacial wells were 10 ppb(5). Toluene was detected in 1.3% of the samples in the US Ground **Water** Supply Survey, 1982, at a maximum concentration of 2.9 ppb and a median concentration of 0.8 ppb(6).

(1) Burmaster DE; *Environ* 24: 6-13, 33-6 (1982)

(2) Tester DJ, Harker RJ; *Water Pollut Control* 80: 614-31 (1981)

(3) Hutchins SR et al; *Environ Toxicol Chem* 2: 195-216 (1983)

(4) Stuermer DH et al; *Environ Sci Technol* 16: 582-7 (1982)

(5) Rich CA; *Stud Environ Sci* 17(Qual Groundwater): 309-14 (1981)

(6) Coturvo JA; *Sci Total Environ* 47: 7-26 (1985)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene is detected in 28% of National Priority List (NPL) sites in groundwater. Average concentration: 5.18 ppm; Maximum concentration: 1100 ppm. /From table/

Sullivan, J.B. Jr., G.R. Krieger (eds.). Hazardous Materials Toxicology-Clinical Principles of Environmental Health. Baltimore, MD: Williams and Wilkins, 1992., p. 304

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

DRINKING WATER: Toluene was detected in 33% of the samples from 30 Canadian treatment facilities at an average concentration of 2 ppb (14 ppb max) in summer months and in 53% of the samples at an average concentration of <1 ppb (13 ppb max), during winter(1). Toluene was detected at concentrations of 0-2 ppb in drinking water of cities supplied by the Great Lakes(2). Toluene was detected in 14% of the samples of drinking water in the US at concentrations of less than 1 part per

trillion(3). In a federal survey of finished drinking water from groundwater sources toluene was detected in less than 5% of the samples(4). Toluene was detected in 3 New Orleans area water supplies at 0-10 ppb(5). Toluene was identified, not quantified, in 60% of drinking water tested in the National Organics Reconnaissance Survey(6). The maximum concentration of toluene in tapwater derived from bank-filtered Rhine River water was 1 ppb(7). Toluene was detected in 3 contaminated drinking water wells in New Jersey at 55, 260, 6400 ppb whereas the highest concentration in drinking water from surface water sources was 6.1 ppb(8). Drinking water supplied from groundwater in England 210 m from a gasoline storage tank contained 0.15 ppb of toluene(9). In a 5-city survey in which the water supplies came from different types of sources with various sources of pollution, 2 contained toluene, one 0.1 ppb and the other 0.7 ppb(10). Toluene was detected in 20 of 182 bottled water samples at an average concentration of 6.92 ug/kg and a range of 0.5-63 ug/kg(11). Toluene was detected in 215 of 1,203 (17.9%) of well samples, generally at concentrations less than 1 ug/L, collected in a 2006 national assessment domestic wells in the U.S. sampled during 1985-2002(12).

(1) Otson R et al; *J Assoc Off Analyt Chem* 65: 1370-4 (1982)

(2) Williams DT et al; *Chemosphere* 11: 263-76 (1982)

(3) NAS; *The Alkyl Benzene USEPA Contract No. 68-02-4655* (1980)

(4) Dyksen JE, Hess AF III; *J Amer Water Works Assoc* 74: 394-403 (1982)

(5) Keith LH et al; pp. 329-73 in *Identification and analysis of organic pollutants in Water*, Keith LH, ed, Ann Arbor Sci Publ (1976)

(6) Bedding ND et al; *Sci Total Environ* 25: 143-67 (1982)

(7) Piet GJ, Morra CF; pp. 31-42 in *Artificial Groundwater Recharge (Water Res Eng Ser)* Huisman L, Olsthorn TN, eds, Pitman Publ (1983)

(8) Burmaster DE; *Environ* 24: 6-13, 33-6 (1982)

(9) Tester DJ, Harker RJ; *Water Pollut Control* 80: 614-31 (1981)

(10) Coleman WE et al; pp. 305-27 in *Analysis and identification of organic substances in water*. Keith L, ed, Ann Arbor, MI: Ann Arbor Sci (1976)

(11) Page RD et al; *J AOAC Int* 76: 26-31 (1993)

(12) Rowe BL et al; *Environ Health Perspect* 115(11): 1539-1546 (2007)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

SURFACE WATER: Toluene was detected in 31 of 204 sites at concentrations of 1-5 ppb in 14 heavily industrialized river basins in the US(1). Toluene was identified, not quantified, in various rivers(2-5). Toluene was detected in the Gulf of Mexico at 3-376 parts per trillion(6,7) and the Vineland Sound, MA at 10-54 parts per trillion(8). Toluene was detected in the Elbe River, Germany at concentrations of 30-243 ng/L(9).

(1) Ewing BB et al; *Monitoring to detect previously unrecognized pollutants in surface waters USEPA 560/6-77-015 (appendix USEPA 560/6-77-015a)* (1977)

(2) Sheldon LS, Hites RA; *Environ Sci Technol* 12: 1188-94 (1978)

(3) Goodley PC, Gordon M; *KY Acad Sci* 37: 11-5 (1976)

(4) Zuercher F, Giger W; *Vom Wasser* 47: 37-55 (1976)

(5) Zou H et al; *Wat Res* 30: 2003-2008 (1996)

(6) Sauer TC Jr; *Org Geochem* 3: 91-101 (1981)

(7) Sauer TC Jr et al; *Mar Chem* 7: 1-16 (1978)

(8) Gschwend PM et al; *Environ Sci Technol* 16: 31-8 (1982)

(9) Gotz R et al; *Chemosphere* 36: 2103-18 (1998)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

RAIN/SNOW/FOG: Toluene was detected in rain in west Los Angeles at 76 parts per trillion(1). Toluene was detected in 71.4% of the rain samples from 7 rain events in Portland, OR, Feb-Apr 1984, at concentrations of 40-220 parts per trillion(2). Snow/ice samples collected directly in-cloud at alpine mountain site, Jungfrauoch, Switzerland, in February and March 2006 during single snow events on four separate days contained mean toluene concentrations of 573, 651, 397, and 558 ng/L(3).

(1) Kawamura K, Kaplan IR; *Environ Sci Technol* 17: 497-501 (1983)

(2) Ligocki MP et al; *Atmos Environ* 19: 1609-17 (1985)

(3) Fries et al; *Sci Total Environ* 391: 269-277 (2008)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.16 Effluent Concentrations



Industries in which the mean effluent levels exceed 1000 ppb are: auto and other laundries, [iron](#) and steel manufacturing, gum and wood chemicals, pharmaceuticals, organic chemicals/plastics manufacturing, paint and ink formulation. The highest mean value is 52 ppm for pharmaceuticals and the highest maximum values are 230 and 260 ppm for pharmaceuticals and organic chemicals/plastics manufacturing(1). Toluene was detected in a plume from General Motors Paint Plant, Janesville, WI at 156 ppb(2). Auto exhaust contained toluene at concentrations of 196-718 mg/cu m(3).

(1) USEPA; *Treatability Manual p. I.9.10-1 to I.9.10-5 USEPA 600/2-82-001a* (1981)

(2) Sexton K, Westberg H; *Environ Sci Technol* 14: 329-32 (1980)

(3) Tsani-Bazaca E et al; *Environ Technol Lett* 2: 303-16 (1981)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

The study presents the measurement of carbonyl, BTEX, [ammonia](#), elemental/organic [carbon](#) (EC/OC) and greenhouse gas emissions from modern



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heavy-duty diesel and natural gas vehicles. Vehicles from different vocations, that included goods movement, refuse trucks and transit buses were tested on driving cycles representative of their duty cycle. The natural gas vehicle technologies included the stoichiometric engine platform equipped with a three-way catalyst and a diesel like dual-fuel high pressure direct injection technology equipped with a diesel particulate filter (DPF) and a selective catalytic reduction (SCR). The diesel vehicles were equipped with a DPF and SCR. Results of the study show that the BTEX emissions were below detection limits for both diesel and natural gas vehicles, while carbonyl emissions were observed during cold start and low temperature operations of the natural gas vehicles. Ammonia emissions of about 1 g/mi were observed from the stoichiometric natural gas vehicles equipped with TWC over all the driving cycles. The tailpipe GWP of the stoichiometric natural gas goods movement application was 7% lower than DPF and SCR equipped diesel. While, in the case of a refuse truck application the stoichiometric natural gas engine exhibited a 22% lower GWP than a diesel vehicle. Tailpipe methane emissions contribute to less than 6% of the total GHG emissions. IMPLICATIONS: Modern heavy-duty diesel and natural gas engines are equipped with multiple aftertreatment systems and complex control strategies aimed at meeting both the performance standards for the end user and meeting stringent USEPA emissions regulation. Compared to older technology diesel and natural gas engines, modern engine and aftertreatment technology have reduced unregulated emissions to levels close to detection limits. However, brief periods of inefficiencies related to low exhaust thermal energy has shown to increase both carbonyl and nitrous oxide emissions.

[PMID:26950051](#)

Thiruvengadam A et al; J Air Waste Manag Assoc 7 (e-pub ahead of print) (2016)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene was detected in landfill gas emissions at concentrations of 20,400 ppb, 34,907 ppb and 76,700 ppb(1). Toluene was detected in the gas emissions of 7 waste disposal sites in the UK at concentrations of 10-287 mg/cu m(2). Toluene was identified, not quantified, in the exhaust of a moped(3) and 4-stroke lawn mower(4). Toluene was detected in car exhaust under normal operating conditions at concentrations of 3.31-4.52 ppm and an average of 3.83 ppm(5). The mean emission rate of toluene is 89-453 mg/km, with the lowest emission rates occurring at higher driving speeds(5). Toluene was detected in the effluent of a hazardous waste incinerator in Germany at a concentration of 34 ug/cu m(6).

(1) *Brosseau J, Heitz M; Atmos Environ 28: 285-93 (1994)*

(2) *Allen MR et al; Environ Sci Technol 31: 1054-61 (1997)*

(3) *Ostermark U, Petersson G; Chemosphere 27: 1719-28 (1993)*

(4) *Gabele P; J air Waste Manage Assoc 47: 945-52 (1997)*

(5) *Baily JC et al; Atmos Environ 24A: 43-52 (1990)*

(6) Jay K, Stieglitz L; *Chemosphere* 30: 1249-60 (1995)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.17 Sediment / Soil Concentrations



SEDIMENT: Toluene was identified, not quantified in sediment from rivers near industrial facilities in the US(1,2). USEPA STORET DATABASE: Toluene was detected in 67 of 397 sediment samples at a median concentration of 5.0 ppb dry weight(3). Toluene was detected in 33% of the sediment samples from Lake Pontchartrain, LA at an average concentration of 0.7 ppb wet weight(4). Toluene was detected at concentrations of less than 0.1 ng/g to 1.2 ng/g in sediment from rivers near Niigata, Japan(5). Toluene was detected in sediment of the Passaic River, NJ at concentrations of 3-250 ug/kg(6).



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(1) Goodley PC, Gordon M; *KY Acad Sci* 37: 11-5 (1976)

(2) Steinheimer TR et al; *Anal Chim Acta* 129: 57-67 (1981)

(3) Staples CA et al; *Environ Toxicol Chem* 4: 131-42 (1985)

(4) Ferrario JB et al; *Bull Environ Contam Toxicol* 34: 246-55 (1985)

(5) Kawata K et al; *Bull Environ Contam Toxicol* 58: 893-900 (1997)

(6) Iannuzzi TJ et al; *Chemosphere* 34: 213-31 (1997)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Soil: Toluene gas was detected at concentrations ranging from 2951 to 9155, 3152 to 10,844, and 5514 to 13,452 ppbv in the cover soil collected from the Case Passerini landfill site in Italy at 5 locations at depths of 30, 50, and 70 cm, respectively(1).

(1) Tassi F et al; *Sci Total Environ* 407(15): 4513-4525 (2009)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.18 Atmospheric Concentrations



URBAN/SUBURBAN: In a survey of 3,195 samples obtained from urban areas in the US, toluene was detected at concentrations of 0-85 ppb (11 ppb median)(1). Average toluene concentrations in US cities range from 0.8-37 ppb with maximum values ranging from 6.5-1,110 ppb(2-9). Daily variations in concentrations and ratios of toluene to [benzene](#) indicate that auto traffic is the most common source of atmospheric toluene(10,11,12). Toluene was detected in Middlesbrough, UK and London, UK at 1.55 and 7.475 ppb, respectively(13). The average concentration of toluene inside buses and cars in Taipei, Taiwan was reported as 367 and 599 ug/cu m(14). Toluene was detected in various streets in Europe at concentrations of 87-127

ug/cu m(15). The concentration of toluene inside automobiles in Paris, France was 178-258 ug/cu m(16). Toluene was measured at mean concentrations of 2.0 and 1.3 wt% in summer and winter, respectively, in headspace vapor, and 8.2 and 7.6 wt% in summer and winter, respectively, in liquid gasoline during a seasonal variation study of gasoline related volatile organic compound emission sources in Riverside, CA in 2005(17).

(1) Brodzinsky R, Singh HB; *Volatile Organics in the Atmosphere: An Assessment of Available Data*. p 126-7 SRI contract 68-02-3459 (1982)

(2) Singh HB et al; *Atmospheric measurements of Selected Hazardous Organic Chemicals USEPA 600/53-81-032* (1981)

(3) Altshuller AP et al; *Environ Sci Technol* 5: 1009-16 (1971)

(4) Singh HB et al; *Atmos Environ* 15: 601-12 (1981)

(5) Arnts RR, Meeks SA; *Biogenic hydrocarbon contribution to the ambient air of selected areas* 128 USEPA 600/3-80-023 (1980)

(6) Bozzelli JW et al; *Analysis of selected toxic and carcinogenic substances in ambient air in New Jersey, NJ Dept Environ Protect* (1980)

(7) Lonneman WA et al; *Hydrocarbons in Houston air. USEPA 600/3-79-018 pp. 44* (1979)

(8) Lioy PJ et al; *J Water Pollut Control Fed* 33: 649-57 (1983)

(9) Pilar S, Graydon WF; *Environ Sci Technol* 7: 628-71 (1973)

(10) Termonia M; *Comm Eur Comm EUR 7624 pp. 356-61* (1982)

(11) Sexton K, Westberg H; *Environ Sci Technol* 14: 329-32 (1980)

(12) Tsani-Bazaca E et al; *Chemosphere* 11: 11-23 (1982)

(13) Derwent RG; pp. 1-15 in *Volatile Organic Compounds in the Atmosphere*. Hester RE, Harrison RM, *Iss Environ Sci Technol No 4*, the Royal Society of Chemistry, Cambridge, UK (1995)

(14) Chan CC et al; *Atmos Environ* 28: 2351-59 (1994)

(15) Coursimault A et al; *Sci Total Environ* 169: 17-23 (1995)

(16) Dor F et al; *J Air Waste Manage Assoc* 45: 103-110 (1995)

(17) Gentner et al; *Environ Sci Technol* 43(12): 4247-4252 (2009)

► Hazardous Substances Data Bank (HSDB)

INDOOR: Toluene was detected at mean concentrations of 4.8 ug/cu m in telephone communications offices, 10.1 ug/cu m in data center offices and 5.7 ug/cu m in administrative offices in the US(1). Toluene was detected in the volatile emissions of newly installed carpet cushions at an emission rate of 4-79 ug/sq m-hr during the first 6 hours after installation(2). Toluene was detected in hairdresser salons in Norway at concentrations of 0.04-0.11 mg/cu m(3). In indoor air samples collected from 100 homes in suburban and rural regions across New Jersey between December 2003 and April 2006, toluene was detected in all homes at concentrations ranging from 2.6 to 160 ug/cu m (mean 25.1 ug/cu m)(4). Toluene was detected in indoor air samples collected from 37 small- and medium-sized commercial



buildings of varying sizes, ages, uses, and regions of California at concentrations ranging from 0.44 to 200 ug/cu m (mean 4.47 ug/cu m)(5).

(1) Shields HC et al; *Indoor air* 6: 2-17 (1996)

(2) Schaeffer VH et al; *J Air Waste Manage Assoc* 46: 813-20 (1996)

(3) Hollund BE, Moen BE; *Ann Occup Hyg* 42: 277-81 (1998)

(4) Weisel CP et al; *Environ Sci Technol* 42: 8231-8238 (2008)

(5) Wu X et al; *Environ Sci Technol* 45(20): 9075-9083 (2011)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

RURAL/REMOTE: Toluene was detected in the atmosphere of 115 remote samples taken in the US at concentrations of 0.057-30 ppb, (0.66 ppb median)(1). Toluene was identified, not quantified, in a forest in Germany(2). Toluene was detected in Langenbrugge, Germany and West Beckham, UK at concentrations of 0.441 and 0.999 ppb, respectively(3). Toluene was detected at a concentration of 0.04 ppb in Iznana, Canaries(3). Ambient air samples taken from the summit of Whiteface Mountain, NY during July 1994 contained an average toluene concentration of 0.114 ppbv (range of 0.031-0.26 ppbv)(4).

(1) Brodzinsky R, Singh HB; *Volatile Organics in the Atmosphere: An Assessment of Available Data*. pp. 126-7 SRI contract 68-02-3459 (1982)

(2) Helmig D et al; *Chemosphere* 19: 1399-1412 (1989)

(3) Derwent RG; pp. 1-15 in *Volatile Organic Compounds in the Atmosphere*, Hester RE, Harrison RM. *Iss Environ Sci Technol No 4*, the Royal Society of Chemistry, Cambridge, UK (1995)

(4) Khwaja H, Narang A; *Chemosphere* 71: 2030-2043 (2008)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

SOURCE DOMINATED: In a survey of 188 source dominated samples from the US, toluene was detected at concentrations of 0.037-5,500 ppb (4.6 ppb median)(1). Toluene was detected in the air of the Lipari and BFI landfills in NJ at 0.40 and 310 ppb(2). Toluene was detected at concentrations of 14-22 ppb 4 miles downwind from a General Motors paint plant(3). The average concentration of toluene around gasoline pumps during fueling was in the range of 0.14-1.2 mg/cu m and the benzene concentrations at the filling stations were in the range of 0.005-0.02 ppm(4). Toluene was detected in the Fort McHenry Tunnel, MD at concentrations of 79-90 ppb(5). Indoor and outdoor air samples collected from 41 tobacco smoking environments (cafes, bars, and restaurants) contained toluene concentrations ranging from 1.8 to 67.1 ug/cu m (mean of 12.3 ug/cu m), while nonsmoking establishments had concentrations ranging from 0.8 to 7.6 ug/cu m (mean of 2.9 ug/cu m)(6). Toluene was detected at concentrations of 0.20, 0.30, 0.33, 0.31, 0.19, 0.21, and 0.21 nL/L in air emission samples collected from a corn silage, alfalfa silage, cereal silage, high moisture ground corn feed, total mixed ration feed,



almond hulls feed, and almond shells feed, respectively, on a large commercial dairy farm in California's San Joaquin Valley(7). Toluene was detected at concentrations of 652,351 and 462,315 ppbv in two gas recovery wells collected from the Case Passerini landfill site in Italy(8).

(1) Brodzinsky R, Singh HB; *Volatile Organics in the Atmosphere: An Assessment of Available Data*. pp. 126-7 SRI contract 68-02-3459 (1982)

(2) Bozzelli JW et al; *Analysis of selected toxic and carcinogenic substances in ambient air in New Jersey*, NJ Dept Environ Protect (1980)

(3) Tsani-Bazaca E et al; *Chemosphere* 11: 11-23 (1982)

(4) American Petroleum Inst; *Gasoline Vapor Exposure Assessment at Service Stations*. American Petroleum Inst Washington, DC: API Publ 4553 (1993)

(5) Zielinska B et al; *Atmos Environ* 12: 2269-86 (1996)

(6) Alonso M et al; *Environ Sci Technol* 44: 8289-8294 (2010)]

(7) Malkina IL et al; *J Environ Qual* 40: 28-36 (2011)

(8) Tassi F et al; *Sci Total Environ* 407(15): 4513-4525 (2009)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



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13.2.19 Food Survey Values



Toluene was identified, not quantified, in baked potatoes(1), mountain cheese(2), fried bacon(3), fried chicken(4), peanut oil(5) and raw beef(6).

(1) Coleman EC et al; *J Agric Food Chem* 29: 42-8 (1981)

(2) Dumont JP, Adda J; *J Agric Food Chem* 26: 364-7 (1978)

(3) Ho CT et al; *J Agric Food Chem* 31: 336-42 (1983)

(4) Tang JT et al; *J Agric Food Chem* 31: 1287-92 (1983)

(5) Chung TY et al; *J Agric Food Chem* 41: 1467-70 (1993)

(6) King MF et al; *J Agric Food Chem* 41: 1974-81 (1993)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.20 Plant Concentrations



Toluene was identified, not quantified, in the Korean Chamachwi plant(1).

(1) Chung TY et al; *J Agric Food Chem* 41: 1693-97 (1993)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Toluene concentrations in plants(1).

Genus species	Family	Common name	Part	Low/High concn (ppm)

<i>Anthum graveolens</i>	Apiaceae	Dill; Garden Dill	Shoot Essential Oil	not reported
<i>Asimina tribola</i>	Annonaceae	Pawpaw	Fruit	0.001/0.024
<i>Brassica oleracea</i>	Brassicaceae	Kohlrabi	Stem	-/0.08
<i>Capsicum frutescens</i>	Solanaceae	Hot Pepper; Chili; Spur Pepper; Red Chili; Tobasco; Cayenne	Fruit	not reported
<i>Capsicum annuum</i>	Solanaceae	Bell Pepper; Green Pepper; Cone Pepper; Paprika; Sweet Pepper; Cherry Pepper	Fruit	not reported
<i>Carica papaya</i>	Caricaceae	Papaya	Fruit	-/0.005
<i>Centella asiatica</i>	Apiaceae	Gotu Kola; Pennywort	Shoot	not reported
<i>Coriandrum sativum</i>	Apiaceae	Coriander; Cilantro; Chinese Parsley	Leaf	-/117.0
<i>Cymbopogon parkeri</i>	Poaceae	Skhabar	Plant	no reported
<i>Elsholtzia cristata</i>	Lamiaceae	Furan Chemotype	Shoot	not reported
<i>Laurus nobilis</i>	Lauraceae	Sweet Bay; Laurel; Bayleaf; Grecian Laurel, Bay Laurel; Bay	Leaf	not reported
<i>Mentha spicata</i>	Lamiaceae	Spearmint	Essential Oil; Leaf	not reported; not reported
<i>Myrtus communis</i>	Myrtaceae	Myrtle	Plant	200.0/710.0
<i>Panax ginseng</i>	Araliaceae	Oriental Ginseng; Chinese Ginseng; Ginseng; Korean Ginseng	Shoot	not reported



Pelargonium graveolens	Geraniaceae	Scented Geranium; Rose Geranium	Essential Oil	not reported
Petroselinum crispum	Apiaceae	Parsley	Leaf	not reported
Pimenta dioica	Myrtaceae	Clover-pepper; Pimenta; Pimento; Allspice; Jamaica-Pepper	Plant	not reported
Pinus elliotti	Pinaceae	Slash Pine	Plant	not reported
Pinus walliciana	Pinaceae	Bhutan Pine	Resin, Exudate, Sap	not reported
Psidium guajava	Myrtaceae	Guava	Fruit	-/2000.0
Rosmarinus officinalis	Lamiaceae	Rosemary	Plant	436.0/2071.0

(1) USDA; Dr. Duke's Phytochemical and Ethnobotanical Databases. Toluene. Washington, DC: US Dept Agric, Agric Res Service. Available from, as of Mar 4, 2016: <https://phytochem.nal.usda.gov/phytochem/search>

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.21 Fish / Seafood Concentrations



Flesh of fish from a petroleum contaminated harbor in Japan contained toluene at 5 ppm(1). Toluene was detected in oysters (*Crassostrea virginica*) from Lake Pontchartrain, LA at an average concentration of 3.4 ppb and in clams (*Rangia cuneata*) at concentrations of 18 and 11 ppb(2). Toluene was identified, not quantified, in boiled shrimp (*Funchalia woodward*) and crab (*Gerion maritae*)(3).

(1) USEPA; *Ambient Water Quality Criteria for Toluene*. pp. C-1 to C-7 (1980)

(2) Ferrario JB et al; *Bull Environ Contam Toxicol* 34: 246-55 (1985)

(3) Misharina TA, Golovnya RV; *J High Resol Chromat* 15: 332-34 (1992)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.22 Milk Concentrations



Toluene was identified, not quantified, in 8 samples of mothers' milk from 4 urban areas(1).

[PMID:7082873](#)

(1) Pellizzari ED et al; *Bull Environ Contam Toxicol* 28: 322-8 (1982)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.23 Other Environmental Concentrations



Leachates from 34 discarded cellular telephones measured by electronic product leaching tests contained an average toluene concentration of 3.7 mg/kg(1). Toluene is a component of cigarette smoke(2). Light oil from coal contains 12-20% toluene; crude oil contains 1.2-2.4% and auto fuel contains 8-12%(3).

(1) Lincoln JD et al; *Environ Sci Technol* 41: 2572-2578 (2007)

(2) Rodgman A, Perfetti TA; *The Chemical Components of Tobacco and Tobacco Smoke 2nd ed.*, Boca Raton, FL: CRC Press p. nn (2013)

(3) Walker P; *Air Pollution Assessment of Toluene*. p. 1-22, 46-92 MTR-7215 Mitre Corp, McLean VA (1976)

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

Evaporation from gasoline tank: 0.3 - 0.9 vol % of total evaporated hydrocarbons; evaporation from carburetor: 0.5 - 2.4 vol % of total evaporated hydrocarbons. In exhaust of gasoline engines: 3-8 vol% of total exhaust hydrocarbons; in exhaust of diesel engine: 3% of emitted hydrocarbons; in exhaust of rotary gasoline engine: 16% of emitted hydrocarbons; in exhaust of gasoline engine: 0.1-7.0 ppm (partly [crotonaldehyde](#)); in 4 municipal landfill gases in S. Finland (1989-1990): average 0.23-137, maximum 143 mg/cu m.

Verschueren, K. *Handbook of Environmental Data on Organic Chemicals. Volumes 1-2. 4th ed.* John Wiley & Sons. New York, NY. 2001, p. 1723

▶ [Hazardous Substances Data Bank \(HSDB\)](#)

13.2.24 Probable Routes of Human Exposure



According to the 2012 [TSCA](#) Inventory Update Reporting data, 73 reporting facilities estimate the number of persons reasonably likely to be exposed during the manufacturing, processing, or use of toluene in the United States may be as low as <10 workers and as high as 9,999 workers per plant; the data may be greatly underestimated due to confidential business information (CBI) or unknown values(1).

(1) US EPA; *Chemical Data Reporting (CDR). Non-confidential 2012 Chemical Data Reporting information on chemical production and use in the United States. Available from, as of Jan 25, 2016: <https://www.epa.gov/chemical-data-reporting>*

▶ [Hazardous Substances Data Bank \(HSDB\)](#)



NIOSH (NOES Survey 1981-1983) has statistically estimated that 2,015,881 workers (391,255 of these are female) were potentially exposed to toluene in the US(1). Occupational exposure to toluene may occur through inhalation and dermal contact with this compound at workplaces where toluene is produced or used. Monitoring data indicate that the general population may be exposed to toluene via inhalation of ambient air, ingestion of food and drinking water, handling of gasoline, and exposure to some consumer products where toluene is used as a solvent(SRC).

(1) NIOSH; NOES. National Occupational Exposure Survey conducted from 1981-1983. Estimated numbers of employees potentially exposed to specific agents by 2-digit standard industrial classification (SIC). Available from, as of Jan 25, 2016: <https://www.cdc.gov/noes/>

▶ Hazardous Substances Data Bank (HSDB)

Toluene was detected in hairdresser salons in Norway at concentrations of 0.04-0.11 mg/cu m(1). The time weighted average (TWA) of toluene in the workplace air of a municipal waste composting facility was reported as 188,000 ug/cu m(2). In a 1989 Danish survey on chemical exposures(3), the number of worker exposure events for toluene were documented: manufacturing of metals, 420; manufacturing of metal fabricated products 64,000; electrical machinery and apparatus, 1,500; manufacture of transport equipment 2,700; painters and carpenters 15,000; construction workers, 5,400; publishing and printing, 6,300; wholesale trades, 5,000; textile and leather manufacturing, 4,400; wood and furniture manufacturing, 5,900; manufacture of chemicals, 8,700; manufacture of paints and petroleum, 1,400; manufacture of non-metallic mineral products, 2,300; manufacture of optical instruments, 2,500 manufacture of plastic and boat building, 1,100; sewage and refuse disposal, 99; agriculture and forestry, 11,000; health services, 2,600. The total number of work related exposure events was 140,000(3). Toluene was detected in the workplace air of glass fiber manufacturing plants and high temperature sealing component and clutch lining plants at a mean concentration of 65 ppm(4).

(1) Hollund BE, Moen BE; *Ann Occup Hyg* 42: 277-81 (1998)

(2) Eitzer BD; *Environ Sci Technol* 29: 896-902 (1995)

(3) Brandorff NP et al; *Occup Environ Med* 52: 454-63 (1995)

(4) Angerer J, Kraemer A; *Int Arch Occup Environ Health* 69: 91-96 (1997)

▶ Hazardous Substances Data Bank (HSDB)

In 3,089 and 1,856 breathing zone measurements of offshore cleanup workers collected between April 27 and October 18, 2010 before and after the cap of the spilling Deepwater Horizon oil well, respectively, toluene had 85% nondetects and was reported to have a mean concentration of 0.031 ppm before the cap and had 94% nondetects and a reported mean concentration of 0.051 ppm after the cap(5). The detected toluene concentrations were suggested to be primarily from engine exhaust rather than the oil slick itself(1).

(1) Avens et al; *Environ Sci Technol* 45(17): 7372-7379 (2011)

13.2.25 Average Daily Intake



AIR INTAKE (assume median concn 11 ppb(1)) 843 ug; WATER INTAKE (assume 2 ppb(2)) 4 ug; FOOD INTAKE - insufficient data.

(1) Brodzinsky R, Singh HB; *Volatile Organics in the Atmosphere and Assessment of available data: p. 126-7 SRI Contract 68-02-3459 (1982)*

(2) Otson R et al; *J Assoc Off Analyt Chem 65: 1370-4 (1982)*

▶ Hazardous Substances Data Bank (HSDB)



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13.2.26 Body Burden



Toluene was identified, not quantified, in 8 samples of mothers' milk from 4 urban areas(1). Toluene was detected in 250 of 250 specimens of human blood at concentrations of 0.2-38 ppb (1.5 ppb avg)(2). Toluene was detected in 91% of the samples of the National Human Adipose Tissue Survey at a maximum concentration of 250 ppb(3). Toluene was identified, not quantified, in expired breath of people at service stations during fueling(4). The mean concentration of toluene in the blood of non-occupationally exposed individuals in the US was 0.52 ppb(5). The average concentration of toluene in the blood and urine of workers in glass fiber and clutch lining plants were 911 ug/L and 2.9 mg/L, respectively(6). Toluene was detected in human blood samples collected from 292 adults aged 20-59 years old in the 1999-2000 NHANES study at a mean concentration of 0.442 ng/mL (range of 0.023-4.880 ng/mL)(7).

(1) Pellizzari ED et al; *Bull Environ Contam Toxicol 28: 322-8 (1982)*

(2) Antoine SR et al; *Bull Environ Contam Toxicol 36: 364-71 (1986)*

(3) Stanley JS; *Broad Scan Analysis of the FY82 National Human Adipose Tissue Survey Specimens Vol. I Executive Summary p. 5 USEPA-560/5-86-035 (1986)*

(4) Lindstrom AB, Pleil J; *J Air Waste Manage Assoc 46: 676-82 (1996)*

(5) Ashley DL et al; *Clin Chem 40: 1401-14 (1994)*

(6) Angerer J, Kraemer A; *Int Arch Occup Environ Health 69: 91-96 (1997)*

(7) Jia et al; *Sci Total Environ 419: 225-232 (2012)*

▶ Hazardous Substances Data Bank (HSDB)

14 Associated Disorders and Diseases



▶ [Comparative Toxicogenomics Database \(CTD\); Open Targets](#)

Associated Occupational Diseases with Exposure to the Compound

[Infertility, female](#) [Category: Reproduction and Development]

[Encephalopathy, chronic solvent](#) [Category: Chronic Poisoning]

[Solvents, acute toxic effect](#) [Category: Acute Poisoning]

▶ [Haz-Map, Information on Hazardous Chemicals and Occupational Diseases](#)

Disease	References
Asthma	PubMed: 10361015 , 15196282 , 15537072 , 15575932 , 21465502 , 24752575 , 9106561 , 21546028 , 22835687 , 19793086 , 17658592 , 24053239 , 21749985 , 23277518
Autism	PubMed: 15585776 , 7687150 , 20423563 , 6150139 , 3410814 , 12205654 , 24130822
Perillyl alcohol administration for cancer treatment	PubMed: 15607313 , 17668437 , 10379660 , 14569192 , 17403619 , 20300169 , 22284503 , 22061338 , 19783829 , 19010317
Celiac disease	PubMed: 3816078 , 16425363 , 10063930 , 6182605 , 6182788 , 24657864 , 21970810 , 27452636
Ulcerative colitis	PubMed: 21059682 , 1740537 , 17314143 , 17269711 , 21761941 , 23516449 , 23867873 , 24811995 , 25598765 , 26806034 , 26848182 , 27609529 , 28842642
Pervasive developmental disorder not otherwise specified	PubMed: 24130822

Nonalcoholic fatty liver disease

PubMed: [23454028](#)

▶ [Human Metabolome Database \(HMDB\)](#)

15 Literature

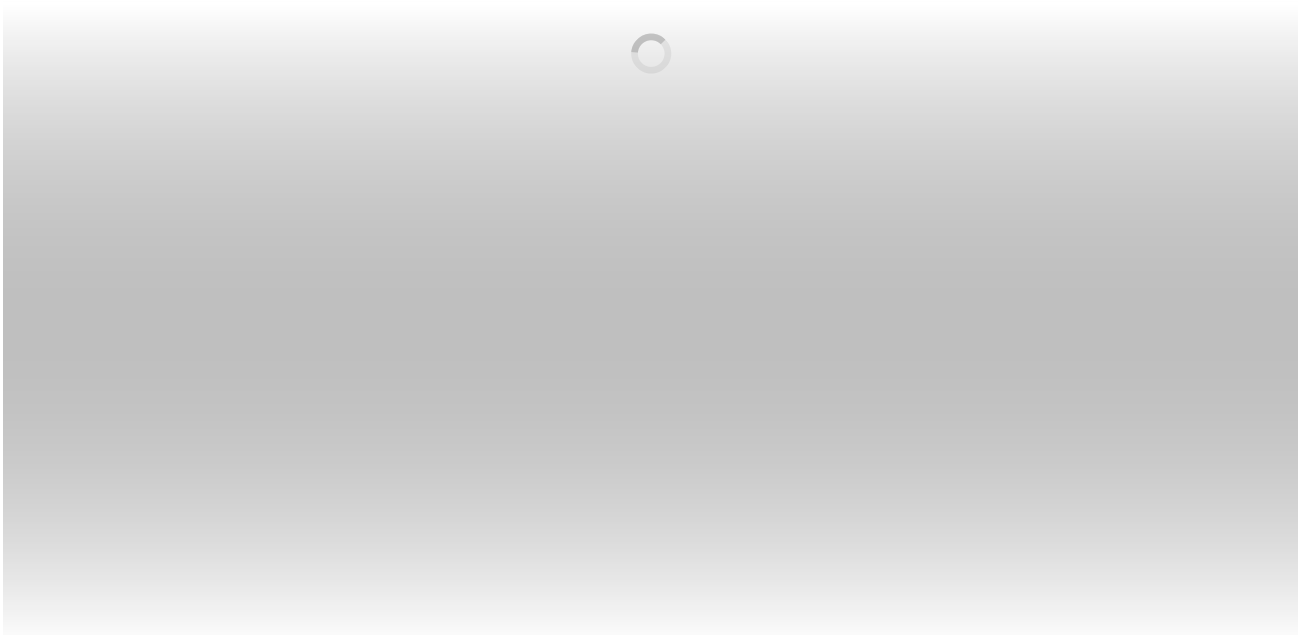


15.1 Consolidated References



▶ [PubChem](#)

15.2 NLM Curated PubMed Citations



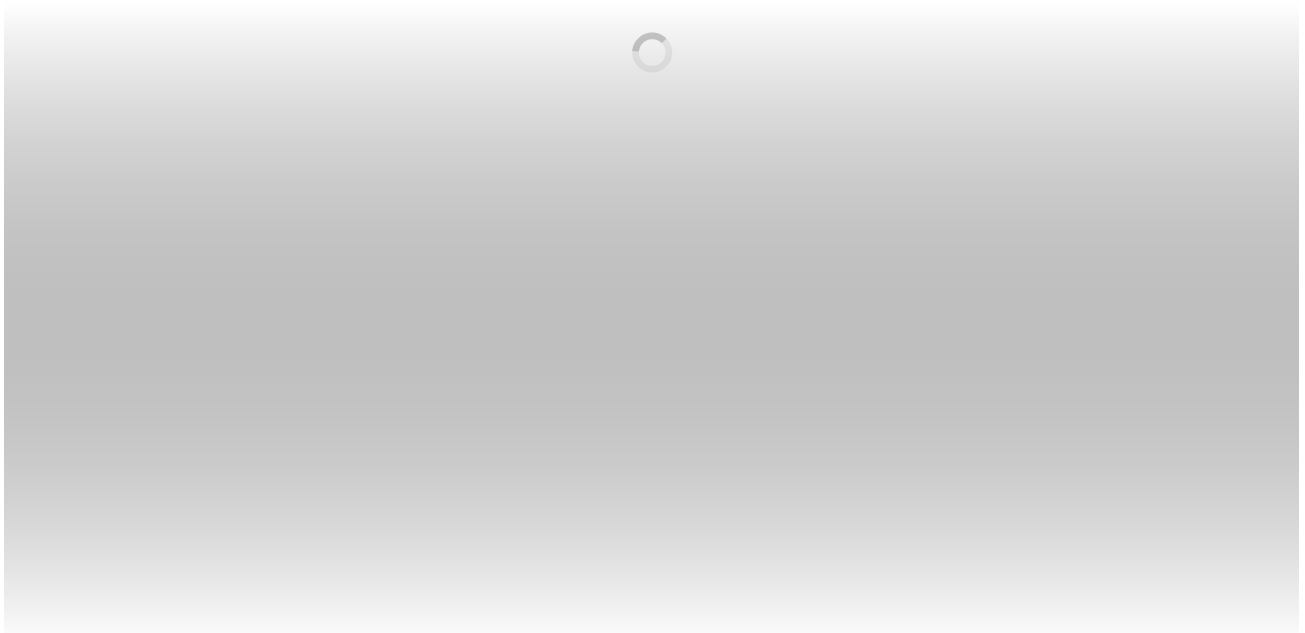
▶ Medical Subject Headings (MeSH)

15.3 Springer Nature References



▶ Springer Nature

15.4 Wiley References



▶ Wiley

15.5 Nature Journal References



Niu et al. The aromatic ene reaction. Nature Chemistry, doi: 10.1038/nchem.1797, published online 17 November 2013 <http://www.nature.com/nchem>

▶ Nature Chemistry

Tsuji et al. alpha-Amino acid and peptide synthesis using catalytic cross-dehydrogenative coupling. Nature Synthesis, DOI: 10.1038/s44160-022-00037-0, published online 14 March 2022

▶ Nature Synthesis

Fan et al. Asymmetric 1,2-oxidative alkylation of conjugated dienes via aliphatic C-H bond activation. Nature Synthesis, DOI: 10.1038/s44160-022-00172-8, published online 3 November 2022

▶ Nature Synthesis



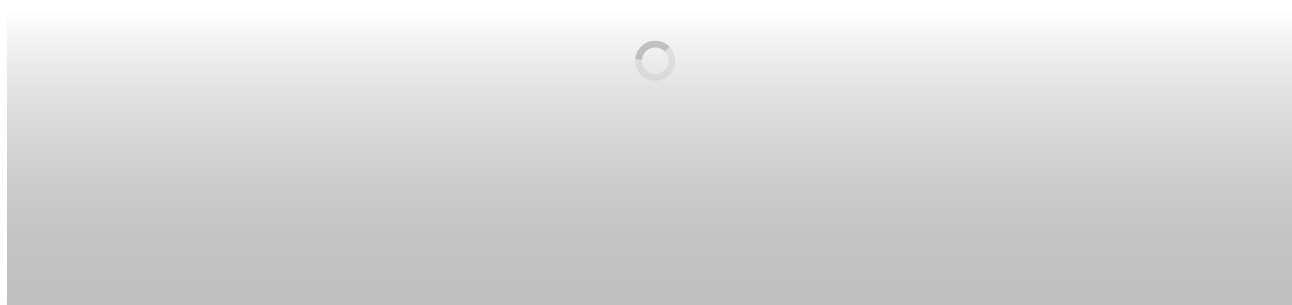
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15.6 Chemical Co-Occurrences in Literature



▶ PubChem

15.7 Chemical-Gene Co-Occurrences in Literature



▶ PubChem

15.8 Chemical-Disease Co-Occurrences in Literature



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▶ PubChem

15.9 Chemical-Organism Co-Occurrences in Literature

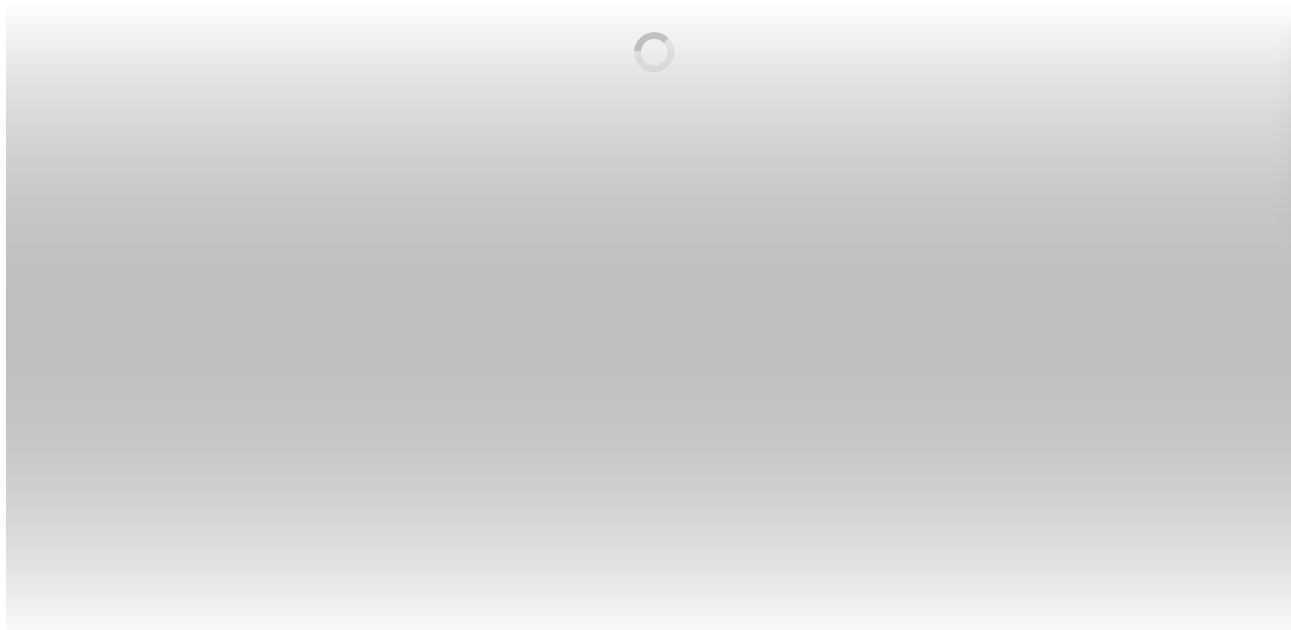


▶ PubChem

16 Patents



16.1 Depositor-Supplied Patent Identifiers



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▶ PubChem

[Link to all deposited patent identifiers](#)

▶ PubChem

16.2 WIPO PATENTSCOPE



Patents are available for this chemical structure:

<https://patentscope.wipo.int/search/en/result.jsf?inchikey=YXFVVABEGXRONW-UHFFFAOYSA-N>

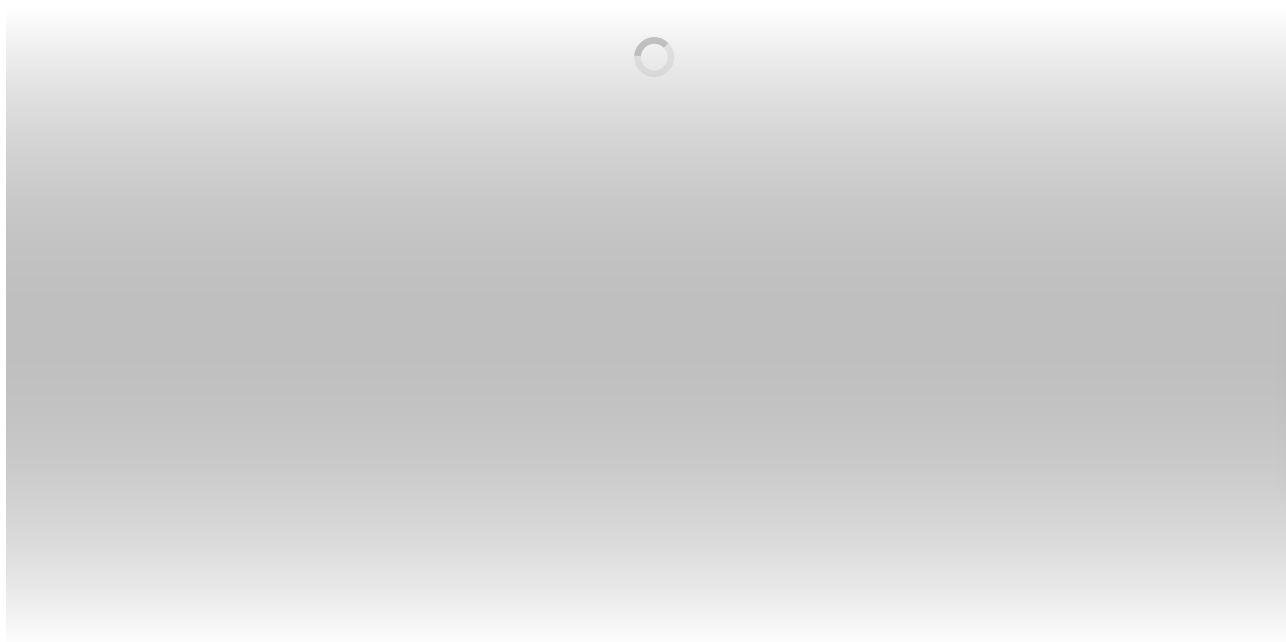
▶ PATENTSCOPE (WIPO)

Patents are available for this chemical structure:

<https://patentscope.wipo.int/search/en/result.jsf?inchikey=WATYYFJGZWEJPH-UHFFFAOYSA-N>

▶ PATENTSCOPE (WIPO)

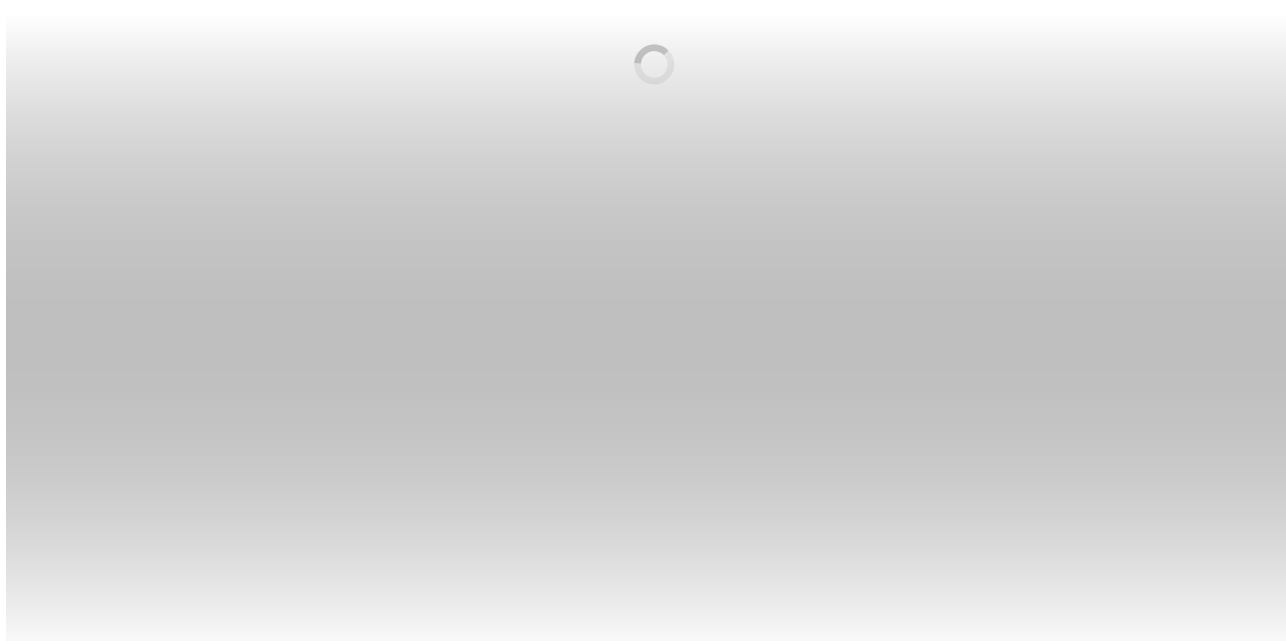
16.3 Chemical Co-Occurrences in Patents



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▶ PubChem

16.4 Chemical-Disease Co-Occurrences in Patents



▶ PubChem

16.5 Chemical-Gene Co-Occurrences in Patents





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▶ PubChem

16.6 Chemical-Organism Co-Occurrences in Patents



▶ PubChem

17 Interactions and Pathways



17.1 Protein Bound 3D Structures



▶ [RCSB Protein Data Bank \(RCSB PDB\)](#)

[View 26 proteins in NCBI Structure](#)


▶ [PubChem](#)



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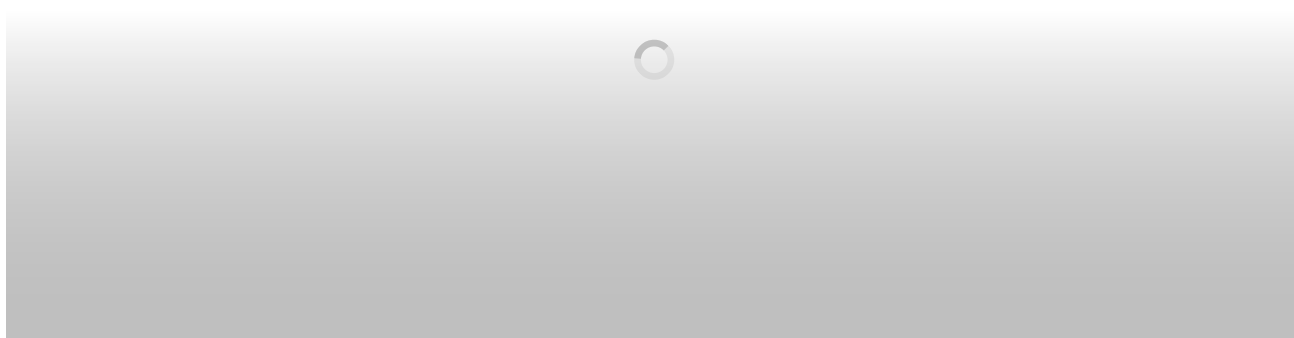
17.1.1 Ligands from Protein Bound 3D Structures



PDBe Ligand Code	MBN
PDBe Structure Code	1JLX
PDBe Conformer	

▶ [Protein Data Bank in Europe \(PDBe\)](#)

17.2 Chemical-Target Interactions



▶ Comparative Toxicogenomics Database (CTD); Toxin and Toxin Target Database (T3DB)

17.3 Pathways



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▶ PubChem

18 Biological Test Results



18.1 BioAssay Results



▶ PubChem

19 Taxonomy

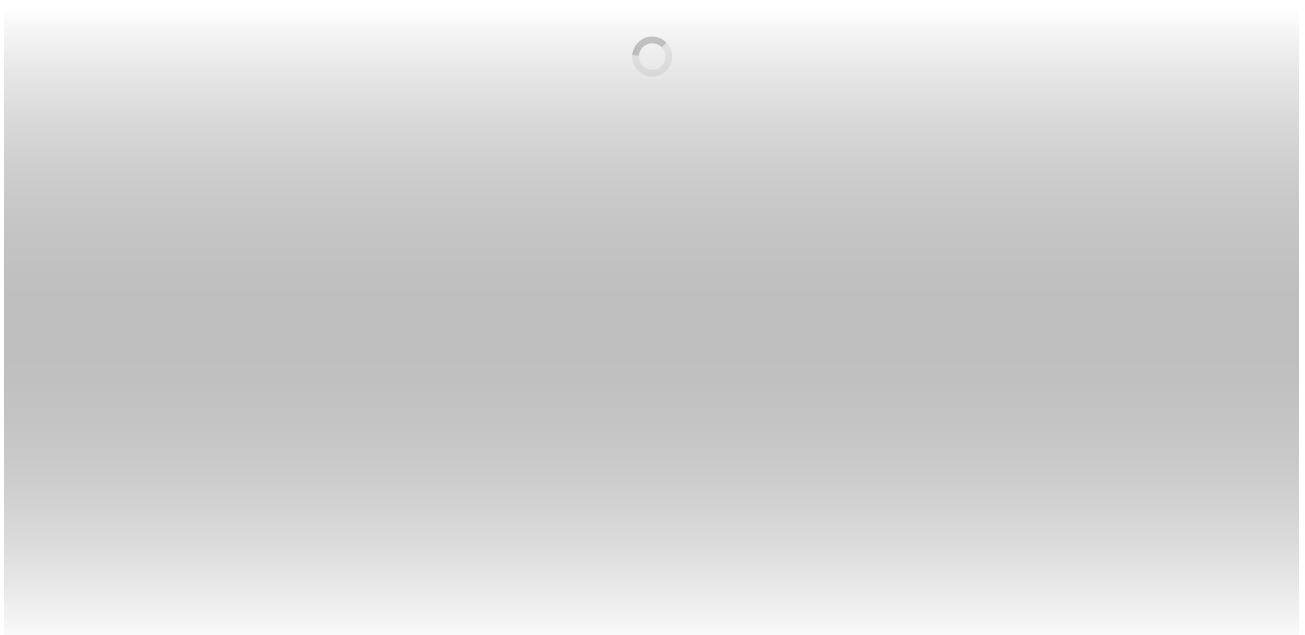


▶ KNApSAcK Species-Metabolite Database; LOTUS - the natural products occurrence datab...

20 Classification



20.1 MeSH Tree



▶ Medical Subject Headings (MeSH)

20.2 NCI Thesaurus Tree



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▶ NCI Thesaurus (NCIt)

20.3 ChEBI Ontology



▶ ChEBI

20.4 ChemIDplus





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▶ ChemIDplus

20.5 CAMEO Chemicals



▶ CAMEO Chemicals

20.6 ChEMBL Target Tree



▶ ChEMBL

20.7 Household Products Database Tree



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▶ Consumer Product Information Database (CPID)

20.8 UN GHS Classification



▶ GHS Classification (UNECE)

20.9 EPA CPDat Classification



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▶ EPA Chemical and Products Database (CPDat)

20.10 Drug Enforcement Administration (DEA) Classification



▶ Drug Enforcement Administration (DEA)

20.11 NORMAN Suspect List Exchange Classification





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▶ NORMAN Suspect List Exchange

20.12 EPA DSSTox Classification



▶ EPA DSSTox

20.13 International Agency for Research on Cancer (IARC) Classification



▶ International Agency for Research on Cancer (IARC)

20.14 Consumer Product Information Database Classification



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▶ Consumer Product Information Database (CPID)

20.15 EPA TSCA and CDR Classification



▶ EPA Chemicals under the TSCA

20.16 LOTUS Tree



C
笔记

▶ LOTUS - the natural products occurrence database

20.17 EPA Substance Registry Services Tree



▶ EPA Substance Registry Services

20.18 MolGenie Organic Chemistry Ontology



▶ MolGenie

20.19 Chemicals in PubChem from Regulatory Sources



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12. ChEBI

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73. Protein Data Bank in Europe (PDBe)

<http://www.ebi.ac.uk/pdbe-srv/pdbechem/chemicalCompound/show/MBN>

74. RCSB Protein Data Bank (RCSB PDB)

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<https://www.rcsb.org/pages/policies>

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75. Rhea - Annotated Reactions Database

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<https://www.rhea-db.org/rhea?query=CHEBI:17578>

76. Springer Nature

<https://pubchem.ncbi.nlm.nih.gov/substance/341139268>

77. SpringerMaterials

toluene

https://materials.springer.com/substanceprofile/docs/smsid_mgaarostlejvdeuz

78. The Cambridge Structural Database

<https://www.ccdc.cam.ac.uk/structures/Search?Ccdcid=725245>

79. Wikipedia

toluene

<https://en.wikipedia.org/wiki/Toluene>

80. Wiley

<https://pubchem.ncbi.nlm.nih.gov/substance/386263965>

81. Medical Subject Headings (MeSH)

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<https://www.nlm.nih.gov/copyright.html>

Toluene

<https://id.nlm.nih.gov/mesh/M0021638.html>

MeSH Tree

<https://www.nlm.nih.gov/mesh/meshhome.html>

Solvents

<https://id.nlm.nih.gov/mesh/M0020141.html>

82. PubChem

<https://pubchem.ncbi.nlm.nih.gov>

83. GHS Classification (UNECE)

GHS Classification

http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html

84. EPA Substance Registry Services

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<https://www.epa.gov/privacy/privacy-act-laws-policies-and-resources>

EPA SRS List Classification

<https://maldi.nist.gov>

85. MolGenie



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MolGenie Organic Chemistry Ontology
<https://github.com/MolGenie/ontology/>

86. PATENTSCOPE (WIPO)

SID 403384269

<https://pubchem.ncbi.nlm.nih.gov/substance/403384269>

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<https://pubchem.ncbi.nlm.nih.gov/substance/440636399>

87. NCBI

<https://www.ncbi.nlm.nih.gov/projects/linkout>



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