Benzene

Benceno; Benzen; Phenyl Hydride.

Бензол

C_6H_6 = 78.11.

CAS — 71-43-2.

NOTE. Benzene may be known as 'benzina', 'benzol', 'benzole', or 'benzolum'. However, 'benzol' is also used to describe a mixture of hydrocarbons and 'benzin' or 'benzine' is used as a name for a petroleum distillate (see also Petroleum Spirit, p.2026).

Description. Benzene is a clear colourless flammable liquid with a characteristic aromatic odour. Wt per mL about 0.88 g. B.p. about 80°. Store in airtight containers.

Adverse Effects, Treatment, and Precautions

Symptoms of acute poisoning after inhalation or ingestion of benzene include initial excitement or euphoria followed by CNS depression with headache, dizziness, blurred vision, and ataxia, which in severe cases may progress to coma (accompanied by hyperactive reflexes), convulsions, and death from respiratory failure. Other symptoms include nausea and irritation of the mucous membranes; ventricular arrhythmias may occur. Direct skin contact with liquid benzene may result in marked irritation, and dermatitis may develop on prolonged or repeated exposure.

Prolonged industrial exposure to benzene vapour has been associated with adverse effects on the gastrointestinal tract and the CNS but in particular with marked effects on the bone marrow and blood. Decreases in the numbers of red or white blood cells or of platelets may occur, producing symptoms of headache, fatigue, anorexia, pallor, and petechiae. In severe cases pancytopenia or aplastic anaemia may develop. Leukaemia, particularly acute myeloid leukaemia, has also developed, often many years after exposure to benzene has ceased. These effects have been reported in workers exposed to relatively high concentrations of the vapour (around 200 ppm or more) but reduced red blood cell counts and anaemia have also been reported at lower concentrations. Chromosome abnormalities have been observed after prolonged exposure to benzene, particularly at the higher concentrations associated with blood dyscrasias; however, the significance of these abnormalities in the development of leukaemia is unclear.

Treatment of poisoning consists of symptomatic and supportive measures. The UK National Poisons Information Service considers that gut decontamination (gastric lavage) is contra-indicated because it may increase the risk of aspiration. In chronic poisoning, repeated blood transfusions may be necessary. Adrenaline and other sympathomimetics should be avoided because of the risk of precipitating cardiac arrhythmias.

◊ Reviews.

1. Health and Safety Executive. Benzene. *Toxicity Review 4*. London: HMSO, 1982.
2. WHO. Benzene. *Environmental Health Criteria 150*. Geneva: WHO, 1993. Available at: http://www.inchem.org/documents/ehc/ehc/ehc150.htm (accessed 29/06/04)

Malignant neoplasms. Epidemiological data support an association between benzene exposure and acute myeloid leukaemia, but the risk after low levels of exposure (1 to 10 ppm) is less clear.[1] However, a large cohort study[2] suggested that there is an increased risk of acute myeloid leukaemia and of non-Hodgkin's lymphoma with benzene exposure at levels below 10 ppm.

1. Austin H, *et al.* Benzene and leukemia: a review of the literature and a risk assessment. *Am J Epidemiol* 1988; **127:** 419–39.
2. Hayes RB, *et al*. Benzene and the dose-related incidence of hematologic neoplasms in China. *J Natl Cancer Inst* 1997; **89:** 1065–71.

Pregnancy. An evaluation of the USA National Natality and Fetal Mortality Survey noted that maternal or paternal occupational exposure to agents such as benzene was associated with an increased risk of still-birth and that paternal exposure to benzene increased the risk of low-birth-weight infants.[1]

1. Savitz DA, *et al*. Effect of parents' occupational exposures on risk of stillbirth, preterm delivery, and small-for-gestational-age infants. *Am J Epidemiol* 1989; **129:** 1201–18.

Pharmacokinetics

Benzene is absorbed after inhalation and ingestion, but is not significantly absorbed through the skin. Some is excreted unchanged from the lungs. Oxidation to phenol and related quinol compounds occurs, the metabolites being excreted in the urine as conjugates of sulfuric or glucuronic acid.

Uses

Benzene was formerly applied as a pediculicide. Its use as an industrial solvent is decreasing.

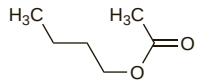
Butyl Acetate

Acetato de butilo; Butylu octan. *n*-Butyl acetate.

Бутилацетат

$C_6H_{12}O_2$ = 116.2.

CAS — 123-86-4.



Description. Butyl acetate is a clear, colourless flammable liquid with a strong fruity odour. Wt per mL about 0.88 g. B.p. 123° to 126°. Slightly soluble in water; miscible with alcohol. Store in airtight containers.

Adverse Effects

Butyl acetate is irritant. High concentrations may cause CNS depression.

Uses

Butyl acetate is used as an industrial solvent and as an extraction solvent in food processing.

Butyl Alcohol

Alcohol butílico; *n*-Butanol; *n*-Butyl Alcohol. Butan-1-ol.

Бутиловый Спирт

$C_4H_{10}O$ = 74.12.

CAS — 71-36-3.

Pharmacopoeias. In *USNF*.

USNF 26 (Butyl Alcohol). A clear, colourless, mobile liquid having a characteristic, penetrating vinous odour. Sp. gr. 0.807 to 0.809. It distils within a range of 1.5°, including 117.7°. Soluble in water; miscible with alcohol, with ether, and with many other organic solvents. Store in airtight containers at a temperature not exceeding 40°.

Adverse Effects and Precautions

Butyl alcohol may be irritant and may cause mild CNS depression with headache, dizziness, and drowsiness.

◊ References to the toxicity of butyl alcohol.

1. WHO. Butanols—four isomers: 1-butanol, 2-butanol, tert-butanol, isobutanol. *Environmental Health Criteria 65*. Geneva: WHO, 1987. Available at: http://www.inchem.org/documents/ehc/ehc/ehc65.htm (accessed 29/06/04)
2. WHO. 1-Butanol health and safety guide. *IPCS Health and Safety Guide 3*. Geneva: WHO, 1987. Available at: http://www.inchem.org/documents/hsg/hsg/hsg003.htm (accessed 29/06/04)

Handling. Suitable precautions should be taken to avoid skin contact with butyl alcohol as it can penetrate skin and produce systemic toxicity.

Uses

Butyl alcohol is used as an industrial and pharmaceutical solvent and as an extraction solvent in food processing.

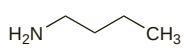
Butylamine

Butilamina; *n*-Butylamine; Butyloamina.

Бутиламин

$C_4H_{11}N$ = 73.14.

CAS — 109-73-9.



Description. Butylamine is a colourless to pale yellow flammable liquid with an ammoniacal odour. Wt per mL about 0.744 g. B.p. about 78°. Miscible with water, with alcohol, and with ether. Store in airtight containers.

Adverse Effects and Precautions

Butylamine is irritant. Symptoms of CNS depression may be observed after exposure to high concentrations of the vapour.

Handling. Suitable precautions should be taken to avoid skin contact with butylamine as it can penetrate skin and produce systemic toxicity.

Uses

Butylamine is used as a solvent.

Carbon Disulfide

Carbon Bisulphide; Carbon Disulphide; Carbonei Sulfidum; Carboneum Bisulfuratum; Carboneum Sulfuratum; Disulfuro de carbono; Schwefelkohlenstoff; Węgla disiarczek.

Сероуглерод

CS_2 = 76.14.

CAS — 75-15-0.

Description. Carbon disulfide is a clear, colourless, volatile, flammable liquid with a chloroform-like odour. Commercial grades have an unpleasant odour described by some as being reminiscent of decaying radishes. Wt per mL about 1.26 g. B.p. about 46°. Store in airtight containers.

Stability. The vapour of carbon disulfide when mixed with air in the proportions of 1 to 50% is highly explosive.

Adverse Effects, Treatment, and Precautions

Carbon disulfide is irritant. Toxic effects may occur as a result of inhalation, ingestion, or absorption through the skin.

Acute poisoning may result in gastrointestinal disturbances and euphoria, followed by CNS depression. Symptoms include headache, dizziness, mood changes, and in severe cases, manic psychoses, delirium, hallucinations, coma, convulsions, and death due to respiratory failure.

Chronic poisoning has been associated with occupational exposure to carbon disulfide vapour for prolonged periods. It is characterised by peripheral neuropathies; CNS effects such as headache, fatigue, insomnia, tremor, emotional lability, extrapyramidal disorders, bipolar disorder, and encephalopathy; gastrointestinal effects including anorexia, dyspepsia, and ulcerative changes; and effects on the eye. Occupational exposure to carbon disulfide has been shown to be associated with an increased incidence of mortality from coronary heart disease. The action of carbon disulfide on endocrine function has resulted in menstrual irregularities, an increased incidence of spontaneous abortions and premature births, loss of libido, sperm abnormalities, and decreased serum-thyroxine concentrations; there is limited evidence of impaired glucose tolerance.

Treatment consists of removal from exposure and general supportive and symptomatic measures. Gastric lavage should be avoided. Adrenaline and other sympathomimetics should also be avoided because of the risk of precipitating cardiac arrhythmias. Peripheral neuropathies may be only slowly reversible.

◊ Reviews of the toxicity of carbon disulfide.

1. WHO. Carbon Disulfide. *Environmental Health Criteria 10*. Geneva: WHO, 1979. Available at: http://www.inchem.org/documents/ehc/ehc/ehc010.htm (accessed 29/06/04)
2. WHO. Recommended health-based limits in occupational exposure to selected organic solvents. *WHO Tech Rep Ser 664* 1981. Available at: http://libdoc.who.int/trs/WHO_TRS_664.pdf (accessed 03/09/08)
3. Health and Safety Executive. Carbon disulphide. *Toxicity Review 3*. London: HMSO, 1981.
4. Beauchamp RO, *et al.* A critical review of the literature on carbon disulfide toxicity. *Crit Rev Toxicol* 1983; **11:** 169–278.

Effects on endocrine function. The effects of exposure to carbon disulfide were studied retrospectively in 265 female workers in the rayon industry exposed for at least 1 year, and 291 non-exposed female workers.[1] Levels of exposure varied over the study period from 0.7 to 30.6 mg/m^3. Women exposed to carbon disulfide had a higher risk of menstrual disturbances than non-exposed women. However, there was no difference between the 2 groups in incidence of toxaemia, emesis gravidarum, spontaneous abortion, premature or overdue delivery, or congenital malformation.

1. Zhou SY, *et al.* Effects of occupational exposure to low-level carbon disulfide (CS) on menstruation and pregnancy. *Ind Health* 1988; **26:** 203–14.

Effects on the heart. An increased incidence of mortality from cardiovascular disease has been found in workers occupationally exposed to carbon disulfide.[1-3] The evidence suggested that the risk decreases after cessation of exposure. However, the association has been critically reviewed.[4]

1. Nurminen M, Hernberg S. Effects of intervention on the cardiovascular mortality of workers exposed to carbon disulphide: a 15 year follow up. *Br J Ind Med* 1985; **42:** 32–5.
2. Sweetnam PM, *et al.* Exposure to carbon disulphide and ischaemic heart disease in a viscose rayon factory. *Br J Ind Med* 1987; **44:** 220–7.
3. MacMahon B, Monson RR. Mortality in the US rayon industry. *J Occup Med* 1988; **30:** 698–705.
4. Sulsky SI, *et al.* Critical review of the epidemiological literature on the potential cardiovascular effects of occupational carbon disulfide exposure. *Int Arch Occup Environ Health* 2002; **75:** 365–80.

Handling. Suitable precautions should be taken to avoid skin contact with carbon disulfide as it can penetrate skin and produce systemic toxicity.

Pharmacokinetics

Carbon disulfide is rapidly absorbed after inhalation and ingestion, and is also absorbed through intact skin. It is excreted unchanged through the lungs and in the urine mainly as metabolites.

Uses
Carbon disulfide is used as an industrial solvent and has been used, in the vapour form, as an insecticide.

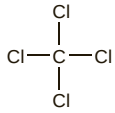
Carbon Tetrachloride

Tetracloruro de carbono; Węgla tetrachlorek. Tetrachloromethane.

Четырёххлористый Углерод

CCl_4 = 153.8.

CAS — 56-23-5.



Description. Carbon tetrachloride is a clear, colourless, mobile, liquid with a chloroform-like odour. Sp. gr. 1.588 to 1.590. B.p. 76° to 78°. Practically insoluble in water; miscible with alcohol, chloroform, ether, petroleum spirit, and fixed and volatile oils. Store in airtight containers at a temperature not exceeding 30°. Protect from light.

Handling. Avoid contact with carbon tetrachloride; the vapour and liquid are poisonous. Care should be taken not to vaporise carbon tetrachloride in the presence of a flame because of the production of harmful gases, mainly phosgene.

Adverse Effects
Individual response to carbon tetrachloride varies widely; inhalation or ingestion of a few mL of carbon tetrachloride has proved fatal and its toxicity appears to be increased by alcohol. Poisoning may follow inhalation, ingestion, or topical application but develops more rapidly after inhalation.

Carbon tetrachloride is irritant; repeated application of carbon tetrachloride to the skin may result in dermatitis. Aspiration may result in pulmonary oedema.

Adverse effects after acute exposure from any route include gastrointestinal disturbances such as nausea, vomiting, and abdominal pain, and CNS disturbances such as headache, dizziness, and drowsiness, with progression to convulsions, coma, and death from respiratory depression or circulatory collapse. Death may also occur as a result of ventricular arrhythmia. Hepatic and renal cellular necrosis can occur and are associated with free radical production; symptoms usually begin a few days or up to 2 weeks after acute exposure to carbon tetrachloride. Renal damage may present as oliguria, progressing to proteinuria, anuria, weight gain, and oedema. Symptoms of hepatic damage include anorexia, jaundice, and hepatomegaly. If hepatorenal necrosis is not fatal recovery is eventually complete.

Symptoms of chronic poisoning are similar to those of acute poisoning; in addition, paraesthesias, visual disturbances, anaemia, and aplastic anaemia have occurred. Carcinogenicity has been demonstrated in *animals.*

◊ References.

1. Melamed E, Lavy S. Parkinsonism associated with chronic inhalation of carbon tetrachloride. *Lancet* 1977; **i:** 1015.
2. Johnson BP, *et al.* Cerebellar dysfunction after acute carbon tetrachloride poisoning. *Lancet* 1983; **ii:** 968.
3. Perez AJ, *et al.* Acute renal failure after topical application of carbon tetrachloride. *Lancet* 1987; **i:** 515–6.
4. Health and Safety Executive. Carbon tetrachloride, chloroform. *Toxicity Review 23*. London: HMSO, 1992.
5. Manno M, Rezzadore M. Critical role of ethanol abuse in carbon tetrachloride poisoning. *Lancet* 1994; **343:** 232.
6. WHO. Carbon tetrachloride health and safety guide. *IPCS Health and Safety Guide 108*. Geneva: WHO, 1998. Available at: http://www.inchem.org/documents/hsg/hsg/hsg108.htm (accessed 29/06/04)

Treatment of Adverse Effects
If carbon tetrachloride vapour has been inhaled the patient should be removed to the fresh air. Clothing contaminated by liquid should be removed and the skin washed. If carbon tetrachloride has been ingested gastric lavage may be performed if the patient presents within 1 hour and activated charcoal may be given.

The usual symptomatic and supportive measures should be instituted. Hepatic and renal function should be monitored closely. Haemodialysis or peritoneal dialysis may be needed if renal function is impaired. Adrenaline or other sympathomimetics should be avoided because of the risk of precipitating cardiac arrhythmias.

Acetylcysteine (p.1550) may be given to patients recently exposed to carbon tetrachloride in an attempt to prevent or modify hepatic and renal damage.

Pharmacokinetics
Carbon tetrachloride is readily absorbed after inhalation and ingestion. It is also absorbed through the skin. Metabolism to reactive free radicals is thought to account for the hepatorenal toxicity of carbon tetrachloride.

Carbon tetrachloride is slowly excreted from the body via the lungs and the urine.

Uses
Carbon tetrachloride is employed in industry as a solvent and degreaser. It was formerly used in certain types of fire extinguisher and as an industrial and domestic dry cleaner but has been largely replaced for this purpose by less toxic substances. Carbon tetrachloride has also been used for the fumigation of cereals.

Carbon tetrachloride was formerly given orally as an anthelmintic but it has been superseded by equally effective and less toxic drugs.

Cyclohexane

Ciclohexano; Cykloheksan; Hexahydrobenzene; Hexamethylene.

Циклогексан

C_6H_{12} = 84.16.

CAS — 110-82-7.

Description. Cyclohexane is a colourless, flammable liquid. Wt per mL about 0.78 g. B.p. about 81°. Store in airtight containers.

Adverse Effects
Cyclohexane is irritant, and may also have effects on the CNS.

◊ Reviews of the toxicity of cyclohexane.

1. Health and Safety Executive. Cyclohexane, cumene, paradichlorobenzene (p-DCB), chlorodifluoromethane (CFC 22). *Toxicity Review 25*. London: HMSO, 1991.

Uses
Cyclohexane is used as an industrial solvent.

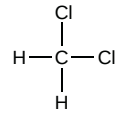
Dichloromethane

Cloruro de metileno; Dichlormethan; Diclorometano; Diklórmetán; Methylene Chloride; Méthylène, chlorure de; Methyleni chloridum; Metileno cloridas; Metyleenikloridi; Metylenklorid; Metylenu chlorek.

Дихлорметан

CH_2Cl_2 = 84.93.

CAS — 75-09-2.



Pharmacopoeias. In *Eur.* (see p.vii). Also in *USNF.*

Ph. Eur. 6.2 (Methylene Chloride; Dichloromethane BP 2008). A clear, colourless, volatile liquid. Relative density 1.320 to 1.332. It may contain not more than 2% of alcohol and/or not more than 0.03% of 2-methylbut-2-ene as stabiliser. Sparingly soluble in water; miscible with alcohol. Store in airtight containers. Protect from light.

USNF 26 (Methylene Chloride). A clear, colourless, mobile liquid having an odour resembling chloroform. Sp. gr. 1.318 to 1.322. Miscible with alcohol, with ether, and with fixed and volatile oils. Store in airtight containers.

Stability. Phosgene is produced on heating of dichloromethane.

Adverse Effects and Treatment
Acute exposure to dichloromethane vapour may depress the CNS; symptoms progress from headache and dizziness to coma and death in severe cases. Pulmonary oedema has been reported. Significant exposure may result in raised blood concentrations of carboxyhaemoglobin and symptoms of carbon monoxide poisoning. Cardiovascular effects have been attributed to hypoxia secondary to carboxyhaemoglobinaemia. There has been a report of haemolysis after acute ingestion of dichloromethane.

Chronic occupational exposure to dichloromethane vapour has produced gastrointestinal disturbances in addition to symptoms observed after acute poisoning. Dichloromethane is a common constituent of paint strippers and may be implicated in volatile substance abuse (p.2019).

The liquid is irritant and high concentrations of the vapour are irritant to the eyes.

Treatment of acute poisoning consists of removal from exposure and supportive and symptomatic measures. Carboxyhaemoglobinaemia should be managed as for carbon monoxide poisoning (p.1688) by giving 100% oxygen; hyperbaric oxygen may be indicated. After ingestion gastric lavage or activated charcoal are generally contra-indicated, although gastric aspiration may be considered in serious cases if the airway can be protected. Adrenaline and other sympathomimetics should also be avoided because of the risk of precipitating cardiac arrhythmias.

◊ References.

1. WHO. Methylene Chloride. *Environmental Health Criteria 32*. Geneva: WHO, 1984. Available at: http://www.inchem.org/documents/ehc/ehc/ehc32.htm (accessed 29/06/04)
2. Health and Safety Executive. Dichloromethane (methylene chloride). *Toxicity Review 12*. London: HMSO, 1985.
3. WHO. Methylene chloride health and safety guide. *IPCS Health and Safety Guide 6*. Geneva: WHO, 1987. Available at: http://www.inchem.org/documents/hsg/hsg/hsg006.htm (accessed 29/06/04)
4. Rioux JP, Myers RAM. Methylene chloride poisoning: a paradigmatic review. *J Emerg Med* 1988; **6:** 227–38.
5. Manno M, *et al.* Double fatal inhalation of dichloromethane. *Hum Exp Toxicol* 1992; **11:** 540–5.
6. Dhillon S, Von Burg R. Methylene chloride. *J Appl Toxicol* 1995; **15:** 329–35.
7. Chang YL, *et al.* Diverse manifestations of oral methylene chloride poisoning: report of 6 cases. *J Toxicol Clin Toxicol* 1999; **37:** 497–504.
8. Jacubovich RM, *et al.* Facial nerve palsy after acute exposure to dichloromethane. *Am J Ind Med* 2005; **48:** 389–92.

Pharmacokinetics
Dichloromethane is rapidly absorbed after inhalation and is also absorbed after ingestion and slowly through intact skin. It appears to be partially metabolised to carbon dioxide and carbon monoxide which are exhaled, although significant blood-carboxyhaemoglobin concentrations may be attained. Some unchanged dichloromethane is exhaled and small amounts are excreted in the urine.

Uses
Dichloromethane is used as a pharmaceutical and industrial solvent. It is also employed as an extraction solvent in food processing.

Dichloromethane is widely used in paint strippers.

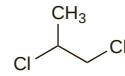
Dichloropropane

Dicloropropano; Propylene Dichloride. 1,2-Dichloropropane.

Дихлорпропан

$C_3H_6Cl_2$ = 113.0.

CAS — 78-87-5.



Description. Dichloropropane is a colourless, mobile, flammable liquid. Wt per mL about 1.16 g. B.p. about 96°. Store in airtight containers.

Adverse Effects
Dichloropropane is irritant; high concentrations may result in CNS depression.

◊ Acute renal failure, haemolytic anaemia, acute liver disease, and disseminated intravascular coagulation has been reported[1] after intentional inhalation of a stain remover containing dichloropropane; the patient recovered after blood transfusions and haemodialysis.

1. Locatelli F, Pozzi C. Relapsing haemolytic-uraemic syndrome after organic solvent sniffing. *Lancet* 1983; **ii:** 220.

Uses
Dichloropropane is used as an industrial solvent, dry cleaning agent, and agricultural defumigant.

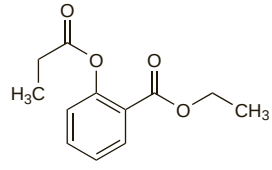
Diethyl Phthalate

Diéthyle, phtalate de; Diethyl-ftalát; Diethylis phthalas; Dietilftalát; Dietilo ftalatas; Dietylftalat; Dietyyliftalaatti; Ethyl Phthalate; Ftalato de dietilo. Benzene-1,2-dicarboxylic acid diethyl ester.

Диэтилфталат

$C_{12}H_{14}O_4$ = 222.2.

CAS — 84-66-2.



Pharmacopoeias. In *Eur.* (see p.vii) and *Viet.* Also in *USNF.*

Ph. Eur. 6.2 (Diethyl Phthalate). A clear, colourless or very slightly yellow, oily liquid. Relative density 1.117 to 1.121. Practically insoluble in water; miscible with alcohol. Store in airtight containers.

USNF 26 (Diethyl Phthalate). A colourless, practically odourless, oily liquid. Sp. gr. 1.118 to 1.122 at 20°. Insoluble in water; miscible with alcohol, with ether, and with other usual organic solvents. Store in airtight containers.