

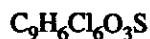
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR ENDOSULFAN

INTRODUCTION

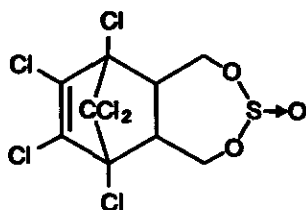
This guideline summarizes pertinent information about endosulfan for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Structure



• Synonyms

6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide; Benzoepin; Beosit; Chlorthiepin; Crisulfan; Cyclodan; Devisulphan; Endocel; Endosol; Ensure; Hildan; Insectophene; Kop-Thiodan; Malix; Niagara 5,462; Thiodan; Thifor; Thiosulfan; Tiovel

• Identifiers

1. CAS No.: 115-29-7
2. RTECS No.: RB9275000
3. DOT NA: 2761 55
4. DOT label: Poison

• Appearance and odor

Endosulfan is a tan, semi-waxy solid that is a mixture of two isomers; it may have a slight, sulfur dioxide-like odor. This substance is an organochlorine pesticide.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 406.95
2. Boiling point: 106°C (222.8°F) at 0.7 mm Hg
3. Specific gravity (water = 1): 1.75 at 20°C (68°F)
4. Vapor density: Not applicable
5. Melting point: 108° to 110°C (226.4° to 230°F) alpha isomer; 208° to 210°C (406.4° to 410°F) beta isomer; 70° to 100°C (158° to 212°F) mixture
6. Vapor pressure at 25°C (77°F): 0.00001 mm Hg
7. Solubility: Insoluble in water; moderately soluble in most organic solvents; soluble in xylene, kerosene, chloroform, acetone, and alcohol.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Education and Information Division

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

8. Evaporation rate: Not applicable

Reactivity

1. Conditions contributing to instability: Heat, sparks, open flame, moisture, and air.
2. Incompatibilities: Edosulfan is incompatible with acids and alkalis (which can cause it to hydrolyze) and is corrosive to iron.
3. Hazardous decomposition products: Toxic gases (such as chlorine and oxides of sulfur) may be released in a fire involving endosulfan.
4. Special precautions: None reported

Flammability

The National Fire Protection Association had not assigned a fire hazard rating for endosulfan; this substance may burn, but it does not ignite readily.

1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits in air: Not applicable
4. Extinguishant: Use dry chemical, carbon dioxide, water spray, standard foam, or fog to fight fires involving endosulfan. Water may be ineffective, but it may be used to cool fire-exposed containers.

Fires involving endosulfan should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of endosulfan may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Dikes should be used to contain fire-control water for later disposal. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving endosulfan. Chemical protective clothing that is specifically recommended for endosulfan may not provide thermal protection unless so stated by the clothing manufacturer. Structural firefighters' protective clothing is not effective against fires involving endosulfan.

EXPOSURE LIMITS

• OSHA PEL

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for endosulfan [29 CFR 1910.1000, Table Z-1].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 0.1 mg/m³ as a TWA for up to a 10-hr workday and a 40-hr workweek for endosulfan. The NIOSH REL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure [NIOSH 1992].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned endosulfan a threshold limit value (TLV) of 0.1 mg/m³ as a TWA for a normal 8-hr workday and a 40-hr workweek. The ACGIH also assigns a "Skin" notation to endosulfan [ACGIH 1993].

• Rationale for limits

The NIOSH limit is based on the risk of convulsions associated with endosulfan exposure and the high toxicity in experimental female animals caused by endosulfan exposure [NIOSH 1992].

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to endosulfan can occur through inhalation, ingestion, eye or skin contact, and absorption through the skin.

• Summary of toxicology

1. *Effects on Animals:* Endosulfan causes central nervous system, kidney, liver, and testicular effects in animals. The dermal LD₅₀ in rabbits is 90 mg/kg [NIOSH 1993]. The 4-hr LC₅₀ is 80 mg/m³ in rats [NIOSH 1993]. The oral LD₅₀ is 18 mg/kg in rats and 7.4 mg/kg in mice [NIOSH 1993]. Farm animals ingesting endosulfan (dose not specified) exhibited ataxia and seizures [Hayes 1982]. Some rats given

oral doses (10 mg/kg/day) died after 15 days; at 5 mg/kg/day, rats survived but showed signs of liver damage at autopsy [Hayes 1982]. In one oral feeding study, rats tolerated endosulfan doses of 2.5 mg/kg/day for 24 months without effects, but feeding at a dose of 5 mg/kg/day for the same period reduced the growth and survival rates in female rats, caused changes in the kidneys of male rats, and caused blood changes in rats of both sexes [ACGIH 1991]. Oral doses of 10 mg/kg/day for 15 days caused degeneration of the somniferous tubules and a significant decrease in testis weight among male rats [ACGIH 1991]. A dose of 5 mg/kg/day or higher on gestation days 6 through 14 increased the mortality of rat dams and increased the rates of resorption and skeletal abnormalities in their offspring [ACGIH 1991].

2. *Effects on Humans:* Endosulfan causes central nervous system and respiratory effects in humans. The estimated lethal dose of endosulfan in humans is 50 to 500 mg/kg [Gosselin et al. 1984]. Suicides and accidental deaths have been described after acute exposure to endosulfan; these episodes resulted in gagging, vomiting, diarrhea, agitation, convulsions, foaming at the mouth, difficulty breathing, apnea, cyanosis, and loss of consciousness [Hayes 1982]. One or more seizures occurred in nine workers exposed to endosulfan while performing various tasks, including the bagging of a 50 percent water-wettable endosulfan powder. These workers experienced a prodromal syndrome consisting of malaise, nausea, vomiting, dizziness, weakness, confusion, and headache. Recovery occurred within a few days [ACGIH 1991; Hayes 1982]. In a case involving sub-chronic exposure, a worker cleaning vats that contained endosulfan residues developed malaise, fainting spells, and seizures; after 4 months of exposure, this worker had three consecutive seizures that resolved after emergency medical treatment. Later, gross cognitive deficits and agitation were diagnosed; 2 years later, this worker continued to have memory impairment, nominal aphasia, and poor visual-motor coordination [Aleksandrowicz 1979].

• **Signs and symptoms of exposure**

1. *Acute exposure:* The signs and symptoms of acute oral exposure to endosulfan include malaise, nausea, vomiting, dizziness, weakness, confusion, headache, nervousness, agitation, tremor, seizures, convulsions, diarrhea, difficult breathing, cyanosis, and loss of

consciousness. Inhalation exposure may cause nausea, confusion, excitement, flushing, and dry mouth.

2. *Chronic exposure:* The signs and symptoms of chronic exposure to endosulfan include malaise, fainting, seizures, convulsions, agitation, cognitive impairments, and respiratory impairment (including shortness of breath and cough).

• **Emergency procedures**

WARNING!
Exposed victims may die!
**Transport immediately to emergency
medical facility!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* **Immediately and thoroughly** flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.
2. *Skin exposure:* Endosulfan can be absorbed through the skin in lethal amounts. **Immediately** remove contaminated clothing and **thoroughly** wash contaminated skin with soap and water for at least 15 min.
3. *Inhalation exposure:* Move the victim to fresh air **immediately**. Have the victim blow his or her nose or use a soft tissue to remove particulates or residues from the nostrils.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if endosulfan or any material containing it is ingested:

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Have the victim drink a glass (8 oz) of fluid such as water.

—Induce vomiting by having the victim touch the back of the throat with a finger until productive vomiting ceases. Do *not* give syrup of ipecac because of possible onset of respiratory depression and seizures.

—Do *not* force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue*: Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures, the location and proper use of emergency equipment, and methods of protecting themselves during rescue operations.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve endosulfan and lead to worker exposures to this substance:

- Use as an insecticide for deciduous fruits, nuts, cotton and vegetables, ornamentals, tea, and coffee
- Use as an acaricide against aphids, thrips, beetles, foliar feeding larvae, cutworms, leafhoppers, the tsetse fly, and slugs

The following methods are effective in controlling worker exposures to endosulfan, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information on control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.

5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to endosulfan, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the central nervous system.

A preplacement medical evaluation is recommended to assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to endosulfan at or below the prescribed exposure limit. The health care professional should consider the probable frequency, intensity, and duration of exposure as

well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the central nervous system.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to endosulfan exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of endosulfan on the central nervous system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for endosulfan.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

Determination of a worker's exposure to airborne endosulfan is made using an OSHA Versatile Sampler (OVS-2) with a 13-mm XAD-2 tube (270/140 mg sections, 20/60 mesh) and an enclosed glass fiber filter. Samples are collected at a recommended flow rate of 1.0 liter/min until a

recommended air volume of 60 liters is collected. Analysis is conducted by gas chromatography using an electron capture detector. This method is described in the OSHA Computerized Information System [OSHA 1993].

PERSONAL HYGIENE

Endosulfan can be absorbed through the skin in toxic amounts. Therefore, if endosulfan contacts the skin, workers should flush the affected areas immediately with plenty of water for 15 minutes, and then wash with soap and water.

Clothing contaminated with endosulfan should be removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of endosulfan, particularly its potential to be absorbed through the skin in toxic amounts.

A worker who handles endosulfan should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where endosulfan or a solution containing endosulfan is handled, processed, or stored.

STORAGE

Endosulfan should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of endosulfan should be protected from physical damage and should be stored separately from alkalis, acids, heat, sparks, and open flame. Because containers that formerly contained endosulfan may still hold product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving endosulfan, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.

2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate the area of the spill or leak.
5. For small dry spills, use a clean shovel and gently place the material into a clean, dry container, creating as little dust as possible; cover and remove the container from the spill area.
6. For small liquid spills, take up with sand or other noncombustible absorbent material and place into of the spill to contain the endosulfan for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

The owners and operators of a facility must comply with EPA's emergency planning requirements if 1 lb or more of endosulfan is present at the facility.

- **Reportable quantity requirements for hazardous releases**

A hazardous substance release is defined by EPA as any spilling, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of containers) of hazardous substances. In the event of a release that is above the reportable quantity for that chemical, employers are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the proper Federal, State, and local authorities.

The reportable quantity for endosulfan is 1 lb. If an amount equal to or greater than this quantity is released within a 24-hr period in a manner that will expose per-

sons outside the facility, employers are required to do the following:

—Notify the National Response Center *immediately* at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].

—Notify the emergency response commission of any State likely to be affected by the release [40 CFR 355.40].

—Notify the community emergency coordinator of the local emergency planning committee (or relevant local emergency response personnel) of any area likely to be affected by the release [40 CFR 355.40].

- **Community right-to-know requirements**

Employers are not required by Section 313 of the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022] to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of endosulfan emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity, as defined in 40 CFR 261.21-261.24. Endosulfan is listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.] and has been assigned EPA Hazardous Waste No. P050. Endosulfan is approved for land disposal as long as the concentration of endosulfan in the waste or treatment residual does not exceed 0.13 mg/kg. Endosulfan also may be disposed of in an organometallic or organic lab pack that meets the requirements of 40 CFR 264.316 or 265.316.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, rele-

vant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

• Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of endosulfan exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

• Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent any skin contact with endosulfan. Chemical protective clothing

should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. One source recommends the use of protective gloves and clothing made of Viton or neoprene for protection against permeation by endosulfan.

If endosulfan is dissolved in an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which endosulfan might contact the eyes (e.g., through dust particles or splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with endosulfan. Contact lenses should not be worn if the potential exists for endosulfan exposure.

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