

Occupational Health Guideline for Diphenyl*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_6H_5C_6H_5$ or $C_{12}H_{10}$
- Synonyms: Biphenyl; phenylbenzene
- Appearance and odor: Colorless to pale yellow solid with a very characteristic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for diphenyl is 0.2 part of diphenyl per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1 milligram of diphenyl per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Diphenyl can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin. (It may be absorbed through the skin).

• Effects of overexposure

1. Short-term Exposure: Exposure to diphenyl may cause irritation of the eyes and throat.

2. Long-term Exposure: Repeated exposure to diphenyl may cause headache, nausea, indigestion, abdominal pain, fatigue, numbness, and aching of the limbs (nervous system damage), and liver damage.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to diphenyl.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to diphenyl at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from diphenyl exposure.

—Liver disease: Exposure to high concentrations of vapor may incur damage to the liver, to which individuals with pre-existing liver disease may be more susceptible.

—Skin disease: Diphenyl can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Central nervous system disorders: Exposure to high concentrations of vapor may cause damage to the central nervous system, to which individuals with pre-existing conditions may be more susceptible.

—Kidney disease: Although diphenyl is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with possible impairment of renal function.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

• Summary of toxicology

At concentrations of $5 mg/m^3$ or higher, irritation of the eyes and throat has been reported. Employees with repeated exposure to higher concentrations had gastrointestinal symptoms as well as polyneuritic complaints, with abnormalities of both the electroencephalogram and the electromyogram. Some showed hepatic damage detected by liver function tests and biopsy, and one fatal case of liver necrosis with some areas of cirrhosis occurred in an individual who had been exposed regularly to concentrations of vapor in air of approximately $100 mg/m^3$. At higher concentrations, mice and rats

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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showed damage to the liver and kidney, as well as broncho-pulmonary effects.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 154
2. Boiling point (760 mm Hg): 254 C (489 F)
3. Specific gravity (water = 1): 1.04
4. Vapor density (air = 1 at boiling point of diphenyl): Not applicable
5. Melting point: 69 C (156 F)
6. Vapor pressure at 20 C (68 F): Very low
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving diphenyl.

4. Special precautions: None

• Flammability

1. Flash point: 113 C (235 F) (closed cup)
2. Autoignition temperature: 538 C (1004 F)
3. Flammable limits in air, % by volume: Lower: 0.6 at 111 C (212 F); Upper: 5.8 at 155 C (311 F)
4. Extinguishant: Water, dry chemical, carbon dioxide, and foam.

• Warning properties

1. Odor Threshold: The *AIHA Hygienic Guide* states that diphenyl has a "distinctive aromatic odor" which is detectable at 0.06 to 0.29 mg/m³.

2. Eye Irritation Level: Concerning eye irritation, the *Hygienic Guide* reports that "mild to moderate irritation is reported by humans exposed to the vapor." Grant reports that when concentrations of 3 to 4 ppm of Dowtherm A (a mixture of diphenyloxide (75%) and diphenyl (25%)) are reached, there is irritation of the eyes, nose, and throat."

3. Evaluation of Warning Properties: Since the odor threshold of diphenyl is well below the permissible exposure limit, diphenyl is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Method

An analytical method for diphenyl is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solid diphenyl or liquids containing diphenyl.

• If employees' clothing may have become contaminated with solid diphenyl, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with diphenyl should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of diphenyl from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the diphenyl, the person performing the operation should be informed of diphenyl's hazardous properties.

• Non-impervious clothing which becomes contaminated with diphenyl should be removed promptly and not reworn until the diphenyl is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of molten diphenyl contacting the eyes.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where solid diphenyl or liquids containing diphenyl may contact the eyes.

SANITATION

- Skin that becomes contaminated with solid diphenyl or liquids containing diphenyl should be promptly washed or showered with soap or mild detergent and water to remove any diphenyl.
- Eating and smoking should not be permitted in areas where solid diphenyl or liquids containing diphenyl are handled, processed, or stored.
- Employees who handle solid diphenyl or liquids containing diphenyl should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to diphenyl may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during mixing for paper impregnation process	Local exhaust ventilation; personal protective equipment
Liberation during impregnation process for producing wrapping papers	Local exhaust ventilation
Liberation during wrapping and packaging of citrus with diphenyl-impregnated paper	Local exhaust ventilation; personal protective equipment
Liberation during use as a dye carrier for plastics and synthetic resin dyeing; during production of derivatives as diphenyl oxide	General dilution ventilation
Use as a heat-transfer medium	General dilution ventilation; personal protective equipment
Liberation during solvent applications in producing allyl alcohol from propylene oxide or phenol	General dilution ventilation

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If diphenyl gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as

possible. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If diphenyl gets on the skin, immediately flush the contaminated skin with water. If diphenyl soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of diphenyl, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

If diphenyl has been swallowed, do not induce vomiting. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

- If diphenyl is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill.
3. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, use a procedure similar to that for small quantities.

- Waste disposal methods:

Diphenyl may be disposed of:

1. By making packages of diphenyl in paper or other flammable material and burning in a suitable combustion chamber.
2. By dissolving diphenyl in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Diphenyl," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Diphenyl," *Hygienic Guide Series*, Detroit, Michigan, 1964.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- Hakkinen, I., et al.: "Diphenyl Poisoning in Fruit Paper Production," *Archives of Environmental Health*, 26:70-74, 1973.
- Henderson, J. S., and Weeks, J. L.: "A Study of the Carcinogenicity for Skin of a Polyphenyl Coolant," *Industrial Medicine*, 42:2, pp. 10-21, February 1973.
- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Paget, G. E. (ed.): *Methods in Toxicology*, F. A. Davis, Philadelphia, 1970.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- *Survey of Compounds Which Have Been Tested for Carcinogenic Activity*, U.S. Public Health Service Publication No. 149, Original, Supplements 1 and 2, 1961-1967, 1968-1969, and 1970-1971.

* SPECIAL NOTE

Diphenyl appears on the Environmental Protection Agency's (EPA) Chemical Assessment Group "List of Chemicals" having substantial evidence of carcinogenicity (Environmental Protection Agency, Washington, D.C., 22 April 1980).

RESPIRATORY PROTECTION FOR DIPHENYL

Condition	Minimum Respiratory Protection* Required Above 1 mg/m ³ (0.2 ppm)
Particulate or Vapor Concentration	
10 mg/m ³ (2 ppm) or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust and mist filter(s). Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m ³ (10 ppm) or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust and mist filter(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust and mist filter. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
300 mg/m ³ (60 ppm) or less	A powered air-purifying chemical cartridge respirator with a full facepiece, organic vapor cartridge, and a high efficiency particulate filter. A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 300 mg/m ³ (60 ppm) or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

