

Occupational Health Guideline for Aniline*

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: $C_6H_5NH_2$
- Synonyms: Aminobenzene; phenylamine; aniline oil
- Appearance and odor: Colorless to brown, oily liquid with a weak amine odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for aniline is 5 parts of aniline per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 19 milligrams of aniline per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has recommended for aniline a Threshold Limit Value of 2 ppm with a skin notation.

HEALTH HAZARD INFORMATION

• Routes of exposure

Aniline can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It is readily absorbed through the skin, either as a liquid or vapor. Even a small amount absorbed from the clothes or shoes may cause toxic symptoms.

• Effects of overexposure

1. Short-term Exposure: Aniline affects the ability of the blood to carry oxygen. Moderate exposure to aniline may cause only a bluish discoloration of the skin. As oxygen deficiency increases, the blue discoloration may be associated with headache, weakness, irritability, drowsiness, shortness of breath, and unconsciousness. If treatment is not given promptly, death can occur. Aniline is irritating to the eyes and may cause eye damage. The onset of symptoms may be delayed.

2. Long-term Exposure: Repeated skin or respiratory exposure to aniline may cause headache, irritability, insomnia, dizziness, decreased appetite, paleness, and anemia.

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 aniline.

• Recommended medical surveillance

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

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the blood, cardiovascular system, liver, and kidneys should be stressed.

—A complete blood count: Aniline has been shown to cause methemoglobinemia. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

• Summary of toxicology

Aniline absorption, whether from inhalation of the vapor or skin absorption of the liquid, causes anoxia due to the formation of methemoglobin. Rats exposed to 5 ppm of vapor daily for 6 months showed no effects other than slight methemoglobinemia. Human exposure to vapor concentrations of 7 ppm has been observed to cause slight symptoms. Rapid absorption through the intact skin is frequently the main route of entry; a small amount absorbed from contaminated clothing or shoes may cause intoxication, characterized by cyanosis. Following skin absorption, the onset of symptoms may be delayed for up to 4 hours. Headache is commonly the first symptom and may become quite intense as the

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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severity of methemoglobinemia progresses. Cyanosis develops early in the course of intoxication, first in the lips, nose, and ear lobes, and is usually recognized by fellow workers. Cyanosis occurs when the methemoglobin concentration is 15% or more. The individual usually feels well, has no complaints, and may insist that nothing is wrong, although cyanosis is evident to observers, until the methemoglobin concentration approaches approximately 40%. At methemoglobin concentrations of over 40%, there usually is weakness and dizziness; up to 70% concentration, there may be ataxia, dyspnea on mild exertion, and tachycardia. The development of intravascular hemolysis and anemia due to aniline-induced methemoglobinemia has been postulated, but neither is often observed in industrial practice despite careful and prolonged study of numerous cases. Occasional deaths from asphyxiation caused by severe aniline intoxication are said to have occurred. Liquid aniline is mildly irritating to the eyes and may cause corneal damage.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 93.1
2. Boiling point (760 mm Hg): 184 C (364 F)
3. Specific gravity (water = 1): 1.022
4. Vapor density (air = 1 at boiling point of aniline): 3.22
5. Melting point: -6.2 C (21 F)
6. Vapor pressure at 20 C (68 F): 0.6 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 3.5
8. Evaporation rate (butyl acetate = 1): Less than 1

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact of liquid aniline with strong acids will cause violent spattering. Contact with strong oxidizers may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving aniline.

4. Special precautions: Liquid aniline will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: 70 C (158 F) (closed cup)
2. Autoignition temperature: 615 C (1139 F)
3. Flammable limits in air, % by volume: Lower: 1.3; Upper: Data not available

4. Extinguishant: Carbon dioxide, alcohol foam, dry chemical

• Warning properties

1. Odor Threshold: May reports an odor threshold for aniline of 7 ppm; the MCA reports that "the odor of aniline can usually be detected without difficulty in concentrations of 0.5 ppm," and Thienes and Haley report an odor threshold of 1 ppm.

2. Eye Irritation Level: The MCA reports that "aniline is mildly irritating to the eyes and may cause

corneal damage," but no quantitative information is given. Grant reports that "many years ago workers chronically exposed to crude aniline vapors had irritation of the eyes, photophobia, and impairment of vision," but he suggests that the disturbances of the cornea and conjunctiva which were observed might have been caused by "quinonelike oxidation products." Based upon the information reported by MCA, aniline is treated as an eye irritant for the purposes of this guideline.

3. Evaluation of Warning Properties: Since the odor threshold ranges from a concentration well below the permissible exposure limit to a concentration only slightly greater than the permissible exposure limit, aniline 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

Sampling and analyses may be performed by collection of aniline in an adsorption tube containing silica gel, followed by desorption with ethanol and gas chromatographic analysis. An analytical method for aniline is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

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 skin contact with liquid aniline, where contact may occur.
- Clothing contaminated with aniline should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of aniline from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the aniline, the person performing the operation should be informed of aniline's hazardous properties.
- Where exposure of an employee's body to liquid aniline may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with aniline should be removed immediately and not reworn until the aniline is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid aniline may contact the eyes.

SANITATION

- Skin that becomes contaminated with aniline should be immediately washed or showered with soap or mild detergent and water to remove any aniline.
- Eating and smoking should not be permitted in areas where liquid aniline is handled, processed, or stored.
- Employees who handle liquid aniline 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 aniline may occur and control methods which may be effective in each case:

Operation

Use in chemical synthesis and intermediates for rubber processing; use in production of MDI and PMPPi in manufacture of rigid polyurethanes; use in synthesis of dyestuffs and intermediates for dyestuffs

Use in synthesis of pharmaceuticals and intermediates for pharmaceuticals; synthesis of hydroquinone for photographic processing; synthesis of intermediates for agricultural chemicals

Use in manufacture of inks, for cloth marking inks, indelible inks, and lithographic and other printing inks

Use in production of PACM monomer in nylon fiber manufacture; use in synthesis of resins

Use in synthesis of intermediates for artificial sweetening agents

Use in synthesis of catalysts and stabilizers for hydrogen peroxide and cellulose; use in synthesis of corrosion inhibitors

Controls

Process enclosure; local exhaust ventilation; personal protective equipment

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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 aniline gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If aniline gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If

aniline soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. Get medical attention promptly.

- **Breathing**

If a person breathes in large amounts of aniline, 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**

When aniline has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. 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 DISPOSAL PROCEDURES

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

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

1. Ventilate area of spill or leak.

2. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

- Waste disposal methods:

Aniline may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

2. By atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volumes 4 and 7, 1974.

RESPIRATORY PROTECTION FOR ANILINE

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Vapor Concentration	
100 ppm or less	<p>A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</p> <p>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</p> <p>Any supplied-air respirator with a full facepiece, helmet, or hood.</p> <p>Any self-contained breathing apparatus with a full facepiece.</p>
Greater than 100 ppm or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p> <p>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.</p>
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	<p>Any gas mask providing protection against organic vapors.</p> <p>Any escape self-contained breathing apparatus.</p>

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

