

Formaldehyde

Introduction

Formaldehyde is a colorless gas that has a bitter odor. Formalin and paraformaldehyde are primarily used as fixatives, which act to preserve and stabilize cells and tissues prior to examination processes. The aqueous solution of formalin is 37-40 percent formaldehyde in water or methanol. Paraformaldehyde is the crystallized polymer of formaldehyde (97%) that is weighed out and dissolved in solution for experimentation or for cell and tissue fixation. Typically, 3-10% formalin or paraformaldehyde solutions are used to perfuse or fix tissues. The purpose of this procedure is to offer guidance on the safe handling of formaldehyde/formalin containing materials at Central Michigan University (CMU). Formaldehyde is widely used in teaching and clinical support laboratories at CMU. Failure to follow proper handling procedures can result in overexposure, leading to serious health concerns.

The Michigan OSHA Formaldehyde Standard (Part 306) establishes an 8-hour time weighted average permissible exposure limit (PEL) of 0.75 ppm, a 15-minute time weighted average short-term exposure limit (STEL) of 2.0 ppm, and a 0.5 ppm action level for an 8-hour time weighted average. The standard requires exposure monitoring and enrollment in the medical surveillance program for employees exposed above the action level or STEL.

Hazards

Michigan OSHA (MIOSHA) Part 306 states that formaldehyde is a complete carcinogen and appears to exert an effect on at least two stages of the carcinogenic process. The National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC) has determined that formaldehyde is carcinogenic to humans, with IARC classifying it as a Group 1 carcinogen. The health hazards of formaldehyde are primarily due to its toxic effects after inhalation, after direct contact with the skin or eyes in liquid or vapor form, and after ingestion. Formaldehyde is a sensitizing agent that can cause an immune system response upon initial exposure. Subsequent exposure may cause severe allergic reactions of the skin, eyes and respiratory tract. Formaldehyde is highly irritating to the upper airways with symptoms of dry or sore throat, itching and burning sensations of the nose, and nasal congestion. The concentration of formaldehyde that is immediately dangerous to life and health is 100 ppm. Concentrations above 50 ppm can cause severe pulmonary reactions within minutes while concentrations above 5 ppm readily cause lower airway irritation characterized by cough, chest tightness and wheezing.

Formaldehyde vapors may produce a sensation of irritation in the eyes with burning, itching, redness, and tearing. Accidental splash injuries with aqueous solutions of formaldehyde (formalin) have resulted in a wide range of ocular injuries including corneal opacities and blindness. The severities of the reactions have been directly dependent on the concentration of formaldehyde in solution and the amount of time elapsed before emergency and medical intervention.

Skin exposure to liquid formalin or formaldehyde vapor can provoke reactions of erythema, edema, and vesiculation or hives. In sensitized individuals, even when airborne concentrations of formaldehyde are well below 1 ppm, skin reactions may occur.

Acute effects from ingestion of formaldehyde can cause severe irritation and inflammation of the mouth, throat and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death. Ingestion of as little as 30 ml of a 37 percent solution of formaldehyde (formalin) can result in death.

Working with paraformaldehyde powder (and, to a lesser extent, flakes or granules), can expose employees to paraformaldehyde dust, which is a strong irritant/sensitizer. Contact with these solutions or paraformaldehyde solids may also cause drying of the skin and/or allergic dermatitis. Consult your Safety Data Sheet for more information on hazards. A useful link to the MIOSHA Formaldehyde Standard is provided below:

http://www.michigan.gov/documents/CIS_WSH_part306_37835_7.pdf

Medical Surveillance

Medical surveillance helps to protect employees' health by identifying potential reversible health problems early. If employees are exposed to formaldehyde at concentrations above 0.5 ppm as an 8-hour average or 2 ppm over any 15- minute period, the law requires CMU to provide medical surveillance at no cost to the employee. Even if exposure is below these levels, employees should inform their supervisor if signs and symptoms are suspected of being related to formaldehyde exposure. The surveillance plan includes a medical disease questionnaire and a physical examination, if the physician determines this is necessary. After a medical examination, the physician will provide a written opinion, which includes any special protective measures recommended and any restrictions on employee exposure. The physician must inform employees of any existing medical conditions which would be aggravated by exposure to formaldehyde. Based upon the physician's written recommendation, CMU will provide recommended accommodations at no cost to the employee. All employees working in an area where formaldehyde exposure is at or above the action level or STEL will be informed of the medical surveillance requirements.

Administrative Controls

All personnel are required to complete Laboratory Safety Training prior to working in a laboratory. BEFORE working with products containing formaldehyde, review the Safety Data Sheets (SDS), technical bulletins, and guidance documents to understand how to manage the hazards.

There must be an approved Standard Operating Procedure (SOP) in place before work begins with formaldehyde. Furthermore, all personnel shall read and fully adhere to this SOP when handling formaldehyde. Be sure to consult and review the Chemical Hygiene Plan before performing any work in the laboratory. Instructions and a template for SOP development may be

found in Appendix K of the Chemical Hygiene Plan on the Office of Laboratory and Field Safety website using the following link:

https://www.cmich.edu/office_provost/ORGS/Lab_Safety/Chemical_Safety/Pages/default.aspx

Training on lab-specific procedures, including the locations of fire extinguishers, safety showers, eyewashes, and fire alarms is required for all personnel and must be documented. Appendix I of the Chemical Hygiene Plan contains the Laboratory Safety Training Record form that must be completed for each worker in the laboratory. This form is found on the Office of Laboratory and Field Safety website using the following link:

https://www.cmich.edu/office_provost/ORGS/Lab_Safety/Chemical_Safety/Pages/default.aspx

Follow the Standard Operating Procedures (SOP's) for work practices involving formaldehyde-containing products. Perform tasks in a manner to limit exposure to formaldehyde and keep containers closed as much as possible.

As with all laboratory practices, be sure there is no food or drink in the laboratory. Wash hands frequently to minimize potential chemical exposure through ingestion and dermal contact.

For areas where exposure monitoring has been conducted and levels are found to be above the PEL or STEL, the area must be posted with the following information:

**DANGER
FORMALDEHYDE
IRRITANT AND CANCER HAZARD
AUTHORIZED PERSONNEL ONLY**

Label receptacles containing formaldehyde as follows:

**FORMALDEHYDE
CANCER HAZARD
AND SENSITIZER OF THE RESPIRATORY SYSTEM**

Engineering Controls

Local Exhaust – Local exhaust ventilation is designed to capture airborne contaminants as near to the point of generation as possible. Use local exhaust (such as a chemical fume hood) whenever possible to limit exposure.

General (Mechanical) Ventilation – General dilution ventilation involves continuous introduction of fresh air into the workroom to mix with the contaminated air and lower your breathing zone concentration of formaldehyde. Where devices emitting formaldehyde are spread out over a large area, general dilution ventilation may be the only practical method of control.

Safety Equipment and Personal Protective Equipment

Eyewash - If there is any possibility that an employee's eyes may be splashed with solutions containing 0.1 percent or greater formaldehyde, an eyewash/drench hose must be available within the immediate work area for emergency use.

Safety Shower - If employees' skin may become splashed with solutions containing 1 percent or greater formaldehyde, for example, because of equipment failure or improper work practices, the MIOSHA formaldehyde standard requires a conveniently located safety shower.

Fire Extinguishers –

Carbon dioxide or dry chemical extinguishers (ABC) should be used to fight formaldehyde fires. Use water spray to keep fire-exposed containers cool; containers may explode in the heat of a fire.

Formaldehyde Neutralizer –

In areas where large amounts of formaldehyde/formalin are present, it is recommended that SPILL-X-FP® formaldehyde polymerizer be available for use in case of spills (see below).

Eye protection –

- Chemical Splash goggles or safety glasses (with side shields) that meet the ANSI Z.87.1 1989 standard must be worn whenever working in a laboratory. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this standard and have side shields. When there is the potential for splashes, goggles must be worn. When appropriate, a face shield should be worn in addition to eye protection.

Skin protection –

- Wear proper PPE as determined from the standard operating procedure developed for each procedure involving formaldehyde; this may include standard nitrile gloves and lab coat.
- If a splash may occur, also wear an impervious apron.

Note: MIOSHA requires that all contact of the eyes and skin with liquids containing 1 percent or more formaldehyde be prevented by the use of chemical protective clothing made of material impervious to formaldehyde and the use of other personal protective equipment, such as goggles and face shields, as appropriate to the operation.

Respirators –

In the unlikely event that exposures are anticipated to exceed the STEL or PEL, respiratory protection will also be required. An air-purifying chemical-cartridge respirator will be provided to the employee after completion of respirator training and successful fit-testing of said respirator. Cartridges must be replaced after 3 hours of use or at the end of the work shift, whichever occurs first, unless the cartridge contains a NIOSH-approved end-of-service-life indicator (ESLI) to show when breakthrough occurs.

Emergency Procedures

Spills - Employees in the area should be prepared to clean up minor spills, including spills confined to the chemical fume hood. Try to keep the vapors from spreading using any ventilation or protective measures available. A commercially available product, SPILL-X-FP® formaldehyde polymerizer, should be available wherever formaldehyde or formalin are used and can be used for all spills (large or small) outside of a chemical fume hood. SPILL-X-FP agent is a urea-based formulation that chemically reacts with formaldehyde to form a urea-formaldehyde polymer (polynoxylin). Proper application of SPILL-X-FP® agent on spilled concentrated formaldehyde solutions or formalin actually results in the formation of a plastic-like material, which can quickly be removed. By eliminating the source of formaldehyde vapors, you are able to quickly remove the spill and restore operations. To clean up a spill, wear double nitrile gloves, splash goggles, face shield and lab coat (and impermeable apron, if available); use absorbent pads to absorb spilled material and place in a sealed container for disposal as hazardous waste. If a spill of appreciable quantity occurs, leave the area quickly unless you have specific emergency duties. Designated persons should isolate the hazard area and deny entry except for necessary people protected by suitable protective clothing and respirators adequate for the exposure. After the spill has been completely absorbed, wash down contaminated area with soap and water at least two times. If unable to handle the spill, call CMU police at 911, leave the area, and remain outside of the spill area until emergency responders arrive.

Contaminated PPE and clean-up materials must be placed in a hazardous waste container for pick-up that is clearly labeled with the following:

**HAZARDOUS WASTE
DANGER
FORMALDEHYDE-CONTAMINATED
CLOTHING/EQUIPMENT
AVOID INHALATION AND SKIN CONTACT
CANCER HAZARD AND SENSITIZER
OF THE RESPIRATORY SYSTEM**

Fire - Evacuate laboratory and call CMU police at 911 (using campus phone) or 774-3081 (using cell phone).

Consult the CMU Chemical Hygiene Plan, Section IX “CHEMICAL EMERGENCY ACTION” section of the Office of Laboratory and Field Safety web site for more information.

https://www.cmich.edu/office_provost/ORGS/Lab_Safety/Chemical_Safety/Pages/default.aspx

Storage

Formaldehyde containing materials and containers should be stored in a cool, dry, well-ventilated area and properly labeled. Use secondary containment whenever possible and use sealed containers.

Disposal

Formaldehyde-containing materials must be disposed as hazardous chemical waste. Liquid wastes must be collected in impervious, closable containers and identified as hazardous waste with appropriate labels. Biological specimens preserved in formaldehyde may be disposed in several ways. Where specimens constitute a very small fraction (i.e., < 5-10%) of the overall volume, collect as liquid waste, above. Where the tissue or specimens constitute a larger, bulkier fraction of the overall waste volume, the liquid fraction should be decanted and the wastes separated into solid and liquid streams. Use caution whenever decanting or straining to avoid free liquids remaining with the solids, and work only in a fume hood or use other local exhaust ventilation to prevent over-exposure to formaldehyde vapors. If the specimens were derived from humans, primates, or other mammals, the solid samples must be disposed of as potentially infectious biomedical waste using red biomedical waste disposal bags. Contact the Biosafety Officer for proper disposal of biomedical waste. (774-3279) Contact the Hazardous Waste Manager for proper disposal of formaldehyde/formalin containing materials. (774-3378) Consult the SDS for additional guidance on proper disposal methods.

Safety in the Anatomy/Dissection Laboratory

Introduction

Anatomical dissection is one of the most exciting and memorable experiences for students. Although performed for centuries, several aspects of dissection pose hazards that need to be recognized. Besides the obvious toxicity of the chemicals used to preserve cadavers, dissection also involves handling sharp surgical instruments and bone fragments that can cause lacerations and punctures, and contact with human tissue, even when “fixed” with preservative, may carry a risk (albeit low) of pathogenicity.

Chemical Hazards

Embalming has long been the method of choice for preserving cadavers. Embalming fluids are water-based solutions that typically contain alcohol, glycerine, phenol, and formaldehyde. These chemicals can affect the body by any route of exposure (inhalation, ingestion, skin contact, percutaneous inoculation). Although dermal exposures can play a role in sensitizing certain individuals, the inhalation of formaldehyde poses the most significant hazard because of its high vapor pressure and known toxicity.

Dissection exposures to formaldehyde have declined markedly over the past decade because of procedural and infrastructure improvements, i.e., using embalming fluid with a smaller amount of formaldehyde, changing cadaver handling protocols, and increasing room and local exhaust ventilation. Based upon monitoring data collected during actual dissection work in the CMU Human Anatomy Laboratories, students and staff have not been routinely over-exposed to formaldehyde, although the potential for overexposures does exist. Besides formaldehyde and phenol, cadavers can also release other compounds that contribute to the general “odor” of the anatomy laboratory. These include the odors of tissues and fats, and various gaseous decomposition products - compounds that are often unpleasant but not identifiable as hazardous. Exposure to chemicals during dissection is minimized through regular air monitoring to evaluate working conditions, maintaining high room air exhaust rates, proper operation of the ventilation system, and using personal protective equipment.

Physical Hazards

The use of sharp surgical instruments as well as the handling of splintered bone or cartilage carries a risk of lacerations, cuts, and punctures. Minimize this risk by keeping equipment in good working condition, working methodically and consciously to avoid accidents, and following safe techniques demonstrated by instructors. Remember to collect disposable sharps in the puncture-resistant containers provided, and never try to retrieve a discarded instrument.

Biological Hazards

Formaldehyde-based embalming fluid has a long and well-documented history as an effective sterilizer. Nevertheless, it is prudent to handle all human tissues, including embalmed cadavers, under “universal precautions.” Universal precautions is an approach to work that assumes,

from the start, that the material handled could potentially be infectious. Minimize your potential exposure by following the instructor's procedures, wear the appropriate personal protective equipment, never wear your dissection clothing elsewhere, and always wash your hands with soap and water when finished. Remember to be conscious of (and avoid) habits such as rubbing your eyes, chewing on pencils, or scratching your nose whenever working with human tissues, blood, blood products, or other potentially infectious materials.

Safety Guidelines for Anatomical Dissection

Never work alone in the anatomical (or any other) laboratory. Accidents can occur at any time, without warning, and your best assurance for help is a partner or nearby person.

Information about chemicals and other materials used in the anatomical dissection is available from the Human Anatomy Laboratory Manager or Instructor. These include Safety Data Sheets (SDS), copies of applicable health and safety standards, and detailed toxicological information.

Odors and chemical exposures The odor of embalmed cadavers is unpleasant, but exposures to formaldehyde and other chemicals are regularly monitored and have been generally found to be below regulatory limits. If you have an existing health condition, particularly respiratory, you may be more sensitive - notify your instructor as soon as possible.

Personal protective equipment (PPE) must be worn, including disposable or dedicated washable clothing (closed lab coat, scrubs), aprons, nitrile gloves, and safety glasses, goggles, or a faceshield. Based upon exposure monitoring, respirators are not required. Individuals sensitized to formaldehyde may require the use of a respirator. Contact the Human Anatomy Laboratory Manager for further direction.

Sharps must be handled with care, and disposed in special, puncture-resistant containers provided. Never try to retrieve a disposed object as serious injury could result.

Good personal hygiene habits are essential. Change out of your clothing as soon as you are finished working, and deposit them in the appropriate container. Wash hands thoroughly with soap and water. During work, be conscious about your hands, and avoid any contact with other parts of your body, especially the face, eyes, and mouth.

Accidents and emergencies must be attended to immediately. In the event of direct skin or eye contact, flush the affected area with water for at least 15 minutes; in the event of a cut or puncture, apply first aid and wash the area with soap and water immediately. Notify your instructor for help in obtaining further medical assistance. Call CMU Police (911) for assistance in cleaning up large, unmanageable spills.

References and Further Information

1. *Michigan Department of Licensing and Regulatory Affairs, Occupational Health Standards, Part 306 Formaldehyde.*
http://www.michigan.gov/documents/CIS_WSH_part306_37835_7.pdf
2. *Chemical Hygiene Plan*, University of Michigan Department of Occupational Safety & Environmental Health.
<http://www.oseh.umich.edu/pdf/ChemicalHygienePlan.pdf>
3. 29 CFR 1910.1048 (OSHA) Formaldehyde
<http://www.gpo.gov/fdsys/pkg/CFR-2006-title29-vol6/pdf/CFR-2006-title29-vol6-sec1910-1048.pdf>
4. *Formaldehyde Health & Safety*, Yale University Office of Environmental Health & Safety.
[http://ehs.yale.edu/sites/default/files/formaldehyde%20\(1\).pdf](http://ehs.yale.edu/sites/default/files/formaldehyde%20(1).pdf)
5. *SPILL-X-FP® formaldehyde polymerizer spill treatment agent, Data/Specification Sheet*, Ansul, Tyco Fire Protection Products.
<https://www.ansul.com/en/us/DocMedia/F-2009072.pdf>
6. OSHA Formaldehyde Fact Sheet
https://www.osha.gov/OshDoc/data_General_Facts/formaldehyde-factsheet.pdf
7. International Agency for Research on Cancer, Press Release number 153, June 15, 2004.
<http://www.iarc.fr/en/media-centre/pr/2004/pr153.html>
8. National Toxicology Program 14th report with new date located at <https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>