Formaldehyde

What is Formaldehyde?

Formaldehyde is a colorless, flammable gas at room temperature with a characteristic pungent odor. It has been used by both clinical diagnostic and research laboratories as a preservative or fixative for over a century.

It's mechanism of action for fixing lies in its ability to form cross-links between soluble and structural proteins. The resulting structure retains its cellular constituents in their in-vivo relationships to each other, giving it a degree of mechanical strength which enables it to withstand subsequent processing (e.g., immunohisto-staining, specimen grossing).

Formaldehyde is typically found dissolved in a water and methanol solution called formalin, or in a powder form called paraformaldehyde. Both are capable of releasing formaldehyde gas. The terms formaldehyde and formalin are often used interchangeably, but there are important differences in their concentrations. A fixative labeled 10% buffered formalin is actually a 4% solution of formaldehyde (i.e., a 10% solution made from a 37-40% solution of formaldehyde)

How is Formaldehyde Used at UMDNJ?

Formaldehyde is typically used as a fixative in 10% formalin or 4% paraformaldehyde solutions. In the research laboratories, very small amounts (i.e., mili-liter amounts and less) are used for denaturing RNA (e.g., Northern Blots), cross-linking proteins, fixing mammalian cell lines, and for tissue perfusions. The Pathology Department uses formalin to fix grossed tissue specimens. The morgues use approximately 20cc of 37% formaldehyde to fix the brains of cadavers.

Symptoms of Exposure

Because formaldehyde is very water soluble it affects the mucous membranes. The effects of formaldehyde exposure can vary from person to person. Typical exposure symptoms are listed below:

Concentration in Air	Symptoms
0.1-5 parts per million (ppm)	Eye irritation, tears , skin irritation , respiratory tract irritation
5-20 ppm	Burning of eyes and respiratory tract, tears, difficulty in breathing/coughing
20-100 ppm	Chest tightening, pain, irregular heartbeat, severe lung irritation, pulmonary edema, death in severe cases

Health Effects of Exposure to Formaldehyde

SKIN:
Formaldehyde is a severe skin irritant and sensitizer. Contact with formaldehyde solutions, vapor or resins can cause eczema (dry, flaking and itching skin) and in extreme case can lead to allergic dermatitis or hives. This is a skin disease that can appear as a simple rash to severe skin cracking and blistering, white discoloration, numbness and a drying or hardening of the skin. These symptoms can also be caused by contact with clothing contaminated with formaldehyde.

EYES:
Exposure to formaldehyde vapor can cause reddening and a burning sensation in the eyes, accompanied by tear production. Formaldehyde solutions coming into direct contact with the eye can cause serious damage to the cornea, possibly leading to blindness.

NOSE, THROAT AND LUNGS:
Low ambient concentrations of formaldehyde can cause irritation of the upper respiratory tract. At higher concentrations, the effects become more severe, with levels above 10 ppm causing coughing, chest tightness and difficulty breathing, and levels of 25 to 30 ppm causing severe respiratory tract injury. Exposure to 100 ppm is immediately dangerous to live and health leading to death from throat swelling and chemical burns to the lungs.

RESPIRATORY SENSITIZATION:
Repeated exposure to formaldehyde can cause allergic asthma. Symptoms of asthma include chest tightness, shortness of breath, wheezing, and coughing. Formaldehyde's long-term effects on the lungs are not fully understood.

CANCER:
Although there is no conclusive evidence available to prove that formaldehyde is a human carcinogen, exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages, and it has been shown to cause cancer in animals. Formaldehyde is therefore considered to be a **probable human carcinogen**, particularly as a cause of nasal and nasopharyngeal cancers as these areas are more likely to come into direct contact with formaldehyde, with repeated and prolonged exposure increasing the risk.

MUTAGENICITY:
Formaldehyde is genotoxic in several in vitro test systems, showing properties of both an initiator and a promoter.

REPRODUCTIVE SYSTEM:
Scientists have made many attempts to study whether formaldehyde might harm pregnancy or the reproductive system. The results have been mixed and complicated. Studies clearly show that formaldehyde does not cause birth defects. There is some uncertainty whether formaldehyde might cause spontaneous abortions and sperm damage. However, it is believed that exposures in most workplaces probably do not pose any significant risk to pregnancy or the reproductive system.

Controlling Formaldehyde Exposure

Regulatory Exposure Limits

The Occupational Health and Safety Administration (OSHA) has set two permissible exposure limits (PELs) for formaldehyde: 1) a 15-minute short-term exposure limit (STEL) of 2.0 ppm; and 2) an 8-hour time weighted average (TWA) exposure limit of 0.75 ppm. OSHA has also adopted an action level (AL) exposure limit of 0.5 ppm calculated as an 8-hour TWA.

PELs are the maximum amounts or concentrations of a chemical that a worker may be exposed to under OSHA regulations. PEL's can be defined in two different ways:

1) Ceiling values - at no time should this exposure limit be exceeded.
2) 8-hour Time Weighted Averages (TWA) - are an average value of exposure over the course of an 8 hour work shift.

Time Weighted Average (TWA) is the permitted exposure limit of airborne concentrations of substances that a worker may be exposed to over an eight hour working day for a five day working week. Higher levels of exposure are permitted provided they are compensated for by equivalent exposures below the standard during the working day (see STEL).

TWA levels are usually lower than ceiling values. Thus, a worker may be exposed to a level higher than the TWA for part of the day (but still lower than the ceiling value) as long as he is exposed to levels below the TWA for the rest of the day.

STELs are expressed as airborne concentrations of substances averaged over a period of fifteen minutes. Workers should not be exposed at the STEL concentration continuously for longer than fifteen minutes, or for more than four such periods per working day. A minimum of sixty minutes should be allowed between successive exposures at the STEL concentration.

Employee Information and Training

Employees who handle formaldehyde must receive annual training. The training shall include: information on the potential health hazards of formaldehyde and the signs and symptoms of exposure; a description of the operations in the work area where formaldehyde is present; an explanation of safe work practices and proper use of personal protective equipment; procedures to follow in the event of a spill or emergency, and the Medical Surveillance Program. A Material Safety Data Sheet (MSDS) for formaldehyde should always be kept in the work area where formaldehyde is being used. The MSDS and this Fact Sheet are excellent tools for training employees on the hazards of formaldehyde. MSDSs are available from the web at http://www2.umdnj.edu/eohssweb/publications/msds.htm Information on the hazards and well as the safe handling of formaldehyde solutions are also covered in both initial and refresher Laboratory Safety training.

The PEOSH Formaldehyde Standard (29 CFR 1910.1048) includes much information on the health hazards, safety precautions and emergency procedures for working with formaldehyde, is available at the following website: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10075&p_text_version=FALS

Controlling Formaldehyde Exposure *(continued)*

EXPOSURE MONITORING

Exposure monitoring may be required to ensure that employees are not over-exposed to formaldehyde vapors. Contact EOHSS for assistance in determining exposure monitoring needs in your laboratory if you work with formaldehyde.

MEDICAL SURVEILLANCE PROGRAM

Employees should immediately report any adverse signs or symptoms which they suspect may be caused by exposure to formaldehyde. Employees exposed to formaldehyde in an emergency situation should seek immediate medical attention.

UMDNJ employees and students who think they may have been over-exposed to formaldehyde vapors should contact Employee Health Services/Occupational Medicine Services or Student Health Services for their Campus.

VENTILATION

Formaldehyde should always be used with adequate ventilation, such as a ducted laboratory fume hood, to minimize inhalation of vapor. Prior approval from EOHSS is required for working with formaldehyde solutions outside a ducted laboratory hood. Use of a charcoal filtered hood (i.e., ductless hood) is not recommended for formaldehyde solutions.

EMERGENCY EQUIPMENT

An eyewash and a quick drench hose or an emergency shower are required in any area where formaldehyde is used.

EYE PROTECTION

Always use chemical goggles or a face shield when handling formaldehyde solutions to minimize the risk of even a small splash or vapor exposure to the corneas. If a face shield is worn, chemical goggles are also required if there is a possibility of a splash to the eyes.

BODY PROTECTION

Impervious clothing, such as an apron or gown must be worn when handling formaldehyde.

GLOVES

Medium or heavyweight nitrile, neoprene, natural rubber, or PVC gloves should be worn when handling concentrated formaldehyde (i.e., 37% solutions). Disposable (exam) nitrile gloves may be used when handling dilute concentrations (10% or less), but should be changed frequently. Visit the EOHSS website at: http://www2.umdnj.edu/eohssweb/publications/external.htm#Gloves for information on glove selection or contact EOHSS directly. Gloves that have not been contaminated with formaldehyde may be discarded in the regular trash. Disposable gloves contaminated with formaldehyde must be thoroughly rinsed before being discarded in the regular trash. Heavily contaminated gloves must be disposed of as chemical waste.

Controlling Formaldehyde Exposure *(continued)*

SAFE WORK PRACTICES

Be sure that formaldehyde solutions are clearly labeled with the chemical's name and hazards. A tray should be used for any work with formaldehyde, in order to contain potential spills. As with any laboratory chemical, do not mouth pipette formaldehyde solutions. Do not eat, drink, or smoke where formaldehyde is handled, processed, or stored, since the chemical can be ingested Always wash hands thoroughly after using formaldehyde, even if gloves are worn.

Spill cleanup material should be available in any area where formaldehyde is used or stored. Products such as formaldehyde neutralizing powders, or formaldehyde neutralizing pads can be placed where leaks or drips might occur.

LABELING

All containers where formaldehyde or formalin solutions are required to be used or stored only in designated areas with posted signage reading "Formaldehyde, potential cancer hazard - eye, nose, throat, respiratory and skin irritant". Containers should be clearly labeled with chemical name. Waste containers of formaldehyde solutions must be immediately labeled with UMDNJ Hazardous Waste labels are soon as the waste is generated.

STORAGE

Formaldehyde and its solutions should not be stored near strong oxidizers (e.g., permanganates, nitrates, peroxides, and chlorates), amines, acids, or alkaline materials. Formaldehyde reacts with HCL to form the potent carcinogen, bis-chloromethyl ether.

Store formaldehyde in labeled, chemically compatible containers, away from heat and flame. Large volume containers, such as 4-liter bottles, should be stored under the ducted laboratory hood, or on a low, protected shelf or in another location where they will not be accidentally spilled or knocked over. Containers larger than 4-liters should be stored inside a deep pan or other secondary containment. Do not store formaldehyde bottles in any area where a leak would flow to a drain.

Specimen containers should be stored in a tray or a secondary container such as heavy duty plastic storage containers, so that any spills would be contained. Formaldehyde storage areas should be checked weekly for any signs of leakage.

WASTE DISPOSAL

Formaldehyde, as all hazardous chemical waste, must be collected following the requirements of the UMDNJ Hazardous Waste Management Plan, which can be found on the EOHSS website at: http://www2.umdnj.edu/eohssweb/publications/hazwastemgmtplan.pdf. All containers must have appropriate lids and be clearly labeled using the UMDNJ Hazardous Waste labels.

Biological materials (i.e., human and non-human tissues) preserved in formaldehyde must be disposed of as medical waste with any remaining formaldehyde solutions collected and disposed of as chemical waste. If necessary, the formaldehyde solutions should be filtered prior to disposal, to remove any remaining bits of tissue. Pipette and collect excess paraformaldehyde solutions used for fixing mammalian cell lines (do not use the house vacuum for this purpose) in an appropriate chemical waste container for disposal through EOHSS.

Spills and Emergency Procedures

CHEMICAL SPILLS

All chemical spills must be reported to EOHSS by contacting the Public Safety general or emergency number for your Campus. For small spills of formaldehyde solutions (i.e., less than 50 cc or ml), apply a formaldehyde absorbent powder such as Spill-X-FP Formaldehyde Polymerizer, available from Lab Safety Supply, part number 2BW-9894-2. Place all spill clean-up materials in a labeled, plastic air tight bag and store in a well ventilated area. Do not use red bags for disposal of formaldehyde spills.

For larger spills (i.e., greater than 50 cc/ml) immediately leave the area and contact the Public Safety general or emergency number for your Campus, making sure to provide Public Safety with information on how to reach you from a safe area. If you are splashed with formaldehyde, use the emergency shower and eyewash immediately, to prevent serious injury.

EMERGENCY MEDICAL PROCEDURES

Skin contact:
Remove contaminated clothing immediately. Wash the affected area of your body with soap or mild detergent for at least 15 to 20 minutes. Report the incident to your supervisor and seek medical attention.

Eye contact:
Wash the eyes immediately with large amounts of water. Get medical attention immediately.

Ingestion:
Ingestion of small amounts of concentrated formaldehyde solution can cause severe irritation of the mouth, throat and stomach, and can lead to loss of consciousness and death. If the victim is conscious, give milk, activated charcoal or water, and get immediate medical attention.

Inhalation:
Seek fresh air and get immediate medical attention.

Contact Information:

E·O·H·S·S
ENVIRONMENTAL & OCCUPATIONAL HEALTH & SAFETY SERVICES

Newark Campus
(973) 972-4812 ◆ Fax (973) 972-3694

Piscataway/New Brunswick Campus
(732) 235-4058 ◆ Fax (732) 235-5270

Scotch Plains Campus
(908) 889-2486 ◆ Fax (908) 889-2496

Camden/Stratford Campus
(856) 566-6189 ◆ Fax (856) 566-6352

Website ◆ http://www2.umdnj.edu/eohssweb