

衛生福利部疾病管制署

## Formaldehyde fumigation

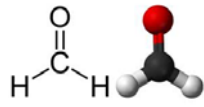
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中區傳染病防治醫療網  
王任賢 指揮官

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## Formaldehyde

$\text{CH}_2\text{O}$   
(Formaldehyde)




formalin=formaldehyde 40% aqueous solution

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## Chemical Description

- Chemical formula: HCHO
- Colorless gas with a pungent, suffocating odor
- Synonyms
  - Gaseous formaldehyde are methanal, methyl aldehyde, and methylene oxide
  - Aqueous solution is formalin
- Highly flammable gas or a combustible liquid
  - Vapors may travel to a source of ignition and flash back
  - Poisonous gases are produced if it catches on fire
  - Containers of formaldehyde may explode in fire



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## Formaldehyde

- The natural form of formaldehyde is a gas. However, formaldehyde is more readily available as a 40% aqueous solution called formalin. Gaseous formaldehyde is used for the fumigation of **buildings, rooms** or **vehicles** which can be sealed. Fumigation with formaldehyde is effective against most viruses and bacteria, including Mycobacteria.

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## Uses of Formaldehyde

- Preservative in medical laboratories
- Embalming agent in mortuaries
- Manufacture of urea, phenol, and melamine resins and for a variety of special industrial chemicals
- Adhesives in the manufacture of particle board, fiberboard, and plywood, and for molding, paper treating and coating, textile treating, surface coating, and foams for insulation
- Formaldehyde is also used as a treatment for athlete's foot, in cough drops, skin disinfectants, mouthwashes, spermatocreams, as a disinfectant for vasectomies and root canals

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## Formaldehyde gas

- Formaldehyde gas is relatively **unstable** and can sometimes **explode**. For formaldehyde fumigation to be complete, the **temperature** must be **above 13 °C** and **relative humidity** must be above **70%**. **Spraying with hot water** is sometimes necessary to achieve these conditions. For fumigation purposes, formaldehyde gas can be produced by **oxidizing formalin with potassium permanganate(高錳酸鉀)**.
- A **1-5% formalin solution** is sometimes used to **disinfect buildings** or as a prophylactic and therapeutic **foot bath** for foot rot in sheep and cattle. The use of formaldehyde in disinfectant situations is declining, due to the strong, irritant odour, corrosiveness, fibrolytic properties and toxicity.

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## Introduction

- In certain circumstances it will be necessary to fumigate MSCs and on occasion rooms for purposes of decontamination.
- The fumigant commonly used is formaldehyde; however this is an extremely toxic compound, which has a **Maximum Exposure Limit [MEL] of 2ppm**. At the end of the process the formaldehyde vapour must be vented to atmosphere to reduce the concentration as low as practicable below the MEL. This can present difficulties, particularly where recirculating MSCs are used.

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## fumigate cabinets in the following circumstances

- Before any maintenance work on the cabinet where the engineer needs to access potentially contaminated parts. E.g.: when HEPA filters are to be changed before carrying out filter penetration tests, when access to the internal fans is required. This would not include routine servicing of the MSC and KI OPF tests, except in circumstances shown below.
- Before any maintenance or testing is carried out on MSCs used in association with any Class 3 BA/GMO or any Class 2 organisms where the risk of exposure cannot be adequately managed by surface decontamination.
- Cabinets in which there has been a major spillage of viable material where inaccessible surfaces may have become contaminated. This should be carried out at the time of the incident or as early as possible after the incident has occurred.
- Where there are any significant changes to the nature of the work carried out. [e.g. use of a significantly different pathogen]

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## Indication of fumigation a BSC in TB laboratories

- replacement of HEPA filters;
- release of the BSC for use after a major biohazardous spill;
- repair work requiring access to the sealed plenum;
- service or replacement of the circulation fan or components;
- maintenance work in contaminated areas;
- performance tests requiring entry into contaminated areas;
- movement of the BSC cabinet to another laboratory;
- changing work programmes, e.g. to non-TB work;
- release of the BSC cabinet for resale or salvage

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## Hazard associated with formaldehyde: I

- Toxic properties
  - Formaldehyde is a highly toxic substance, corrosive and a severe irritant. It has been shown to cause cancer in animals.
  - It has a MEL of 2ppm which is a short-term exposure limit [STEL] and an odour threshold of 1ppm which is very close to the MEL. It is mandatory to ensure that the MEL is never exceeded and that exposure is kept below as low as practicable below the MEL. It should be noted that some individuals are not able to detect its presence, even at levels around or above the MEL and therefore may not be aware that they are being exposed, unless an appropriate monitoring device is used.

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## Hazard associated with formaldehyde: II

- Physical Properties
  - Formaldehyde is explosive at 7.75% in dry air. Above 600 C explosive air-vapour mixtures can be formed, unless the atmosphere is humid. Because it penetrates poorly in very dry conditions, for both safety and efficacy the conditions should be humid and warm [above 65% relative humidity and above 200C].
  - In order to achieve this, a proprietary fumigation kettle must be used to produce the required vapour.

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## Hazard associated with formaldehyde: III

- Chemical Interaction
  - Under certain conditions formaldehyde can react with hypochlorite and other chlorine containing chemicals such as Chlorox to form bis-(chloromethyl)-ether which is a known lung carcinogen. Chlorine containing compounds must therefore be removed from rooms and cabinets before fumigation

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### Control measure to reduce risk: I

- The first principal of control is to remove the hazard or substitute with something less harmful. Currently the **alternative** to fumigation is **vaporised hydrogen peroxide** which is less toxic but should only be used in strictly defined circumstances where its efficacy can be demonstrated.
- Fumigation with formaldehyde must be carried out in **accordance with a written protocol**.

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### Control measure to reduce risk: II

- The procedure must only be carried out by suitably **trained and authorised personnel**. This is a task for experienced technical staff and must not be undertaken by students.
- Sufficient **warning signs** must be displayed
- Where possible **rooms** should be **locked** to prevent entry.
- Remove sources of chlorine** from room/MSC
- Exposure to liquid formaldehyde during preparation should be kept to a minimum. When priming fumigation kettles the exact amount of formaldehyde should be dispensed into a small plastic universal container **within a fume cupboard** and then transferred to the MSC kettle.

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### Control measure to reduce risk: III

- In the case of room fumigation, the controls should be **operable from outside**.
- Use only **proprietary fumigation kettles**.
- Ensure the **integrity of seals** around MSC 'night blinds' and on any exhaust ducting. If necessary by the use of **duct tape**.
- Ideally cabinets should be **vented via the roof**, in which case Estates Officers must be informed in advance. Where it is necessary to vent via a window then care must be taken to ensure that **vapour cannot re-enter** into another area to impinge on passers-by.

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### Control measure to reduce risk: IV

- Suitable respiratory protective equipment** [full-face respirator] must be available for use in the event of emergency/inadvertent release. Staff must be trained in its correct use and the filter must be changed in accordance with manufacturer's instructions.
- A **formaldehyde meter must be available** and used to check that levels are below the MEL. **Checks should be made at frequent intervals**, as it has been known that levels can fall below the MEL and then build up again over time. The Safety Office has a formaldehyde meter which can be booked out on loan.

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### Recommended concentrations and contact times

- Sufficient formaldehyde should be vaporised to produce an airborne concentration of at least **50mg/m<sup>3</sup> for a minimum of 6 hours**. Use of **excessive amounts** can result in **polymer deposition** and may cause **filter blockage in the MSC**

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### Formaldehyde can be generated by

- Heating equal volumes of formalin solution and water [Bear in mind that formalin solution is 36% in water]
- Depolymerisation** of paraformaldehyde by **heating**, providing **adequate humidity** is available.


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## Routes of Exposure

- In clinical and laboratory settings exposure to formaldehyde typically occurs through **inhalation** and **skin exposure**
  - Inhalation occurs when containers are left uncapped, heated or instruments are not properly vented
  - Formaldehyde should be used in a chemical fume hood
- Skin exposure occurs when formaldehyde is in contact with skin or eyes. Proper personal protective equipment should be worn to minimize the amount of skin contact



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## Health Effects

- Formaldehyde is a potential human carcinogen.**
- Airborne concentrations above 0.1 ppm (parts per million parts of air) can cause irritation of the eyes, nose, and throat.
- Excessive inhalation of vapors can cause acute respiratory distress, chemical pneumonitis, and bronchial asthma .
- Skin contact may cause various skin reactions including irritation and sensitization.
  - Sensitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

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## Health Effects


- Acute: Eye and respiratory irritation can result from exposure to the liquid and vapor forms. Severe abdominal pains, nausea, vomiting and possible loss of consciousness could occur if ingested in large amounts.
- Chronic: High concentration of vapor inhaled for long periods can cause laryngitis, bronchitis or bronchial pneumonia. Prolonged exposure may cause conjunctivitis. Nasal tumors have been reported in animals.
- Know the health effects and if you experience any, report them to your supervisor immediately!**

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## How EH&S Monitors Exposure

- An Assay Technology ChemDisk monitor for formaldehyde is worn on the lapel to represent the breathing zone.
- Monitor is worn for at least 15 minutes or the duration of the procedure.
- The monitor is collected and sent to an AIHA accredited laboratory for testing.
- A report of the results is distributed to the supervisor and the employee.



Passive monitor to determine airborne exposure.

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## Exposure Monitoring

- When does EH&S perform air monitoring?
  - Initial assessment and potential air monitoring to determine baseline with current use and controls.
  - Annual monitoring thereafter to monitor employee exposures.
  - Periodic monitoring when initial results are above the limits or there is a change in the procedure.
- Air monitoring results are compared to OSHA and ACGIH limits.

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## Employee Exposure Limits for Formaldehyde

- OSHA
  - Action Level (AL), 0.5 ppm measured over 8 hours
  - Permissible exposure limit (PEL) 0.75 ppm measured as an 8-hour time weighted average (TWA)
  - Short Term Exposure Limit (STEL) is 2 ppm, maximum exposure allowed during a 15-minute period
  - If exposure exceeds any of these limits, changes must be made to reduce employee exposure.
- ACGIH TLV
  - Ceiling 0.3 ppm, instantaneous measurement if possible

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## Labeling and Storage

- Label must include:
  - Chemical name without abbreviations or symbols
  - Name of the responsible party
  - Hazard class
  - Date opened or expiration date recommended
- All mixtures and solutions, composed of 0.1 percent or greater formaldehyde and all materials capable of releasing formaldehyde in excess of 0.1 ppm must include a warning that **formaldehyde presents a potential cancer hazard**
- **Store in a secure, closed container below shoulder level in secondary containment with Class 9 carcinogens**

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## Required Training


- Initial Training
  - Completion of this presentation and passing grade on quiz
  - Specific training from supervisor on the safe use of formaldehyde in your work environment
- Annual training for all employees exposed to formaldehyde concentrations of 0.1 ppm or greater
  - ECU employees are generally not exposed to concentrations this high

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## Safe Use in Clinic or Laboratory

- Create a lab safety plan for formaldehyde use
  - [Model plan available](#)
- MSDS available
- Know the signs and symptoms of exposure
- Use only in areas designated for carcinogens
- Wear the appropriate personal protective equipment
  - Front or back closing lab coat
  - Safety goggles
  - Nitrile or neoprene gloves
    - Latex gloves do not provide any chemical resistance
  - No shorts or open toed shoes
- Wash hands, counters and equipment after use



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## Spills and Leaks

- Wear suitable personal protective equipment.
- Do not touch the spilled material; stop the leak if it is possible to do so without risk.
- Remove sources of ignition.
- Isolate the area so others do not inadvertently become exposed or transport the spilled material.
- If you cannot safely handle the spill, contact EH&S immediately at 328-6166.



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