Organic Solvents - used in degreasing, cleaning, thinners, paints, inks & adhesives

Introduction

The use of organic solvents is extremely widespread throughout the University and, while the degree of hazard may vary, all solvents should be considered potentially hazardous.

All people have an obligation to ensure workplace health and safety, by taking reasonable precautions and exercising proper diligence in the use of these solvents. A simple hazard evaluation and risk assessment process will enable these obligations to be met, and ensure that the appropriate control measures are implemented and maintained. The first step in this process should be the compiling of a hazardous substances register, containing material safety data sheets, storage locations and quantities, and risk assessment notes.

The risk assessment should outline the requirements for appropriate ventilation, work practices, personal protective equipment, storage and disposal to minimise the risk associated with acute and chronic health effects of solvent exposure.

Background

The basis for classification of organic solvents is by chemical composition. The members of the same class, in general, have similar solvent characteristics and chemical action. However, important variations in toxic effect often occur within the group. These harmful effects may follow inhalation of the vapour, eye or skin contact with liquid or vapour, or by ingestion. Inhalation is usually the most significant route of entry into the human body, while some organic solvents may be absorbed through the skin with or without causing damage to the skin itself.

A general summary of toxic responses is presented for organic solvents in a subsequent section. However, it is important to stress that solvents produce their own individual biological responses, and as such each solvent should be evaluated prior to its use. Where there is a likelihood that workers will be exposed to organic solvents, steps should be taken to minimise the exposure. Any exposure must be below the *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment* [NOHSC:1003(1995)]. Control measures would include elimination, substitution for less toxic products, enclosure of work procedures and processes, local exhaust ventilation, appropriate work practices, and the use of personal protective equipment to prevent skin contact and inhalation.

Organic solvents are routinely used for a variety of applications throughout the University, some of which include: degreasing processes in workshops, cleaning, synthesis operations in laboratories, paint carriers and thinners, and as pesticide carrier solvents. Chlorinated, aliphati and aromatic hydrocarbon, alcohol and ketone solvents are commonly used, either as pure reagent, or in complex proprietary mixtures.

Common Classes of Organic Solvents

Chlorinated	Aliphatic hydrocarbons	Aromatic hydrocarbons
trichloroethane	n-hexane	benzene
trichloroethylene	n-heptane	toluene
methylene chloride	pentane	xylenes
chloroform	cyclohexene	naphthalenes
carbon tetrachloride	cyclohexane	
tetrachlorethylene	petroleum ether	
Alcohols/Glycols/Ethers	**Esters/Ketones/Aldehydes**	**Others**
methanol	ethyl acetate	formaldehyde
ethanol	acetone	glutaraldehyde
propanol	methyl ethyl ketone	carbon disulphide
butanol	methyl isobutyl ketone	pyridine
ethylene glycol	methyl n-butyl ketone	amides
diethyl ether		amines

Products such as Stoddard solvent, turpentine, white spirits, kerosene and other mixed hydrocarbons contain a complex mixture of components determined by the petroleum sources, processing methods and mixing ratios. Generally, these petroleum products have relatively low toxicity but are highly flammable, and their storage, handling and use requires special fire prevention measures. Simple process assessments should ensure that there is no undue health and safety risk associated with their use.

Degreasing solvents such as Stoddard solvent, kerosene, mixtures of white spirits and halogenated hydrocarbons are widely used throughout the University. These solvents are often marketed under proprietary names which provide little information on the actual solvent composition. Careful consideration of each of the chemical components is required to determine the overall health hazard of these mixtures. In particular, products which contain n-hexane, benzene, trichloroethylene, methyl n-butyl ketone, diethyl ether, carbon tetrachloride, and carbon disulphide should be closely scrutinised. Efforts should be made, where practicable, to eliminate, substitute or minimise their concentration in the formulation to be used. If this is not possible further engineering controls such as enclosing the process or providing local exhaust ventilation, should be implemented.

In some instances, products are being marketed as *safety solvents*. This is usually because the product does not present a flammability hazard when used as directed. However, they may still have the potential to cause adverse health effect. Thorough review of these products prior to use is highly recommended.

Health Effects

Exposure to organic solvents can vary greatly depending on work conditions and practices. Exposures may be described as either acute (single dose, high concentration exposures over short periods), or chronic (repeated or continuous exposures over long periods) exposures. These exposures may initiate toxic responses with the part of the body with which they come into contact (local effects), or cause changes to the function of other organs (systemic effects). These responses may be immediate (acute) or delayed (chronic).

Respiratory tract

Vapours may be irritating to the lining of the respiratory tract, affecting the nose, throat and lungs. Asthma-like reactions have been reported with some organic solvents.

Skin

Solvent contact with the skin often causes drying, cracking, reddening and blistering of the affected area, leading to both irritant or allergic dermatitis. Absorption of solvents through the skin may also produce systemic health effects.

Eyes

Direct contact with vapour or liquid may cause eye irritation.

Liver

Many organic solvents are potentially toxic to the liver, either alone or in combination with other solvents.

Kidneys

Both short term and long term exposure to certain organic solvents has been found to be harmful to the kidneys. Carbon tetrachloride, trichloroethane and petroleum distillates are amongst the most toxic.

Cardiovascular system

Chlorinated hydrocarbon solvents (methylene chloride, chloroform and trichloroethane) may cause harmful effects on the heart, including abnormal heart rhythms and contribute to coronary heart disease.

Nervous system

Exposure to organic solvents can result in a variety of serious effects in both the central and peripheral nervous systems. The acute effects range from alcohol-like intoxication, stupor and insensibility, to unconsciousness and eventually lead to death from respiratory failure. Other symptoms may include drowsiness, headache, dizziness, gastric discomfort and nausea. Long term exposure to both n-hexane and methyl n-butyl ketone is associated with degeneration of nerve cells in the peripheral nervous system, resulting in symptoms such as restless legs, muscle cramps, pains , weakness and loss of sensation in the limbs. Long term repeated exposure may also effect the central nervous system. Symptoms may include fatigue, mood disturbance, difficulty in concentrating, memory loss, personality changes and loss of motivation. This damage may become permanent after extended exposure periods.

Organic solvent exposure and cancer

Benzene is the only common solvent which has been proven definitively to cause cancer in humans from industrial use, with extended exposure to benzene increasing the risk of leukaemia.

Other organic solvents have been shown to cause cancer in laboratory animals, and it is suspected that these solvents may pose a risk to workers who have long term exposure. Accordingly, appropriate steps should be taken to ensure that unnecessary exposure is avoided, and any such exposure is minimised to the lowest practical level.

Reproductive system

Although many studies remain inconclusive due to lack of control over confounding variables related to organic solvent exposure, it is likely that some solvents may affect male fertility, produce irregular menstrual flows, increase the rate of spontaneous abortion, congenital malformations and tumours, and other teratogenic effects. Carbon disulfide has been clearly identified as an occupational reproductive hazard. For further information relating to reproductive hazards, refer to the UQ Guideline for Reproductive Hazards and Work.

Recommendations

Elimination and Substitution

Whenever practical, a substance that gives rise to a harmful atmospheric contaminant should be eliminated or replaced by one with similar technical properties, but which is less harmful to health.

Consideration should be given to the use of water-based, heavy duty detergent cleaners instead of organic solvents, for the removal of dirt and grease on machinery equipment and parts. Where organic solvents are required in a process, investigations of both the technical suitability of the formulation and the health hazards associated with the solvent components are considered essential to determine the product's overall suitability.

Work Practices and Engineering Controls

It is important to prevent skin contact and inhalation of solvent vapours while conducting degreasing, cleaning or similar operations. Examples of some practical control methods follow:

- Avoid manual mixing and pouring by using sealed dispensing units for filling and emptying. This procedure reduces the generation of aerosols and vapours and reduces the opportunities for spillage.
- Enclose all cleaning, mixing and pouring procedures where possible. Ensure soaking containers of solvents are fully covered or sealed.
- Maintain good hygiene practices. Avoid leaning over solvent- containing vessels, and minimise skin contact and inhalation of vapours. After using solvents, wash gloves prior to removal. Wash hands prior to eating, drinking or using the toilet. Do not eat, drink, or smoke in the workplace.
- Do not use solvents for routine cleaning tasks, where a less toxic substance would be adequate.
- Degreasing, cleaning or similar operations should be situated in open areas or other locations with good ventilation. Vapours should not be allowed to infiltrate surrounding work areas. This is especially important where naked flames, sparks or welding operations are performed.
- In cases where degreasing, cleaning or similar operations are a regular occurrence, exhaust systems may be required to control vapour emissions.
- Solvents should be stored appropriately. Specific reference to *AS1940 The storage and handling of flammable and combustible liquids*, should be made for the appropriate storage requirements of flammable liquids.
- Appropriate disposal of waste solvents is important, and should follow sound waste disposal principles as outlined in the Environmental Management System Waste Management Program
- Atmospheric concentrations of solvent vapours should be kept as low as possible. The *Workplace Health and Safety Act 1995* requires that these levels not exceed the exposure standards recommended by *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment* [NOHSC:1003(1995)]. Monitoring methods are available to determine workplace atmospheric concentrations. Assessments should be undertaken by the OH&S Unit Occupational Hygiene Adviser to determine the effectiveness of current control strategies.

Personal Protective Equipment

Personal protective equipment should only be used where other methods of control (which generally reduce the risk in a more reliable manner) are not practical in the circumstances. When personal protective equipment is to be used, only Standards Australia approved products should be selected. Items of personal protective equipment such as respirators, gloves, disposable suits, and goggles must be evaluated to ensure suitability for use with the particular substance/s of concern.

Examples of appropriate equipment include:

- **Elbow length gloves** - the material type that should be used (rubber, pvc, butyl, nitrile, neoprene, etc.) is highly dependent on the solvent in use. Compatibility for use with a particular solvent must be investigated. Glove thickness, permeation and degradation rates are important considerations here. Surgical gloves are not effective in protecting against solvent exposure and should not be used for this purpose.
- **Apron** - pvc aprons are generally adequate to protect against splashes. In some instances whole body protection may be required, eg tyvek splash resistant suits.
- **Goggles** - large volume solvent work requires the use of chemical goggles. These are now available with anti-fog characteristics and can be worn over prescription glasses.
- **Respirator** - the important consideration here is the type of cartridge required to prevent inhalation of solvent vapour. Generally an organic vapour cartridge will be sufficient. However, cartridge suitability should still be checked for each solvent. Remember the limiting factor for respirator usage is the face seal. People with facial hair will not get an effective seal and other options will need to be considered.

Personal protective equipment should be personal issue items and only reused after thorough cleaning and decontamination.

Emergencies and First Aid

Written emergency procedures are needed for major spills and exposures. In the event of accidental contact, the skin or eyes should be flushed with running water immediately. When dealing with spills clear the affected area and use personal protective equipment. Isolate the leak, stop the flow and contain the spill with inert adsorbent material. Do not dispose to sewer. The spill should be collected and disposal arranged as outlined in Standard Operating Procedure 17.

Further Enquiries

For further enquiries contact the Occupational Health and Safety Unit on 07 - 3365 2365, and ask for the Occupational Hygiene Adviser.