

SOLVENTS



FOREWORD

This booklet forms part of a series on the protection of workers' health. It aims to highlight to employers and workers the potential dangers of organic solvents that can be encountered in industry and to offer advice on measures which can be adopted to minimize such dangers.

It is the responsibility of an employer to ensure that the working environment does not constitute a danger to the health of his employees. To achieve this, he must not only apply all recognized control measures but must be satisfied that his employees are aware of the hazards of solvents and that they strictly adhere to the safety principles at all times.

This booklet and others in the series are available free of charge from offices of the Occupational Safety and Health Branch of the Labour Department.

Occupational Safety and Health Branch
Labour Department
June 2000

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1

USES OF ORGANIC SOLVENTS

A wide variety of organic industrial solvents are used in many industries throughout the world. Many of these solvents may be harmful to health although there are others, equally efficient as solvents, which have less harmful effects.

An employer should know precisely which solvents are used in his factory and the health risks that they carry. This is in his own interests and constitutes part of an employer's responsibility to his employees. The solvents which present the greatest hazard to the health of those who work with them include: Benzene, Carbon tetrachloride, Chloroform, Ethylene dichloride, Tetrachloroethane and Carbon disulphide.

The various properties, uses and harmful effects of these solvents, and others in common use, are listed in this booklet as an appendix.

In Hong Kong exposure to organic solvents occurs most commonly in the following industries and trades:

a. Fabric Cleaning

Dry cleaning trades; garment and fur industries.

-Among workers associated with the operation of dry cleaning machines and particularly in those engaged in the cleaning of fabrics and furs by hand.

b. Metal Degreasing

All industries in which solvents are used for the cleaning of metal parts or machinery. These include the electronics and watch industries; garages and motor repair shops.

-Among workers engaged in the application of solvents by brushing, or wiping, or dipping, and by workers working with or close to hot degreasing tanks or solvent sprays.

c. Paints and Lacquers

Paint and lacquer manufacturers; furniture and rattan trades; car spraying; all other

trades engaged in painting or spraying; decoration of pottery and china.

-Among workers involved in paint or lacquer application, particularly spraying; in those engaged in adding or preparing thinner during the manufacture of paints and lacquers; in those engaged in the stripping of paint.

d. Printing

Offset printing and screen printing

-Among workers engaged in the operation of printing machines, particularly cleaning of rubber blankets or screens with solvents.

Other industries which may use solvents during the course of their business are: the plastics and rubber industries; industries using or manufacturing adhesives; manufacturers of fire extinguishers and refrigeration units.



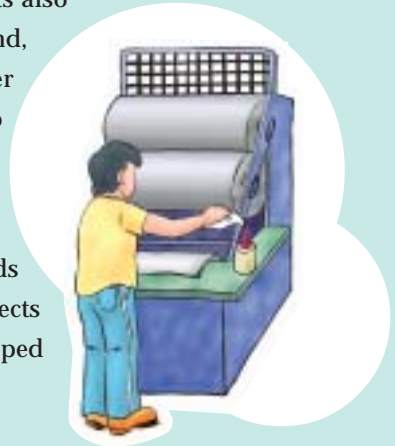
SOLVENTS AS A HAZARD TO HEALTH

ENTRY

Solvents may enter and affect the body by inhalation (breathing) or by absorption through the skin.

Inhalation - of solvent vapour or spray mist. This is more likely when hot solvent or spray is used but cold solvents also give off significant amounts of vapour and, because workers tend to work in closer contact with cold solvents, their use is no less dangerous.

Skin absorption - primarily by direct contact of the liquid solvent with the hands and arms of workers who are cleaning objects manually or handling objects recently dipped in or coated with solvent.



EFFECTS

Different solvents attack the body in different ways. However, their main effects can be broadly divided into two :

- (I) acute poisoning, resulting from the absorption over a short period of high concentrations of solvent ; and
- (II) chronic poisoning, the result of continued or repeated exposure to lower concentrations over a longer period of time. Abuse of solvents, e.g. 'gluesniffing' can lead to tragic deaths.

Acute poisoning

Narcosis - is generally the result of the inhalation of solvent vapour. The affected person first appears to be slightly drunk or light headed. He may laugh or talk nonsense or he may stagger around and his speech may become slurred; if the poisoning is severe, then he will lapse into unconsciousness, coma and possibly die.

Irritation of throat, eyes or skin - by either direct contact or inhalation. All irritating cough, red and stinging eyes, and a rash, commonly on the hands and arms, indicate that overexposure to solvents is taking place. A rash or dry cracked skin may occur following chronic exposure.

Chronic poisoning

Liver and kidney damage - following inhalation or direct contact. These serious and sometimes fatal effects may be indicated in the affected person by fatigue, loss of weight, abdominal pain, jaundice, passing of dark coloured or scanty amounts of urine. Damage to these organs may also follow acute poisoning with certain solvents.

Blood damage - may occur following exposure to some solvents, particularly benzene. The onset of anaemia is often gradual. The symptoms will include increasing general tiredness, weakness, pale complexion, dizziness, loss of appetite and loss of weight.

Effects on nervous system - After prolonged or repeated exposure to low concentrations of solvent, a worker may suffer from damages of the central nervous system. Changes in behaviour e.g. nervousness, irritability, incoordination, impairment of memory, vision and hearing may occur. Carbon disulphide is most notorious in causing these effects. Exposure to n-hexane and methyl butyl ketone can damage the peripheral nervous system and lead to muscle weakness and numbness.

Other non-specific symptoms may also be associated with poisoning by solvents. These include headache, dizziness, nausea, vomiting, cough and chest pain.



3 THE SAFE USE OF ORGANIC SOLVENTS

(a) Guide for Employers

Employers should understand firstly that no solvent is entirely harmless and that reasonable precautions must be taken to avoid exposing their employees to high concentrations of any solvent. **Literature on the safe use of the solvent which is normally provided by the solvent manufacturer should always be read and the advice followed.**

The fundamental principles of the safe use of solvents are:

(i) Substitution

Replacement of a harmful agent by a safer substitute (e.g. organic solvent by aqueous cleansing chemicals) is the best method of controlling a health hazard. Experience from many industries has shown that such substitution of relatively less harmful or toxic solvents for the more poisonous ones not only control the health hazard but may also result in an improved industrial process.



(ii) Closed systems

In chemical plants, closed or sealed systems are the rule, which is one reason why the manufacture of toxic substances is often less hazardous than their use. Dry cleaning plants and metal degreasing units should also be enclosed.

(iii) Ventilation

All workplaces using solvents should be well ventilated with air draughts removing vapours away from the workers. General ventilation should be supplemented by exhaust ventilation where necessary.

When the work area is air-conditioned, the ventilation mode of the air-conditioner should be switched to fully OPEN position to allow maximum air exchange with the exterior.



General ventilation system for areas where solvents are used should be segregated from the ventilation system of the whole premises.

Small degreasing tanks should be fitted with local exhaust ventilation preferably of the rim type. Paint and lacquer spraying must be carried out in chambers or cupboards with appropriate exhaust ventilation.

(iv) Supervision

Close supervision should be maintained by the management to ensure all control measures are implemented effectively and operated efficiently. No eating, drinking, smoking or sleeping in solvent using or handling areas should be strictly observed.

This is especially important in high-risk operations such as the cleaning of degreasing tanks and paint vats. Fatal accidents will be avoided if men work in pairs, so that while one man works inside the tank, the other remains outside on watch for accidents.

(v) Washing facilities

Washing facilities should be provided at convenient locations in the working premises for the employees to wash hands after being soiled. Appropriate cleaner and skin conditioner should be available for uses. Using solvents for skin cleaning should be discouraged.



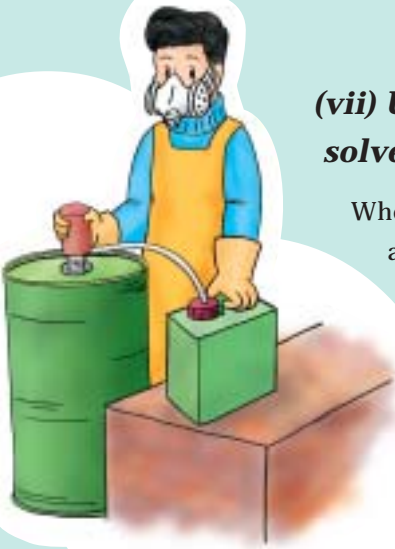
(vi) Housekeeping

All solvent containers should be properly covered to avoid unwarranted evaporation into the work environment. Self-closing metal bins are advisable for the disposal of solvent-soaked wastes. Spilled solvents should be cleaned up as soon as possible.



(vii) Uses, handling and transport of solvents

Whenever practicable, use only the minimum amount of solvent for the purpose. Mechanical devices, e.g. pumps, should be used whenever possible to avoid spillage and direct contact during solvent transfer.



(viii) Personal protection

Solvent-proof gloves, boots, sleeves and aprons should be supplied and used where required. Some materials will be degraded by specific organic solvents. (e.g. rubber gloves are not recommended to trichloroethylene). Hence, it is imperative that the suppliers/ manufacturers be consulted prior to making your choice. Every time before use, gloves should be tested for leakage. This can be done easily by blowing air into the gloves and observing for leakage.

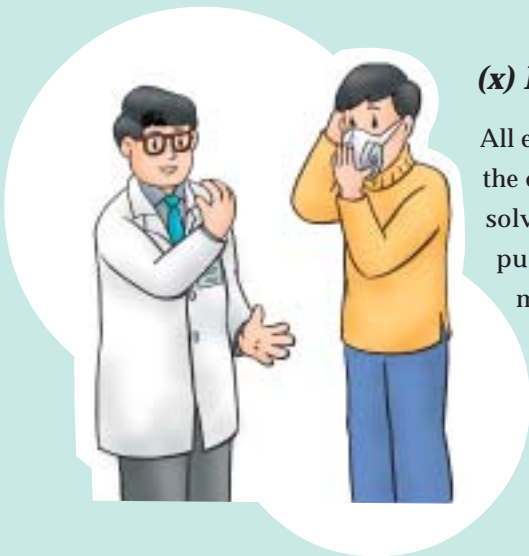
Respiratory protection is the last line of defence and should not be taken as a substitute for engineering control measures. However, when effective engineering control is not immediately feasible, or while it is being installed, appropriate respirators may be temporarily employed. Half-face or full-face respirators with suitable adsorbing medium for organic vapours may be considered. When not in use, the respirators should be sealed in air tight bags to avoid early saturation of the adsorbing medium. Air breathing equipment is essential for those engaged in the cleaning, from within, of large degreasing or paint vats.

(ix) Medical examination

Pre-employment medical examination may prevent susceptible individuals from possible injurious effects of organic solvents. For instance, anaemic individuals should not work with benzene and those with liver or kidney diseases should not work with organic solvents.

Periodic medical examinations are advisable for the early detection and management of possible adverse effect caused by exposure to organic solvents.

Biological monitoring should be included in the medical examination program as and when appropriate. It is a practical monitoring approach which has taken account of various routes of entry and host difference in absorption and susceptibility. Biological exposure indices (BEI) have been established for a number of solvents and they represent warning levels of biological response to the toxic substances, for example, 2,5-hexanedione in urine index for n-hexane and MBK exposure, and total trichloroethanol in blood index for 1,1,1-trichloroethane exposure.



(x) Health education

All employees should be instructed on the dangers involved in working with solvents and should understand the purpose of the various preventive measures.

(xi) Warning notices and safety regulations

These should be clearly displayed in the area where solvents are in use. For instance, chlorinated hydrocarbons, e.g. trichloroethylene, perchloroethylene, when in contact with naked flame or very hot surfaces will decompose to give off phosgene which is highly toxic. All employees should be educated on its toxic effects, and warning notice be displayed prohibiting any naked flame in the workplace where the organic solvent is used.

(xii) Maintenance

All control measures should be regularly checked and maintained to ensure high effectiveness and efficiency of performance. All personal protective equipment should be checked before use and repaired/ replaced as and when necessary. Do not use any defective protective equipment.



(b) Guide for Employees

(i) Remember that organic solvents are injurious to health.

(ii) Avoid breathing in the vapour or spray; many solvents do not give off odour or smell so do not rely on your sense of smell to detect them. Do not let liquid solvent come in direct contact with your skin or eyes. Protect yourself by the use of suitable gloves, boots, sleeves, aprons, respirators and goggles.

(iii) Observe all safety regulations, warning notices and follow safety instructions given by your employer.

(iv) Report ill-health to your supervisor. When you see your doctor, tell him that your work may bring you into contact with solvents and, if possible, tell him the names of particular solvents.



(v) Do not smoke or bring food into the workroom.

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THE CONTROL OF ORGANIC SOLVENTS IN THE AIR

Methods are available for measuring the concentration of a variety of organic solvents in air, and thus, any hazard created by the use of these substances can easily be detected. Exposure to dangerous concentrations of solvent vapours is avoidable in all cases. The Occupational Health Service will be pleased to give advice both on the health risk involved and on safety precautions which may be necessary.

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CONCLUSION

In the introduction to this booklet, it was pointed out that this series is aimed at drawing the attention of employers and employees to certain poisonous substances encountered in industry. This particular booklet sets out some of the hazards involved in the use of organic solvents and how they can be avoided. If you, as manager of an industrial undertaking, are using organic solvents in any process you should ask yourself the following questions:

- (1) Do I know what solvents are in use in my workplace?*
- (2) Have I taken all necessary steps to make the process safe?*
- (3) Are all workers aware of the dangers of working with organic solvents, and are precautions being observed in potentially dangerous processes such as the cleaning of degreasing tanks?*
- (4) Is supervision adequate?*
- (5) Do I need to arrange testing for organic solvents in the working atmosphere?*
- (6) Do I need to arrange medical examination for my staff?*



Further Information

If you are in any doubt whatever, please contact the Occupational Health Service of the Labour Department:

Address: 15/F, Harbour Building, 38 Pier Road, Central, Hong Kong

Telephone: 2852 4041

Facsimile: 2581 2049

E-mail: laboureq@labour.gcn.gov.hk

Website: <http://www.info.gov.hk/labour>

APPENDIX

COMMONLY USED SOLVENTS

Type	Name	Other Names	Uses	Fire hazard	Health hazard
Alcohols	Isopropyl alcohol	IPA	Solvent for soldering flux	Yes	Slight
Aliphatic hydrocarbons	Kerosene	Paraffin, kerosine	Metal degreasing	Yes	Slight
	n-hexane	Skellysolve B Hexane	Solvent for paints and adhesive	Yes	Moderate
Aromatic hydrocarbons	Benzene	Benzole, coal naphtha	Solvent for rubber, fat, grease, lacquer	Yes	Very dangerous
	Ethyl benzene	Ethyl benzol, Phenylethane	Solvent/diluent in gasoline, etc	Danger of explosion Yes	Moderate
	Toluene	Toluol, methyl benzene	Solvent for rubber, fat, grease, lacquer	Yes	Moderate
	Xylene	Xylol, xylol, dimethyl benzene	Solvent for rubber, fat, grease, lacquer	Yes	Moderate
	Styrene		Solvent for reinforced plastics	Yes	Moderate
Chlorinated hydrocarbons	Carbon tetrachloride	Tetra-chloromethane	Textile cleaning, Metal degreasing, Fire extinguishers	None*	Very dangerous

APPENDIX - contd.

Type	Name	Other Names	Uses	Fire hazard	Health hazard
	Chloroform	Trichloromethane	Bonding adhesive	None*	Very dangerous
	Dichloromethane	Methylene chloride	Paint remover, Refrigerant	None*	Moderate
	1,1,1-Trichloroethane	'Chlorothene' 'GenKlene'	Textile cleaning, Metal degreasing	None*	Slight
	Trichloroethylene	'Tri', 'Westrosol'	Textile cleaning, Metal degreasing	None*	Dangerous
	Tetrachloro-ethylene	Perchloroethylene	Textile cleaning, Metal degreasing	None*	Dangerous
	1, 2-Dichloroethane	Ethylene dichloride, Dutch oil	Metal degreasing	Yes*	Very dangerous
	o-Dichlorobenzene	O. D. C. B.	Textile cleaning, Insecticides	None,	Dangerous
	1, 2-Dichloroethylene dichloride	Acetylene dichloride	Textile cleaning, Metal degreasing	Yes*	Slight
	Tetrachloroethane	'Acetosol' 'Bonoform', 'Cellon'	Textile cleaning	None*	Very dangerous
Esters	n-Amyl acetate	Isoamyl acetate, banana oil, pear oil, 'Pentacetate'	Paint and lacquer solvent, Pearl essence	Yes	Moderate
	n-Butyl acetate	Butyl acetic ether	Paint and lacquer solvent, Pearl essence	Yes	Slight

APPENDIX - contd.

Type	Name	Other Names	Uses	Fire hazard	Health hazard
	Ethyl acetate	Acetic ether, vinegar naphtha	Paint and lacquer solvent, Pearl essence	Yes	Slight
	2-Ethoxy ethyl acetate	Cellulosolve acetate, ethylene glycol monoethylether acetate, Ethyl Oxital acetate Retarder X246, HMDS III	Retarder, Solvent for ink, nitrocellulose & resins	Yes	Slight
Ethers and ether alcohols	Diethyl ether	Ether, ethyl ether, ethyl oxide	Paint and lacquer solvent, Lenses cleaning	Yes, explosive	Slight
	Methyl cellosolve	Methyl glycol, 2-methoxy-ethanol	Solvent for lacquer and printing ink	Yes	Moderate
	n-Butyl cellosolve	2-butoxyethanol	Solvent for lacquer and printing ink	Yes	Moderate
Fluorocarbon solvents #	Fluoro trichloromethane	'Freon' MF, F11.	Degreasing of electronic components	None*	Slight
	1,1,2-Trichloro-1,2,2-trifluoroethane	'Freon' TF 'Arklone' P, F113	Degreasing of electronic components	None*	Slight
Glycols	Ethylene glycol	1, 2-ethanediol	Solvent for cosmetic manufacture	Yes	Moderate
	Ethylene glycol monomethyl ether	Methyl cellosolve	See methyl cellosolve	Yes	Moderate

APPENDIX - contd.

Type	Name	Other Names	Uses	Fire hazard	Health hazard
Ketones	Acetone	Dimethyl ketone, propanone	Metal degreasing	Yes	Slight
	Cyclohexanone	Keto-hexamethylene, pimelic ketone	Printing ink solvent	Yes	Moderate
	Isophorone	3, 5, 5-trimethyl 2-cyclohexene-1-one	Printing ink solvent	Yes	Moderate
	Methyl ethyl ketone	2-Butanone	Paint solvent, Printing ink solvent	Yes	Slight
	Methyl butyl ketone	MBK	Paint solvent	Yes	Moderate
	Others:	Turpentine		Paint solvent	Yes
	Carbon disulphide	Carbon bisulphide	Solvent for fats, oil, resin & waxes	Yes Danger of explosion	Very dangerous
	White gasoline	Petrol	Fuel, Metal degreasing, Cleaning of printing plates and rubber blankets	Yes	Moderate

Occupational exposure limits have been established for the above solvents. Please refer to 'A Reference Note on Occupational Exposure Limits for Chemical Substances in the Work Environment' for the values established.

* Dangerous fumes may be given off when in contact with hot surfaces.

#Banned from import by the Environmental Protection Department in 1996.



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Labour Department**