Chapter 1 : - NLM Catalog Result

Organic solvents are carbon-based substances capable of dissolving or dispersing one or more other substances. Organic solvents can be carcinogens, reproductive hazards, and neurotoxins. Carcinogenic organic solvents include benzene, carbon tetrachloride, and trichloroethylene.

This level involves both symptoms of neurotoxicity and abnormalities of performance on formal neuropsychological testing. The Type 2 disorder has been divided into Type 2A sustained personality or mood changes such as emotional instability and diminished impulse control and motivation and Type 2B impairment in intellectual function manifested by diminished concentration, memory, and learning capacity. The third and most pronounced level of disorder is described as severe chronic toxic encephalopathy WHO Workshop , or the Type 3 disorder International Solvent Workshop. The condition is characterized by global deterioration in intellectual and memory functions dementia that may be irreversible, or at best, only poorly reversible. Type 1 and 2 disorders are the most likely to be reported among solvent-exposed workers. Type 3 disorders to date have been seen only in individuals who have abused solvent-containing products i. For example, persons who abusively inhaled toluene almost daily for 1 to 7 years showed evidence of severe, multifocal CNS damage with cortical, cerebellar, and brain stem atrophy, electrophysiologic abnormalities, and neuropsychologic deficits Lazar et al. Neurophysiologic Effects Neurophysiologic methods are useful indicators of nervous system malfunction or damage Seppalainen Neurophysiologic effects of chronic exposure to a mixture of organic solvents were studied in Finnish automobile spray painters who had a mean employment time of These painters were exposed to mixtures of nine organic solvents, the main components of which were butyl acetate, toluene, white mineral spirits, and xylene. The potential exposure of each subject was graded as low, intermediate, or high, based on workplace measurements of the solvents and information provided by the subject or the employer Seppalainen et al. A followup study was conducted with 87 patients 3 to 9 years after they were diagnosed as having chronic solvent intoxication following occupational exposure mean of The frequency of slow nerve conduction velocities in these workers remained relatively similar, and electromyographic abnormalities fibrillations and loss of motor units increased. These results suggest that electrophysiologic abnormalities may be permanent even after workers are removed from organic solvent exposure Seppalainen and Antti-Poika Studies of groups of solvent-exposed workers have also shown statistically significant differences in EEG abnormalities when compared with unexposed populations. One study involved 30 workers who were exposed for a mean of 17 years to jet fuel composed of organic hydrocarbons. The EEG results suggest changes in neurologic function indicative of chronic organic solvent exposure. Neurobehavioral Effects When compared with groups of unexposed workers, groups exposed to solvents showed increases in subjective symptoms Type 1 , personality and mood changes Type 2A , and poor performance on tests of CNS function, which indicated intellectual impairment Type 2B. Neurobehavioral performance tests of CNS function i. Neurologic and psychologic tests were administered to 65 workers housepainters, paint and varnish factory workers, printers, dry cleaners, and boat factory workers exposed primarily to white mineral spirits, toluene, perchloroethylene, or styrene for a mean of Also noted was a statistically significant frequency 0. This condition has been reported in another study in connection with diffuse cerebral atrophy Willanger and Klee Fifty workers exposed to solvents in the paint industry for a mean of 18 years, and 50 unexposed matched controls received psychiatric and psychologic examinations Orbaek et al. This result suggests that the greater the exposure of workers to organic solvents, the more frequent the symptoms of mental disturbance. The psychologic examination consisted of a battery of psychometric tests for examining workers with suspected toxic encephalopathy. The exposed workers with indications of brain dysfunction were among the more heavily exposed subjects, indicating a possible relationship between exposure level and effect. Evaluations of neurobehavioral functions in groups of workers exposed to solvents have also addressed the reversibility of CNS effects resulting from solvent exposure.

Fifty-six workers were diagnosed as having occupational diseases caused by exposure to organic solvents primarily halogenated and aromatic hydrocarbons and mixtures of paint solvents for a mean duration of 9. The workers were given a series of psychologic tests 5 or more years after cessation of solvent exposure. Metabolism Absorption Inhalation and percutaneous absorption are the primary routes of solvent uptake into the peripheral blood, which begins within minutes of the onset of exposure WHO ; Engstrom et al. Uptake by inhalation is the principal route and depends on the following: Increased levels of physical exercise increase pulmonary ventilation and cardiac output and lead to increased pulmonary solvent uptake over baseline resting levels in volunteers. Percutaneous absorption is also a major route of entry for organic solvents that are readily soluble in both lipids and water. Immersion of both hands in xylene for 15 min produced blood concentrations of xylene roughly the same as those following inhalation of ppm for an equal period of time Engstrom et al. Solvent uptake through the skin depends on 1 duration of contact, 2 skin thickness, perfusion, and degree of hydration, and 3 the presence of cuts, abrasions, or skin diseases Riihimaki and Pfaffli ; Bird Distribution and Transformation Following absorption, organic solvents undergo biotransformation which occurs primarily in the liver , or they accumulate in lipid-rich tissues such as those of the nervous system WHO ; Bergman Metabolism in the liver generally consists of oxidative reactions catalyzed by the cytochrome P mixed-function oxidase system followed by conjugation with glucuronic acid, sulfuric acid, glutathione, or glycine. Metabolism usually results in the detoxication of the organic solvent through formation of water-soluble compounds that are excreted through urine or bile Toftgard and Gustafsson However, metabolism may also produce reactive intermediate metabolites that are more toxic than the parent compound. These metabolites are capable of covalently binding to essential macromolecules e. For example, n-hexane and methyl n-butyl ketone solvents that produce peripheral neuropathies in exposed workers [Herskowitz et al. This type of metabolic activation of solvents is believed to be mediated by the cytochrome P system, which is more predominant in extrahepatic tissues WHO Studies have been conducted on the modification of solvent metabolism rates in exposed workers by other exogenous substances, principally ethanol. The authors concluded that this increase in blood toluene concentration is possibly, a result of competition for alcohol dehydrogenase necessary for the metabolism of both toluene and ethanol. This result suggests an increase in toluene metabolism as a result of the alcohol-mediated induction of hepatic solvent- metabolizing microsomal enzymes Waldron et al. In a study of the metabolic, interaction of ethanol and xylene, 14 volunteers were exposed to m-xylene in an inhalation chamber, with and without prior ethanol ingestion Riihimaki et al. This result suggests an ethanol-mediated inhibition of microsomal xylene metabolism. Thus it appears that acute ethanol ingestion raises blood toluene and xylene concentrations through competition for metabolism, whereas chronic ethanol ingestion induces solvent-metabolizing enzymes and thereby lowers blood solvent concentrations. Workplace exposures to several solvents simultaneously or to solvent mixtures may result in similar metabolic interactions. Excretion Solvent elimination occurs through exhalation of the parent compound in expired air or through urinary or biliary excretion of water-soluble metabolites or of unchanged solvent. Because excretion kinetics vary among compounds kinetics must be considered in planning biologic monitoring in which elimination of these compounds is measured as an estimate of solvent uptake Baker et al. Conclusions The research data presented in this CIB have focused on the neurotoxic effects produced in humans and animals exposed to organic solvents on an acute or chronic basis. The acute effects of solvent inhalation in both humans and animals include narcosis, anesthesia, CNS depression, respiratory arrest, unconsciousness, and death. The majority of organic solvents have yet to be tested for chronic neurotoxic effects in animals; thus experimental animal data supporting the evidence for chronic effects confirm only a limited number of organic solvents as neurotoxicants see Appendix B. Research indicates that chronic exposure of animals to some organic solvents may cause irreversible CNS changes that are characteristic of brain damage. In man, the acute reversible effects of exposure to organic solvents appear to result from properties of the parent compound. However, the chronic effects may be caused by metabolic activation of the parent compound, which results in more reactive intermediate metabolites e. Chronic effects are often correlated with changes in nervous tissue structure and function that may be irreversible. Chronic neurotoxicity in workers exposed to organic solvents over a period of months to years includes 1 peripheral neuropathies such as axonal degeneration seen in workers exposed to hexacarbon solvents e. Epidemiologic studies have demonstrated correlations of workplace solvent exposures with the types of solvent-related CNS dysfunctions noted above and changes in neurophysiologic parameters such as nerve conduction velocities. Studies have demonstrated that these effects can persist for months to years after removal of workers from solvent exposure. The extent to which chronic neurotoxicity is reversible remains to be established; peripheral nerves have the capacity to regenerate, but damage to the CNS is more often permanent. The nervous system effects of exposure to organic solvents can lead to significant morbidity and increased risk of accidental injury, both on the job and away from work. The precise extent to which worker exposure to organic solvents increases the likelihood of accidents or illnesses remains to be determined, however. The studies that indicate the potential for organic solvents to induce toxic effects on the human nervous system are not without shortcomings. Some evidence of CNS impairment is based on subjective data gathered from questionnaires. Neurophysiologic and neuropsychologic methods of detecting nervous system damage or deviations from normal CNS function can be questioned in epidemiologic studies because of the variability of response in normal individuals. In addition, workers using solvents are often exposed to complex mixtures of organic chemicals and other workplace chemical hazards; such exposures can confound the interpretation of epidemiologic data. However, NIOSH believes that the collective toxicologic and epidemiologic data on organic solvent neurotoxicity provide sufficient evidence to warrant concern about adverse health effects from occupational exposure to these chemicals. Research Needs The following research needs have been identified: Recommendations Occupational exposure to organic solvents can cause adverse health effects, and the potential for these solvent-induced effects may increase the risk of accidental injuries. Employers should therefore make every effort to keep exposure concentrations below these levels. Worker education programs should be instituted to inform workers about the hazards of exposure to organic solvents and to provide information on safe handling practices. Many organic solvents are recognized by NIOSH as carcinogens or as reproductive hazards in the workplace. NIOSH is also concerned about those organic solvents for which only neurotoxic effects have been reported. No precise determination has been made about the excess risk i. Prudent public health policy requires that employers voluntarily assess the conditions under which workers may be exposed to organic solvents and take all reasonable precautions to reduce exposure. Guidelines for Minimizing Worker Exposure to Organic Solvents The guidelines below are general in nature and should be adapted to specific work situations as required. The area in which organic solvents are used should be restricted to those workers essential to the process or operation. Exposure Monitoring Qualified industrial hygiene personnel should make initial and periodic surveys of worker exposure. These surveys are necessary to determine the extent of worker exposure and to ensure that controls already in place are operational and effective. The manual discusses how to determine the need for exposure measurements and how to select sampling times. Short-term samples should be taken during periods of maximum expected exposure by using all available knowledge of the work areas, procedures, and processes. Area and personal measurements may be useful in identifying sources of exposure at processes and operations. Controlling Worker Exposure Proper maintenance procedures and worker education are all vital aspects of a good control program. An education program should be used to inform workers about the materials to which they are exposed, the nature of the hazards they pose, the methods for control, and appropriate personal hygiene procedures 29 CFR Workers should also be given access to relevant exposure and medical records 29 CFR Three basic methods exist for limiting worker exposures to organic solvents: Careful planning and thought should precede implementation of these methods. Contaminant Controls Engineering controls should be used as the primary method to eliminate the potential for organic solvent exposure in the workplace and to prevent fires and explosions. Achieving and maintaining reduced concentrations of organic solvents in the workplace depend on the implementation of engineering control measures such as properly constructed and maintained closed-system operations and exhaust ventilation with appropriate safety designs. Closed-system operations provide the most effective means for minimizing worker exposures to organic solvents. Closed-system equipment should be used for manufacturing, storing, and processing organic solvents. Where closed systems cannot be used, local exhaust ventilation should be provided to direct vapors away from workers and to prevent the recirculation of contaminated exhaust air. Exhaust ventilation systems for quality control laboratories or laboratories where samples are prepared for analyses should be designed for adequate capture and containment of organic solvent vapors. Special consideration should be given to exposures that may occur during the release of these compounds from pressurized sampling containers. Ventilation equipment should be checked at intervals that will ensure adequate performance. System effectiveness should also be checked when there are any changes in production, process, or control that might result in increased exposure to airborne organic solvents. Worker Isolation If feasible, workers should be isolated from direct contact with the work environment by the use of automated equipment operated from a closed control booth or room.

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Chapter 2 : CDC - NIOSH Publications and Products - Organic Solvent Neurotoxicity ()

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Identification of the hazard Elimination or reduction of the risk Review and evaluation of any control strategies. Elimination or substitution of solvents Solvent exposure should be controlled, like other hazards, according to the hierarchy of control measures, beginning with eliminating the substance. In other words, can the job can be done without using the hazardous solvent? Organic solvents vary in the degree of risk they pose to health. For example, water-based solvents may be used instead of organic solvents. Sometimes the job may be done in a different way so that exposure to solvents is either eliminated or reduced. Engineering Controls If elimination or substitution is not suitable, engineering measures may need to be applied. Engineering controls may include: Using mechanical handling methods or automating the tasks. Local exhaust ventilation at the point where the solvent is used. Enclosing operations so that solvent exposure is isolated. Mechanical or general ventilation to dilute the workplace air however this is not as effective as local exhaust ventilation to remove the contaminants. Administrative Controls When other approaches are not fully effective, certain administrative measures can minimise exposures. For example, prevent entry to areas where solvent vapour concentrations may build up by sign posting, limiting the amount of time workers spend doing certain jobs, etc. Personal protective equipment PPE If none of these control measures are suitable or are not effective in your workplace, appropriate personal protection should be provided for exposed workers: Protective clothing to cover all exposed parts of the body and personal clothing Boots, gloves, eye protection and suitable respirators to prevent splashes, skin contact and inhalation of vapours. All personal protective equipment must be of a type suitable for the particular chemicals in the solvent. PPE should be the final option in the hierarchy of control measures. It should be an interim measure until other controls are put in place. In addition to the above, it is important that the employer: Provides information and training, and increases awareness of people who work with solvents. Ensures solvents are appropriately stored in a cool place, away from any potential ignition sources. Ensures the storage area is well ventilated and firmly secured. Ensures that solvent containers are properly labeled indicating the hazards of the substance and what should be done in case of an emergency. Ensures spills or leaks are contained with sand or other appropriate absorbents. Spillages must not be allowed to enter drains or other waterways. Advice for workers Do not use a substance unless you have been provided with adequate information about it and training in how to use it. They should have have the appropriate PPE if it is needed. Workers should also practice good hygiene by washing hands well before eating, drinking, smoking or going to the toilet. For this reason it is extremely important that the employer provides adequate facilities for washing, dining and so on. In addition, the General duties chapter of the Regulation also applies. Many solvents have exposure standards that must be complied with in the workplace. These standards indicate the permissible "airborne contaminant" levels of exposure, and, in some cases, ceiling levels to which workers may be exposed without causing detrimental health effects. Under the legislation, the employer must take all practicable steps to eliminate or reduce the risks of exposure to the solvents. More information on solvents Some commonly used solvents, and their uses, are:

Chapter 3 : Reducing the Environmental Impact of Industrial Solvent Use

Safety and health aspects of organic solvents. Proceedings of the International Course on Safety and Health Aspects of Organic Solvents. Espoo, Finland, April ,

Most of the organic solvents are combustible, often highly volatile and extremely flammable and they should always be handled with care. Some solvents produce vapours which are heavier than air. These may move on the floor or ground to a distant ignition source, such as a spark from welding or caused by static electricity. The vapours may also explode from smoking. Vapours of solvents can also accumulate in confined places and stay there for a long time, presenting risks for health and property. Solvents enter the body by inhalation, by swallowing and through the skin. The effect depends on several factors, such as how easily the solvent evaporates at the ambient temperature? Panting increases the amount inhaled. Solvents, their vapours and mists have various effects on human health. Many of them have a narcotic effect, causing fatigue, dizziness and intoxication. High doses may lead to unconsciousness and death. Exposure to large doses of solvents may slow down reaction- time and affect rational judgement. This may increase the risk of accidents both at work and outside, such as in the traffic on the way back home. Solvents irritate the eyes and the respiratory tract. Solvents clean and defat not only metal plates in industrial processes but also the skin. This is a very common cause of skin disorders and dermatitis. Some solvents penetrate the skin and enter the blood circulation. Solvents may damage the liver, kidneys, heart, blood vessels, bone marrow and the nervous system. The solvents which pose the most serious risk to health should be substituted by less hazardous ones. If this is not possible with regard to the workprocess, at least the conditions during handling should be adjusted so that there is no risk of skin contact and that the concentration of vapour in the air is kept low. This may be achieved, for example, by using a closed process. Amongst the most hazardous solvents are benzene, carbon disulphide and carbon tetrachloride. Solvents are excreted in urine and sweat or they may be exhaled. Workplace controls and practices Good work practices and training can help to reduce hazardous exposures. For most of the hazardous solvents it is possible to find a substitute with the same characteristics but less drastic effects on health. Ventilation is important and it should be considered carefully when using solvents. Equipment fire extinguishers, absorbant material, etc. Personal protective equipment such as aprons, gloves and masks with filters should be available where needed, and they should be used according to the recommendations. Storage of this equipment should be in a clean place away from possible contact with solvent vapours. It is used as a solvent in many areas of industries, such as rubber and shoe manufacturing, and in the production of other important substances such as styrene, phenol and cyclohexane. It is essential in the manufacture of detergents, pesticides, solvents and paint removers. Some countries recommend even lower levels. The odour threshold is 12 ppm. The odour serves only as a warning of exposure. If you are handling benzene without smelling it, this does not mean that there is no exposure. Health effects Benzene enters the body through inhalation and it may pass through the skin. Exposure to low concentrations of benzene vapour or to the liquid which has penetrated the skin may cause dizziness, lightheadedness, headache, loss of appetite and stomach upset. Exposure can also irritate the nose and throat. High exposures to benzene may cause irregularities in the heart beat which can lead to death. Repeated exposure can damage the bone marrow, which is the blood-forming organ, causing a condition called aplastic anaemia. This may also lead to death. Long-term health effects may follow when exposure to benzene has lasted for a long period of time; several months or years. Benzene is a cancer-causing substance: There is sufficient evidence that benzene causes leukaemia in exposed workers. Many scientists say that there is no safe level of exposure to a carcinogen. Benzene may cause birth defects in animals. Until further testing has been done it should be handled very carefully as a possible agent causing birth defects in humans as well. In several countries there are severe restrictions for using and selling benzene. Workplace controls and practices As a solvent benzene can be substituted with a variety of less hazardous ones. Toluene is a similar solvent to benzene. It has the general adverse effects of solvents but it has been shown neither to cause cancer nor to damage the bone marrow. White spirit is often used as a substitute for more dangerous solvents. Less volatile solvents, such as xylene and mesitylene, have the same type of characteristics as toluene. Gasoline should never be used as a substitute. It may contain benzene, tetraethyl lead or other hazardous substances. Engineering control is the most effective way of reducing exposure where substitution is not possible. Isolation of operations can also reduce exposure. Personal protective equipment, for example, breathing protection, is sometimes necessary although less effective. However, recommendations are only guidelines and may not apply to every situation. Improper use of the respirator is dangerous. The best choice would be a helmet with fresh air supply and a face piece operating with positive pressure, blowing clean air from inside the helmet or hood outward. Not all types of gloves can resist the strong solvent power of benzene. Viton or PVA gloves are recommended although even they have limited resistance to benzene. When clothing is contaminated it should be changed promptly to avoid intake through the skin. Eating, smoking or drinking should not be allowed where benzene or other hazardous solvents are handled. Handling and storage Benzene vapour is heavier than air and may move along the floor to a distant ignition source. Smoking and open flames are prohibited where benzene is handled, used or stored. It should be stored in tightly closed containers in a cool well- ventilated area away from heat. Metal containers need to be grounded to avoid ignition from sparks caused by static electricity. Attention should be paid to electrical equipment, this should be explosion-proof. Benzene reacts violently with oxidizing agents, such as permanganates, nitrates, peroxides, chlorates and perchlorates. If benzene is accidentally spilled, the following steps should be taken: Restrict persons from the area of spill unless they wear protective equipment. Remove all ignition sources. Ventilate the area of spill or leak. Absorb the liquid in inert material, such as vermiculite, dry sand, earth and deposit in sealed containers. Do not wash benzene into the sewage system. It may cause an explosion. Benzene is a hazardous waste. Large spills should be cleaned by experts from the fire department. Classification and labelling Benzene is classified as toxic and highly flammable in the EU. Risk R and safety advice S phrases are:

Chapter 4 : Lithium | Salts in Organic Solvents | Albemarle

Millions of workers are exposed to solvents on a daily basis. Health hazards associated with solvent exposure include toxicity to the nervous system, reproductive damage, liver and kidney damage, respiratory impairment, cancer, and dermatitis.

Basic Analytical Toxicology Practical aspects of analytical toxicology It has been assumed that users of this manual will have some practical knowledge of clinical chemistry and be familiar with basic laboratory operations, including aspects of laboratory health and safety. However, some aspects of laboratory practice are particularly important if results are to be reliable and these are discussed in this section. The material contained in those monographs is complementary to that given here, and the volumes will be useful to those without a background in analytical chemistry. The toxicity of some of them is not widely recognized the ingestion of as little as ml of the commonly used solvent methanol, for example, can cause serious toxicity in an adult. Some specific hazards have been highlighted, but many have been assumed to be self-evident - for example, strong acids and alkalis should never be stored together, strong acids or alkalis should always be added to water and not vice versa, organic solvents should not be heated over a naked flame but in a water-bath, and a fume cupboard or hood should always be used when organic solvents are evaporated or thin-layer chromatography plates are sprayed with visualization reagents. Laboratory staff should be aware of local policies regarding health and safety and especially of regulations regarding the processing of potentially infective biological specimens. There should also be a written health and safety policy that is available to, and understood by, all staff, and there should be practical, written instructions on how to handle and dispose of biological samples, organic solvents and other hazardous or potentially hazardous substances. A health and safety officer should be appointed from among the senior laboratory staff with responsibility for the enforcement of this policy. Ideally, disposable plastic gloves and safety spectacles should be worn at all times in the laboratory. Details of the hazards associated with the use of particular chemicals and reagents can often be obtained from the supplier. The maximum limits of common or important impurities are often stated on the label, together with recommended storage conditions. Some chemicals readily absorb atmospheric water vapour and either remain solid hygroscopic, for example the sodium salt of phenytoin or enter solution deliquescent, for example trichloroacetic acid - see section 6. Others for example, sodium hydroxide readily absorb atmospheric carbon dioxide either when solid or in solution, while phosphate buffer solutions are notorious for permitting the growth of bacteria often visible as a cloudy precipitate. Where chemicals or primary standards, such as drugs, are obtained from secondary sources, it is important to have some idea of the purity of the sample. Useful information can often be obtained by carrying out a simple thin-layer chromatographic analysis, and the ultraviolet spectrum can also be valuable. For example, the specific absorbances for the drug colchicine in ethanol are and at nm and nm, respectively. However, this procedure does not rule out the presence of impurities with similar relative molecular masses and specific absorbance values. Semi-automatic pipettes are normally calibrated to measure aqueous fluids relative density about 1 , and should not be used for organic solvents or other solutions with relative densities or viscosities greatly different from those of water. Positive displacement pipettes should be used for very viscous fluids, such as whole blood. Accuracy can easily be tested by weighing or dispensing purified distilled or deionized water; the volumes of 1. Low relative humidities may give rise to static electrical effects, particularly with plastic weighing boats, which can influence the weight recorded. When preparing important reagents or primary standards, particular attention should be paid to the relative molecular masses molecular weights of salts and their degree of hydration water of crystallization. Potassium cyanide has a relative molecular mass of Particular care should be taken when weighing out primary calibration standards, and the final weight plus tare weighing boat weight should be recorded. The simplest procedure is distillation using an all-glass apparatus glass distilled. The distillation should not be allowed to proceed too vigorously otherwise impurities may simply boil over into the distillate. If highly purified water is required then water already distilled can be redistilled double distilled. The pH of distilled water is usually about 4 because of the presence of dissolved carbon dioxide. A negative control blank helps to ensure that false positives owing to, for example, contaminated reagents or glassware are not obtained. Equally, inclusion of a true positive serves to check that the reagents have been prepared properly and have maintained their stability. In general, all glassware, particularly test-tubes, should be rinsed in tapwater immediately after use. This should be followed by rigorous cleaning in warm laboratory detergent solution, then rinsing in tapwater and in purified water before air-drying. Badly contaminated glassware can be soaked initially in concentrated sulfuric acid relative density 1. However, this mixture is extremely dangerous, and treatment with a modern laboratory detergent is usually all that is needed. Quantitative tests require even more vigilance to ensure accuracy and precision reproducibility. When a new batch of a standard solution is prepared it is prudent to compare the results obtained in analysing a material of known concentration with those given by an earlier batch or an external source to ensure that errors have not been made in preparation. As in other areas of clinical laboratory practice, it is important to organize an internal quality control scheme for all quantitative procedures, and to participate in external quality assurance schemes whenever possible. An example of a laboratory worksheet is given in Fig. It is advisable to allocate to each specimen a unique identifying number as it is received in the laboratory, and to use this number when referring to the tests performed using this specimen. Ultraviolet spectra, calibration graphs and other documents generated during an analysis should always be kept for a period of time after the results have been reported. The recording of results of colour tests and thin-layer chromatographic analyses is more difficult, and is discussed in subsequent sections. Doubtful or unusual results should always be discussed with senior staff. In analytical toxicology, SI mass units should be used to report the results of quantitative analyses. It is useful to remember that: A list of conversion factors is given in Annex 2. This is an area with great potential for confusion, and care must be taken to ensure that the clinician is fully aware of the units in which quantitative results are reported. Some of these tests are, for practical purposes, specific, but compounds containing similar functional groups will also react, and thus interference from other poisons, metabolites or contaminants is to be expected. Further complications are that colour description is very subjective, even in people with normal colour vision, while the colours produced usually vary in intensity or hue with concentration, and may also be unstable. Many of these tests can be performed satisfactorily in clear glass test-tubes. However, use of a spotting tile a white glazed porcelain tile with a number of shallow depressions or wells in its surface gives a uniform background against which to assess any colours produced, and also minimizes the volumes of reagents and sample that need to be used. Colour tests feature prominently in the monographs section 6 , where common problems and sources of interference in particular tests are emphasized. When performing colour tests it is always important to analyse concurrently with the test sample: If the test is to be performed on urine, then ideally urine from a patient or volunteer known to have taken the compound in question should be used. However, this is not always practicable and then spiked urine blank urine to which a known amount of the compound under analysis has been added should be used. With plasma and serum, a simple form of pretreatment is protein precipitation by vortex-mixing with, for example, an aqueous solution of trichloroacetic acid, followed by centrifugation to produce a clear supernatant for analysis. Hydrolysis of some compounds, including possibly conjugated metabolites in urine sulfates and glucuronides , either by heating with acid or by treatment with an enzyme preparation, is also employed. This either gives a reactive compound for the test as with benzodiazepines and paracetamol or enhances sensitivity as with laxatives and morphine. Solvent extraction removes water and dissolved interfering compounds, and reduction in volume by evaporation of the extract before analysis provides a simple means of concentrating the compounds of interest and thus enhancing sensitivity. Some form of mechanical mixing of the aqueous and organic phases is normally necessary. Of the methods available, vortex-mixing is the quickest and the most efficient for relatively small volumes. Ideally, the centrifuge should have a sealed motor unit which is flashproof and tubes should be sealed to minimize both the risk of explosion from ignition of solvent vapour and the risks associated with centrifugation of infective specimens. Finally, filtration of the organic extract through silicone-treated phase-separating paper prevents contamination of the extract with small amounts of aqueous phase. Commercial prebuffered extraction tubes so-called solid-phase extraction are now widely used for liquid-liquid extraction, especially in preparing urine extracts for drug screening see section 5. Such tubes have the advantage that a wide range of basic compounds, including morphine, and weak acids, such as barbiturates, can be extracted in a single step. However, they are relatively expensive and cannot be reused. The volatile compound is subsequently trapped using an appropriate reagent sodium hydroxide solution in the case of hydrogen cyanide held in a separate compartment. The cells are normally allowed to stand for hours at room temperature for the diffusion process to be completed. The analyte concentration is subsequently measured in a portion of the trapping solution either by spectrophotometry or by visual comparison with standards analysed concurrently in separate cells. The Conway apparatus is normally made from glass, but polycarbonate must be used with fluorides since hydrogen fluoride etches glass. The cover is often smeared with petroleum jelly or silicone grease to ensure an airtight seal. In order to carry out a quantitative assay at least eight cells are needed: Compounds are separated by partition between the mobile and stationary phases. TLC is relatively inexpensive and simple to perform, and can be a powerful qualitative technique when used together with some form of sample pretreatment, such as solvent extraction. However, some separations can be difficult to reproduce. The interpretation of results can also be very difficult, especially if a number of drugs or metabolites are present. TLC of solvent extracts of urine, stomach contents or scene residues forms the basis of the drug screening procedure outlined in section 5. TLC can also be used as a semiquantitative technique, as described in the monograph on coumarin anticoagulants section 6. The aim of this section is to provide practical information on the use of TLC in analytical toxicology. More general information on the theory and practice of TLC can be found in the references listed in the Bibliography. Some commercially available plates incorporate a fluorescent indicator, and this may be useful in locating spots prior to spraying with visualization reagents. Prior soaking of the plate in methanolic potassium hydroxide and drying may improve the chromatography of some basic compounds using certain solvent systems but, generally, addition of concentrated ammonium hydroxide relative density 0. Reversed-phase plates, which have a hydrophobic moiety usually C2, C8 or C18 bonded to the silica matrix, are also available. However, HPTLC and reversed- phase plates are more expensive and have a lower sample capacity than conventional plates, and are not recommended for the procedures outlined in this manual. It is important to ensure that the plates are clean and free from grease. The silica gel is first mixed with twice its own weight of water to form a slurry. The slurry is then quickly applied to the glass plate using a commercial spreader to form a film 0. Small amounts of additives such as fluorescent markers can be included if required. The plates are dried in air and should be kept free of moisture prior to use. The quality of such home-made TLC plates should be carefully monitored; activation i. Dipping techniques, whereby glass plates are coated by dipping into a slurry of silica and then dried, give very variable results and are not recommended. In general, home-made plates tend to give silica layers that are much more fragile than those of commercially available plates and chromatographic performance tends to be much less reproducible. Experience suggests that it is best to use one particular brand of commercially available plates. However, even with commercial plates dramatic batch-to-batch variations in retention and sensitivity to certain spray reagents may still be encountered. Normally, however, the sample is placed directly on to the silica-gel layer. The plate should be prepared by marking the origin with a light pencil line at least 1 cm from the bottom of the plate - care should be taken not to disturb the silica surface in any way. A line should then be scored on the plate 10 cm above the origin to indicate the optimum position of the solvent front; other distances may be used if required. The samples and any standards should be applied carefully at the origin in the appropriate columns, using a micropipette or syringe so as to form spots no more than than 5 mm in diameter. If larger spots are produced, resolution will be impaired when the chromatogram is developed. Sample extracts reconstituted as appropriate should be applied first, followed by the standards or mixtures of standards; this sequence minimizes the risk of cross-contamination.

Chapter 5 : Organic Solvents

Organic Solvents. National Institute of Occupational Safety and Health (NIOSH) Workplace Safety & Health Topic. Contains links to controls and recommendations for various organic solvents. Controlling Cleaning-Solvent Vapors at Small Printers. U.S. Department of Health and Human Services (DHHS), National Institute of Occupational Safety and Health (NIOSH), Publication No. , ().

Occupational Safety and Health Administration ; Workers Compensation ; Workplace Safety The issue of industrial safety evolved concurrently with industrial development in the United States. The discussion of industrial safety began to shift in the s from one concerned primarily with compensation issues to one concerned with prevention and with the study of long-term effects of occupational hazards. Today, industrial safety is widely regarded as one of the most important factors that any business, large or small, must consider in its operations. Employers are required to compensate employees for work-related injuries or sickness by paying medical expenses, disability benefits, and compensation for lost work time. In return, workers are barred in many instances from suing their employers, a provision that protects employers from large liability settlements of course, employers may still be found liable in instances where they are found guilty of neglect or other legal violations. In his Industrial Safety: The Act, which was the first comprehensive industrial safety legislation passed at the federal level, passed nearly unanimously through both houses of Congress. One of the factors contributing to strong support for the act was the rise in the number of work-related fatalities in the s, and particularly the Farmington, West Virginia, mine disaster of , in which 78 miners were killed. The Occupational Safety and Health Act was distinguished by its emphasis on the prevention ofâ€"rather than compensation forâ€"industrial accidents and illnesses. Among the key provisions of the act were the development of mandatory safety and health standards, the enforcement of these standards, and standardized record-keeping and reporting procedures for businesses. OSHA regulations cover all private-sector employers with one or more workers and are therefore an area of regulatory law about which small businesses must be away. OSHA regulations do not, however, cover employers in the public sector municipal, county, state, or federal government agencies ; self-employed individuals; family members operating a farm; or domestic household workers. So-called "horizontal" standards apply to all industries whereas "vertical" standards apply to specific industries or occupations. When OSHA drafts a proposal for a permanent standard, it first consults with industry and labor representatives and collects whatever scientific, medical, and engineering data is necessary to ensure that the standard adequately reflects workplace realities. Proposed standards are published in the Federal Register. A comment period is then held, during which input is received from interested parties including, but not limited to, representatives of industry and labor. At the close of the comment period, the proposal may be withdrawn and set aside, withdrawn and re-proposed with modifications, or approved as a final standard that is legally enforceable. All standards that become legally binding are first published in the Federal Register and then compiled and published in the Code of Federal Regulations. The cause of industrial safety has also been reinforced by the passage of significant "right-to-know" laws. Right-to-Know laws require that dangerous materials in the workplace be identified and that workers be informed of these dangers as well as trained in their safe use. In addition to federal worker health and safety laws, individual states are permitted to develop and operate their own job safety and health programs. If the state can show that its job safety and health standards are "at least as effective as" comparable federal standards, the state can be certified to assume OSH Act administration and enforcement in that state. OSHA approves and monitors state plans, and provides up to 50 percent of operating costs for approved plans. Managers typically determine hazards by the examination of accident records, interviews with engineers and equipment operators, and the advice of safety specialists, such as OSHA or insurance companies. Industrial health hazards are typically categorized into three classes: About one-tenth of industrial accidents result from operating machinery, and these accidents often result in severe injury. Among the most dangerous types of machinery are power presses and woodworking tools, which most commonly cause injury to the hands. A number of mechanisms have been developed to safeguard against such injuries. The simplest of these are barrier guards, in which the moving parts of machinery are enclosed in a protective housing. These safeguards are typically used in conjunction with sensors so that the machine cannot be operated without them. Other types of safeguards include those which prevent a machine from operating unless a worker has both hands properly in place, automated material feeding devices, warning labels, and color coding. Toxins are most commonly ingested through inhalation, and the most commonly inhaled substances are dust, fumes, and smoke. Toxins are also commonly absorbed through the skin, and this is a bigger problem than many business owners and managers realize. Indeed, some studies indicate that skin disorders result in approximately , lost working days each year. The most common of these disorders is dermatitis, which is particularly problematic in the food preparation and chemical industries. Among the most commonly-used toxins are industrial solvents. The toxicity of solvents varies widely by type, but the most toxic of these are carcinogens and can cause permanent damage to the nervous system through prolonged occupational overexposure. In addition, organic solvents, such as those made from petroleum, are often highly flammable. Tightly-fitted respirators with activated charcoal filters are used to protect against inhalation of organic solvents, particularly in spraying applications in which solvents are atomized. Ventilation systems comprised of fans and ducts are also used to control airborne toxins of all types. Rubber gloves are commonly used to prevent skin absorption of organic solvents. One of the most rapidly-growing types of reported occupational injury is what the U. Bureau of Labor Statistics refers to as "disorders associated with repeated trauma. All employers covered by the OSH Act are required to keep records regarding enforcement of OSHA standards; research records; job-related injury, illness, and death records; and job hazard records. But while small businesses must adhere to many of the same regulations that govern the operations or larger companies, there also are several federal industrial safety programs available exclusively to smaller business enterprises, and OSHA and state regulatory agencies both enjoy some discretion in adjusting penalties for industrial safety violations for small companies. For example, OSHA has discretion to grant monetary penalty reductions of up to 60 percent for businesses that qualify as small firms. It also gives smaller firms greater flexibility in certain safety areas i. Is It the Holy Grail of the Workplace? Occupational Safety and Health Administration. Problem Solver or Troublemaker?

Chapter 6 : Types of Solvents

In combination with the solvent, salts are affecting all aspects of reactivity: Reaction rates, Chemoselectivity, Regioselectivity, Stereoselectivity. Solid salts are in general dusty materials. In many cases they are hygroscopic, corrosive, and may cause health damages.

Health effects associated with vapors and dusts generated by these activities include eye irritation, upper respiratory irritation, nausea and dizziness, lightheadedness, headache and irritability. Several different types of roofing applications are available. While older methods include applying coal-tar pitch and asphalt, newer roofing technologies use rubber or other synthetic membranes as roofing materials. Each type of roofing application should be evaluated for the potential for releasing chemical contaminants. Rubber or synthetic membrane applications use organic solvents in adhesives, primers, sealants and hardening agents. During the application of poly-urethane roofing, methylene-bisphenyl-isocyanate and organic solvent vapors may be released which can cause adverse health symptoms. Painting may introduce many chemicals into the indoor environment. In addition to paints, other products such as strippers, primers, and thinners may also be used. The solvents and additives found in paints, strippers, primers, and thinners may cause indoor air quality problems, due to the evaporation and aerosolization of the solvents and additives found during and after application. Paints are usually described by the solvent systems utilized in their formulations. The two common types of paints are: The amount of VOCs present in paints and released into the indoor environment may contribute to indoor air quality problems during painting operations. Paint manufacturers have formulated paints that have lower VOCs, but these paints tend to be thicker and more difficult to apply. Some companies are producing paints from "natural" products. These paints are not considered to be hazard free, but they are developed from substances which are less harmful. Construction and Demolition Work: Construction and demolition work usually creates nuisance dust. The greatest amount of dust may be generated during sweeping. If good housekeeping practices are not used, this may lead to excessive dust in the work area, which may cause adverse health effects for building occupants. What can be done to reduce potential health hazards? The regulation requires renovation or new construction that results in the diffusion of dust, stone and other small particles, toxic gases or other harmful substances in quantities hazardous to health be safeguarded by local ventilation or other protective devices to ensure the safety of employees. Renovation areas in occupied buildings must be isolated and dust and debris must be confined to the renovation or construction area. Examples of isolation measures may include: Before using paints, adhesives, sealants, solvents, or installing insulation, particle board, plywood, floor coverings, carpet backing, textiles, or other materials, the employer must check product labels or obtain in formation from the manufacturers of those products on whether or not they contain volatile organic compounds such as solvents, formaldehyde, or isocyanates that could be emitted during regular use. This information must be used to select products and to determine necessary measures to be taken. The employer must notify employees at least 24 hours in advance, or promptly in emergency situations, of work to be performed on the building that may introduce air contaminants into the work area. Although not part of the regulation, the following actions may be necessary: The MSDS can be obtained from the contractor or the manufacturer of the product. The HSFS can be obtained by contacting the New Jersey Department of Health, Right to Know Program, at ; In addition, if the above control measures are not adequate, then work may need to be performed when the building is not occupied. Much research and attention has been focused on a whole host of indoor air contaminants and stressors in office buildings as well as in the home. Asbestos, formaldehyde, radon, bacteria, fungi, carbon monoxide, hydrocarbons, particulates, nitrogen oxides, ozone, fiberglass, tobacco smoke, temperature, humidity and poor ventilation top the list. Any of the aforementioned may be a cause of IAQ problems. Employee symptoms associated with IAQ problems may include eye, nose, throat, and upper respiratory irritation, skin irritation or rashes, chills, fever, cough, chest tightness, congestion, sneezing, runny nose, muscle aches, and pneumonia. Ensure an adequate outside air supply. The ventilation system should be operating at original design specifications. Eliminate or control known and potential sources of air contamination, both chemical and microbial. What can be done if the air quality is unacceptable? Conduct employee interviews to obtain pertinent information regarding what symptoms are being experienced, how many employees are affected, when they are affected, where they work, what they do, etc. Review building operations and maintenance procedures to determine when and what type of chemicals are being used during cleaning, floor waxing and stripping, painting, gluing, pesticide spraying, roofing operations, renovation and construction activities, etc. Also determine when deliveries, which may generate vehicle exhaust, occur, or if furniture, drapery, and office equipment has been recently installed. Conduct a walk-through inspection to evaluate possible sources that may contribute to IAQ complaints. Inspect the HVAC system, window air conditioners, office dehumidifiers, etc. Review the building blueprints of the duct work and ventilation system to determine if the system is adequately designed. Conduct air sampling, if necessary, to determine if specific contaminants are present or if adequate fresh air is being supplied. Carpeting and the adhesives used to glue it down may contain many chemicals, some of which may cause adverse health effects. These chemicals can be found in carpet fiber bonding materials, backing glues, solvents, anti-static and anti-stain treatments, fire retardants, pesticides and fungicides. Most commercial carpeting comes with a styrene-butadiene latex rubber backing. Carpeting may be shipped from the factory in plastic-covered rolls. When it is unrolled for installation, certain chemicals called volatile and semi-volatile chemicals may be released into the air. The chemicals may continue to off-gas from days to months. Potential adverse health effects depend on what type of carpeting is installed, how much adhesive is used, and how much fresh air is being circulated in the building by the ventilation system. Health complaints have also been associated with cleaning products used to shampoo carpets, mold growth on carpets, and allergic reactions to mites and their dander in carpeting. Limit the use of carpeting in the workplace. Never use carpeting where persistent moisture may be present. Before carpeting is installed, make certain that it is properly aired out. When removing old carpeting, first vacuum it thoroughly. Relocate workers during installation. Isolate and ventilate the work area. Keep the carpet clean and dry. Use the least volatile adhesive. Carcinogens What can be done to control the use of carcinogens? Carefully review the use of any carcinogens in the school. Substitute less hazardous substances except for benzene in gasoline or fuel for which there is no substitute. Review the Material Safety Data Sheets for information on the hazards of the new products. A wide range of adhesives are used for bonding wood. The most commonly used adhesives are synthetic and may contain formaldehyde; some also contain organic solvents. Any of these synthetic adhesives may re-lease chemicals into the air. Health effects associated with low level exposure to solvents include dizziness, headaches, nausea, drowsiness, loss of balance and vomiting. Some vapors used in adhesives are flammable in air and precautions should be taken to eliminate sources of ignition in the work area. Woodworking machines with high-speed cutting tools such as saws, planers and routers should have exhaust ventilation equipment to collect sawdust and wood shavings at the source. When working with adhesives that contain organic solvents, work in a well ventilated area. Various products are used to finish wood-working projects; some of these finishes contain organic solvents which have the potential for creating health problems if over-exposure occurs. By substituting a water-based product, potential airborne organic vapors can be reduced. Wear latex-nitrile or neoprene gloves when working with organic based solvents. Wear rubber or synthetic type gloves when working with water based solvents. For more information on this subject refer to "Safe Schools: The PEOSH Laboratory Standard is de-signed to protect public employees from intermittent exposure to a broad range of chemicals encountered in laboratories. The standard addresses the specific concerns which make laboratory activities different from industrial activities in the use and handling of hazardous chemicals. The standard covers all laboratories engaged in the use of "hazardous chemicals" in accordance with the definition of "laboratory use" and "laboratory scale" as provided in the standard. This means that chemicals are used in such a way that the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely handled by one person. Laboratory scale excludes workplaces whose function is to produce commercial quantities of materials. Laboratory Use of Hazardous Chemical: This means the handling or use of hazardous chemicals in which all of the following conditions are met: Multiple chemical procedures or chemicals are used; The procedures involved are not part of a production process, nor in any way simulate a production process; Chemical manipulations are carried out on a "laboratory scale. The standard does not cover laboratories where the use of a chemical provides no potential for employee exposure e. Develop and write a CHP that contains: Standard operating procedures; Exposure control measures including engineering controls, personal protective equipment, and personal hygiene practices; Requirements for properly functioning fume hoods and other protective equipment; Provisions for medical consultation and medical examinations; Designation of a chemical hygiene officer; Establishment of a chemical hygiene committee; Establishment of a hazard identification system; Establishment of a respiratory protection program; Establishment of a recordkeeping procedure. Darkrooms - Photodeveloping What can be done to reduce potential health hazards? Supply adequate ventilation in darkrooms to control acetic acid vapors and other vapors and gases produced. Exhaust darkroom air to the outside and do not recirculate this air to any other areas of the building. Supply an adequate amount of make-up air. One major supplier of developer chemicals recommends supplying air changes per hour for workrooms and using local exhaust ventilation for processing and mixing tanks. Use slot exhaust hoods for mixing tanks. Only trained staff should mix photoprocessing powders and concentrated solutions. Powders should be mixed under a local exhaust system. Use local exhaust ventilation for color processing. Provide an emergency eyewash station in or near the darkroom. Kiln emissions can include: Some possible health effects include lung irritation from the sulfur oxides which can form sulfurous and sulfuric acid mist or droplets, and lung irritation from chlorine gases, nitrogen oxides, and ozone.

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Chapter 7 : Department of Health | Workplace Health and Safety | Common Hazards Found in Public Scho

Division of Environmental Health & Safety Best Management Practices Division of Environmental Health & Safety Horsebarn Hill Road U ehs@racedaydvl.com Recycling When large volumes of organic solvents are being used in laboratories, consideration should be given to methods of recycling such as distillation.

Al Bredenberg Jun 11, Industrial and manufacturing firms commonly rely on solvents for a multitude of tasks: Many corporate sustainability programs are seeking eco-friendly solutions around the employment of organic solvents, which are volatile organic compounds VOCs that have environmental and health effects. Many organic solvents are carcinogenic or toxic. Department of Labor, millions of U. Solvents present health hazards, the agency says, including "toxicity to the nervous system, reproductive damage, liver and kidney damage, respiratory impairment, cancer and dermatitis. Organic solvents react in the atmosphere in sunlight, producing an air pollutant known as "ground-level ozone. They also harm building materials, forests and crops. The UK government says monitoring and managing solvent use and emissions not only help businesses meet regulatory requirements but also save them money. Traditional solvents generally work better for heavily oiled parts or parts that are difficult to dry or have complex shapes, Schulz says. In certain industries, such as aviation and aerospace, the requirements might call for "flawless degreasing" that can only be achieved with traditional solvents. Some industries, such as electronics, might have requirements for "good material compatibility" or non-corrosive cleaning agents that point to conventional solvents. In the absence of such requirements, an assessment might reveal opportunities for employing solvents with less damaging environmental and health impacts. Another reason for greener solvent practices is energy conservation. Due to the fact that solvent regeneration is the most energy-intensive step in this type of cleaning process, modern solvent systems are equipped with heat recovery devices. These devices are being continuously improved. The operation should aim for closed-loop recycling, in which used solvent is sent off-site for remanufacturing and brought back and reused for the same process. The amount wasted or emitted should be monitored, reported and kept minimally. The report stresses that "society can no longer tolerate one-time use and disposal" of solvents, although "obviously, the recycled product cannot affect finished product quality. He tells me that "avoiding excessive energy consumption is one of the principles of green chemistry," and that presents a key challenge in developing greener alternatives. Jessop wrote in the journal Green Chemistry "Searching for green solvents," , no. He says, "Making such processes greener is not going to make much difference in the overall environmental impact of solvents because only a small fraction of the volume of solvents used in industrial activities is for chemical synthesis. Jessop says researchers who are interested in reducing the environmental damage of solvents should focus their efforts on four "grand challenges": Ensuring "that green solvents are available as replacements for non-green solvents of every kind. Alternative products are proposed based just on one characteristic, such as being derived from biomass. To be truly green, says Jessop, a solvent has to be evaluated on all of its characteristics and on the environmental impact from its total life cycle, including its production. Developing "easy-to-remove polar aprotic solvents. Jessop explains to me that "polar aprotic solvents are, indeed, a very useful class of solvents; lots of processes in industry use them, but "it takes too much energy to remove these particular solvents. Solvents are frequently used in crucial manufacturing steps but then have to be removed. Distillation is commonly used, but it requires a lot of energy and involves the use of VOCs, which come with all of their attendant health and environmental problems. Jessop believes meeting these four challenges requires that green chemistry researchers adjust their focus to areas that will have more positive effects.

Chapter 8 : SOLVENTS - International occupational safety & health information centre

Haglid K, Karlsson JE, Kyrklund T, Rosengren L, Wikgren A, Kjellstrand P (). Animal models of neurotoxicity - aspects *on organic solvent induced alterations in the gerbil brain during and after exposure: adaptation, tolerance, and irreversibility. In: Organic solvents and the central nervous system, EH5.*

Chapter 9 : Solvents - OHS Reps

Solvent Vapour Degreasing - addresses the occupational health and safety aspects of solvent vapour degreasing. The harmful effects of solvents follow inhalation of vapour, eye and skin contact with liquid or vapour or ingestion.