Ether: It's hazards and safe use

Ether (diethyl ether, ethyl ether) is an extremely common solvent that is routinely used in varying quantity in laboratory procedures through out the University, it is however a substance that has extreme physical hazards cognisance of which must always be a priority when planning even the simplest of procedures and the use of best laboratory practice at all times is paramount in ensuring its safe use.

Major safety hazards

Explosion and fire hazard

Owing to its volatility and extremely low flashpoint temperature of - 40oC , diethyl ether is one of the greatest fire hazards commonly encountered in the laboratory; it is classed under the UK Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP) as extremely flammable (F+) and has been assigned the following EU Safety Phrases:

- S9 Keep container in a well ventilated place
- S16 Keep away from sources of ignition
- S29 Do not empty into drains
- S33 Take precautionary measures against static discharges

and the following EU Risk Phrases:

- R12 Extremely flammable
- R19 May form explosive oxides
- R22 Harmful if swallowed
- R66 Repeated exposure may cause skin dryness or cracking
- R67 Vapours may cause drowsiness and dizziness

Ether does not require a source of ignition such as a naked flame, or spark to initiate combustion.

Ether vapour may be ignited by hot surfaces such as hot plates, steam pipes, electric lamps and static electricity discharges, and since the vapour is heavier than air, it may travel a considerable distance to an ignition source and flash back. Sufficient static electricity to initiate flash ignition can build up when large quantities of ether is being poured from one vessel into another. Ether vapour forms explosive mixtures with air at concentrations of 1.9% to 36% (by volume). Carbon dioxide or dry powder extinguishers should be used for ether fires.

Ethers absorb and react with oxygen from the air, in the presence of light, forming unstable peroxides that can detonate with extreme violence when they become concentrated through evaporation or distillation and disturbed by heat, shock or friction.

Health hazards

Toxicity

Acute: harmful by inhalation in high concentrations which can cause inebriation, sedation, unconsciousness and respiratory paralysis. Diethyl ether is irritating to the eyes, respiratory system and skin but these effects are usually reversible on removal of exposure. Due, probably in part, to its high volatility the liquid is not easily absorbed through the skin, however repeated contact can remove the skins natural oils and cause dryness, cracking of the skin and other dermal complaints.

Chronic: there is no evidence of carcinogenic or teratogenic effects attributable to the use of diethyl ether. However it is known that chronic exposure to vapour can lead to exhaustion, drowsiness, dizziness and other central nervous system disorders, along with a loss of appetite.

Handling and control of exposure

Diethyl ether (ethyl ether, ether) must be handled in the laboratory using only best practice methodology, these supplemented by additional precautions for the use of extremely flammable substances.

Before using ethers in any work activity, including research activities, a suitable and sufficient assessment of the risk created by the activity, and in particular the use of hazardous substances, to the health or safety of employees, or others, who may be affected by the work must be undertaken. As this is a requirement of UK law work which includes the use of any hazardous or dangerous substance must not be undertaken until the risk assessment is complete and suitable control measures are implemented that ensure adequate control of any identified health or safety risk.

As a result of the health hazards associated with the use of ethers they are classed as ‘hazardous substances’ under the Control of Substances Hazardous to Health Regulations (COSHH) and because of their associated safety hazards they are classed as 'dangerous substances' under the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), consequently risk assessment must be undertaken in compliance with both sets of Regulations.

It is however worth noting here that the first and absolute requirement, which has been tested in case law, is that of substitution of a hazardous, or dangerous substance, with one that is non, or less, hazardous, therefore ethers must not be used in research or other work activities if there is available another substance, that will perform the required function and exhibits less hazardous safety or health properties. This is a fundamental requirement of the hierarchical control measures required of both the COSHH and DSEAR Regulations and if you do not first consider this in your risk assessment you are failing to comply with the Regulations. Only if substitution is not open to you should you continue to use ethers and then you must follow

and implement the control methods in the hierarchical priority laid out in the Regulations.

Fire, explosion hazard

For a fire to start there requires to be present, an ignition source, fuel, and oxidizers, good laboratory practice in avoiding fire must be based on avoiding the presence one of these components. Dilution of vapours until they are no longer flammable is one of the most effective means of preventing flammable gaseous mixes from forming, thus decanting should always be carried out in a fume cupboard. However as ether has a particularly low flash point, is extremely volatile, and forms explosive mixtures with air in concentrations of as little as 1.9% one must never assume that a particular fume cupboard will dilute vapours sufficiently quickly to avoid hazardous build up.

Whenever possible ether must only be used in areas free from ignition sources, this including hot plates, steam baths, lamps, hot pipes, etc. In instances where this is not possible, or practicable, only the minimal quantities should be worked with and this only after the activity has been subject to rigorous risk assessment in accordance with DSEAR. All decanting from large volume containers into working ampoules must be completed within a fume cupboard prior to the introduction of ignition sources. Where electrical laboratory equipment is to be used in the presence of ethers consideration must be given in any risk assessment to the need for intrinsically safe (spark proof) equipment.

It is a requirement in this University's Health and Safety Policy (Part 5, 3.7 &3.9) that only minimum quantities of flammable solvents and reagents are used/stored in the laboratory. In use containers kept/used in the open laboratory should not exceed 500ml, for persons experienced in the laboratory techniques of distillation, solvent extraction and solvent evaporation, a limited batch size of 2.5 litres of flammable solvents is suggested; less experienced workers are recommended to use appreciably smaller batches.

Explosion risk may be enhanced in the case of ethers, compared with other solvents, because of their tendency to form unstable peroxides on contact with air. It is suggested that the date of receipt should be marked on the container and again on first opening. Once opened the containers should be tested regularly for the presence of peroxides see 'The Storage of Ethers and the Detection and Removal of Peroxides'. Whilst commercially supplied diethyl ether normally contains additives that inhibit the formation of peroxides; distillation removes these inhibitors and renders the ether more prone to peroxide formation.

Inhalation hazard

Diethyl ether is classed as having adequate warning properties and has been assigned a Workplace Exposure Limit (WEL) of 100ppm Long-Term-Exposure Limit (8hr TWA reference period) and 200ppm Short-Term-Exposure Limit (15 minute reference period) by the Health and Safety Commission in the UK. The

LTEL is set at a level which should adequately control the chronic effects of exposure to ethers and the STEL is set at a level to control the acute effects.

In order to control inhalation exposure risk bench top work with ethers should be kept to an absolute minimum and use made of fume cupboards wherever possible although, as stated above, care must be exercised regarding sources of ignition that may be present within the fume cupboard.

Dermal hazard

Gloves are required to protect against the dermal hazard: nitrile, or polyvinyl alcohol (PVA) gloves are suitable for use with ether but it should be noted that because of their lack of thickness disposable gloves are only suitable as splash resistance (circa. 3 minute breakthrough time) and should be replaced as soon as contamination is evident. If immersion protection is required then a thicker re-usable glove should be employed (circa. 120 minute breakthrough). Ansell Gloves manufacture a 'Barrier Chemical Resistant' glove with a quoted breakthrough time when used with ether of >480 minutes. Ansell also market a nitrile reusable glove 'Virtex' which is slightly thicker than a disposable glove, but not as thick as the normal reusable gloves, thus they claim affording dexterity along with greater breakthrough times. Please note latex/natural Rubber gloves are not suitable for work with ethers.

In the event of skin contact the affected area should be immediately washed with soap and water and any contaminated clothing removed. In the case of eye contact, the affected eye should be subjected to copious irrigation at an eye wash station for 15minutes and medical attention sought.

Ingestion

Ether is mildly toxic by ingestion and should this occur medical help should be sought immediately.

Storage and Spillage

Storage

Ethers should be stored in tightly closed containers within properly labelled fire resistant metal cabinets, or bins, and on drip trays. They must be stored separate from oxidizers. Containers of solvents such as ethers should be returned to the storage facility as soon as possible after use and you are reminded of the requirement of Part 5 (3.9) of the University Health and Safety Policy 'In order to minimise the risk of a serious laboratory fire, the maximum amount of flammable reagents and solvents etc., stored in any one laboratory should not exceed fifty litres'. Amounts above fifty litres must be stored in a properly constructed and bunded flammables store.

Spillage

Because of its extremely flammable nature a spillage of ether must be dealt with using extreme caution. All ignition sources should be removed and the up as quickly as possible using a proprietary spill pillow, absorbent matt, or an inert material such as sand (never use sawdust). The material containing the absorbed ether should be placed in a suitable sealed container and disposed of via the School of Chemistry's Chemical Waste Disposal System, for details contact: Tim.Calder@ed.ac.uk .

Spillage of large quantities, or in a small room, may result in an inhalation hazard, in this case your School's Spill Response Team should be contacted in order that the spill can be dealt with using full-face respirators fitted with organic vapour filters.

Disposal

Disposal of excess or waste ether must only be via the School of Chemistry's Chemical Waste Disposal System, ethers must never be poured to drain.