Washington State Department of
Labor & Industries

Working Safety with Solvents

A safety & health guide

Developed by the Division of Occupational Safety & Health (DOSH)

What will be covered

What are solvents?

Where are solvents used?

What are the hazards of solvents?

How to control solvent exposure

Protective gloves and solvents

Respirators and solvents

Hazard communication and solvents

What are Solvents?

Solvents are liquid chemicals that are used to dissolve oils, greases and paints, or are ingredients in paints, glues, epoxy resins, mastics, inks and pesticides.

They are often used in cleaning and degreasing materials and tools and in spray painting.

Examples include gasoline, acetone, alcohol, turpentine, paint thinner, kerosene, mineral spirits, toluene, xylene and methylene chloride.

Typical uses of solvents

Spray painting – toluene, xylene, mineral spirits

Cleaning metal or plastic parts – trichloroethylene, trichloroethane

Cleaning tools - acetone, MEK, toluene, xylene, mineral spirits

Fiberglass products - acetone

Printing presses – a variety of solvents

Silk-screening – a variety of solvents

Dry cleaning - perchloroethylene

Furniture refinishing - methylene chloride

Plastics manufacturing – a variety of solvents

Electronics – glycol ethers

Flammable and combustible solvents

Most solvents will burn – except those with chlorine in their chemical makeup (like methylene chloride, or perchloroethylene).

The more volatile a solvent is (turns into vapor), the more flammable it is.

A solvent with a flashpoint of 100˚ F or less is designated “flammable” and ignites easily.

If the flashpoint is more than 100˚ F, the solvent is called “combustible” and is more difficult to ignite.

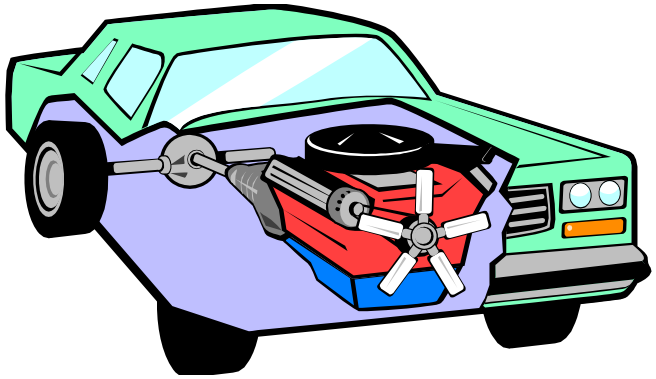
Flashpoint: the lowest temperature at which a solvent gives off enough vapor to burn when a flame or spark is present.

Limits of Flammability of Solvents

The limits of flammability is the range that a mixture of air and a solvent vapor is flammable.

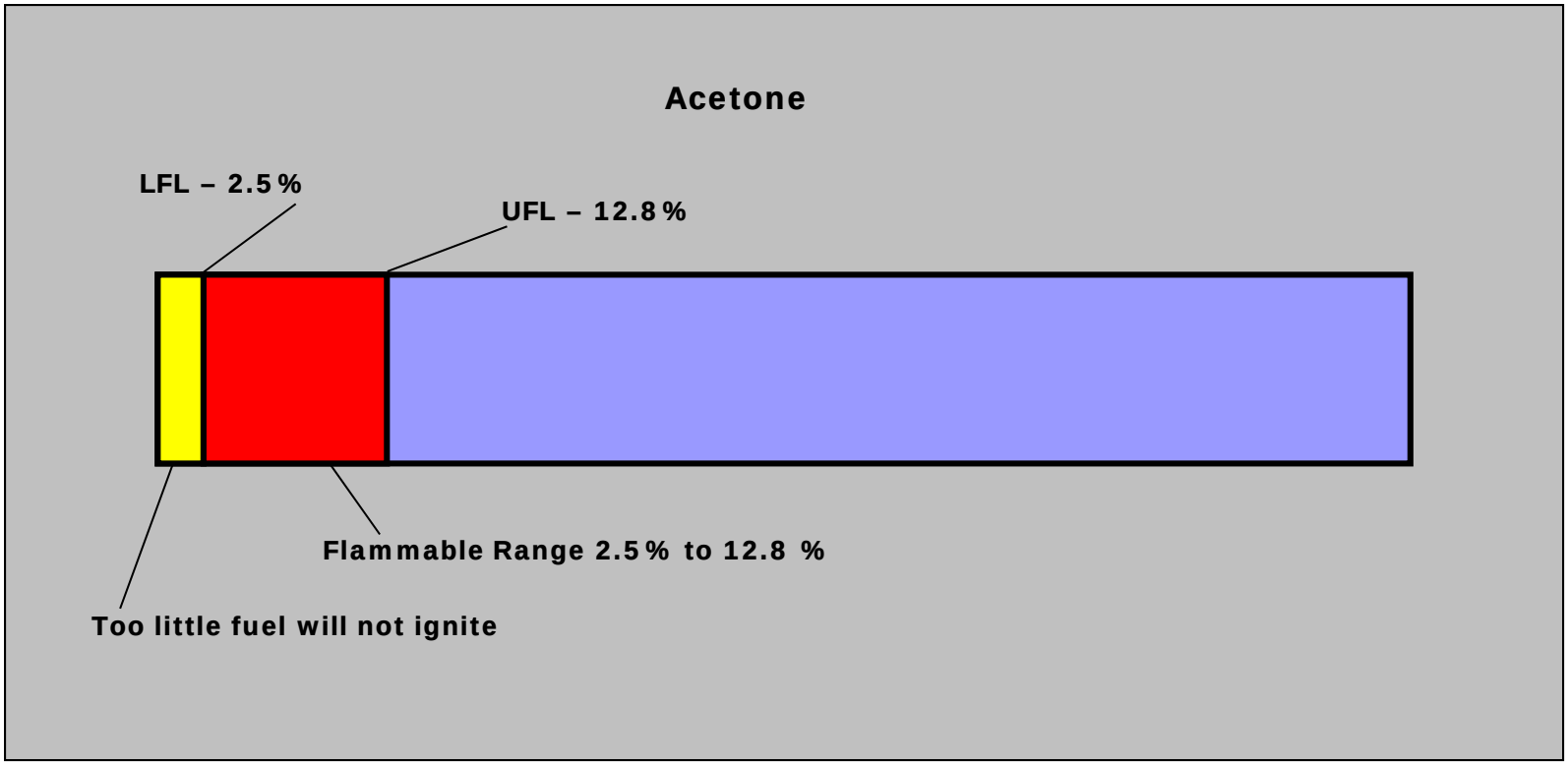
Mixtures can be too lean (not enough vapor) or too rich (too much vapor) to ignite and burn.

An example is an automobile engine. Even though gasoline is very flammable, the car won't run if the mixture is too rich (too much gasoline vapor) or too lean in the carburetor or fuel injection system.



When solvent vapors can ignite

Lower and upper flammable limits – LFL & UFL



This slide shows that acetone will not burn or explode if it is less than 2.5% in the air or more than 12.8% in the air.

Other solvents have different LFLs and UFLs. The UFL can be exceeded in closed confined spaces. "LFL" is also called "LEL" – lower explosive limit.

Flammable Solvents

Lower Flammable Limit – LFL (LEL)

In most work situations, the "lower flammable limit" (LFL) is the main concern.

Vapors from flammable liquids in the workplace are often too diluted to catch fire or explode.

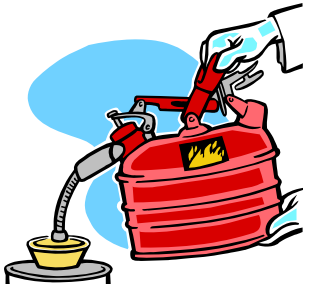
In a small room or confined space like a tank, the vapor levels can quickly go above the LFL.

DOSH regulations prohibit anyone entering a confined space if flammable vapor levels are above 10% of the LFL. LFL is also called "LEL" or "lower explosive limit".

Flammable Solvent Safe Practices

Keep away from open flames or sparks.

Use containers specially designed (UL - approved) for flammable liquids.



Ground and bond metal containers when transferring solvents to prevent static electricity sparks.

Acetone, toluene, xylene, turpentine, gasoline and MEK are especially flammable solvents (flashpoint below 100 degrees F)

Health Hazards of Solvents

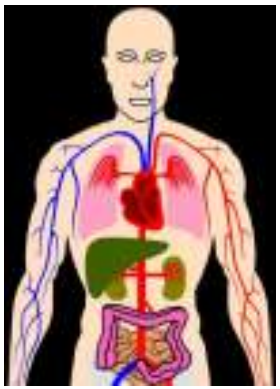
As a group, solvents can:

Irritate your eyes, nose or throat,

Make you dizzy, high, sleepy, give you a headache or cause you to pass out,

Affect your judgment or coordination,

Cause internal damage to your body,



Dry out or irritate your skin.

Solvents and Skin

Solvents can have a direct effect on the skin and be absorbed through the skin.

Most solvents will dissolve the natural oils in the skin and cause dryness and chapping.

Some solvents are also directly irritating to the skin or cause severe skin allergies in some people.

Regular or constant immersing or cleaning bare hands with solvents will cause skin dermatitis.

Solvent dermatitis

Skin absorption of solvents

Some liquid solvents will go through the skin into the body.

Some of these absorbed solvents can damage internal organs or cause long-term health damage.

In some cases as much of a solvent can enter through the body by skin absorption as by inhalation.

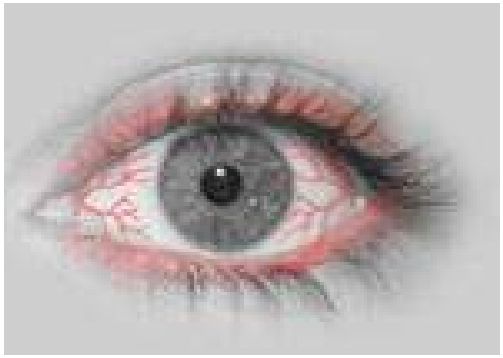
Other chemicals dissolved in solvents can also pass through the skin along with the solvent.

Gloves and protective clothing are the best protection.

A group of solvents known as “glycol ethers” and certain alcohol solvents are especially absorbable through the skin and cause internal health effects.

Solvents and the eyes

A direct liquid solvent splash into the eyes can cause extreme irritation or even damage.



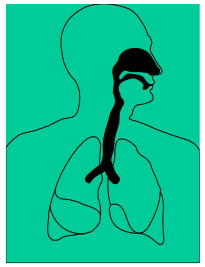
Some solvent vapors can also be irritating to the eyes.

Some solvents are absorbed through the eyes.

Eye protection is often needed to protect against liquid splashes.

Solvent vapors in the air

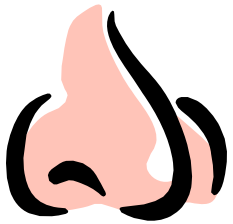
Because most solvents send vapors into the air, inhalation is the most common route of exposure.



Some solvents are more toxic than others.

Even with low toxicity solvents, an exposure to extremely high levels can cause sudden death.

Some solvents have <u>strong</u> odors even at harmless levels while others have <u>no</u> odor at dangerous levels.



Permissible Exposure Limits

Most commonly used solvent vapors have “Permissible Exposure Limits” (PELs) or allowable amounts in the air.

Most of these limits are based on average 8-hour exposures – a few are peak or ceiling limits.

The lower the limit, the more toxic the solvent is.

Examples of PELs for common solvents:

- acetone – 750 ppm
- isopropyl alcohol – 400 ppm
- MEK – 200 ppm
- turpentine – 100 ppm
- xylene – 100 ppm
- toluene – 100 ppm
- ethyl benzene – 100 ppm
- trichloroethylene – 50 ppm

ppm = parts per million 10,000 ppm = 1% in air

Some Especially Dangerous Solvents

Benzene –blood damage and leukemia

N-hexane – peripheral neuropathy (tingling & numbness in hands and feet)

Methanol – blindness

Carbon tetrachloride – severe liver & kidney damage

Certain Freons – irregular heartbeat

Certain glycol ethers – damage to fetus, lowered sperm count, blood damage

Many of these chemicals are no longer used because of their high health hazards. However they may occasionally show up in products in small amounts, in products from other countries, or as an unintended contaminant.

Solvent Vapor Exposure

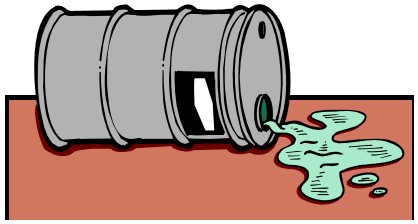
Activities that produce large amounts of solvent vapors

Spraying & spray-painting

Frequent use of solvent-soaked rags to clean parts or cleaning large surface areas

Dipping or cleaning parts in large open containers

Large spills or releases



How can solvent vapor exposure be reduced?

Eliminate the solvent – this is the most foolproof method, but not always possible. Cleaning can sometimes be done with strong detergents.

Substitute with a less toxic solvent – the toxicity must be known. Sometimes there is no good substitute.

Substitute with a less volatile solvent – solvents that evaporate less readily may not give off enough vapors to exceed the PEL.

How can solvent vapor exposure be reduced?
(continued)

Enclosing a process using solvents – prevents vapors from escaping into the air.

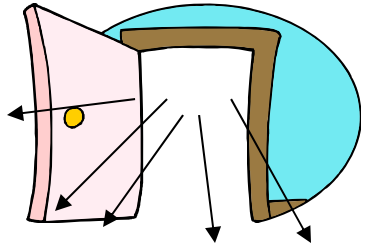
Covering all open-topped containers and tanks during non-use – reduces the time vapors are being emitted into the air.

Prohibiting the use of the solvent in unventilated enclosed or confined spaces –ventilation will reduce levels in the air.

General or exhaust ventilation – see next slide

General Ventilation

General ventilation dilutes the concentration of the solvent in the air of a room or space.



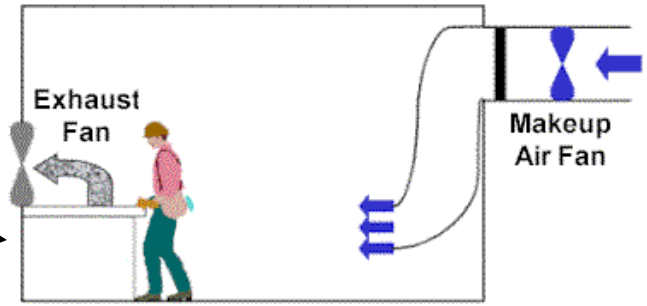
When small amounts of solvents are used or the solvents are low toxicity, general ventilation is usually adequate.

General ventilation may be as simple as opening a door or window, or installing a wall or roof fan to bring in fresh air.

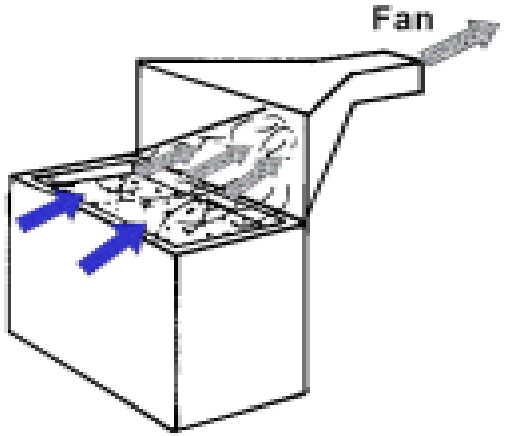
Exhaust Ventilation

Exhaust ventilation is essential when solvents are used in confined spaces even in moderate amounts.

Local exhaust ventilation which capture solvent vapors at the source may be needed.



Local exhaust ventilation is usually needed indoors when highly toxic solvents are used or when large amounts of less toxic solvent vapors are generated.



Use of Respirators

Respirators are the last choice for protection of employees from solvents, only after other possible methods are found not feasible.

The type of respirator needed depends on the toxicity and amount of solvent vapor in the air.

Paper masks do not protect against solvents – the vapors go right through them.

These are only good for dust. →

Why Respirators Are the Last Choice

Respirators have major limitations:

- ✓ They can leak, wear out, or be the wrong kind.
- ✓ They can be hot, uncomfortable and make it hard to see or communicate.
- ✓ They can be hard to breathe through.
- ✓ People may remove them in contaminated air.

Types of Respirators for Solvents

Four types of respirators provide protection

Air-purifying half-face respirator – solvent is captured in an activated charcoal cartridge

Air-purifying full-face respirator – same as above, but also provides protection from solvent eye irritation

Powered air purifying respirator (PAPR)- air is pulled through cartridges by an battery-operated fan. Reduces breathing resistance.

Air-line Respirator – fresh air is supplied by a hose from a compressor. The most protective type typically used for high levels or confined space work.

How Cartridge Respirators Work

Cartridges capture solvents during inhalation

Air inhaled in, solvents trapped

Air inhaled in, solvents trapped

Air exhaled out

This picture shows how air moves in and out of the respirator. The act of breathing creates a negative pressure inside the mask, which is why these and dust masks are sometimes called “negative pressure respirators”. If the mask does not fit properly along the edges, contaminated air can enter. This is why fit-testing is essential when using these kind of respirators.

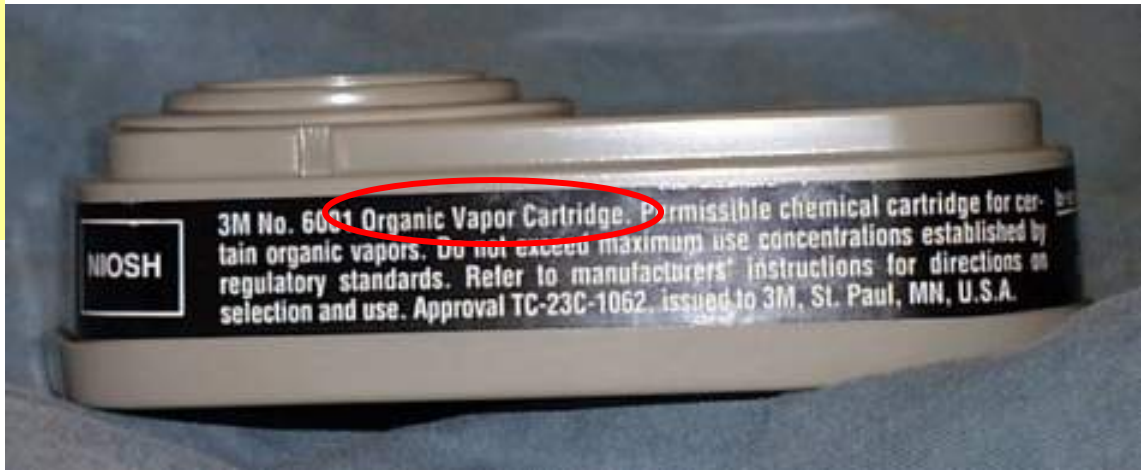
Respirator Cartridges for Solvents

"Organic vapor" cartridges are the only type that capture solvent vapors.

Cartridges for solvents will absorb only so much solvent until breakthrough occurs.

Cartridges are not suitable for some solvents since they are not trapped inside the cartridge. (includes methanol and methylene chloride)

Cartridges should be selected and changed regularly according to manufacturers recommendations.



Air-line Respirators For Solvents

Air-line respirators are required when solvent levels are more higher than the 10 times the PEL of the solvent.

Air-line respirators are limited to 300 feet of hose.

Fresh air is typically supplied from an air compressor.

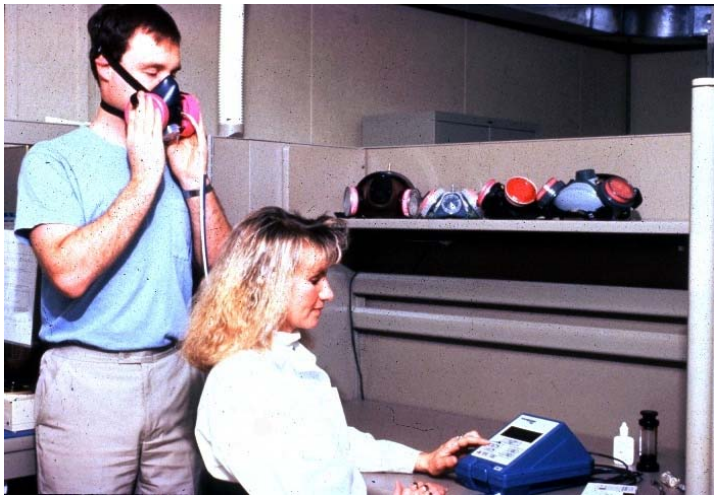
The compressor must be able to supply high quality clean air.

Link to air quality requirements

Respirator Fit

Respirators Must Fit Properly

Respirators must fit properly to prevent solvent vapor leaks around the edges.



Fit-testing must be done before first wearing a respirator.

Beards are not allowed when wearing most respirators because they will leak.

Some loose-fitting respirators do not require fit-testing and can be used with beards.

Employee Respirator Training

Training is required for any employee wearing respirators.

Training must cover why respirators needed, their limitations, how to clean and maintain and how to use.

If you don't know how to use a respirator properly, you can get a false sense of protection.

Link to training requirements

Gloves for Solvent Skin Protection

Only “chemical resistant” gloves will provide adequate protection for the hands.

Leather or cloth gloves will simply soak up solvents and hold them against the skin.

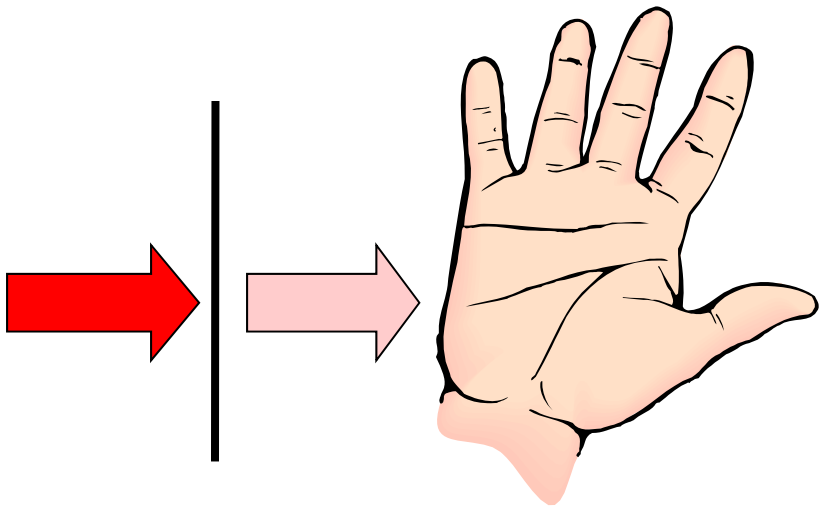
Latex gloves will be softened or dissolved by some solvents.

Chemical-Resistant Gloves

Chemical-resistant gloves facts

Chemical-resistant gloves are not totally “chemical-proof”

Solvents will eventually penetrate the gloves over time.



The thicker the glove, the more resistant it is to solvents.

Solvents will also break down (swell, crack or weaken) the glove material over time.

Chemical-Resistant Gloves

Chemical glove selection

No single glove material will protect against all solvents.

You must select gloves according to the type of solvent.

Good chemical gloves are made of Viton®, butyl, nitrile, neoprene, PVC or a combination of these.

Link to chemical glove selection guide

Chemical-resistant Gloves

Using chemical-resistant gloves

You should know what solvent you are handling and how long the gloves will keep the chemical out.

1 Hr? 8 hrs?

Throw away gloves whenever degradation is visible or you know chemicals have leaked inside.

When handling highly toxic solvents, two layers of chemical-resistant gloves can provide additional protection.

Solvents and Hazard Communication

All employees must be trained on the hazards of the specific solvents they use or are exposed to.

Material safety data sheets (MSDS) provide information on product ingredients and hazards of solvents.

All employees must have access to the MSDS as well as training.

All containers of solvents must be labeled with the name and hazards of the contents.

MATERIAL SAFETY DATA SHEET

Trade Name: **ACETONE**

Chemical Family: Acetone

Formula: C3 H6 O

Manufacturer: **Supplier:**

Emergency Phone #'s

Transportation EMG. Phone #'s CANUTEC

HAZARDOUS INGREDIENTS

ACETONE: 99% CAS # 67-64-1
Exposure limits, PPM : OSHA-PEL 750 , ACGIH - TLV 750
LD50 Orla rat 9750 MG/KG , Skin rabbit 20 G/KG, LC50 rat 16000 PPM

PHYSICAL DATA

Appearance & Odor: Clear colorless liquid, sweet odor
Vapor pressure: MM HG/20 DEG. c :184
Vapor density: (AIR 1) 2.0
Solubility in water: 100%
Specific gravity: (Water = 1) 0.79

FIRE AND EXPLOSION DATA

Flashpoint & Method 0% F (TCC)
Flammable Limits: LFL 2.0 , UFL 13.0
Extinguishing Media: water spray, dry chemical, CO_2, alcohol foam
Special equip. & procedures: Self contained breathing apparatus & complete protective clothing. Acetone is extremely flammable, any source of ignition will ignite it. Vapor is extremely explosive.

REACTIVITY DATA

Conditions Contributing to Instability: Heat, Sparks & Open Flame
Incompatible Substances: Acids, Oxidizing materials, Alkalis, Amines, Potassium T-Butoxide, Alkanolamines, Ammonia, Aldehydes, Chlorinated compounds.
Hazardous Decomposition Products: Carbon Monoxide, Carbon Dioxide
Hazardous Polymerization: will not occur.

Example MSDS

Label Information for Solvent Products

What is on the product label?

- The manufacturer
- The name of the product
- A hazard warning
- A list of hazardous ingredients

Be sure all solvent containers are labeled.

Further Information on Solvents

OSHA – Occupational Safety & Health Administration

http://www.osha.gov/SLTC/solvents/solutions.html

NIOSH – National Institute of Occupational Safety & Health

http://www.cdc.gov/niosh/topics/organsolv/

CROET - Center for Research on Occupational & Environmental Toxicology

http://www.croetweb.com/links.cfm?topicID=39

Got Solvents? Want Help?

If you use solvents at your workplace, but don't know if they are a safety or health hazard, you can get help from L & I – DOSH by requesting a safety and health consultant visit.

Click on the link below for more information.

http://www.lni.wa.gov/Safety/Basics/Assistance/Consultation/about.asp

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