Solvents – A Primer

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What is a solvent?

A solvent is capable of dissolving another substance. It is usually a liquid that is water-based or hydrocarbon-based. Hydrocarbon-based solvents are also termed organic solvents. They tend to evaporate at room temperature ("off-gas") and are known as "volatile organic compounds" or "VOCs". Often, several different solvents are used in a single product. Products such as paints, glues and pesticides are examples of mixtures containing a number of different solvents.

Organic solvents are of particular concern because they have physical properties that allow them to enter the human body and also cross the placenta easily. Possible routes of exposure include:

1. Inhalation (example: breathing in vapors from gasoline)
2. Ingestion (example: drinking contaminated water)
3. Skin absorption (examples: using turpentine on a rag, showering in contaminated water)

Most solvents have short half-lives and persist in the environment and in the human body for no more than several days. Exposures, however, may occur daily and involve mixtures of solvents that may have similar effects.

Many organic solvents target the nervous system and may cause both acute (narcosis) and chronic (neurobehavioral) effects. Some solvents have been associated with peripheral neuropathy, others with hearing loss, yet others with reproductive harm. Solvent exposure may mimic alcohol exposure.

Some commonly used organic solvents are:

1. **Acetone** - found in nail polish remover, tobacco smoke, vehicle exhaust; used in the manufacture of plastics, fibers, drugs, and other chemicals.
2. **Alcohols** – including ethanol, methanol, butyl alcohol, propyl alcohol, and others. Used as disinfectants, antifreezes, and as fuels; may be used in the chemical synthesis of pharmaceuticals, plastics, lacquers, polishes, plasticizers, perfumes, cosmetics, synthetic resins, adhesives, inks, and preservatives. Methyl alcohol, an ingredient in paint and varnish removers, may cause optic nerve damage and blindness.
3. **Benzene** – one of the world's major commodity chemicals. Used primarily as an intermediate in the production of other chemicals, mostly styrene (for styrofoam, other plastics), cumene (for various resins) and cyclohexane (for

nylon, other synthetic fibers). Also an important raw material for the manufacture of synthetic rubbers, gums, lubricants, dyes, pharmaceuticals, and agricultural chemicals. A natural component of crude and refined oil (gasoline in U.S. contains ~ 2% benzene by volume). Used to be an important component of many industrial cleaning and degreasing formulations but now has been replaced mostly by toluene, chlorinated solvents, or mineral spirits.

4. **Chloroform** – found in refrigerants, propellants, grain fumigants, dry cleaning spot remover; used in the synthesis of fluorocarbons for plastics.
5. **Ethylene Glycol** – used to make antifreeze and de-icing solutions for cars, airplanes, & boats; an ingredient in hydraulic brake fluids, in inks used in stamp pads, ballpoint pens, & print shops; also used as a solvent in the paint & plastics industry and in the production of polyester fibers.
6. **Glycol Ethers** – group of related compounds used in many high tech industries in the manufacture of printed circuit boards, as an intermediate in manufacture of plasticizers, as a solvent in coating applications for automobiles, coils, machinery and equipment, and metal furniture and appliances and in cleaning and printing ink formulations, also used in photography, dyeing applications, and as a jet fuel deicer. Four are recognized reproductive and hematopoietic toxins (EGME - ethylene glycol monomethyl ether; EGMEA – ethylene glycol monomethyl acetate; EGEE – ethylene glycol monoethyl ether; EGEEA – ethylene glycol monoethyl ether acetate)
7. **Methyl Ethyl Ketone (also known as MEK or 2-Butanone)** – used in the manufacture of glues, paints, and other finishes; also found in vehicle exhaust and cigarette smoke; high risk industries include plastics, shoe factories, printing plants, and sporting goods manufacturers.
8. **Methylene Chloride** – found in some spray paints, paint and varnish removers, degreasers, aerosol propellants; also used in decaffeination of coffee, as a fumigant for grains and fruits, urethane foam production, and manufacture of photographic film
9. **N-Methyl-2-Pyrrolidone (NMP)** – used in the production of microelectronics, paint, paint stripper, wire coating; under consideration as an absorption enhancer for topical pharmaceuticals
10. **Perchloroethylene –** used in dry cleaning, metal degreasing, machining, and electroplating; also found in auto paint.
11. **Phenol –** used primarily in the formation of phenolic resins and in the manufacture of nylon and other synthetic fibers; found in analytical agents, disinfectants, antiseptics, certain medicinal preparations such as mouthwash and sore throat lozenges, lotions, and ointments, tobacco smoke; also used in slimicides (chemicals that kill bacteria and fungi in slimes)
12. **Stoddard Solvent (similar to mineral spirits, naphthas, petroleum napthas and petroleum distillates) –** used in the manufacturing industry (for metal degreasing), dry cleaning, paint and print industries; also used in many cleaning agents, paints, paint thinners, coatings, waxes, printing inks, photocopier toners, adhesives, rubber products, polishes, and pesticides. Contains at least 200 different products including benzene, toluene, and

xylene. Among these products, the more aromatics, the more hazardous the mixture.

13. **Styrene –** used in the manufacture of reinforced plastics, polystyrene (commonly used for disposable cups and food containers), polyester resins, rubber, insulation, fiberglass, pipes, automobile parts, carpet backing.
14. **Toluene –** used in making paints, paint thinners, nail polish, lacquers, adhesives, rubber and in some printing and leather tanning processes. Also found in stain removers, cleaning agents, gasoline additive/vehicle exhaust
15. **Trichloroethanes (1,1,1 trichloroethane is most commonly used trichloroethane; also known as chloroethane or TCA) -** used as a solvent, refrigerant, degreasing agent, and fumigant; also used in the manufacture of plastics, textiles, medicinal drugs such as topical anesthetics used to numb skin prior to medical procedures such as ear piercing and skin biopsies; also used as a topical treatment for sports injuries; released in fumes from burning of plastics and other materials found in trash; found in common household products such as paints, air fresheners, deodorant sprays; sold in drug paraphernalia shops as Ethyl Gaz, Ethyl Four Star, Black Jac, and Maximum Impact; may also occur in some drinking water supplies as a result of formation during chlorination, contamination of rivers and lakes used as drinking water supplies, or seepage into groundwater resulting from storage of chemical wastes or disposal at waste sites.
16. **Trichloroethylene –** used as a metal degreaser, refrigerant; in the production of polyvinyl chloride, pharmaceuticals, and insecticides; in the processing of textiles; also an ingredient in adhesives, paint and paint removers, stains, finishes, lubricants, some types of typewriter correction fluids, spot removers, and rug cleaning fluids.
17. **Xylene –** found in permanent markers, paints, lacquers, varnishes, insecticides, gasoline; also used in rubber, plastic, and leather manufacturing.

Few homes/industries are free of solvents; particularly "high risk" occupations include: cleaning, dry cleaning, auto repair/diesel mechanics, electronics/semiconductors, plastics, printing, painting, furniture refinishing, carpet installation, cosmetology – especially nail salons, shoe and leather manufacturing.

Product labels may not clearly state that the product contains an organic solvent. If the following terms are mentioned in the label, the likelihood of the product containing an organic solvent is good:

1. **flammable**
2. **combustible**
3. **contains petroleum distillates**
4. **breathing vapors may be harmful**

Generally 100% organic solvents:	**May be partially solvent-based (some are water or detergent based):**
furniture stripper	furniture oils, polishes, wax
turpentine	shoe care products
charcoal lighter fluid	spot removers
dry cleaning fluids	rug and upholstery spot remover cleaners
paint thinner	glues & adhesives
nail polish remover	metal & wood cleaners
degreasers	paints
gasoline, kerosene	wood finishes (varnish, shellac, stain)
propane, butane	

Product labels with **caution** or **warning** usually imply less hazard than **danger** or **poison**. Opt for water-based solvents whenever possible.

Resources

1. Generations at Risk – Reproductive Health and the Environment by Ted Schettler, MD, Gina Solomon, MD, Maria Valenti, and Annette Huddle, 1999.
2. Children's Environmental Health, Pediatric Clinics of North America, October, 2001.
3. Handling Wastes: Household Solvents, Nebraska Cooperative Extension NF94-93, by Niemeyer, Heiden, and Woldt, 1997.
4. Occupational Health: Recognizing and Preventing Work-Related Disease and Injury, 4th Edition by Barry S. Levy MD, MPH and David Wegman MD, MSc, Ed, 2000.
5. ATSDR ToxFAQs @ www.atsdr.cdc.gov/toxfaq.html
6. Children's Health Environmental Coalition/HealtheHouse @ www.checnet.org/HealtheHouse
7. Washington Toxics Coalition @ www.watoxics.org
8. Massachusetts Division of Occupation Safety @ www.state.ma.us/dos
9. National Institute for Occupational Safety and Health @ www.cdc.gov/niosh/homepage.html. You can look chemicals up in the NIOSH Pocket Guide at www.cdc.gov/niosh/npg/npg.html
10. Massachusetts Department of Public Health, Occupational Health Surveillance Program @ www.state.ma.us/dph/bhsre/ohsp/ohsp.htm; 617-624-5632
11. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment @ www.state.ma.us/dph/beha/beha.htm; 617-624-5757