

A Guide to Greener Chemistry: Solvents

- 1) Be aware that the use of hazardous solvents can oftentimes be reduced by simply making a mixture with other less hazardous chemicals. *For example, methylene chloride mixed with hexane and commonly used alcohols has been shown to have similar properties to methylene chloride itself.*
- 2) Consider oven-drying glassware instead of using acetone to dry glassware.
- 3) Consider eliminating the use of solvents altogether by using microwave or ultrasound irradiation, inorganic supports, or solid state chemistry.
- 4) Consider substituting water as a solvent. Water has been shown to be a great solvent for organic reactions, with better yields than organic solvents in some cases.
- 5) Consider solvent substitutions in extractions, which have the greatest potential for success; the only desirable qualities for a chosen solvent are based on solubility of a product and its density compared to water.

Ex. Supercritical fluids have been found to be especially useful in the separation of enantiomers.
Wolf, C. and Pirkle, W. H. (1997) *Liquid Chromatography-Gas Chromatography*, **15**, 352-361.

Aqueous surfactants and macromolecular solutions have also exhibited good solubilization of organic compounds in micellular solutions in which the extraction solution can be regenerated after removal of organic compound.

Alexandris, et al. (1994) *Macromolecules*, **27**, 2414-2425.

- 6) Be aware of the biodegradability of the solvent you are using. *Aliphatic chains, straight chains, monomers, and the presence of double bonds are more biodegradable than branched chains, aromatic or ring structures, halogenated or nitrated compounds, and polymers.*
- 7) Be careful about what is labeled a “green solvent.” The definition of a green solvent is not clearly defined, and regulations and rules are not always based on safety or environmental consequences.
- 8) Be aware that the hazard of a mixture of chemicals is equal to or greater than the hazard of the most harmful chemical.
- 9) Be aware that everything that goes up fume hoods is released directly into the air and can still cause damage to the environment even if it is absent from the lab.
- 10) Be aware that the fate of most hazardous waste is incineration, which feeds directly into the environment.
- 11) Be aware of the origins of a solvent. Is it petrochemical, a natural product, or a by-product of a reaction that is already being used on a large-scale.

Sample References

Solvent Free Reactions:

Long, T.E. and Hunt, M. O., Eds. (1998) *Solvent-Free Polymerization and Processes: Minimization of Conventional Organic Solvents*, American Chemical Society, Washington, D.C.

Varma, R. S. (1999) *Green Chemistry*, **1**, 43-55.

Strauss, C. R. (1999) *Australian Review of Chemistry*, **52**, 83-96.

Perio, B., Dozias, M. J. and Hamelin, J. (1998) *Organic Processes Research & Development*, **2**, 428-430.

Loupy, A., Petit, A., Hamelin, J., Texierboullet, F., Jacquault, P., and Mathe, D. (1998) *Synthesis-Stuttgart*, 1213-1234.

Microwave heating:

<http://www.organic-chemistry.org/pdf/Art/MW.pdf>

Guide to choosing low-risk solvent:

Kob, N. E. "Dibasic Ester: A Low Risk, Green Organic, Solvent Alternative." *Clean Solvents*, ACS Symposium Series 819, M. Eds. A. Abraham and Luc Moens. Washington, D.C.: American Chemical Society, 2002.

<http://ehp.niehs.nih.gov/members/1998/Suppl-1/253-271sherman/full.html>

Guide to choosing crystallization solvents (UNIFAC):

Nass K. K. (1994) *Industrial & Chemical Engineering Chemistry Research*, **33**, 1580-4.

Guide to choosing solvents with similar solubility properties:

Charles Hansen, "Hansen Solubility Parameters," CRC Press, 2000.

Information on common solvents:

Lewis, G.R. (1994) *1,001 Chemicals in Everyday Products*, Van Nostrand Reinhold, New York.