



Pollution Prevention Resources & Green Chemistry

The concept of Green Chemistry encourages processes that reduce or eliminate the use and generation of hazardous substances. Google "Green Chemistry" and you'll find tons of information. Here are some good sites:

The Journal of Green Chemistry <http://www.rsc.org/Publishing/Journals/gc/> recommends these 12 guidelines when designing experiments. They also have a searchable database of methods.

1. **Prevention** – It is better to prevent waste than clean it up.
2. **Atom Economy** – Synthetic methods should maximize that materials used are incorporated into the final product.
3. **Less Hazardous Chemical Syntheses** – Use and generate substances of little or no toxicity.
4. **Design Safer Chemicals** – Products should be design to be effective while minimizing toxicity.
5. **Safer solvent and Auxiliaries** – Auxiliary substances (solvents) should be eliminated or made innocuous.
6. **Design for Energy Efficiency** – Minimize energy use, conduct processes at room temperature and pressure when possible.
7. **Use Renewable Raw Materials** rather than depleting materials when practical.
8. **Reduce Derivatives** – Minimize intermediate steps that require more reagents and may generate waste.
9. **Catalysts** are superior to stoichiometric reagents because they eliminate by-products.
10. **Design for Degradation** – Products should break down so they are innocuous and do not persist in the environment.
11. **Real-time Analysis for Pollution Prevention** – Develop methods to perform in-process monitoring for hazardous substance formation.
12. **Chose Substances for Safety**, accident prevention, explosions and releases to the environment.

Here are some recommended solvent substitutions. (From the Green Chemistry Journal article <http://www.rsc.org/Publishing/Journals/GC/article.asp?doi=b711717e>):

Preferred	Usable	Undesirable
Water	Cyclohexane	Pentane
Acetone	Heptane	Hexane(s)
Ethanol	Toluene	Di-isopropyl ether
2-Propanol	Methylcyclohexane	Diethyl ether
Ethyl acetate	Methyl <i>t</i> -butyl ether	Dichloromethane
Isopropyl acetate	Isooctane	Dichloroethane
Methanol	Acetonitrile	Chloroform
Methyl ethyl ketone	2-Methyl THF	Dimethyl formamide
1-Butanol	Tetrahydrofuran	<i>N</i> -Methylpyrrolidinone
<i>t</i> -Butanol	Xylenes	Pyridine
	Dimethyl sulfoxide	Dimethyl acetate
	Acetic acid	Dioxane
		Benzene
		Carbon tetrachloride

More Sites

U of Oregon Database of Green Education Materials <http://www.uoregon.edu/~hutchlab/greenchem/>

American Chemical Society Green Publications: <http://pubs.acs.org/promo/greenchemistry/articles.html>

U.S. EPA <http://www.epa.gov/gcc/>