
Chemical Safety/Lifecycle Management Task Group

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Chemical Publication Team Report

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Green Chemistry

- Supports Executive Order 13423
- “In charting a course to a sustainable future, policymakers will need to guide industrial development in such a way that it fully integrates matters of environmental quality and human health.”
 - taken from Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation at www.ucop.edu/cprc/greenchemistryrpt.pdf

Developments in the European Union

- The E.U. Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive will prohibit the use of lead, cadmium, mercury, certain flame-retardant chemicals, and other toxic materials in electronic and electrical equipment sold in the E.U.
- The Waste Electrical and Electronic Equipment (WEEE) directive requires electronics producers to “take-back” their products at the end of their useful life.

Developments in the European Union

- The proposed Registration, Evaluation and Authorization of Chemicals (REACH) initiative will require chemical producers to register most chemicals that are widely used and will place restrictions on the use of about 1,400 chemicals of very high concern.
 - This may mean manufacturer can't use non-green chemistry anywhere in the process.

States Passing Legislation Pertaining to Chemicals

- Methyl tert-butyl ether (MTBE)
 - Connecticut
 - Maryland
 - Montana
 - New Jersey
 - New York
 - Rhode Island

2005 California Bills

- AB 342 *establishing a perchlorate fee*
- AB 908 *prohibiting manufacture, sale, and distribution of various phthalates*
- AB 990 *prohibiting sale of various halogenated solvents, requiring substitutes*

Chemical Substitution

- The Royal Society of Chemistry has produced a note on **Practical Aspects of Chemical Substitution.**
- Substitution is defined as: “The replacement or reduction of hazardous substances in products and processes by less hazardous or non-hazardous substances, or by achieving an equivalent functionality via technological or organizational measures.”
 - <http://www.rsc.org/AboutUs/News/RSCnews/AdviceOnChemicalSubstitution.asp>

Chemical Substitution

- Substitution should be based primarily on risk rather than hazard and should be goal-orientated rather than prescriptive.
- Substitution requires considerable stakeholder involvement, including regulators, informed users/consumers, and suppliers.
- It is a multi-component process designed to reduce the overall risk to one that is broadly acceptable.
- To be effective, the substitution processes must be transparent.

Chemical Substitution

- Substitution should be the outcome of comparative risk assessment and evaluation, incorporating human health, wildlife and environmental concerns. It involves:
 - Identification of a group of chemical substances considered as possible substitutes
 - Development of risk profiles of candidate substitutes
 - Expert group summarization of risk profiles for each candidate
 - Risk evaluation of candidates by stakeholder group
 - Choice of best alternative candidate by majority stakeholder view (or consensus if appropriate)

Listing of Substitutes for Ozone-Depleting Substances

- <http://www.epa.gov/ozone/snap/lists/index.html>
- **Acceptable substitute for ODS in Metals Cleaning:**
Monochlorotoluenes and benzotrifluorides
- **ODS Being Replaced:** CFC-113, Methyl Chloroform
- **Conditions or Restrictions:**
 - Subject to a 50 ppm workplace standard for monochlorotoluenes and a 100 ppm standard for benzotrifluoride.
 - **Comments:**
 - The workplace standard for monochlorotoluenes is based on an OSHA PEL of 50 ppm for orthochlorotoluene. The workplace standard for benzotrifluoride is based on the company-set acceptable exposure limit.

Listing of Substitutes for Ozone-Depleting Substances

- **Unacceptable Substitutes** for ODS in Metals Cleaning
- **Substitutes:** Dibromomethane, HCFC-141b and its blends, Chlorobromomethane
- **ODS Being Replaced:** CFC-113, Methyl Chloroform High ODP
 - **Comment:** other alternatives exist

Tool # 1: EPA Green Chemistry Expert System

- <http://www.epa.gov/greenchemistry/pubs/tools.html#expert>
- The GCES features are contained in five modules:
 1. The [Synthetic Methodology Assessment for Reduction Techniques \(SMART\)](#) module quantifies and categorizes the hazardous substances used in or generated by a chemical reaction, based on information entered by the user. Reactions can be modified in the SMART module and re-evaluated to optimize their green nature.
 2. The Green Synthetic Reactions module provides technical information on green synthetic methods.

Tool # 1: EPA Green Chemistry Expert System

3. The Designing Safer Chemicals module includes guidance on how chemical substances can be modified to make them safer; it is organized by chemical class, properties, and use.
4. The Green Solvents/Reaction Conditions module contains technical information on green alternatives to traditional solvent systems. This module also allows users to search for green substitute solvents based on physicochemical properties.
5. The Green Chemistry References module allows the user to obtain additional information using a number of search strategies. The user may also add references to this module.

Tool # 2: Green Chemical Alternatives Purchasing Wizard

- <http://web.mit.edu/environment/academic/purchasing.html>
- Is a guided process that allows the user to search from a select list of solvents commonly used in the laboratory, and the associated process.
- Identifies less hazardous and more environmentally benign chemicals or processes that may be substituted,
- And provides journal references as well as URLs to information that is available online.
- Users may print article information or have e-mail sent with the URL for the article reference.

Purchasing Wizard Substitutes for Xylenes

- Ethanol
- Fluorous Solvents (F-626)
- HistoSolve
- Microwave Irradiation
- Solventless or Solvent-Free Reactions
- Volatile Methyl Siloxanes (VMS)
- Water

U. Mass Lowell's 2006 Five Chemicals Study

- Studied alternatives for:
 - Lead and Lead Compounds
 - Formaldehyde
 - Perchloroethylene
 - Hexavalent Chromium
 - Di (2-ethylhexyl) phthalate

U Mass Lowell Case Study

- Summary of major lead uses in Mass.:
 - Batteries
 - Ammunition
 - Glass
 - Heat Stabilizer in Plastics & Resins
 - Metal Finishing
 - Electronics (solder, board surface finish, components)
 - Sheet Lead (sound barriers, roof flashing, radiation shielding)
 - Bulk Metal (castings, weighting applications, ammunition)
 - Pigments
 - § http://www.turi.org/home/press_center/press_releases/umass_lowell_s_toxics_use_reduction_institute_five_chemicals_study_reveals_practical_alternatives_for_massachusetts_industry_and_consumers

U Mass Lowell Case Study

- Alternative ammunitions:
 - Bismuth
 - Copper
 - Iron
 - Tungsten
 - Zinc

U Mass Lowell Case Study

- Wheel Weights Alternatives:
 - Zinc and ZAMAC (an alloy of zinc, aluminum and copper)
 - Steel
 - Plastic
 - Copper
 - Tin
 - Tungsten
 - Iron
 - Internal balancing system, including plastic beads or other material inserted into the tire

U Mass Lowell Case Study

- Alternatives for Fishing Sinkers:
 - Bismuth and bismuth/tin
 - Brass
 - Tin
 - Copper
 - Iron
 - Ceramic
 - Zinc
 - Steel
 - Tungsten, tungsten/nickel alloy, or tungsten/polymer composite

States Banning Sale of Lead Sinkers

- Massachusetts—June 2000
- Maine—January 2002 (banned sale of lead sinkers weighing ½ oz. or less)
- New Hampshire—January 2006
- New York—May 2004
- Vermont—January 2006 (banned sale)
- Vermont—January 2007 (banned use)
- U.S. Fish and Wildlife Service—Two National Wildlife Refuges and Yellowstone National Park
- Great Britain—1987
- Canadian National Parks and National Wildlife Areas

EFCOG Substitution Example

- My Hang Huynh of the Los Alamos National Laboratory recently developed a series of nitrotetrazole compounds that do not use lead or other toxic heavy metals.
- When detonated, these nitrotetrazole compounds release only nitrogen, carbon dioxide, and water.
- The nitrotetrazole compounds are inert in water and can be synthesized faster and less expensively.
- Nitrotetrazole compounds do not spontaneously detonate.
- The only waste produced from the manufacturing process is non-toxic salt water.
- The nitrotetrazole compounds were extensively tested in real applications and found to be functionally comparable to the lead-based primaries.

Individual Researcher Needs Help to Find Substitutes

- Google search for solvent substitution gets multiple hits
- Success of solvent substitution is different for each reaction/process
- Researcher may have overlapping responsibilities/processes
- Each substitution must be tested

Recommendation

- Share successful substitutions developed at each EFCOG site
- Share methods to drive or promote green chemistry substitutions