

Green Chemistry at MIT



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Term Project for 11.122

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Presentation Overview

- Introduction/Motivation
- What is Green Chemistry?
- Is it being practiced at MIT?
- Where do we go from here?



Motivation

- References to University of Zurich case:
 - A first year chemistry laboratory course for 170-210 students has been reorganized to minimize its chemical residues by input reduction and substitution, networking of material flows, separate collection and recycling at the source. Compared to previous years, the problematic wastes were reduced by a factor of ca. 100 and total now less than 15 kg per academic year.
(Source: H. Fischer, “Environmental Protection by Practical Chemistry”, *Chimia* 45, 1991)
 - “Instead of teaching the students once-through, linear thinking ... Fischer ... decided to *reverse the process* - ...[teaching] instead how to turn the toxic wastes back into pure, simple reagents. This would save costs at both ends and encourage “cyclic thinking”
(Source: Hawken, Lovins & Lovins, *Natural Capitalism*, Little, Brown and Company Sept. 1999)
- Sounds great!
- Can we do this at MIT?



Chemical Waste

- US produces over 260,000,000 tons of hazardous waste each year
- Chemical and petrochemical companies produce over 70% of this total
- Disposal
 - About 2/3 into landfills
 - Incinerated
 - Dumped into rivers



University Chemistry Laboratories

- Much smaller scale than industry
 - Universities only produce 1% of national chemical waste
 - Still 5.2 billion pounds (not all by chemistry labs)
- Different Operation Model than Industry
 - Research and teaching labs
 - Profit is not primary objective → enables utilization of techniques whose initial cost and risk may prohibit industry
 - Waste management costs not often born by department so they do not limit operation
- Bottom Line
 - Potentially large polluters to local neighborhoods
 - Large potential to take initiative in researching and implementing green chemistry, i.e. become the model



MIT Hazardous Waste

- MIT produces about 15,000-20,000 containers of hazardous waste per year (size of containers: 500mL – 4L)
- The majority of chemical waste is incinerated to reduce liability
- In 1998 MIT was forced to spend \$550,000 in penalties and environmental projects as punishment for 18 violations of federal environmental laws
 - No leaks to environment
 - Improper management (storage, handling, labeling of waste)

Source: Conversation with William Van Schalkwyk, MIT Assistant Director of Environmental Programs, November 30, 2001.



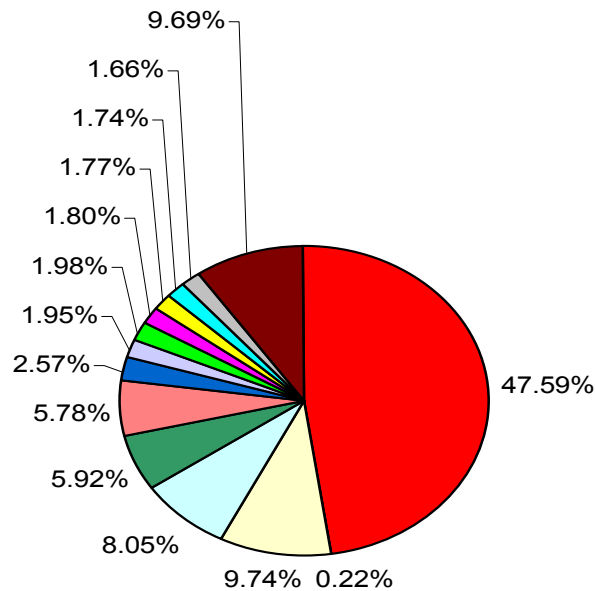
MIT Undergraduate Chemistry Teaching Laboratories

- So far this year, the chemistry department has produced 47.8% of MIT's hazardous waste (translates to ~ 8,500 containers per year)
- However, undergraduate chemistry labs only produce about 20 containers per semester
 - Only .50% of total Chemistry Dept. waste
 - Only .22% of total MIT waste
- Research laboratories produce the vast majority of the chemistry department's waste (~145 bottles per week + call-ins)

Source: "2001 Semi-Annual MIT Hazardous Waste Removal", obtained from Jeffrey Bernard, Technical Assistant, MIT Environmental Health and Safety Office

Hazardous Waste Removal at MIT

Semi Annual Waste Removal



- Other Chemistry Department Laboratories
- Undergraduate Chemistry Laboratories
- Chemical Engineering
- Biology
- Materials Science and Engineering
- Center for Cancer Research
- Physics
- Division of Bioengineering and Environmental Health
- MIT Medical
- Harvard MIT Division of Health Sciences and Technology
- Microsystems Technology Laboratories
- Civil and Environmental Engineering
- Brain and Cognitive Sciences
- Other



The Big Question

- University hazardous waste production is a miniscule portion of total US hazardous waste production
- MIT hazardous waste production Raising awareness among chemistry majors
- Make them watch something like Trade Secrets. Get them thinking seriously.