

NEVADA SMALL BUSINESS DEVELOPMENT CENTER BUSINESS ENVIRONMENTAL PROGRAM

CS-FY95010UNIV

WASTE MINIMIZATION IN THE CHEMISTRY LAB AT THE UNIVERSITY OF NEVADA, RENO

Waste Reduction Case Study

PROJECT

University of Nevada, Reno (UNR) is a land grant university established in 1864 and is one of the seven institutions with the University and Community College System of Nevada. The Chemistry Department at UNR received a grant from the Nevada Division of Environmental Protection (NDEP) to implement a waste minimization project in their under-graduate organic chemistry laboratory. The project involved scaling down the organic chemistry experiment methodology wherein the students would use smaller quantities of chemicals thus generating less waste.

BACKGROUND

The undergraduate organic chemistry department offers three levels of organic chemistry courses (CHEM 143, 345 and 347/348) and about 400 students enroll in these courses each year. The laboratory work includes both organic synthesis and characterization experiments. The quantity and composition of reagents used vary with each experiment. Waste constituents include both organic solvents containing organic compounds and organic and inorganic reagents including acetone and benzene to name a few. As the composition of the waste generated varies greatly in a chemistry lab, the cost to dispose of the waste is generally very high. Prior to the implementation of the project 675 gallons of waste per year was generated in the organic chemistry lab, which was managed as a hazardous waste.

PROJECT IMPLEMENTATION

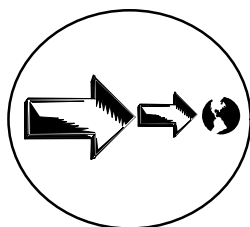
The methodology adopted by the chemistry department to accomplish the project was conceptually simple - scale down experiments. However, the faculty had to maintain the integrity and the educational value of the experiments. Each and every experiment was individually evaluated and experiments were scaled down up to a factor of five; this reduced the quantity of chemicals used and the quantity of waste generated.

To accomplish this reduction in the experiment size, the chemistry department had to procure suitable glassware and equipment. Prior to the implementation of the project, students used 24/40 size glassware in the organic chemistry lab courses. This glassware was replaced by 14/20 size glassware. The larger 24/40 size glassware was not suitable for use in experiments when reagents were reduced by a factor of five due to lack of control over heating and reflux rates, mixing, and increased transfer losses.

In addition to the 14/20 size glassware, the chemistry department also purchased heating mantles, power supplies and associated clamps to match the size of the new glassware. New laboratory instructions were developed emphasizing proper use of chemicals and proper handling of wastes.

The smaller glassware has reduced the broken glassware costs as the students find it easier to handle. The cost of replacing the 14/20 size glassware is also less than 24/40 size glassware. Despite reduction in experiment sizes, the solvent usage has not scaled down by a factor of five; "students motivated by wanting to get good product yields and

"The project goal was a substantial reduction in quantities of both chemicals consumed and wastes produced," says Dr. Kent Ervin, Associate Professor, Dept. of Chemistry, UNR, "as an additional benefit, under-graduate chemistry students, who represent the future technical and health services employee base for the state of Nevada are taught an appreciation of the importance of waste reduction methods."



This case study was developed by the Business Environmental Program of the Nevada Small Business Development Center with funding provided by the Nevada Division of Environmental Protection.

high purities, tend to use excessive amounts of solvents, mainly acetone, to clean their glassware,” points out Dr. Kent Ervin, Associate Professor, Department of Chemistry, UNR, “we will continue education efforts to try to reduce amounts of rinse solvents added to the waste stream.”

SUMMARY OF WASTE REDUCTION & COST SAVINGS

The purchase costs of the 14/20 size glassware and associated equipment amounts to \$44,638; NDEP provided half the costs in grant money. The purchased glassware and equipment include round bottom flasks, adapter tubes, connecting tubes, distillation columns, condensers, separatory funnels, clamps, buchner funnels, heating mantles, etc. The following table illustrates the quantities and costs associated with the organic chemistry lab prior to and after implementation of the project.

ITEM	PRIOR TO PROJECT IMPLEMENTATION	AFTER PROJECT IMPLEMENTATION
Waste Quantities	675 gallons per year	280 gallons per year
Waste Disposal Costs (@\$10/gallon)	\$6,750	\$2,800
Quantities of Chemicals Purchased (Solids)	620 pounds	193 pounds
Quantities of Chemicals Purchased (Liquids)	253 gallons	183 gallons
Material Purchase Costs	\$9,239	\$4,691
Glassware Replacement	\$6,000	\$2,460

Cost savings on the project are as follows:

Hazardous waste disposal cost savings	\$ 3,950
Material purchase cost savings	\$ 4,550
Glassware replacement cost savings	\$ 3,540
Total	\$ 12,040

The initial cost of implementing the project, i.e., \$44,638 will be recovered in approximately 3.7 years. After that, the chemistry department will save an additional \$12,040 per year which can be utilized for other projects. The old 24/40 size glassware is up for sale; the revenues from the sale will help defray the costs of the project implementation and will decrease the pay back period.

“Despite good results, our goal of 80% reduction in both hazardous waste and feedstocks was unfortunately not completely achieved due to various reasons,” says Dr. Kent Ervin, “to name a few, about 10% of the experiments did not work well with a factor of five reduction in reagents, we had to scale it down by a factor of two or three, and our solvent usage did not decrease as much as anticipated.”

COMMENTS

The reduction in the size of the experiments will pay off in the long run. The chemistry department feels that gradually phasing in the reduction in different classes on a semester basis would work better; some variation in the equipment and glassware for certain experiments can be accomplished by phasing the project.

Switching over to electrical heating mantles can significantly reduce hazards associated with open flames. The reduction in glassware breakage can also result in fewer student injuries.

Students support is critical for the success of the project; “the students were aware of our attempts to minimize chemical use and waste generation for environmental and cost considerations,” says Dr. Kent Ervin, “as long as the educational value of the laboratory experience was not compromised they were highly supportive.” Congratulations to the UNR chemistry department; Dr. Kent Ervin / Mr. Donald Wedor, Director of Laboratories can be reached at (702) 784-6041. For further information on reducing laboratory waste at educational institutions, please contact the Business Environmental Program at (800) 882-3233.