FACT SHEET

Division of Environmental and Financial Assistance
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Laboratory Pollution Prevention

Implementing pollution prevention practices can help you develop an awareness of efficient waste management, reduce liability, lower worker exposure and save operating costs.

Reducing the emission of pollutants in research, educational and commercial laboratories is important for several reasons. Adopting pollution prevention (P2) practices results in direct environmental benefits, and is an important objective consistent with both national and state environmental policies. In addition, exploring and adopting P2 measures in laboratory settings carries a tremendous potential for reducing pollution in future industrial processes.

In 1989, U.S. EPA shifted its focus from controlling pollution after the fact to preventing it at the source. The Pollution Prevention Act of 1990 emphasizes this shift. Laboratory P2 is at the center of the green chemistry initiative established by U.S. EPA.

P2 in Research, Educational and Commercial Laboratories

Implementing P2 practices can help you develop an awareness of efficient waste management, reduce liability, lower worker exposure and save operating costs.

It is imperative that laboratory professionals from all disciplines be educated in P2 and green chemistry concepts during their academic training in order for it to become standard practice in the laboratory industry. In addition, addressing P2 and green chemistry concepts in the classical chemistry curriculum can greatly speed the incorporation of P2 into industrial manufacturing processes.

Professional chemists are often knowledgeable about P2 concepts and are able to identify, develop and implement effective P2 technologies. However, for P2 to be most effective, it needs to be an integral part of laboratory management.

Laboratories have unique waste management problems because they generate diverse waste streams, although not necessarily in large quantities. Literally thousands of wastes are generated in laboratories which are comparable to other operations such as arts, printing, photography, maintenance and vocational programs.

Laboratories have often turned to using lab packs to dispose of small quantities of hazardous waste. Lab packs provide a simple, short-term solution for disposing small quantities of chemicals. However, the increasing long-term costs and liability associated with disposing lab packs makes this option less desirable than exploring ways to reduce waste.

Successful P2 begins with a strong commitment to prevent generation of wastes. The following sections describe several areas labs can look at in identifying strategies to reduce wastes, including material handling, operating practices and policies, employee training and loss prevention.

Laboratory Pollution Prevention

Management Practices

Establish annual goals for institution-wide and departmental waste reduction. First, determine past annual waste generation totals, then assess economic and technical feasibility for establishing and achieving specific reduction goals.

Centralize waste management and appoint a safety/waste management officer. This will facilitate a coordinated and efficient implementation of regulations, institutional policies and waste reduction goals. It also provides an information clearinghouse. Because of the independent climate in which most research is conducted, development of an organizational mind set is extremely important. Without this, further efforts may have little or no effect.

Establish an inventory control program to trace chemical usage from cradle to grave. Always be aware of the status of hazardous waste. Consider setting up a computer tracking and inventory system to track hazardous waste generation. An inventory program also can promote common users sharing chemicals, identify extremely hazardous materials and high volume users and delineate points where waste reduction options are needed.

A challenge for labs is that decentralized decision-making is characteristic of the management structure. This means that special considerations, such as a coordinated inventory system, may be needed when designing a P2 program.

Initiate a waste exchange when the material to be disposed could be reused. In labs, a waste exchange is generally limited to unopened containers which have not been contaminated. A periodic newsletter can be used to alert laboratory personnel to chemicals that are available. Having a strong inventory program can also promote sharing of chemicals by common users. If an on-site waste exchange is not practical, look into regional waste exchanges.

Conduct routine self-audits to minimize reagent accumulation and maximize recycling and sharing surplus materials. Ohio EPA has a laboratory P2 checklist at ***epa.ohio.gov/portals/41/p2/labp2checklist.pdf***.

Chemical Purchasing Policies

Institute a chemical review process. Constantly evaluate the opportunity to use less hazardous chemicals. Tools such as U.S. EPA's Green Chemistry Expert System can help you find less toxic alternatives. Institute procedures to restrict hazardous chemical purchases to only those absolutely needed for the current commercial, instructional or research programs and in minimal amounts needed for short-term use.

Do not buy chemicals in bulk. Bulk chemical purchases often lead to large volumes of expired materials which are costly to treat or dispose of. A centralized purchasing program can monitor requests for chemicals. Stagger deliveries of chemicals and implement policies that address sharing of chemicals among common users and plans for leftover chemicals.

Consider disposal costs at time of purchase. Many chemicals deteriorate with time. The disposal cost for expired materials may be 20 to 50 times the original purchase price. The real cost of chemicals should be regarded as the initial purchase price plus any ultimate disposal costs. Reduced disposal costs can often offset savings from buying in bulk.

Consider handling and disposal requirements. If the facility does not have adequate storage and safety provisions for a chemical, its purchase should be discouraged. Try to use nonhazardous chemicals or those that are suitable for reuse.

Reduce expired stock. Negotiate chemical's expiration dates with suppliers based on their intended use. Order reagents only in amounts required and stock smaller containers to help prevent waste due to surplus or shelf-life expiration.

Use up old stock. Rotate chemical stocks to avoid shelf-life expiration. Use a first-in, first-out policy to keep chemicals from becoming outdated.

Avoid donated chemicals. Do not accept donated chemicals or free samples unless they meet a specific need, since they can become a future waste problem.

Chemical Purchasing Policies

Provide employee training. Training programs for those who may generate or handle chemicals should include minimizing chemical hazards, spill prevention, preventive maintenance and emergency preparedness and response.

Educate employees about the benefits of waste minimization and specific techniques for reducing waste generation. Communicate through departmental meetings, memos, seminars, presentations and brochures. Provide special training

for procurement staff in order to raise awareness of the full costs of hazardous and unused chemicals. Ohio EPA has online P2 training at ***epa.ohio.gov/portals/41/training/LabP2training2.pdf***.

Solicit employee suggestions for green chemistry and waste reduction ideas and promote employee participation in your P2 program. Create an incentive program for employees who propose P2-related ideas.

Laboratory Practices

Microscale or nanoscale experiments. These processes are specifically designed to scale down the volume of chemicals used in laboratory experiments and generate less hazardous waste. The scale of analytical material can be reduced immensely, leading to additional reductions in reagents, catalysts and solvents required for these experiments. Microscale or nanoscale practices can decrease fire and explosion hazards, reduce exposure to hazardous chemicals and drastically reduce waste disposal costs.

Increase use of instrumentation and alternative methods. Modern instrumentation not only achieves more reliable results, but also reduces chemical usage. Alternative teaching methods, such as computer simulation or interactive video chemistry labs, offer an alternative to the traditional wet chemistry laboratory, reducing chemical usage and associated potential hazards. Many labs that used films have now moved to digital imaging.

Substitute less toxic or hazardous compounds and/or use an entirely different experiment is often practical. For example:

- substitute sodium hypochlorite for sodium dichromate;
- use alcohol for benzene;
- substitute cyclohexane for carbon tetrachloride in the standard quantitative test for halide ions;
- replace acetamide with stearic acid in phase change and freezing point depression experiments; and
- use specialty detergents such as potassium hydroxide or sonic baths in place of chromic acid solutions to clean glassware.

Utilize green chemistry to eliminate waste. Redesign experiments to eliminate steps which create hazardous end products. This often results in more efficient processes and has the additional benefit of teaching students to avoid generating hazardous wastes while improving chemical processes.

Pre-weigh chemicals for student use in teaching labs when appropriate. This will reduce waste by spills and other mishandling. Students can participate in pre-weighing and handling exercises.

Reuse or recycle spent solvent. When cleaning with solvent, reuse spent solvent for the initial cleaning and use fresh solvent only for the final rinse.

Employ on-site distillation and reuse. Advantages include reducing disposal costs and avoiding purchase of large quantities of new solvent. Distill and reuse solvent for classroom experiments or as a cleaning agent where ultra-pure solvent is not required. Small solvent distillers are available. Check with fire and worker safety regulations regarding on-site solvent distillation operation.

Segregate waste streams. Provide a properly labeled container for each waste stream for better waste management at lower cost. Do not dilute or mix hazardous and nonhazardous waste. Segregate recyclable and nonrecyclable wastes. Segregate solvent in a closed-top drum and recycle. Segregate used oil from other wastes. Include waste segregation as part of the educational process.

Segregate precious metal wastes, such as those containing platinum, palladium, rhodium, gold or silver, since they can be recovered using chemical procedures specific to those metals.

Apply waste minimization technologies to management of metallic wastes and their solutions. Waste mercury can be easily recycled depending on the type or degree of contamination. Information about commercial recyclers is available from Ohio EPA at ***epawebapps.epa.state.oh.us/Recyclers/jsp/search.jsp***.

Provide a designated safe facility for waste storage, segregation and treatment to promote proper management of hazardous waste and aid in waste reduction.

Laboratory Pollution Prevention

Label incoming chemicals. When stocking new chemicals, label with purchasing date and add storage code and safety precautions.

Maintain containers and labels. Routinely inspect and clean old containers, tighten lids and maintain legible labels. Re-label as needed. Unidentified reagents and wastes cannot be legally shipped for disposal and present a difficult waste management problem.

Conclusion

Under current regulations, all generators are responsible for safely managing their hazardous waste from cradle-to-grave. Laboratories recognize that they must reassess existing chemical waste management to alleviate the pressure of skyrocketing disposal costs, improve worker safety and reduce future liability.

The best way to manage waste is prevention. For more information, see the resource list below. Ohio EPA's Office of Compliance Assistance and Pollution Prevention (OCAPP) is available to help identify P2 strategies. OCAPP can also help with your regulatory compliance needs. For more information, visit ***epa.ohio.gov/defa/*** or contact us at (800) 329-7518.

References and Resources

- Online P2 Training for Laboratory Managers and Staff — ***epa.ohio.gov/portals/41/training/LabP2training2.pdf***
- Laboratory P2 Checklist — ***epa.ohio.gov/portals/41/p2/labp2checklist.pdf***
- Laboratory P2 Training Reference Guide — ***epa.ohio.gov/portals/41/p2/labp2refguide.pdf***
- U.S. EPA Green Chemistry Program — ***epa.gov/greenchemistry/***
- U.S. EPA Green Chemistry Tools and Literature — ***www2.epa.gov/green-chemistry/resources***
- American Chemical Society, Green Chemistry Institute — ***acs.org/content/acs/en/greenchemistry.html***