

Pollution Prevention (P2) for Biosciences

In Arizona, the bioscience and healthcare industry had an annual earnings of \$21.4 billion, employed over 320,000 people in 2015, and more than \$383 million went to academic research and development in 2014.¹ This resource summary is intended to assist the biosciences industry reduce waste at the source through green chemistry practices, reducing chemical use and inventory control.

Green Chemistry

Toxic substances are used and hazardous waste is generated in the bioscience industry. Green chemistry designs chemical products and processes that reduce or eliminate the use of those toxic substances or the generation of hazardous waste.

Several drivers exist for changing products through green chemistry,² such factors include:

- Designing safer chemicals and products
- Increasing producer responsibility
- Diminishing supplies of non-renewable resources
- Increasing costs of storage and disposal of raw materials and hazardous waste

Finding sustainable alternatives to chemicals and incorporating green chemistry are ways the industry can curb the amount of toxic substances used and hazardous waste generated. The benefits of green chemistry include reduced impact to human health, the environment and the economy. Such benefits include cleaner air and water,

safer consumer products, less chemical disruption of ecosystems and improved competitiveness of chemical manufacturers. Many resources exist to assist the biosciences industry in embracing green chemistry:

See the American Chemical Society's page to find educational resources for green chemistry and engineering.³

EPA's Green Chemistry page⁴ provides information on funding for green chemistry, the Green Chemistry Challenge, resources and tools.

Greening Your Laboratories

Applying sustainability techniques to laboratories helps to reduce waste of materials and create a healthier environment for workers. Various ways in which a lab can be greened include recovering solvent used, purchasing alternatives for cleaners and detergents that are any of the following: phosphate-free, biodegradable, chlorine-free, non-corrosive or natural surfactants. EPA Safer Choice has many options for chemical alternatives including medical instrument cleaners.⁵ See the American Chemical

Society's recorded webinar: How to Create a Greener and More Sustainable Lab.⁶ Do you use an Ultra-Low Temperature (ULT) freezer in your lab? If so, reducing the freezer temperature from -80 degrees Celsius to -70 degrees Celsius (-94 degrees Fahrenheit) can increase the lifespan, save on equipment costs and reduce its energy consumption by 42 percent.⁷ Additionally, when you conduct a freezer cleanout and remove frost buildup, you reduce energy use while disposing of old materials, freeing up space and ensuring the freezer is clean and working efficiently. If a new freezer is required, visit the Energy Star website for information on selecting energy efficient freezers.⁸

"Shut the Sash!" -- Fume hoods can also consume a lot of energy when not shut or closed. Significant energy savings can be achieved just by ensuring that fume hoods are closed when they are not in use.⁹

Ways in which you can remind people to shut the sash are to use visual cues such as labels, stickers, or magnets; develop a poster or infographic and appoint a person to ensure the sash is closed when not in use.

Reducing Dichloromethane Use

The Toxics Release Inventory (TRI) program collects information on toxic substances used and reported by facilities.¹⁰ Since 2003, Dichloromethane total releases have decreased by 58 percent. Companies are reducing the use of dichloromethane by either finding alternatives or reusing the waste material for other purposes.

Read about the following case studies to learn more:

1. An organic chemical manufacturer that previously used dichloromethane to clean equipment when changing from one process to another, switched from dichloromethane to a less hazardous cleaning solution of water and limonene.¹¹
2. A pharmaceutical facility reused gas chromatography solvents recovered in first pass distillation back into the column when clean (and permitted by clients), instead of discarding them and using virgin solvents.¹²

Inventory Control

Inventory control can be the biggest investment for a facility. A well-developed, monitored and maintained inventory control system can result in leaner operations, reduced operational expenses and reduced disposal of both raw, unused material and expired material.

To begin the task of developing an inventory control system, take stock of everything in the lab including old and new materials and determine which materials are needed, can still be used and which need to be disposed of. It is preferable that this inventory system be developed and maintained through a computer program (such as a spreadsheet) or an inventory control software.

Dispose of waste material in accordance to the regulations. Evaluate what materials are used most often and which are used less; this will help you determine how much stock you need to keep of each material and which materials should be ordered as needed.



Develop a central ordering system or appoint a person to order materials for all departments. This will ensure that a single point of ordering exists which can avoid excess ordering or ordering material that is already in the lab. Plan the storage location of material so that it is readily available and close to the point of use. Group material by expiration date and use the first-in, first-out (FIFO) method to minimize waste generation from expired materials. Maintain the inventory spreadsheet or software with the material expiration dates and location to track the lifespan and storage area of the material. The inventory list should be checked quarterly to monitor expiration dates and material that is not being used. To address excess material, a chemical exchange program can be beneficial as different organizations can use any unexpired, unused raw material such as trade colleges and universities.

Helpful Tools

American Chemical Society (ACS) Tools for Green Chemistry & Engineering¹³ provides information such as:

Reagent Guide – encourages chemists to choose ‘greener’ choices for reaction conditions.

Solvent Selection Guide – a selection of solvents based on health, safety and environmental criteria.

Process Mass Intensity Calculator – provides help benchmarking and quantifying improvements toward greener manufacturing.

MedChem Tips and Tricks – addresses purification, solvents, reagents, energy and resources.

ACS Recorded Webinars¹⁴ – ACS has partnered with the ACS Green Chemistry Institute to provide several free webinars accessible to the general public.

References

- ¹ [Arizona Commerce Authority. *Bioscience & Healthcare.*](#)
- ² [European Journal of Biotechnology and Bioscience. *Green Chemistry \(Today and Tomorrow\).*](#)
- ³ [ACS. *Online Educational Resources for Green Chemistry & Engineering.*](#)
- ⁴ [EPA. *Green Chemistry.*](#)
- ⁵ [EPA. *Search Products that Meet the Safer Choice Standard.*](#)
- ⁶ [ACS. *Webinar: How to Create a Greener and More Sustainable Lab.*](#)
- ⁷ [International Institute for Sustainable Laboratories. *Temperature Tuning.*](#)
- ⁸ [Energy Star. *Laboratory Grade Refrigerators and Freezers.*](#)
- ⁹ [Harvard University. *Shut the Sash Program.*](#)
- ¹⁰ [EPA. *P2 Spotlight: Reducing Dichloromethane Waste Management.*](#)
- ¹¹ [EPA. *Envirofacts. Search Results: Emerald Performance Materials LLC.*](#)
- ¹² [EPA. *Envirofacts. Search Results: Johnson Matthey Pharma Services.*](#)
- ¹³ [ACS. *Tools for Green Chemistry & Engineering.*](#)
- ¹⁴ [ACS. *Webinars and Videos.*](#)

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