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## Nuts and bolts of chemical process pollution prevention: An environmentally benign approach

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### ABSTRACT

The objective of this paper is to provide practical strategies for preventing waste and reducing energy consumption in chemical manufacturing facilities. The examples are drawn from more than 400 case studies contained in the ChemAlliance, a database of pollution prevention and environmental best management practices. The paper emphasizes the need for an engineering approach to Pollution Prevention (commonly called PP or P2) opportunity identification, which builds upon an understanding of common process and “root causes” for waste and emissions, and provides practical, commercially proven techniques for how to eliminate these root causes in both new and existing chemical process facilities.

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### KEYWORDS

Pollution;  
Prevention;  
Waste;  
Industry.

### INTRODUCTION

Prevention is better than cure - this proverb does not only apply to disease treatment but also to pollution treatment. In other words, pollution that is not created does not have to be managed. This is the central theme of Pollution Prevention (popularly known as P2 or PP). Simply put, pollution prevention or P2, is about avoiding the creation of pollution and waste, rather than trying to clean it up or manage it after the fact.

Traditionally, waste has been managed through treatment, recycling, control equipment, and landfilling together called Pollution Control. These are often referred to as “end-of-pipe” processes because they tell

about how to treat the wastes once they are formed. These solutions also cost lot of money, and are sometimes not environmentally sound.

In contrast to this, P2 involves determining where waste is generated to identify how best to eliminate or reduce it at the source. Thus, by employing P2 strategies, pollution is prevented at the source and hence it eliminates or at least reduces the need for pollution control equipments and processes<sup>[1]</sup>.

The US Environmental Protection Agency (EPA) defines Pollution prevention (P2) as a method of reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing conservation

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techniques, and re-using materials rather than putting them into the waste stream<sup>[2]</sup>.

### COMMON P2 PRACTICES

Pollution prevention opportunities can be found throughout any operation. For instance, installing different equipment or technology, or changing raw materials or staff routines can result in pollution prevention. The ways in which P2 is achieved varies from one sector to another, but typically there are seven common practices.

#### Materials or feedstock substitutions

In many cases, it is possible to replace some of the materials/feedstock used in the production process or embedded within a product with non-polluting or less-polluting materials that perform equally well, or even better. This is sometimes referred to as source elimination.

#### Product design or reformulation

Many times a design change or reformulation is found to improve efficiency and reduce environmental impact.

#### Equipment or process modifications

Older equipment can be inefficient and existing processes may release an excess of pollutants and waste. In addition, there may be substitutes available for areas where pollutants are in use. Rethinking equipment and processes can result in improved efficiency and safety and reduced operating costs.

#### Spill and leak prevention

Modifying existing procedures to prevent waste from spills or leaks can save money in product and clean-up costs as well as reduce worker exposure to hazards.

#### On-site reuse, recycling or recovery

All non-product outputs should be viewed as a loss of raw materials. On-site reuse and recycling could have significant environmental or economic benefits. Think of waste as a potential product that is being thrown away, and that a price is paid to manage that waste.

#### Improved inventory management or purchasing techniques

Many businesses are now practicing inventory techniques such as 'first-in, first-out' or 'just-in-time' delivery, which reduce waste and losses of material or product from expiration or over-stocking. Think about implementing a policy to purchase products and raw materials that have a smaller impact on the environment over their entire lifecycle.

#### Good operating practices or training

P2 can be part of ongoing efforts to enhance operating efficiencies and reduce health and safety risks through staff training and improved work procedures. Adjust production schedules to minimize equipment changeovers; review maintenance scheduling; and investigate staff training to improve material handling and identify P2 opportunities<sup>[2]</sup>.

#### Strategy for implementation of P2 in chemical industry

##### (1) Determine what wastes are generated

- Examine all of the waste streams, including process wastes, hazardous wastes, nonhazardous wastes, solid wastes, and office waste. Look in trash cans and dumpsters to determine what materials are being thrown away and consider what wastes are poured down the drain, such as rinse waters and process waters. Examine the energy and water consumption and look for high and low usage trends in the water and electric bills.
- Characterize each waste stream - determine where the waste comes from, what processes generate it, and how much is being discarded.

##### (2) Identify waste prevention measures

- Evaluate all wastes for possible reduction. Determine how you can reduce each waste, evaluate the purchasing policies, and determine what you can reuse.
- Identify potential production changes that would improve efficiency, including process, equipment, piping, and layout changes.
- Investigate opportunities for new products or ingredients that prevent waste generation.

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- Identify resources that will help you conduct a waste reduction assessment at the business. Regulatory agencies might be able to provide technical assistance in identifying potential waste prevention measures.

### **(3) Set the priorities and goals**

- Prioritize waste prevention opportunities by considering cost, ease of implementation, payback, and other benefits, such as increased employee safety.
- Try focusing on a few opportunities that are easy to implement, have low capital investment, save you money, and reduce large volumes of waste.
- Set attainable goals, such as reducing office paper waste by 25 percent or reducing the waste hauling and disposal costs by Rs. 50,000 annually.

Investing in energy-efficient equipment proved to be a smart move for Pearl Pressman Liberty (PPL), a commercial print facility in Philadelphia, Pennsylvania. PPL joined EPA's Green Lights program (a daughter program of EPA's Energy Star program) to learn how using efficient lighting could help them cut costs. In just 1 month, PPL completed energy-efficient lighting upgrades that are now producing savings of more than \$21,000 a year -the energy reductions from these upgrades are equivalent to removing 28 cars from U.S. highways, or planting 56 acres of trees in US forests!

### **(4) Get employee involvement**

- Teach the employees how to prevent waste. Describe the waste prevention policies and goals, and provide training to employees who must change how they handle materials.
- Promote the waste prevention activities. Hold a kickoff event to describe the goals and highlight the benefits for the business. Use posters or signs to get the word out to employees and place the signs in areas where waste prevention activities should happen.
- Encourage employee involvement by offering incentives. Prizes or awards can be given for the best ideas or those that result in the most savings. A portion of the savings can also be given to employees or their departments<sup>[4]</sup>.

### **A case study of employee involvement in P2!**

Frost Paint and Oil in Minneapolis, Minnesota, is a

manufacturer of industrial paints and linseed oil-based varnishes. Several years ago, the company reviewed its waste streams, including paint sludge, varnish oil sludge, and process water and established a goal of reducing them by 10 to 15 percent. After evaluating a number of options for reducing waste, the company decided that the quickest and least expensive way to prevent waste was to implement an employee incentive program. The employees, 35 at the time, were motivated by the promise that two-thirds of any resulting savings would be passed on to them. As a result of the employee incentive program, Frost Paint and Oil reached its waste reduction goal in 1 year! The innovative approach reduced hazardous waste by 55 percent and saved the company \$25,000. The following year, the incentive program continued to work, further reducing hazardous waste generation by 22 percent<sup>[5]</sup>.

### **Role of P2 in chemical industries**

There are significant opportunities for chemical industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use. Such changes offer industry substantial savings in reduced raw material, pollution control, and liability costs as well as help protect the environment and reduce risks to worker health and safety.

Waste prevention is a business strategy from which any company, regardless of size or type, can benefit. In addition to cost savings, it can also help to improve worker safety, reduce liability, and enhance the company image in the community. Furthermore, if the waste we are eliminating or reducing is regulated under state or federal law-and our reductions are significant enough - we might be able to avoid costly permits and government approvals.

## **CONCLUSION**

In addition to all these financial advantages, waste prevention is the right thing to do. Preventing waste prevents pollution, making our neighborhood and community a safer, healthier place to live. In the end, we benefit, the environment benefits, the community benefits, and our company establishes itself as a good corporate citizen, providing immeasurable, lasting rewards.

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- [5] Pollution Prevention Success Stories-[www.ec.gc.ca/pp](http://www.ec.gc.ca/pp), A web site showcasing over 100 success stories recognizing the P2 results achieved by companies, institutions, organizations, and facilities across Canada. (10.03.2010), (2010).