Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Pollution Prevention Applications to Chemical Engineering

Prepared by Jeff Handt

Over the last two decades, this country's energy policy shifted from a desire to lessen its dependence on foreign oil to a more practical interest in efficient use of energy, regardless of its source. This change reflects an unlikely convergence of altruistic concerns with bottom-line, business-minded thinking: in the global economy, companies will seek to wed technological progress with sustainable development, which is loosely defined as "development that meets current needs without compromising future resources." It may be realized through the emerging ethic of pollution prevention (P2). This mindset seeks to eliminate environmental problems before they develop by considering ecological impacts during the earliest stages of product design. Because the focus of pollution control shifts up the process line from the end to the front, this approach is also known as source reduction.

If justified concerns for the planet's well-being are not incentive enough, P2 is being strongly driven by economic forces. The U.S. Department of Commerce estimates that the domestic market for "greener" goods and services amounts to $50–60 billion annually. And other regions of the global economy have already caught on. Denmark and The Netherlands, for example, have undertaken extensive studies to apply life cycle accounting to consumer and commercial products. The German government has taken what is probably the most aggressive policy, as evidenced by its recent requirement that retailers accept all product packaging returned by customers. While it would be premature to judge the success of this effort, the legislation has certainly had seismic effects on consumer and corporate behavior across the Continent. Process modifications have also put German auto manufacturers in a position to accept retired car bodies.

In a notable departure from traditional environmental policy, which is characterized by punitive measures and mountains of legislation, the United States is gravitating toward P2 almost out of common sense. After the cornerstone Pollution Prevention Act of 1990, the United States EPA issued a series of policy statements that tended to *encourage* the conversion, rather than dictate it through the old "command and control" tack. Significantly, the government as a whole is also leading by example. Among other programs, federal agencies have converted to exclusive use of high recycled content paper.

This new effort to reduce pollution at the source presents a profound challenge for chemical engineers. They may find improvement to existing systems can be marginal without financially risky overhaul, and that design of new systems will involve unfamiliar considerations and tradeoffs. But, as always, they will be in a situation of unique responsibility. While a convincing case can also be made for the civil engineer's role, chemical engineers, involved in product and process design in the politically sensitive and physically dangerous realm of chemicals, have a greater impact on our surroundings than most other engineers. They can thus have a dramatic positive effect on the global environment. Any chemical engineering curriculum that ignores this relationship is doing a disservice to the profession and the public.

The accompanying "Pollution Prevention and Chemical Engineering Resource List" serves to address this need. It inventories educational tools and reference materials by media type and subtopic. The **Problem Sets** category includes a collection of 21 problems that cover life cycle analyses, unit operations design, P2 economics, and other subjects developed at UCLA by David Allen,

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Nandkumar Bakshani, and Kirsten Sinclair Rosselot. The **Case Studies** listing include Franklin Associates' series on consumer-product packaging, as well as a document produced through the Center on the design of a CFC-free refrigerator. There are too many **Books** and **Journal Articles** to single out any particular titles for special mention; this situation is encouraging except for efforts to organize and condense this material.

The potential ramifications of P2 for chemical engineers are widespread. Successful waste reduction programs have been incorporated in metal fabrication, electronics, textiles, petroleum fuel products, chemical products, printing and publishing, and many other businesses. The **Reports** section cites the EPA's *Guides to Pollution Prevention* in 12 different industries.

Once the primary target of regulations, fines, and public scorn, the chemical industry now has an opportunity to be a champion of P2. The Chemical Manufacturer's Association (CMA) responded in 1988 with "Responsible Care: A Public Commitment." This program embraced a set of operating guidelines that the CMA's 185 member companies are obliged to follow. These tenets include communicating with employees and the public, coordinating emergency response plans with local officials, ensuring worker health and safety, and safely transporting materials outside the plant's fence line. P2 has been identified as a key practice to implement these guidelines. Any CMA company that fails to pursue this agenda will lose its membership. The message "Responsible Care" sends is that cutting corners with respect to ecological criteria will reduce future profitability, either directly on the ledger or through bad public relations.

Some chemical companies reached this conclusion years ago, and their ability to clean up their processes will also draw others to P2. While a number of prominent manufacturers have instituted very successful waste reduction programs, two will be mentioned here. 3M's "Pollution Prevention Pays" is often credited as a pioneering effort. Instituted in 1975, this program has carried out 3,000 projects, cutting the company's releases and its energy consumption by half, saving $530 million. The **Reports** and **Video** sections have more information on 3M's work in this area. Dow Chemical Company began its active "Waste Reduction Always Pays" (WRAP) program in 1986. In 1990, it launched 53 P2 projects whose savings exceeded the investment after only one year. More on WRAP can be found in the **Case Studies** section.

The "Resource List," by no means exhaustive, is intended to help faculty incorporate P2 concepts into their courses. Many of the materials are synopsized in the accompanying "Annotated Bibliography of Chemical Engineering Related Pollution Prevention Sources." Suggestions for additional entries are encouraged and comments are welcome.

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The National Pollution Prevention Center for Higher Education
University of Michigan, Dana Building
430 East University Ave.
Ann Arbor, MI 48109-1115
• Phone: 313-764-1412
• Fax: 313-647-5841
• E-mail: nppc@umich.edu

The mission of the NPPC is to promote sustainable development by educating students, faculty, and professionals about pollution prevention; create educational materials; provide tools and strategies for addressing relevant environmental problems; and establish a national network of pollution prevention educators. In addition to developing educational materialsand conducting research, the NPPC also offers an internship program, professional education and training, and conferences.

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