

Principles of Waste Avoidance and Utilization

The minimization of wastes requiring disposal is increasingly important as available disposal options become more and more constrained, and particularly as more substances enter everyday use that are not readily decomposed in the natural environment and that can present long-term hazards. This chapter sets out some basic principles for waste minimization in industrial processes, where "minimization" is taken to include avoidance of the generation of wastes, when practical, and the productive utilization of any wastes that are generated.

In some rural or nonindustrialized areas, wastes are typically organic or inert and do not pose major disposal problems, particularly since they are often utilized for animal food or other purposes. However, as the level of industrialization increases, or even simply as a result of growing access to packaged and consumer goods, waste disposal becomes an increasing problem in virtually all societies. The problems are typically associated with nonbiodegradable or bioaccumulative substances such as waste pesticides, solvents, heavy metals, and chemical sludges. These are often production wastes, but they can also arise from inappropriate application (pesticides) or poor consumer behavior (waste motor oils). The development and widespread use of new substances such as plastics and the products that they have made possible have improved the standard of living for millions, but they have also introduced new threats to the environment, as typified by the histories of DDT and polychlorinated biphenyls (PCBs).

The long-term solution to the problem of persistent or hazardous wastes must lie in efforts to find alternatives to the hazardous substances. In the meantime, high priority should be given to minimizing the use of resources and reducing the discharge of wastes.

Precautionary Approaches

The need to avoid or minimize the release of complex organic or inorganic substances into the environment is all the greater because of un-

certainty about their effects on human health and the natural environment and the very high costs of retrofitting or cleanup. At the same time a realistic attitude must be maintained regarding developing countries. Much industrial and product design is based on industrial country practice, and almost all of the fundamental science on which regulation is based has been carried out in the more advanced economies. Although there will be some opportunities to leapfrog to more sophisticated systems, the priority in developing countries should be to ensure that policymakers and regulators are up-to-date and informed and avoid repeating fundamental mistakes made in the course of industrialization elsewhere.

A particular challenge for developing countries is to take advantage of affordable and productive technologies from industrial countries without allowing the importation of outdated or outlawed equipment or substances. Technologies and materials science are changing rapidly, but so are the sources of information. Environmental agencies in developing countries that do not have the resources to carry out their own research can find much of the necessary information publicly available, although an investment of time and resources will frequently be needed to find the appropriate answers.

Definitions

Waste minimization is one of a number of related terms and concepts that, despite having similar overall goals and often being used interchange-

ably, may differ significantly in basic principles and in emphasis. In this *Handbook*, *waste* is used to refer to a material from a manufacturing process that has no value to the manufacturer and that has to be disposed of in some manner. (Waste of energy, an important related issue, is addressed elsewhere.)

Avoidance refers to actions by the producer to avoid generating the waste. *Utilization* includes the range of actions that make the waste a useful input to other processes, eliminating the need for disposal. Waste minimization thus comprises both avoidance and utilization. Processes that reduce the toxicity or potentially harmful impacts of a waste can in some cases be regarded as minimization, although in other circumstances such changes represent treatment before disposal.

Although the terminology used may vary, a number of important activities can be distinguished. *Reuse* refers to the repeated use of a “waste” material in a process (often after some treatment or makeup). *Recycling* refers to the use by one producer of a waste generated by another. *Recovery* is the extraction from a waste of some components that have value in other uses.

Hierarchy of Approaches

Waste avoidance and utilization can be seen as part of a broader hierarchy of approaches to achieving sustainable development. At the highest level are approaches that seek to satisfy human needs and requirements in ways that do not waste resources or generate harmful by-products or residuals. These approaches include changing consumer behavior and reexamining the range and character of the products and services produced. At a slightly lower level are efforts to redesign products and services and to raise consumers’ awareness about the impacts of their decisions. Application of techniques such as life cycle analysis (LCA) is part of the difficult analysis of the overall impacts of products and services on the environment. Such approaches are at present adopted mainly by the more advanced organizations in industrial countries.

More directly relevant to industrial activity in developing countries are approaches focused on improvements in production processes. These

approaches include cleaner production, pollution prevention, and waste minimization, all of which are related, to a greater or lesser degree, to better management, improvements in production processes, substitution of hazardous inputs, reuse and recycling of wastes, and so on.

The next step, which should be minimized but is not to be neglected, is treatment and proper disposal of wastes. The lowest level in the hierarchy, and the one that all the other levels strive to eliminate, is remediation of the impacts of wastes discharged to the environment. Cleanup is costlier than prevention.

Policy and Regulatory Framework

A clear and effective governmental framework for waste management is necessary. Such a framework should include the delegation of relevant powers to the lower levels of government that are typically responsible for implementation. It should be based on a clear and broadly accepted long-term policy and should include a predictable and flexible regulatory regime and targeted economic incentives. At the same time, programs should be put in place to increase awareness and education, with the long-term objective of changing the behavior of manufacturers and consumers in the direction of minimizing waste generation.

Producers and Consumers

Efforts must be made to involve both producers and consumers in waste minimization and utilization. Producers can improve their performance through both management changes and technological improvement; some producers in industrial countries are now making serious efforts to examine the impacts not only of their production processes but also of the products themselves. LCA is still an evolving tool, but it does focus attention on the overall impact of the production, use, and disposal of products.

Consumers in some of the wealthier countries are moving toward a greater awareness about the need for waste reduction, as shown by participation in recycling schemes and some demand for environmentally friendly products. However, progress is often slow, and there is a need for ongoing education and awareness, as well as

careful analysis of options and incentives. In developing countries, the demand for resources often leads to significant recycling of materials such as glass, metals, and plastics. These recycling systems have important social and economic consequences at the local level, and their “improvement” must be approached with care.

Complexity

Waste management efforts are linked closely with income levels. There is a broad progression from recycling of most materials in the poorest societ-

ies, through increasing consumerism—often with little concern for waste problems—in low- and middle-income countries, to the environmental activism of some rich countries. The appropriate waste avoidance and utilization strategy for any situation must take into account the level of the economy, the capabilities of government at different levels, and the environmental circumstances. As with any other environmental strategy, there is a need for public involvement and political support in the identification of priorities and the implementation of the necessary enabling measures.