CHAPTER 14

Rationale of Environmentally Balanced Industrial Complexes

Industry's contribution to the era of waste utilization is highlighted by its acceptance to use the ultimate in waste utilization: the environmentally balanced industrial complex (EBIC) system. The system comprises two or more compatible industrial plants located in close proximity to one another in one complex. Each plant uses the waste of another plant as part or all of its raw material. No wastes are discarded into the environment outside the complex. No wastes have to be transported or sold outside the complex. The environment is protected from environmental degradation. And people (consumers) benefit from lower-priced products. Industry also gains a competitive price advantage over other plants that choose to operate in separate locations and are encumbered with waste-treatment costs.

Although the real measurable cost of industrial environmental pollution control remains relatively small when compared to total production or value-added costs, it can be a significant amount when considered by itself. In fact, the amount may be enough to influence industry management to consider whether to produce or discontinue the manufacturing of specific goods. Although environmental engineers are usually not involved in that decision, the goal should be to reduce treatment costs to a minimum while protecting the environment to a maximum.

In conventional industrial solutions to waste problems, industry uses separate treatment plant units, such as physical, chemical, and biological systems. These separate treatment systems increase manufacturing costs. These costs are also easily identified and, even if relatively small when compared to other production costs, are opposed by industry. On the other hand, reuse costs, if any, in an EBIC will be difficult to identify and more easily absorbed into reasonable production costs.

Large, water-consuming and waste-producing industrial plants are ideally suited for location in such industrial complexes. Even though their wastes—if released to environment—might cause pollution, such wastes may be amenable to reuse by close

association with satellite industrial plants using wastes and producing raw materials for others within the complex.

Examples of such major industries are steel mills, fertilizer plants, sugarcane refineries, pulp and paper mills, and tanneries. Cement plants may also produce the ideal product to allow a perfect match for the phosphate fertilizer plants in a balanced industrial complex.

One needs to choose the proper mix of industries of the appropriate size and locate them in a specific area isolated from other municipal, industrial, or commercial establishments. These choices will be highly influenced by marketing and socioeconomic factors.

Since 1977, I have proposed several typical complexes for tannery, pulp and paper, fertilizer, steel mill, sugarcane, and textile industries (Nemerow et al. 1978, 1980, 1987; Nemerow and Dasgupta 1981, 1984, 1985; Nemerow 1980a,b, 1984; Tewari and Nemerow 1982; Nemerow and Veziroglu 1988). Such complexes have the presumed advantages of minimizing production costs and adverse environmental impacts. Optimization of these advantages will meet the objectives of both industries and environmentalists.

Although the advantages of this type of complex are obvious, there are certain difficulties to overcome. One involves compatibility. There is no evidence that waste and product compatibility necessarily mean industrial working compatibility. Other plant operating requirements such as labor availability, marketing of products, and taxes may not mesh as easily.

Another involves optimal mass balances. Again, there is no evidence showing that all plants within such a complex can operate at or near their optimum production required for economic purposes. However, lack of evidence is no reason to discard the principle, but reason for more complete investigation and trials. In the middle to late 1990s, the field of "industrial ecology" became recognized as one step in promoting "waste utilization" rather than "waste treatment." An ardent supporter of this concept is Suren Erkman[1] who has surveyed this field and written extensively on the modern interpretation of industrial ecology. In one of his latest contributions to this concept (2001), he summarizes as follows:

> Industrial ecology aims at looking at the industrial system as a whole. Industrial ecology does not address just issues of pollution and environment, but considers as equally important, technologies, process economics, the inter-relationship of businesses, financing, overall government policy and the entire spectrum of issues that are involved in the management of commercial enterprises. As such, industrial ecology can provide a conceptual framework and an important tool for the process of planning economic development, particularly at the regional level. Also, industrial ecology may offer options, which are not only effective for protecting the environment but also for optimising the use of scarce resources.

[1] Suren Erkman, Institute for Communication and Analysis of Science and Technology, Geneva, Switzerland.

> Thus, industrial ecology is especially relevant in the context of developing countries, where growing populations with increasing economic aspirations should make the best use of limited resources.

The reader should recognize the similar philosophies and goals of the "industrial ecology" concept described by Erkman and others and the EBIC concept proposed here. Both "beg" for implementation on a practical scale to verify and fortify their theoretical premises.

In the following chapters, I present justification for both potential and realistic industrial complexes that apply to the aforementioned principles and objectives.

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