ЕКОЛОГІЯ
ECOLOGY

UDK 502.33

O.O.Vovk, Dr. Eng. Sc., Prof.
National technical university of Ukraine "Kiev Polytechnic Institute"

STRATEGIES FOR ENVIRONMENTAL IMPACT REDUCTION ON TECHNOSPERE

Methods for environmental problems solving throw a systems approach so that the connections between industrial practices/human activities and environmental / ecological processes can be more readily recognized were analyzed in this article . A systems approach for a holistic view of environmental problems, making them easier to identify and solve were proposed.
Key words: ecologization, life cycle, technospere, industrial metabolism, environmental strategies.

Introduction

The development of strategies for environmental impact reduction is an attempt to provide a new conceptual framework for understanding the impacts of the technosphere on the environment. This new framework serves to identify and then implement strategies to reduce the environmental impacts of products and processes associated with industrial systems, with an ultimate goal of sustainable development.

It is obviously important to study physical, chemical, and biological interactions and interrelationships both within and between industrial and ecological systems. Additionally, some researchers feel that such attempts should involve identifying and implementing strategies for industrial systems to more closely emulate harmonious, sustainable, ecological ecosystems.One goal is to change the linear nature of our industrial system, where raw materials are used and products, by-products, and wastes are produced, to a cyclical system where the wastes are reused as energy or raw materials for another product or process. Fundamental to solving environmental problems in the technosphere is identifying and tracing flows of energy and materials through various systems. This concept, sometimes referred to as industrial metabolism, can be utilized to follow material and energy flows, transformations, and dissipation in the industrial system as well as into natural systems. The mass balancing of these flows and transformations can help to identify their negative impacts on natural ecosystems. By quantifying resource inputs and the generation of residuals and their fate, industry and other stakeholders can attempt to minimize the environmental burdens and optimize the resource efficiency of material and energy use within the industrial system. Fundamental to industrial ecology is identifying and tracing flows of energy and materials through various systems. This concept, sometimes referred to as industrial metabolism, can be utilized to follow material and energy flows, transformations, and dissipation in the industrial system as well as into natural systems. The mass balancing of these flows and transformations can help to identify their negative impacts on natural ecosystems. By quantifying resource inputs and the generation of residuals and their fate, industry and other stakeholders can attempt to minimize the environmental burdens and optimize the resource efficiency of material and energy use within the industrial system.

Goal and tasks

The primary goal of strategies for environmental impact reduction development is to promote sustainable development at the global, regional, and local levels. Sustainable development has been defined by the United Nations World Commission on Environment and Development as "meeting the needs of the present generation without sacrificing the needs of future generations.". Key tasks inherent to sustainable development include: the sustainable use of resources, preserving ecological and human health (e.g. the maintenance of the structure and function of ecosystems), and the promotion of environmental equity (both intergenerational and intersocietal). This strategy should promote the sustainable use of renewable resources and minimal use of non-renewable ones. Industrial activity is dependent on a steady supply of resources and thus should operate as efficiently as possible. Although in the past mankind has found alternatives to diminished raw materials, it can not be assumed that substitutes will continue to be found as supplies of certain raw materials decrease or are degraded. Besides solar energy, the supply of resources is finite. Thus, depletion of nonrenewables and degradation of renewables must be minimized in order for industrial activity to be sustainable in the long term.Human beings are only one component in a complex web of ecological interactions: their activities cannot be separated from the functioning of the entire system. Because human health is dependent on the health of the other components of the ecosystem, ecosystem structure and function should be a focus of industrial ecology. It is important that industrial activities do not cause catastrophic disruptions to ecosystems or slowly degrade their structure and function, jeopardizing the planet's life support system.A primary challenge of sustainable development is achieving intergenerational as well as intersocietal equity. Depleting natural resources and degrading ecological health in order to meet short-term objectives can endanger the ability of future generations to meet their needs. Intersocietal inequities also exist, as evidenced by the large imbalance of resource use between developing and developed countries. Developed countries currently use a disproportionate amount of resources in comparison with developing countries. Inequities also exist between social and economic groups within the worlds countries.

Material and research results

Various strategies are used by individuals, firms, and governments to reduce the environmental impacts of industry. Each activity takes place at a specific systems level. Pollution prevention is defined by the U.S. EPA as "the use of materials, processes, or practices that reduce or eliminate the creation of pollutants at the source." Pollution prevention refers to specific actions by individual firms, rather than the collective activities of the industrial system (or the collective reduction of environmental impacts) as a whole. The document in this compendium entitled "Pollution Prevention Concepts and Principles" provides a detailed examination of this topic with definitions and examples. Waste minimization is defined by the U.S. EPA as "the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, sorted, or disposed of."16 Source reduction is any practice that reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environmental prior to recycling, treatment or disposal. Total quality environmental management (TQEM) is used to monitor, control, and improve a firm's environmental performance within individual firms. Based on well-established principles from Total Quality Management, TQEM integrates environmental considerations into all aspects of a firm's decision-making, processes, operations, and products. All employees are responsible for implementing TQEM principles. It is a holistic approach, albeit at level of the individual firm. Many additional terms address strategies for sustainable development. Cleaner production, a term coined by UNEP in 1989, is widely used in Europe. Its meaning is similar to pollution prevention. In Clean Production Strategies, Tim Jackson writes that clean production is . . . an operational approach to the development of the system of production and consumption, which incorporates a preventive approach to environmental protection. It is characterized by three principles: precaution, prevention, and integration. *These strategies* represent approaches that individual firms can take to reduce the environmental impacts of their activities. Along with environmental impact reduction, motivations can include cost savings, regulatory or consumer pressure, and health and safety concerns. What environmental strategies potentially offers is an organizing umbrella that can relate these individual activities to the industrial system as a whole. Whereas strategies such as pollution prevention, TQEM, and cleaner production concentrate on firms' individual actions to reduce individual environmental impacts, industrial ecology is concerned about the activities of all entities within the industrial system. The goal of industrial ecology is to reduce the overall, collective environmental impacts caused by the totality of elements within the industrial system.

System Tools to Support strategies for environmental impact reduction

Life Cycle Assessment (LCA)

Life cycle assessment (LCA), along with "eco-balances" and resource environmental profile analysis, is a method of evaluating the environmental consequences of a product or process "from cradle to grave." The Society for Environmental Toxicology & Chemistry (SETAC) defines LCA as "a process used to evaluate improvement analysis — evaluation and implementation of opportunities to reduce environmental burden Some life cycle assessment practitioners have defined a fourth component, the scoping and goal definition or initiation step, which serves to tailor the analysis to its intended use. Other efforts have also focused on developing streamlined tools that are not as rigorous as LCA (e.g., Canadian Standards Association.)

Methodology

A Life Cycle Assessment focuses on the product life cycle system. Most research efforts have been focused on the inventory stage. For an inventory analysis, a process flow diagram is constructed and material and energy inputs and outputs for the product system are identified and quantifiedThe U.S. EPA has stated that an LCA "is a tool to evaluate the environmental consequences of a product or activity holistically, across its entire life."

Components of an LCA

LCA methodology is still evolving. However, the three distinct components defined by SETAC and the U.S. EPA are the most widely recognized:

1. inventory analysis — identification and quantification of energy and resource use and environmental releases to air, water, and land
2. impact analysis — technical qualitative and quantitative characterization and assessment of the consequences on the environment

Regardless of the current limitations, LCAs offer a promising tool to identify and then implement strategies to reduce the environmental impacts of specific products and processes as well as to compare the relative merits of product and process options. However, much work needs to be done to develop, utilize, evaluate, and refine the LCA framework.

Life Cycle Design (LCD) and Design For the Environment (DfE)

The design of products shapes the environmental performance of the goods and services that are produced to satisfy our individual and societal needs. Environmental concerns need to be more effectively addressed in the design process to reduce the environmental impacts associated with a product over its life cycle. Life Cycle Design, Design for Environment, and other similar initiatives based on the product life cycle are being developed to systematically incorporate these environmental concerns into the design process.Life Cycle Design (LCD) is a systems-oriented approach for designing more ecologically and economically sustainable product systems. Coupling the product development cycle used in business with a product's physical life cycle, LCD integrates environmental requirements into each design stage so total impacts caused by the product system can be reduced.Design for Environment (DfE) is another design strategy that can be used to design products with reduced environmental burden. DfE and LCD can be difficult to distinguish. They have similar goals but evolved from different sources. DfE evolved from the "Design for X" approach, where X can represent manufacturability, testability, reliability, or other "downstream" design considerations. Braden Allenby has developed a DfE framework to address the entire product life cycle. Like LCD, DfE uses a series of matrices in an attempt to develop and then incorporate environmental requirements into the design process. DfE is based on the product life cycle framework and focuses on integrating environmental issues into products and process design.Life cycle design seeks to minimize the environmental consequences of each product system component: product, process, distribution and management. When sustainable development is the goal, the design process can be affected by both internal and external factors.Internal factors include corporate policies and the companies' mission, product performance measures, and product strategies as well as the resources available to the company during the design process. For instance, a company's corporate environmental management system, if it exists at all, greatly affects the designer's ability to utilize LCD principles.External factors such as government policies and regulations, consumer demands and preferences, the state of the economy, and competition also affect the design process, as do current scientific understanding and public perception of risks associated with the product.

The needs analysis

As shown in the figure, a typical design project begins with a needs analysis. During this phase, the purpose and scope of the project is defined, and customer needs and market demand are clearly identified. The system boundaries (the scope of the project) can cover the full life cycle system, a partial system, or individual stages of the life cycle. Understandably, the more comprehensive the system of study, the greater the number of opportunities identified for reducing environmental impact. Finally, benchmarking of competitors can identify opportunities to improve environmental performance. This involves comparing a company's products and activities with another company who is considered to be a leader in the field or "best in class."

Design requirements

Once the projects needs have been established, they are used in formulating design criteria. This step is often considered to be the most important phase in the design process. Incorporating key environmental requirements into the design process as early as possible can prevent the need for costly, time-consuming adjustments later. A primary objective of LCD is to incorporate environmental requirements into the design criteria along with the more traditional considerations of performance, cost, cultural, and legal requirements.

Conclusions

As we struggle with what the appropriate levels of Ukrainian technosphereecologization should be, we are faced with the fundamental question of whether our policy designed to create a pristine domestic environment through continued and increasing reliance on other regions of the world for heavy industrial activity is ethically and morally defensible. It is perhaps easy to conclude, in the absence of global or comprehensive thinking, that domestic harvest levels should be significantly reduced. Consideration of raw material options, and associated environmental impacts logically leads, however, to a much different conclusion. When seeking to protect the environment, the lack of a global perspective can and does lead to what amounts to irresponsible and unethical regional environmentalism. As we enter what has been called a new era of ecoeconomy, we need to totally rethink our positions and approach to environmental issues with a global and comprehensive view. To do otherwise will ill serve both the world's environment and its people. While environmental assimilative capacity varies greatly from one location to another, some broad emission and discharge target guidelines are given as a starting point for project design. The use of specific project design criteria can help to confirm that all relevant actions have been taken to minimize environmental impact.Within the operating company environmental control must become a priority to be managed rather than an unwelcome nuisance to be attended to when problems start to appear. Effective control only occurs when corporate management adopts environmental performance goals and a suitable management structure from the outset.

References

1. Ayres, Robert V. 1988. "Self Organization in Biology and Economics." *International Journal on the Unity of the Sciences 1, no. 3.*

2. Ayres, Robert U., and Allan V. Kneese. 1969. "Production, Consumption and Externalities." *American Economic Review* 59, no. 3: 282-296.

3. 1989. 'Externalities: Economics and Thermodynamics." In: F. Archibugi and P. Nijkamp, eds., *Economy and Ecology*: Towards Sustainable Development. Dordrecht: Kluwer Academic Publishers.

4. Georgescu-Roegen, Nicholas. 1971. *The Entropy Law and the Economic Process*. Cambridge, Mass.: Harvard University Press.

5. Nriagu, J. O. 1990. "Global Metal Pollution." *Environment* 32, no. 7: 7-32.

6. Rogner, Hans-Holger. 1987. "Energy in the World: The Present Situation and Future Options." In: *Proceedings of the 17th International Congress of Refrigeration August* 24-28, 1987.

УДК 502.33

О.А. Вовк, д-р техн. наук, проф.

Национальный технический университет Украины «Киевский политехнический институт»

СТРАТЕГИИ СНИЖЕНИЯ ЭКОЛОГИЧНКОГО ВОЗДЕЙСТВИЯ НА ТЕХНОСФЕРУ

В статье были проанализированы методы решения экологических проблем при использовании системный подхода, для выявления и определения взаимосвязей между промышленной деятельностью/ деятельностью человека и окружающей среды / экологических процессов. Был предложен системный подход для холистического представления экологических проблем с целью упрощения их идентификации и решения.

Ключевые слова: экологизация, жизненный цикл, техносфера, индустриальный метаболизм, экологические стратегии.

УДК 502.33

О.О. Вовк, д-р техн. наук, проф.

Національний технічний університет України «Київський політехнічний інститут»

СТРАТЕГІЇ ЗНИЖЕННЯ ЕКОЛОГІЧНОГО ВПЛИВУ НА ТЕХНОСФЕРУ.

У статті були проаналізовані методи вирішення екологічних проблем при використанні системного підходу, для виявлення та визначення взаємозв'язків між промисловою діяльністю / діяльністю людини і навколишнього середовища / екологічних процесів. Був запропонований системний підхід для холістичного уявлення екологічних проблем з метою спрощення їх ідентифікації і рішення.

***Ключові слова*:** екологізація, життєвий цикл, техносфера, індустріальний метаболізм, екологічні стратегії.

Надійшла .15. 09.2015

Received 15.09.2015