INDUSTRIAL POLLUTION PREVENTION STRATEGY - CLEANER PRODUCTION

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Summary

Being coined by UNEP in 1989, cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment. The precaution & preventative principle, the integration principle, the comprehensive principle and the continuity principle are implied under the conception of cleaner production. Compared to end-of-pipe approaches, cleaner production is a win-win strategy.

After about 20 years' effort, the implementation of cleaner production has become a global activity, and has gained many achievements and had significant impact. These achievements and impact can be assessed at various levels: the technology promoter, the managerial catalyst, the paradigm reformer and the conceptual bridge connecting industrialization and sustainability. However, cleaner production also faces some challenges, such as cultural reluctance, organizational resistance, technology innovations and sustainable consumption, etc.

To implement cleaner production, a multi-tool strategy and integrated framework should be adopted: environmental management systems and other socio-economic incentives create the framework for changes. Government policies and strategies orient this framework towards clear objectives, technological tools will ensure their realization and environmental education and training will ensure a long-term result.

In the 21st century, cleaner production should expand both the stakeholder base and the activity base. Furthermore, it should be integrated into the core decision-making at both governmental and enterprises levels. Cleaner production will thus be a part of conventional economic and social practice by paying more attention to ecological

industries and sustainable consumption.

1. Introduction

The 20th century shows a clear evolution in the general attitudes of governments and industries regarding environmental impacts. Correspondingly, the awareness of the need for an integrated approach to environmental pollution and resource depletion problems is a step-by-step process.

In the earlier decades of the 20th century, three categories of environmental attitudes can be summarized: *foul & flee, concentrate & contain and dilute & disperse*. However, all these attitudes prove to fail in the long run, and cause many environmental problems and even environmental disasters, such as the photochemical pollution in London, the mercurialism accidents in Japan in the 1960s. All these problems showed that the dilute & disperse strategy was no longer effective for important point-source pollutions, and led to the first change of general attitude about the 1960s. Industries began to install purification units at the end of the emission pipes of various production processes. This reactive waste management is the so called "end-of-pipe approach (EOP)" From a historical point of view, EOP approaches played an important role in controlling industrial pollution to a certain extent. However, the EOP approach is not "the solution" because it usually causes secondary pollution and increases both the capital costs and operation costs that are burdensome to most enterprises. Even worse, the EOP approach has deeply penetrated into the routine decision-making of both industries and governments, which brings the most stubborn barrier to implement cleaner production (see in later session). In 1970s, with the emerging of the concept of sustainable development, cleaner production was proposed and advocated based on the lessons learned from traditional industrial pollution control practices. It is a pro-active and integrated solution to pollution problems by eliminating or reducing pollutants at the source during the course of production processes. These *pollution prevention* and *waste minimization* strategies appeared to be necessary to reduce the enormous costs of clean-up actions, certainly from the moment that the polluter pays principle was brought into legislation. By bringing the environmental and the business concern together, the new approach of cleaner production has proven its benefits and will be promising in the 21st century.

With the changes of general attitudes regarding environmental pollution, environmental technology, management and legislation also evolve. The technical solutions for environmental problems show a clear evolution from end-of-pipe approaches towards precaution and prevention. Since the middle of 1980s, source-oriented and product-oriented technologies are highlighted in almost every basic discipline. For example, *Green Chemistry, Green Materials* and *Green Design* are standing on the frontiers of each of their research scopes. In respect of environmental management, in the 1970s, business focused on end-of-pipe activities, i.e. to measure, prevent, limit or correct environmental damage to air, water and soil, as well as those dealing with problems related to waste, noise and ecosystems. Since the 1980s, business began to integrate the ideas of cleaner production into all business activities from production, management, budgeting, to marketing activities, instead of purely technological solutions. A similar situation also takes place in respect of environmental legislation. Early environmental legislation was introduced to solve specific and sometimes local pollution problems.

Therefore legislation was pollutant and source-specific and concerned single environmental media. This type of legislation was of the command and control type. Under this type of environmental legislation, mostly end-of-pipe technologies were sufficient to meet legal requirements. As a consequence, environmental policy and legislation did not give clear incentives to invest in cleaner production. Later in the 70s and the 80s, market instruments like charges and taxes were introduced, environmental legislation began to evolve into a more integrated market-oriented or hybrid type. After the 1990s, with the globalization of environmental problems, environmental legislation becomes more and more guided by global problems.

Although cleaner production has gained worldwide attention, it should be implemented and promoted further. Just as Dr. Klaus Toepfer, Executive Director of the United Nations Environment Programme, says, "to a large extent we have built the world-wide consensus on cleaner production. However, we have not reached the end of the road and we must foster greater commitment."

2. Concept and Basic Principles of CP

2.1 Definition

In the 1980s, there were a great number of competing concepts related to pollution prevention principles, such as pollution prevention, cleaner technologies, low-and non-waste technologies, waste prevention, waste minimization, etc. Against this background, UNEP first put forward cleaner production in 1989, "cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to reduce risks to humans and the environment" Since the term was proposed, cleaner production has evolved over time and there are a number of variations in the way it is defined. Table 1 provides various definitions of cleaner production.

UNEP (1989)
cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to reduce risks to humans and the environment.

UNEP (1996)
The continuous application of an integrated preventative environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment.
  - *Production processes: conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.*
  - *Products: reducing negative impacts along the life cycle of a product, from raw materials extraction to ultimate disposal.*
  - *Services: incorporating environmental concerns into designing and delivering services.*

OECD

Cleaner production is an integrated preventative environmental strategy for processes and products to reduce risks to human health and the environment.

EEA

Cleaner production is a preventative integrated continuous strategy for modifying products，processes or services to enhance effectiveness which improves environmental performance and reduces costs.

Environment Australia

Cleaner Production is a strategy to continuously improve products, services and processes to reduce environmental impact, and to work towards ecologically and economically sustainable development.

SETC, China

Cleaner Production is the continuous application of pollution prevention strategies to processes and products, through ongoing improvement of management practices and technologies in order to enhance efficiency of resource utilization, to eliminate pollution emissions and to reduce risks to people and the environment.

Table 1: Cleaner Production Definitions

From all the definitions above, one common feature can be found: cleaner production is a preventative upstream approach rather than a curative downstream approach. The main target of cleaner production is to focus on the prevention or reduction of waste and inefficient use of energy and resources. To achieve this target, technological innovations or modifications should be made in process production, product design and even consumption patterns.

However, the conception of cleaner production still evolves. In parallel with the growth of CP, scientists, engineers, industrial managers, and many others have begun to recognize that true long-term sustainability of our industrial economic systems will require that societies learn to break our dependence on single use throughput of natural resources and growing production of wastes. This dependence has led to unsustainable impacts on the environment and disruption of natural systems. Instead, we must develop "cyclical" production systems that increasingly reuse and recycle all materials. Similar to biological ecosystems in which one organism's waste is the source of food for another organism, we must develop industrial systems in which there are no "wastes" but only residual materials that can be used to produce other useful products. This recognition has led to the concept of Industrial Ecology (IE) and the development of a new area of scientific study that examines industrial systems in the context of the natural, social, and economic systems that surround them.

2.2. The Guiding Principles

Four basic guiding principles are implied in the conception of cleaner production.

(a) The precaution & preventative principle

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Biographical Sketches

Lei SHI is an associate professor of Tsinghua University. He obtained his Ph.D. and M.A. degree from Dalian University of Technology (1999, 1996). Dr. Shi's current research is centered on integrating pollution prevention principles into the processes of product design and industrial manufacturing, the organizing framework for the study of the interactions of the modern technological society with the environment. He published over 30 technical papers in various scientific journals.

Ruirui LI graduated from Suzhou Urban Construction and Environment Protection Institute in 1990 and began to work in Department of Environment Science and Engineering, Tsinghua University. She was engaged in the management of State Key Joint Laboratory of Environment Simulation and Pollution Control. From 1997 she took part in the cleaner production working group of China Council for International Cooperation on Environment and Development (CCICED) and began to study cleaner production. She got her master degree in Tsinghua University in Jan. 2001 and the title of her thesis is Assessment Indicator System Frame of City Cleaner Production in China.

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