

# **Cleaner Production as a Graduate Level Energy and Environmental Engineering and Management Course at AIT**

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## **Abstract**

Cleaner Production offers an integrated approach in addressing issues related to the handling of wastes and pollutants in industries. The concept of Cleaner Production is different from the concept of end of pipe control of environmental problems in many ways, and CP provides a holistic approach to deal with the problems faced by the industries and other economic sectors. Senior and middle level managers and engineers therefore need an in-depth understanding of Cleaner Production and related tools to better manage their enterprises.

Environmental considerations are as far as possible made in a life-cycle or “cradle to grave” perspective, so that environmental problems are not moved from one part of life-cycle of product to another, for example, from a processing company to the customer of the company. CP at graduate level has been recently initiated at the Asian Institute of Technology (AIT). This paper aims to discuss how CP has been introduced and implemented as an interdisciplinary area at AIT. The program has been aimed at professionals from the government, private, non governmental organisations and academicians working in energy, environment and process integration fields. A good knowledge of CP would help steer the industry in a sustainable manner.

## **1. Evolution of Pollution Management in Industries:**

In the immediate post World War II era, higher product quantity management was the target of industries, as compared to quality improvement. This was due to the fact that industries had local markets and monopoly in one particular type of product ensured good profit margins inspite of just satisfactory quality. During this period industries did not pay attention to industrial pollution, and often dilution of pollution was considered the best solution. In the 1960s, Japanese and German industries introduced the concept of product quality management which was accepted by other developed nations. Moreover, globalization of markets, free trade, multinationalisation of companies further strengthened this concept. Of course to remain competitive and to earn profits as well, the products were of good quality and were high priced.

Waste is an unavoidable byproduct in any manufacturing process. For example, washing operations in textile or electroplating industries produces wastewater that is unusable and unwanted. With the new concept of product quality management, industries began looking at better quality products and higher production capacities, but in the process started damaging the environment in terms of emissions, toxic and heavy metal laden wastewater, hazardous solid wastes, etc. Thus, in order to abate the pollution generated by the industries, national governments introduced pollution control regulations, whereby the industries were expected to treat waste prior to discharge into natural environment (Modak et al, 1997).

Pollution control technologies (such as effluent treatment plants, wet scrubbers and filters) introduced in the industrialization process were essentially add-ons and as such were considered as dead investment by the industries, with no profitable returns. These control technologies are known as the "end of the pipe" technologies, and they basically changed the phase of the pollutants rather than eliminating them from the carrying medium. For example filters, effluent treatment plants, scrubbers all produce sludge or solid waste which had to be disposed.

The industries then realized that both quality and quantity of wastes produced was as important as the products themselves and should be minimized to abate the adverse environmental impacts. Thus was born the concept of total quality management or preventive environmental management, which involved all the above elements of industrial production. Beyond this concept lies the domain of a holistic, integrated management system denoted by ISO 14000, Sustainable Development that incorporates all aspects of environment and production.

## **2. Evolution of Environmental Education in the Asia Pacific region**

Educational curriculum of the Asia Pacific universities have closely followed the above trends in dealing with industrial pollution issues by offering graduate programs either in "environmental engineering" or in "environmental sciences". These traditional graduate programs had curriculum based on end of pipe treatment of generated wastes. In wastewater treatment, most courses deal with major environmental impact, types of treatment system like physico-chemical treatment, biological treatment, and advanced treatment systems like membrane systems, etc., . All these courses train on how to operate treatment system to reach required effluent standards. Solid waste management courses deal with problems related to solid waste, its treatment systems (separation, recycling, stabilization, and incineration) and its disposal methods (landfilling). Air pollution management course deals causes of air pollution, monitoring and controlling air Pollution. This trend has been closely replicated by the universities in their under-graduate programs also in recent years (Visvanathan & Polprasert, 2001)

On the other hand, Cleaner Production is an integrated approach in handling wastes and pollutants in industries, and so is different from the concept of end of pipe control of environmental problems in many ways. An in-depth understanding of Cleaner Production and related tools is therefore necessary as a basis for the planning of training and educational activities for CP. The concept of CP is characterized by the following:

- Environmental Considerations are integrated in planning and development
- Environmental problems are prevented at source and
- An interdisciplinary approach is required to address the issues faced by the industries.

Environmental considerations are as far as possible made in a life-cycle or "cradle to grave" perspective, so that environmental problems are not moved from one part of life-cycle of product to another, for example from a processing company to the customer of the company.

Past experiences in the region reveals that capacity building in cleaner production is designed and implemented either in an *ad-hoc* basis or was focused on training the specialists. Generally, industries serve as "training center" for developing the skills of industrial workers and entrepreneurs. The training and experience acquired enable them to branch out to other

fields. However, the informal-on the job type of training is usually not well organized. Therefore, CP training activities should not only be limited to the training of specialists, but also reach out to the various cross sections of users ranging from technicians to planners.

This paper aims to discuss how CP has been introduced and implemented as an interdisciplinary area at AIT. Information about the institute and the earlier course curriculum in environmental engineering is first presented. The Cleaner production program that has been recently introduced will be then presented in detail.

### **3. Introducing Cleaner Production at AIT**

The Asian Institute of Technology (AIT), founded in 1959, is an autonomous, international, postgraduate institution in engineering and management. AIT fosters the exchange, disseminate, and learning of advanced technological knowledge and expertise to met the need for well trained personnel in key positions in the private and public sectors.

The Institute's Mission is the following: *"AIT will take a leadership role in the promotion of technological change and its management for sustainable development in the Asia and Pacific Region, through high level education, research and outreach activities which integrate technology, planning and management. The focus of the Institute's activities is in technology, with special emphasis on the inter disciplinary fields, and will include attention to environmental and socio-economic considerations"*.

Environmental engineering and science education related to the technology and management of pollution in industries is basically taught in the following fields of study: Environmental Technology and Management, Water and Wastewater Engineering and Environmental Toxicology, Technology and Management. Students learn about energy conservation technologies, energy management and policies in the Energy Program's three different field of study: Electric Power System Management, Energy Economics and Planning, and Energy Technology.

The Environmental Engineering Program at AIT is one of the oldest post-graduate program in the Asia Pacific region. Started more than 35 years ago, it has trained more than 900 graduates. Most of this program's alumni hold very senior management and decision making positions in the government and private sector. However, the research and other activities were basically on sanitary engineering and end of pipe treatment for industrial effluents. This approach is no longer satisfactory to industry. Environmental regulations are becoming stricter and industries and related organisations are opting for the application of cleaner technologies and thus minimize the waste generation at source, and at the same time reduce energy consumption, thus saving cost and reducing GHG emission.

Figure 1: Energy and Environmental Approach towards Cleaner Production (Kumar & Visvanathan, 2000)

The industries of Asia are now looking for graduates who have a general environmental literacy among all their employees rather than a few environmentally specialized engineers. Pollution prevention and cleaner production concepts require actions by production and design engineers, and not only by environmental specialists. To develop preventive principles

leading to sustainable development, the education of every engineer is not complete without a good sounding of basic environmental education.

With current trends in population growth and industrialization, wastes and pollutants are released faster than earth can absorb them and natural resources are consumed faster than they can be restored. Industrial pollution is growing even more rapidly than economic growth, which results in environmental degradation. Therefore the traditional approach of environmental engineering education needs reformulation, which should take into consideration the rapid development on the industrial sector at the same time. The engineering graduates should be able to look for solutions based on the multidisciplinary nature of environmental and sustainability approach.

#### **4. Cleaner Production at AIT**

##### ***4.1 Master's program:***

AIT introduced the interdisciplinary postgraduate program on "Cleaner Production" in January 2000. This program is aimed at professionals working in the area of energy, environment and process integration fields. This program focuses on adoption of cleaner production practices to control pollution, reduce energy consumption and to make profits by improving the performance of industry. Cleaner production emphasizes reducing the pollution at the source and paying little attention to pollution control aspects. While the application of CP practices significantly reduces the pollution load, a certain amount of pollution load may still need to be handled. Therefore, an integrated approach combining both end of pipe approach and CP philosophy is part of training. The Cleaner Production program has the following four theme courses:

*Principles of Cleaner Production:* The objective of this course is to provide the concepts of industrial development and the role of energy and environment. Here, as part of the pollution and energy consumption abatement, the concept of cleaner production is introduced. This is examined through tools such as mass balance, energy and environmental audits, energy and water pinch analysis, and financial analysis of CP options. Case studies from the industry are given.

*Eco design and manufacturing system:* This module deals with the concept of incorporating sustainable product design and manufacturing in the traditional industrial product development stages. Major emphasis is on design for pollution prevention, design for environment, design for recycling/reuse, concept of inverse manufacturing, etc. Towards the development of "cleaner products" life cycle assessment (LCA) is used as environmental assessment tool in this course.

*Corporate Environmental Management:* The focus of this module is on proactive pollution preventive strategies for corporate environment management. It covers a range of issues from formulation of corporate environmental strategy to development of specific managerial tools and methods that can be applied to measure assess and communicate environmental performance. This course is designed to provide the students with knowledge, skills, insight and confidence, enabling them to design strategies for corporate environmental management in their future careers.

*Environmental Economics:* This course deals with the following aspects: economic approach to environmental protection and management; economic rational for social and environmental

regulation; economics of pollution control; environmental economics and laws; criteria for evaluation of environmental policies and management measures; policy instruments for local, regional and global environmental management; environmental accounting; financing, pricing and cost recovery of environmental infrastructure and services.

*Eligibility:* To be eligible for admission to the Master's Degree, a candidate must hold a Bachelor Degree (normally four year program) or its equivalent in an appropriate field of study from recognized institution and have undergraduate grades significantly above average. The program is designed in the following manner: The student would join any existing field of study (like any normal admission), but would specialise in Cleaner Production by:

- following certain selected required courses related to Cleaner production and
- carry out research on Cleaner Production.

A schematic description about this interdisciplinary program is shown in figure 2.

The courses are taught for twelve weeks and are based on lectures from faculty and invited external resource persons. Assignments and laboratory experiments complement the lectures. Videos and examination of case studies help in gaining a deeper picture of CP. Mid term after six weeks and a final exam are also held.

Students would also be required to follow other courses to satisfy the degree requirements, and carry out a thesis or research study on Cleaner Production.

#### **4.2 Certificate Program**

In parallel to this regular post-graduate degree program on CP, AIT has also initiated a ten week certificate program. This certificate program was initially developed in collaboration with UNEP, which provided seed funding in the form of scholarships. This CP certificate program was principally aimed at the following target groups:

- Mid and senior level technical personnel from the industrial sectors, who have keen interest in implementing CP concepts in their industries;
- Policy makers and researchers from government sectors and industry organizations; and
- Teachers and other academic staff from educational/research institutions planning to introduce Cleaner Production in their programs

This program was designed to enhance the participants' technical and management skills to implement cleaner production concepts in their respective work places. It essentially consists of four courses listed above, of which at least three are to be taken by each participant. These four basic CP courses are designed to introduce the concepts of cleaner production by considering technological design, managerial issues and economic aspects. Participants can also follow other courses offered at the institute. At their interest, and depending on their grades, participants could also transfer to Master's program.

#### **4.3 Observations**

*4.3.1 Students:* Since inception of the Master's and certificate program on Cleaner production, 6 students have graduated with a Master's degree and 16 students in the Certificate program. There has been a keen enthusiasm among the students for these courses. Students from the

following fields of study follow one or many of the four CP courses: energy, environmental engineering, post harvest engineering, management, industrial engineering and School of Management. Their background ranges from engineering, science and other disciplines.

*4.3.2 Faculty:* Three of the four courses offered under the CP program are by a group of faculty from various disciplines. This allows providing a more holistic view of the subject taught. Moreover, this program has brought faculty from all the four schools of the institute. External resource persons from the industry, government, private and international organisations were invited to give their perspective on CP.

## **5. Conclusion**

The Cleaner production formal education has been recently initiated both at the Master's level and as a Certificate program (3 months) at AIT. It provides flexibility to the students to major in their area of interest and at the same time having a sound knowledge regarding Cleaner production. The major advantage is that the teaching faculties come from varied disciplines, and so a holistic approach is available to students.

## **6. References**

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3. Visvanathan. C and Polprasert. C., (2001), "Environmental Education in Asia: Trends and Needs", Conference on Status, Trends and Priorities in Environmental Education and Research, University of Yangon, 7-9 June, Yangon, Myanmar.

**Figure 1: Energy and Environmental Approach towards Cleaner Production**

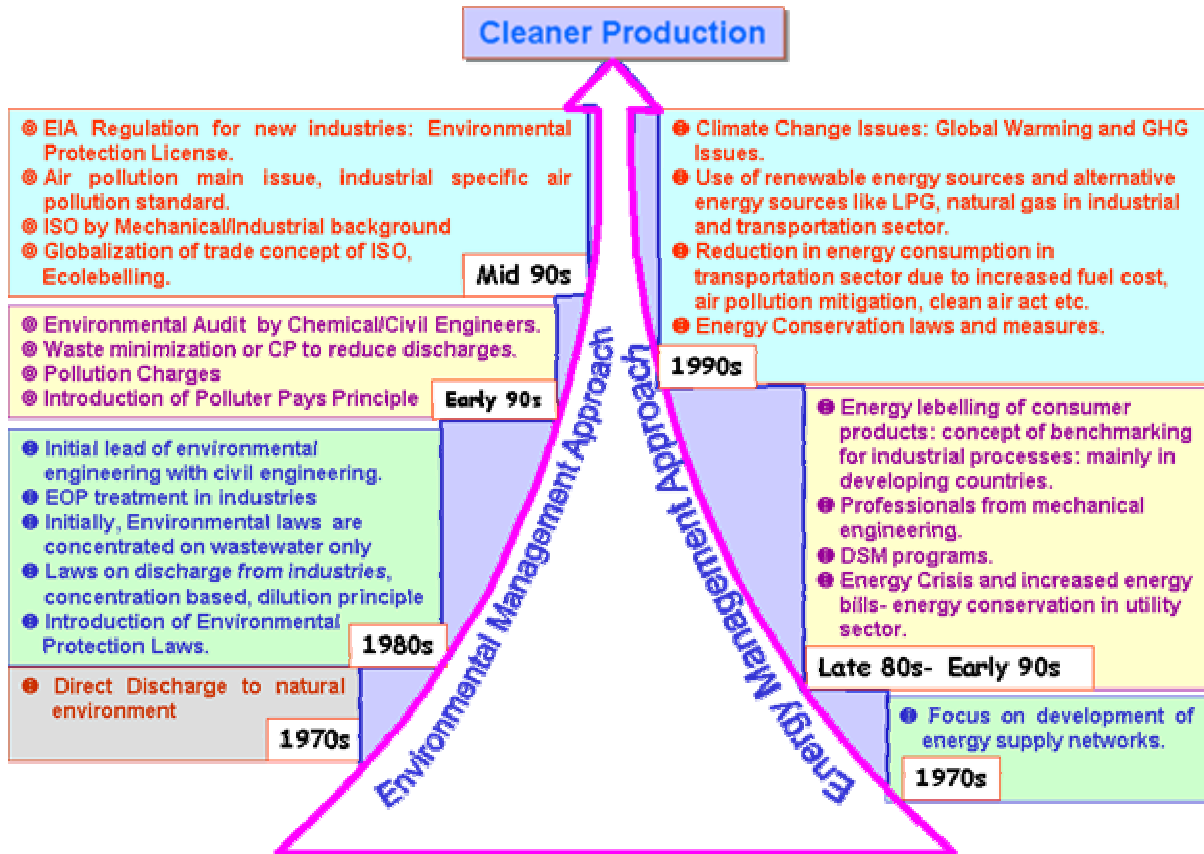
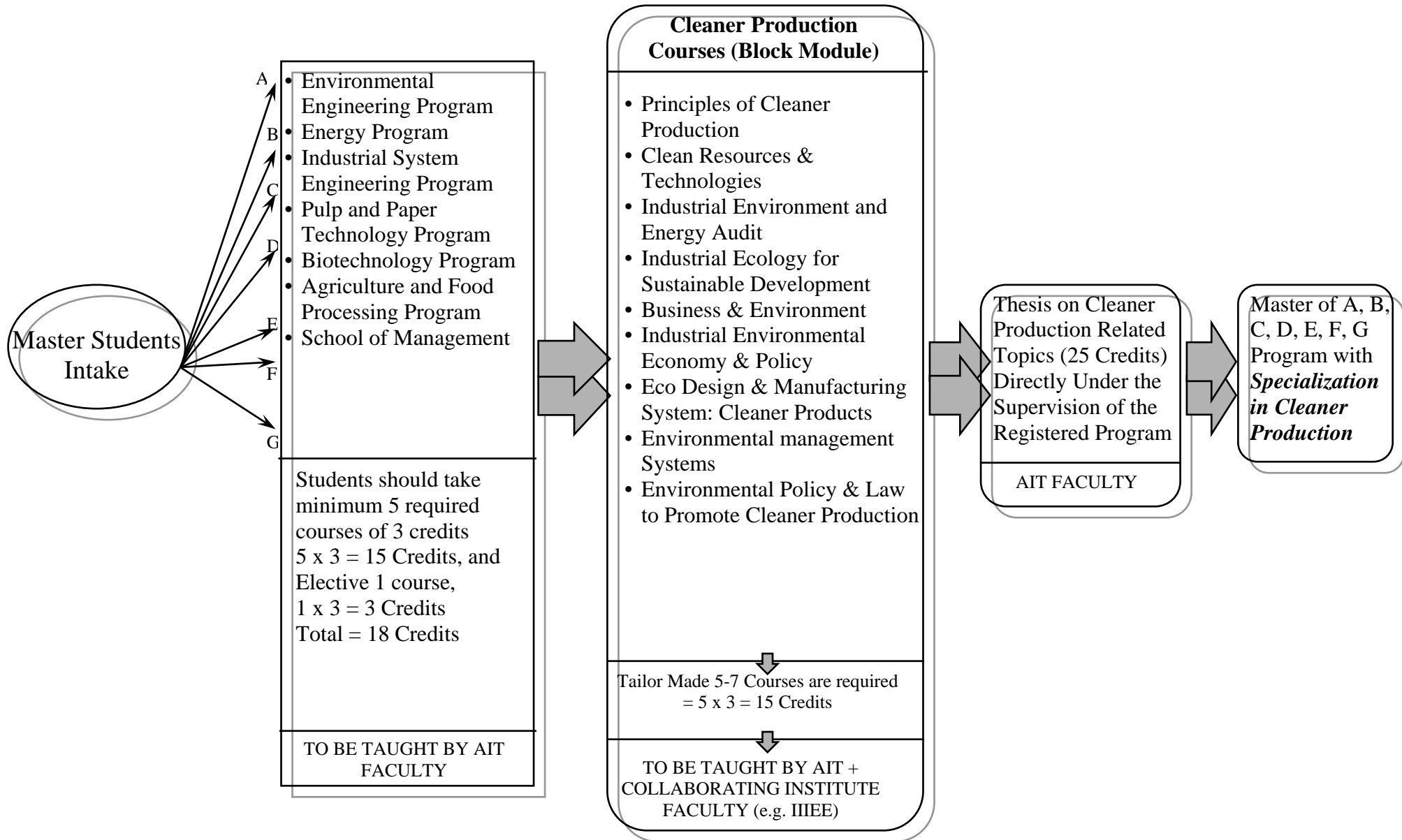






Figure 2: Interdisciplinary Post Graduate Program in Cleaner Production



*Example : A Student who is admitted to (say) Energy Program and wants to specialize in Cleaner Production, will be a student of Energy Program taking all the required courses in Energy Program (and thus satisfying AIT requirements). However the student will have to follow a set of courses (5- from Cleaner Production Block Module) related specifically to Cleaner Production to satisfy the AIT requirements for the mention of “Specialization in Cleaner Production” in the Degree Certificate.*