Signification and Achievements of Cleaner Production Implementation in Curriculums at AIT

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1. Introduction:

Current Environmental Education and Training Trends in Asia Pacific Region:

During immediate post World War II era, higher **product quantity management** was the target of industries, and little was done for 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. Nevertheless, in 1960, Japanese and German industries introduced the concept of product quality which was accepted by most of the leading developed nations. Moreover, globalization of markets, free trade and 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 generation 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 started introducing few of the pollution control regulations, whereby the industries are expected to treat waste prior to discharge into natural environment. The control technologies are know as the "end of the pipe' technologies".

Pollution control technologies (such as effluent treatment plants, wet scrubbers, filters etc.) introduced in the industrialization process were essentially add-ons and as such were considered as dead investment by the industries, with no profitable returns. Moreover, they just changed the phase of the pollutants rather than eliminating them from the carrying medium. For example filters, ETPs, scrubbers all produce sludge or solid waste which has to be disposed off. Hazardous and toxic solid wastes involve considerable risk in landfilling.

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Slowly, the industries started realizing that quality and quantity of wastes produced was also as important as the products 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 in industrial production. Beyond this concept lies the domain of a holistic, integrated management system denoted by **ISO 14000, Sustainable Development** that incorporates every aspect of environment and production.

Many national universities in Asia Pacific region offer graduate programs either in "environmental engineering" or in "environmental sciences". These traditional graduate programs have developed curriculum based on end of pipe treatment of generated wastes. In wastewater treatment, most of courses are deal with major environmental impact, types of treatment system like Physico-Chemical Treatment, Biological Treatment, and advanced treatment systems like membrane systems. All these courses train on how to operate treatment systems 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. All these are developed based on end of pipe approach.

During the past 5 years, many of these national universities developed under-graduate programs also in the similar line. But the Cleaner production is the latest integrated approach in handling 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. 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.

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.

Though cleaner production mainly deals with waste reduction and elimination of related activities, it is in fact a multidimensional activity, encompassing environmental pollution, energy and climate change related issues, as schematized in figure 1. The proposed cleaner production focuses on several areas, which are shown in this figure. Cleaner production emphasizes reducing the pollution at the source and paying little attention to Pollution control aspects. While the application of CP approaches 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 the part of training.

The past experience in the region reveals that capacity building in cleaner production is to be 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, future CP training activities should not only be limited to the training of specialists, but also reach out to the various cross sections of future technicians and planners.

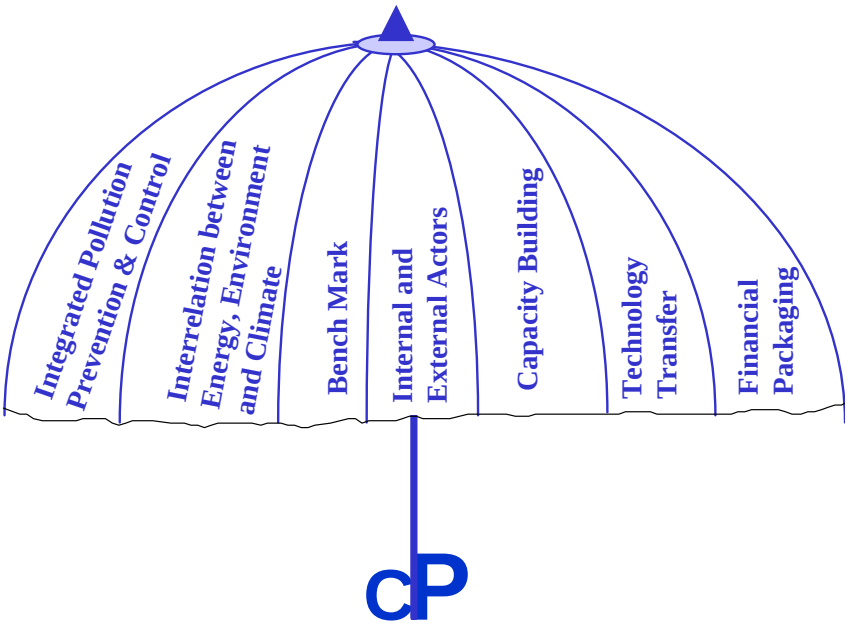

Figure 1: Seven Focal Areas of Cleaner Production

Whereas introduction of cleaner production concepts in the traditional academic programs are extremely limited to few institutions in this region, namely:

- Introduction of Graduate program on Cleaner Production :
    - RMIT University, Melbourne, Australia,
    - Asian Institute of Technology, Bangkok, Thailand,
    - Swinburne University of Technology, Australia,
- Introduction of CP concepts in the on-going gradate or Business Management Courses, etc:
    - Hong-Kong University,
    - Indian Institute of Technology

2. 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. AIT takes its role as the active partner in the promotion of technological changes and development in the Asia – Pacific region.

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 inter disciplinary fields, and will include attention to environmental and socio-economic considerations.

AIT is a research and educational institution with four major schools: School of Environment, Resources and Development (SERD); School of Civil Engineering (SCE); School of Advanced Technologies (SAT) and School of Management (SOM). SERD has different programs such as Agricultural and Food Engineering Program, Bioprocess Technology Program, Energy Program, Environmental Engineering Program, Human Settlement Development program, Pulp and Paper Technology Program, Space Technology Applications and Research Program and Urban Environmental Management program. SCE has Geotechnical Engineering program, Infrastructure Planning and Management Program, Structural Engineering and Construction program, Transportation Engineering and Water Engineering and management Program. SAT has Computer Science and Information Management Program, Industrial System Engineering Program and Telecommunications Program.

Environmental Engineering Program has three different fields of studies: Environmental Technology and Management, Water and Wastewater Engineering and Environmental Toxicology, Technology and Management. Energy Program has three different fields of studies: Electric Power system Management, Energy Economics and Planning and Energy Technology.

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.

The environmental Engineering Program at AIT is one of the oldest post-graduate programs in the Asia Pacific region. It has served for 35 years this region, and produced around 900 graduates as of today. Most of these program alumni's hold very senior management and decision making positions in the governmental sectors. However, as a tradition Environmental Engineering Program basically did research work on Sanitary Engineering and End of Pipe Treatment for industrial effluents. This kind of approach is no longer economical to industry. Environmental regulations are becoming stricter and stricter. Industry and Research & educational institutions started to think minimizing waste generation at the source by using cleaner technologies, which automatically reduces energy consumption.

Today the industry in Asia is looking for more and graduate 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, not only by environmental specialists, In fact

in order to develop preventive principles and sustainable development, what we need is every engineer to have a good basic environmental education.

As it is important to reformulate the age old approach of environmental engineering education, taking into consideration the rapid development on the industrial production sector, Engineering graduates have to be taught to think from their traditional narrow field of specialization to generating solution based on the multidisciplinary nature of environmental and sustainability approach.

In line with the above thinking, AIT is introducing an interdisciplinary postgraduate program in "Cleaner Production" from January 2000. This cleaner production program is organized by School of Environment, Resources and Development", as an interdisciplinary field, which helps professionals who are working in energy, environment and process integration fields towards sustainable development. The detailed information about this interdisciplinary program is shown in the *figure 1*. This program focuses on adoption of cleaner production practices to control pollution and to make profits by improving the performance of industry.

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.

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 that program. However, the student will have (1) to follow a set of courses (5- from cleaner production block module) related specifically to cleaner production and (b) do thesis/ research study in cleaner production area to satisfy the requirements for the mention of " Specialization in Cleaner Production" in the Degree Certificate.

In parallel to this regular post-graduate degree program on CP, AIT is also planning for a 10 week certificate postgraduate program. This certificate program will be targeting the mid-level managers/engineers from industrial sectors. This certificate program is being developed in close collaboration with the UNEP cleaner production group, it will mainly focus on, the engineers and managers to acquire new skills in environmental subjects such as environmental management system, waste and energy auditing, preventive environmental management, etc.,

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Typical Course Out line in 1980s

ASIAN INSTITUTE OF TECHNOLOGY

Environmental Engineering Division

EV 16 - INDUSTRIAL WASTEWATER POLLUTION AND CONTROL - 1980

Week	Subject
1	Effect of Wastewaters on Stream - Stream Standards Effluent Standards - Industrial Pollution Control Programs
2	- Computation of Organic Wastewaters on Streams - Treatability Investigation
3	- Wastewater Volume Reduction - Wastewater Strength Reduction - Wastewater Analyses - Interpretation of Results
4	- Oil Removal - Food Processing Industry Wastes, e.g. Brewery Wastes, Tapioca Wastes
5	- Rubber Wastes - Sugar Wastes j Palm Oil Wastes
6	- Operation and Costs - MID TERM EXAMINATION
7	- Neutralization - Equalization and Proportioning - Removal of Suspended Solids
8	- Removal of Colloidal Solids - Removal of Inorganic Dissolved
9	- Removal of Organic Dissolved Solids
10	- Treatment and Disposal of Sludge Solids
11	- Paper Industry Wastes - Slaughterhouse Wastes
12	- Textile Wastes _ - Metal Fabricating Wastes - Detergent Wastes
13	- Petroleum Industry Wastes - Thermal Pollution, Heavy Metals - Radio-active Wastes

Typical Course Outline in 2000

Asian Institute of Technology
Environmental Engineering Program

May 1999 Term

ED08.21 - Industrial Wastewater Pollution and Control 3(3-0)

Course Objectives: The objective of this course is to present for both ***environmental engineers and managers an overall view on industrial wastewater pollution control strategies and techniques.*** This course will deal with the issues such as : technical strategies of a sound industrial wastewater pollution control program; identification and classification of different pollutants and their effects on surrounding environment; different in-plant waste reduction management techniques both by modifying the production processes and by reducing volume and strength of pollution; overall review of different wastewater and sludge treatment techniques; technical feasibility study for selecting an appropriate treatment method.

- Course Objectives, Content & Reference books
- Introduction Lecture: - Urbanization and Industrialization and their impacts on environment and economy - State of Urbanization in Asia & Pacific
- Standards / Incentives
- Control & Monitoring Programs
- Nature and origin of water pollutants
- Effects of water pollution - SAC/ Eutrophication
- Neutralization / equalization
- Physico-Chemical Treatment
- Biological Treatment
- Tertiary Treatment & Sludge Treatment
- ***Overview of Industrial Pollution Management***
- ***Industrial Processes and Waste Characterization***
- ***Industrial Waste Inventory : Rapid Waste Assessment***
- ***Cleaner Production and Industrial Waste Treatment (EOP & CP)***
- ***Industrial Wastewater Monitoring & Sampling***
- ***Common Effluent Treatment Plants***
    - Case Studies
        - Paper and Pulp Industry Wastes
        - Textile
        - Food Processing Cream industry
- ***Industrial Waste Auditing***
        - ***Tannery***
- Technical Pre-feasibility Study for Industrial
- Wastewater Treatment: Palm Oil Industry
- Case Study Assignment : Discussion
- Field Visits and Presentation of Term Paper

ASIAN INSTITUTE OF TECHNOLOGY
SCHOOL OF ENVIRONMENT, RESOURCES AND DEVELOPMENT

E...99: ***Principles of Cleaner Production, 3(3-0)*** **Term: September, 2000**

Rationale: Cleaner production (CP), is defined as a continuous application of an integrated preventive environmental strategy to processes, products and services to improve eco efficiency and reduce risks to humans & environment. Application of this concept has demonstrated clearly that it helps to use resources efficiently, reduce costs and wastes. The purpose of this course is to introduce the concept of CP practice and technologies in the important sectors of the economy, methodologies and tools to apply CP to use energy efficiently, reduce pollution and minimize wastes. Detailed examples and case studies to explain the concept will be presented.

Catalogue Description: The objective of this course is to introduce the concept of cleaner production, the role of energy use in industrial and commercial sector establishments and its implication on the environment. Pollution and energy consumption abatement measures using cleaner production concepts will be explained using mass and energy balance, tools to conduct energy and environmental audits, and water and energy pinch analysis. Cleaner production applications will be presented using case studies from selected industrial applications.

Pre-requisite: None

Course Outline:

1. Introduction: Industrial and commercial sector development and related energy and environmental issues.
2. Cleaner production, its definition, and role in industrial and commercial sector. Link with sustainable production and consumption concepts, life cycle analysis, extended producer responsibility. Pollution prevention vs. pollution control, - overview on cleaner production. Explanation of what is pollution control, and the technologies associated with it; approaches and means of pollution prevention.
3. Energy and environmental parameters/concepts for CP: Basic terminology, units, measurement techniques, significance, etc (BOD, COD, TSS, TDS, Color, etc
4. Waste and energy audit methodologies. Application of mass and energy balance in energy of and environmental audit, Sankey diagram.
5. Major industrial processes considering energy and environmental points of view. Identification of major unit processes associated with energy consumption and pollution generation.
6. Pollution prevention through process integration (energy & environment). Process optimization by integrating both energy and environmental aspects. Energy management concepts and measures to improve energy efficiency.
7. Energy and Water Pinch: An efficient waste minimization tool.
8. Occupational Health and Safety, quality of product, and other aspects of CP.
9. Financial analysis of CP options: Cash flow, payback period, net present value, internal rate of return, profitability index, depreciation, etc.
10. Case Studies from industries: Pulp & paper, electroplating and cloth washing operations, etc.

Typical Chemical Engineering Curricula on "Pollution Prevention"
University of California - USA

Life Cycle Analyses

1. Paper or plastic? A life cycle inventory comparing unbleached paper grocery sacks and polyethylene grocery sacks
2. A life cycle inventory for soft drink containers
3. A life cycle inventory for polystyrene and paper containers
4. A life cycle inventory for three diapering systems

Identifying and Prioritizing Pollutants from Industrial Sites

5. Estimating and reducing fugitive emissions
6. Estimating and reducing secondary emissions
7. Estimating and reducing emissions from an API separator
8. Prioritizing pollution prevention options

Selecting Environmentally Compatible Materials

9. The use of chlorinated solvents: implications for global warming, stratospheric ozone depletion and smog formation
10. Choosing a degreasing solvent: an environmental dilemma
11. Thermodynamic constraints in the reprocessing of commingled plastics
12. Additives for enhancing the miscibility of commingled plastics

Design of Unit Operations for Minimizing Waste

13. Minimizing solvent emissions from vapor degreasers
14. The design of distillation column re-boilers for pollution prevention
15. Reducing wastes during batch processing changeovers
16. Reaction pathway optimization for waste reduction

Economics of Pollution Prevention

17. The effect of future liability costs on return on investment
18. Economic analysis of a pollution prevention process modification
19. The economics of newsprint recycling

Process Flow sheeting for Minimization of Waste

20. Mass exchange networks: equilibrium, operating and load lines
21. Mass exchange networks: composition interval diagrams and composite load lines
22. Mass exchange networks: pairing the rich and lean streams and determining the pinch

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