TECHNOLOGICA ACTA

Journal of Science-professional from Chemistry and Technology – Faculty of Technology Tuzla

Vol. 5 Number 2, page 1 – 48, Tuzla, December 2012. year

Publisher / Izdavač
Faculty of Technology University inTuzla

Printing / Štampa
IN SCAN d.o.o. Tuzla

Journal prints two times of year

Technologica Acta is indexed in the following database: CAB Abstracts, COBISS, Index Copernicus Journal Master List, EBSCO

This number of Technologica acta is supported by the Federal Ministry of Education, Science and Culture of Bosnia and Herzegovina

Edition / Tiraž: 200

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CONTENT

ROLE OF TECHNOLOGY AS A BASIS OF CLEANER PRODUCTION

PROFESSIONAL PAPER

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ABSTRACT

The present study describes the general cleaner production aims, which correspond to the prevention criteria of the IPPC-Directive. It presents cleaner production practices and technologies, and examines the methods of successful application of cleaner production practices in companies which seek to realize ecological targets. Minimization of waste and reductions in material and energy inputs are the most important environmental aims. Sustainable technological development and innovations do not automatically lead to total reduction of environmental burden of industrial production. However, technological innovation is an important factor and seems to play a central role in the long-term initiation of cleaner production. Sustainable technology is usually connected with the design and analysis of complex, integrated management systems and sustainable development, and it is a central target in environmental science and growth of global economies. Environmental improvement of a company's strategy by application of the idea of cleaner production linked with sustainable technologies leads to produce environmentally friendly products and leads to increase the position of company on the market.

Key words: theoretical fundamentals of cleaner production, clean technology, sustainable development

INTRODUCTION

The industrial engineering consumes materials and is dependent on a continuous supply of them. Increasing population and living standards cause the consumption rate to grow. Finding ways to use materials more efficiently is a prerequisite for a sustainable future. Recent global attention to the issues and challenges of sustainable development is forcing industries to conduct self-assessments to identify where they stand within the framework for sustainability, and more importantly, to identify opportunities, strategies and technologies that support achieving this goal. Design for environmental sustainability is the long-term view: that of adaptation to a lifestyle that meets present needs without compromising the needs of future generations. The time-scale is measured in decades or centuries and the adaptation required is much greater.

Environmental technology (abbreviated as *envirotech*) or green technology (abbreviated as *green tech*) or clean technology (abbreviated as *clean tech*) is the application of environmental science and green chemistry to conserve the natural environment and resources, and to curb the negative impacts of human involvement. Sustainable development is the core of *environmental technologies*.

Sustainable engineering is the process of using energy and resources at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs.

This is the time when people try to reach sustainable development through achievement of zero landfill status, minimize storm water discharge and

pollutant loadings into protected waters of the state, reduce energy consumption, an attempt to create self –supporting infrastructures.

Considering the costs of energy, inefficiency of generating waste, it is the sustainable development that we need to focus on in the future. Many of the critical environmental problems we face today are related to water, energy food security and waste. These involve low tech solutions which are available now and can be applied immediately; information on these technologies can be distributed broadly using electronic networks. These are four specific activities in support of sustainable development.

1. Re-address engineering responsibilities by incorporating sustainable development principles into the codes of ethics of engineering organizations throughout the world.
2. Incorporation of long term environmental impacts and costs into the analysis of alternative solutions being considered.
3. Information exchange is a very important part of sustainable development and technological innovation.
4. Near term solutions to critical global environmental issues such as fresh water and global climate change exist for application in both developed and developing countries and for all regions of the world. These solutions can be put in service in one to three year timeframe by engineers, business leaders and government policymakers.

1. The material life cycle and criteria for assessment and energy

The material life cycle is shown in Figure 1, drawn from the Earth's resources, which are processed to give materials. These are manufactured into products that are used and, at the end of their lives, discarded, a fraction perhaps entering a recycling loop, the rest committed to incineration or landfill. Energy and materials are consumed at each point in this cycle (we shall call them "phases") with an associated CO_2, SO_x, NO_x and other emissions and gaseous, liquid and solid waste, collectively, called environmental "stressors". These are assessed by the technique of life cycle analysis (LCA). A rigorous LCA examines the life cycle of a product and assesses in detail the eco-impact created by one or more of its phases of life, cataloging and quantifying the stressors. This requires information for the life history of the product at a level of precision that is only available after the product has been manufactured and used. It is a tool for the evaluation and comparison of existing products, rather than one that guides the design of those that are new. A full LCA is time consuming and expensive, and it cannot cope with the problem that 80% of the environmental burden of a product is determined in the early stages of design, when many decisions are still fluid. This has led to the development of more approximate "streamline" LCA methods that seek to combine acceptable cost with sufficient accuracy to guide decision-making, the choice of materials being one of these decisions. But even then there is a problem: a designer, seeking to cope with many interdependent decisions that any design involves, inevitably finds it hard to know how best to use data of this type. How are CO_2 and SO_2 emissions balanced against resource depletion, toxicity or ease of recycling?

There is an international agreement: the Kyoto Protocol of 1997 binding the developed nations that signed it to

progressively reduce carbon emissions, i.e. CO_2. At the national level the focus is more on reducing energy consumption, but since this and CO_2 production are closely related, they are nearly equivalent. Thus, there is certain logic in basing design decisions on energy consumption or CO_2 generation (Fig. 1).

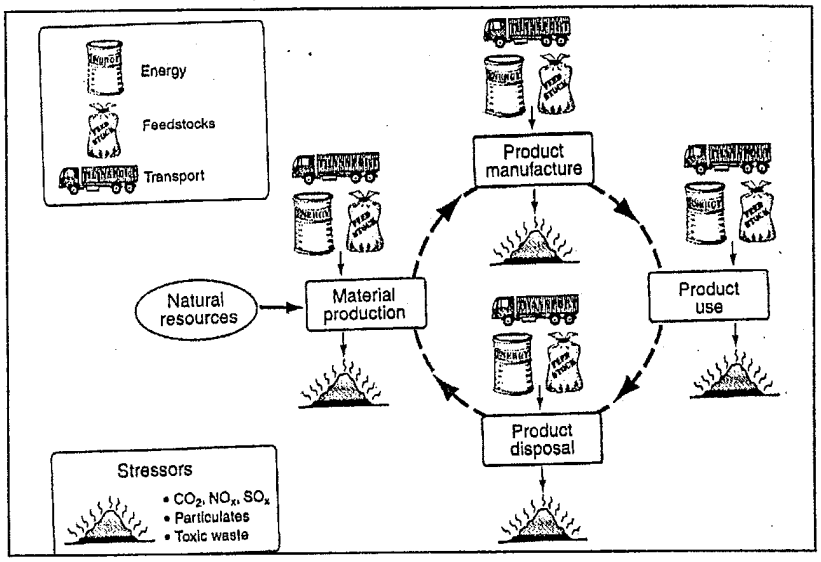

Figure 1. Ore and feedstock are mined and processed to yield a material. This is manufactured into a product that is used and, at the end of its life, discarded or recycled. Energy and materials are consumed in each phase, generating waste heat and solid, liquid and gaseous emissions. The material life cycle. (B. Allenby, 2004)

2. Sustainable technology and natural environment

There are a lot of possibilities to reduce the environmental burden of industrial production. For example, optimization of the environmental performance through good housekeeping, total quality management, application of end-of-pipe techniques, recycling of wastes, non renewable products substitution or adaptation to clean technological innovations. Clean technology is the most important factor for economic growth of industries and it seems to play a main role not only in the idea of cleaner production, but also in sustainable development. The development of clean technology seems to be the main factor of a company's strategy. Each of the companies, which wants to reach the competitive position on the market and wants to be environmentally friendly should compile the strategy of technology. The risk of initiation of a strategy of technology may be limited across accumulating, processing and using in decision making process, on information about techniques, products, machines, capital and human resources and environmental parameters. The basic actions of preparation of the strategy of technology contains a recognition of all using technologies in company and an identification of all components of technology (Fig.2), which are the object of scientific investigations.

Analyzing of all components of technology is very important. It helps in the selection of suitable techniques of production, which should guarantee established productivity, quality of realized processes and allows to manufacture ecological products. The initiation of the new technology is very expensive process, however in along period of time, technology is one of main factors which influences quality of products.

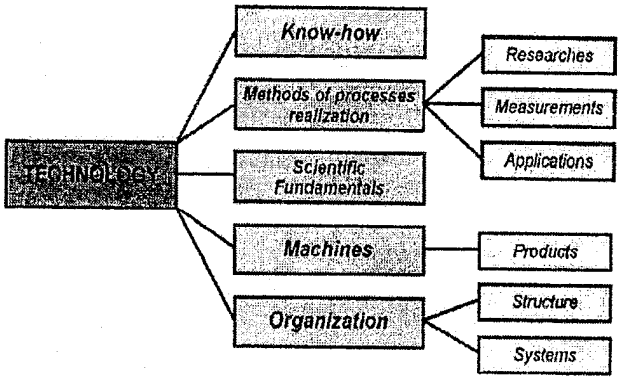

Figure 2. Components of technology (W. Shramm et al., 1998)

The better quality of products causes not only the growth of competitiveness, but what is more, it influences the productivity of process, as a result that the modern technologies influence shortening the duration of the production cycle and increasing the number of products.

In ractice, a technology and realization of technological processes is in the exact relationship from elements of working and natural environments. Steering of technological processes cannot be realized without consideration of all settings in company processes and external environment (Fig.3).

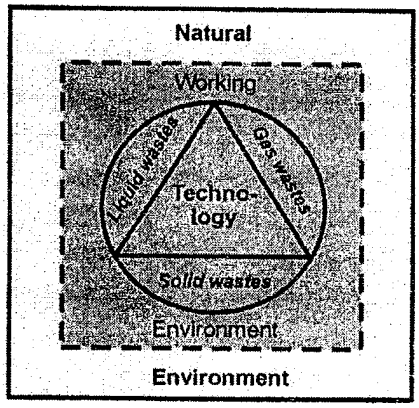

Figure 3. Technology and natural environment (F. A. Vollenbroek, 2002)

Because of the fact that the process technologies should be carried out from a cleaner production point of view, the development of sustainable technology should be based on the general cleaner production aims. The technological process, which is based on clean technology should tend to reduce or minimize the amount of:

- resources consumed;
- waste and emissions generated;
- hazards of the waste and emissions generated (mainly by usage substitution of input materials);
- risk of accident or malfunction.

The mentioned purposes essentially correspond to the prevention criteria of the IPPC-Directive (Integrated Pollution Prevention and Control). According to the

above ecological targets, companies should apply the following technological innovations:

- auxiliary technology, which includes all the supporting technologies to monitor and control the existing production process and all the logistics and technological infrastructure;
- end-of-pipe technology, which can be defined as all techniques added at the end of the existing processes to decrease the amount of environmentally harmful emissions;
- in-process technology, which includes improvement and application of the existing technology - changes are integrated within the process hardware of the existing production steps;
- new technology, which includes a new production process principle or a new technical plant design.

Generally, most companies, when implementing changes in their production process, apply the first three stages of technological innovations: auxiliary technology, end-of-pipe technology or in-process technology. However, introducing a new (sustainable) technology brings the best profits.

Cleaner production is defined as the continuous application of an integrated preventative environmental strategy to processes and products to reduce risks to humans and the environment. As for production process, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all wastes.

Successful application of cleaner production in companies depends on property management, maintenance, adequate infrastructure and training of people. The transfer of cleaner production practices should be realized by:

- technological capacity (ability to adapt clean technologies),
- training capacity (ability to train and educate various groups of people about the ideas of cleaner production),
- institutional capacity (ability to network and co-operate among different stakeholders),
- government capacity (ability to prepare and implement policies in different policy fields).

Technological capacity is one of the most important methods of applying the idea of cleaner production. Environmental technology is usually connected with the design and analysis of complex, integrated management systems and sustainable development in the areas of:

- role of the design in the operation of environmental technology, control of integrated environmental systems,
- role of computer methods in the operation and control of environmental systems,
- education and training requirements to provide efficient operation and maintenance of complex environmental systems in the range of clean technology.

The successful promotion of idea of cleaner production and environmentally sound technologies is necessary to:

- built business strengths of company,
- connect the business and environmental advantages of sustainable technology,
- initiate long-term investments in the technology transfer and development,
- existence of government assistance and support mechanisms.

However, cleaner production and sustainable technologies will not be efficient without environmental management

systems, which are the framework, set by top management of company.

CONCLUSION

Minimization of waste and emissions and reductions in material and energy inputs are the most important environmental aims. Sustainable technological development and innovations do not automatically lead to total reduction of environmental burden of industrial production. However, technological innovation is an important factor and seems to play a central role in the long-term initiation of cleaner production.

Environmental improvement of a company's strategy by application of the idea of cleaner production linked with sustainable technologies leads to produce environmentally friendly products and moreover leads to increase the position of company on the market. Cleaner products must be given an essentially stronger meaning in the future because of the necessary transition to sustainable economy and development.

Sustainable development and idea of cleaner production is a central target in environmental science and plays a key role in the growth of global economies. Therefore, modern industrial and manufacturing companies should apply technologies designed to minimize pollution and use of finite resources. These technologies tend to improve the global environment and human life.

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