Cleaner Production opportunities and its benefits in Biotech Industry

Ghatna Trivedi[1] Ast Prof. Minerva Pandya[2]
[1]M.E. [Environmental Management] Student [2]Assitant Professor
[1,2]Department of Environmental Engineering
[1,2]L.D. College of Engineering, Ahmedabad, Gujarat

Abstract— Biotechnology is said to be used as tool for cleaner production. There has been much discussion regarding potential environmental benefits and hazards associated with biotechnology. Biotechnology is increasingly being viewed as a major weapon against environmental damage. Cleaner production is considered as a part of this strategy and yet there is still widespread ignorance about this emerging technology but there are many areas in biotech industry where application of cleaner production can be beneficial economically as well as environmentally. There are many sectors of biotechnology; each sector has different process and products. By analyzing process of each class of biotechnology, Cleaner production opportunities can be generated specifically. Major processes in this industry where cleaner production can be applied are heat transfer, mass transfer, mechanical operations, separation techniques, etc. cleaner production at smaller level may also leads to benefits in overall economy and waste minimization in process. Cleaner production aims at waste reduction, onsite recovery, product modification and energy conservation. Although there are several barriers to cleaner production but it can be overcome considering the benefits obtained from cleaner production.

Keywords: Cleaner production, Biotechnology, waste minimization

I. INTRODUCTION

Cleaner production is the maximum feasible reduction of all waste generated at production sites. It involves judicious use of resources through reuse of material, source reduction, water conservation; energy efficiency, etc. preventing or recycling at the source eliminates the need for off-site treatment and disposal. Elimination of pollutants at source is typically less expensive than waste collecting, treating and disposal. Cleaner production facilitates conservation of energy and raw material, cost reduction, increase in efficiency, sound environmental process, etc. The concept of 'biotech' or 'biotechnology' encompasses a wide range of procedures for modifying living organisms according to human purposes — going back to domestication of animals, cultivation of plants, and "improvements" to these through breeding programs that employ artificial selection and hybridization. Modern usage also includes tissue culture technologies as well as cell and genetic engineering.

II. BIOTECHNOLOGY

Biotechnology is defined by the American Chemical Society as the application of biological process, biological systems or organisms by various industries to learning about the science of life and the improvement of the value of materials and organisms such as crops, livestock, and pharmaceuticals. Biotechnology is being used to engineer and adapt organisms, especially microorganisms, in an effort to find sustainable ways to clean up contaminated environments.

CLASS OF BIOTECHNOLOGY	EXAMPLE
Red	Genetic engineering, antibiotic production, etc
White/Grey	Industrial enzyme production
Green	Transgenic plants, tissue culture, etc
Blue	Aquatic or Marine biotechnology

Table 1: Classes of Biotechnology

The elimination of a wide range of pollutants and wastes from the environment is an absolute requirement to promote a sustainable development of our society with low impact on environment. Biological processes play a major role in the removal of contaminants. Biotechnology makes use of catabolic versatility of microorganisms and their ability to degrade/convert compounds. New methodological breakthroughs in genomics, proteomics, sequencing, bioinformatics and imaging are producing vast amounts of information. In the field of Microbiology, genomic studies opens a new era providing unprecedented *in silico* views of metabolic and regulatory networks. Microbiology also offers clues to the evolution of degradation pathways and to the molecular adaptation strategies to changing environmental situations.

Generally Biotechnology Classes Below:

Red Biotech: is applied to medical processes. Some examples are the engineering of genetic cures through genomic manipulation, and the designing of organisms to produce antibiotics.

White/Grey Biotech: applied to industrial processes. An example of it is the organism designed to produce a useful chemical.

Green Biotech: applied to agricultural processes. An example is transgenic plants designed in such a way to grow under specific environmental conditions or in the presence (or absence) of certain agricultural chemicals.

Blue Biotech: It describe the marine, aquatic applications of biotechnology.

III. BIOTECHNOLOGY AS TOOL FOR CLEANER PRODUCTION

Research works and industrial data regarding industry, both say that biotechnology can be used as a tool for cleaner production. Biotechnology is competitive with and in many cases complements chemical methods for achieving clean technologies. Biotechnology is a technology that provides powerful routes to clean industrial

products and processes and is expected to play a growing role. Biotechnological operations are now used in a wide range of major industrial processes. Applications

tend to be industrial-sector specific; the report addresses chemicals and Pharmaceuticals, textiles and leather, food and feeds, metals and minerals, pulp and paper, and energy. Biotechnology-based processes have been successfully integrated into large-scale operations. Industrial penetration of biotechnology is increasing as a consequence of advances in recombinant DNA technologies. Biotechnological operations have lead to cleaner processes with low waste generation and in some cases lower energy consumption. In industrial process such as Ammonium acrylate is the key intermediate in the manufacture of acrylic polymers, is made by hydrolyzing acrylonitrile to acrylic acid and reacting this with ammonia. The reaction is energy-intensive and gives rise to by-products which are difficult in removal. Process based on a bacterial enzyme which directly Synthesises ammonium acrylate of the same quality under less energy-demanding conditions, has been Operating for several years at full scale. And In paper making, treating cellulose fibers in the pulp using cellulase and hemicellulasez enzymes allows water to drain more quickly from the wet pulp which reduce processing time and energy used for drying. Trials have shown that machine speeds can be increased by up to 7 per cent and energy input reduced by as much as 7.5 per cent. Replacing thermo mechanical pulping by biopulping has resulted in up to 30 per cent reduction in electrical energy consumption. Replacement of chemical process by enzymatic process has been showing huge benefits like high efficiency, reduced cost and time, minimized and decomposable waste, etc.

IV. Cleaner Production Opportunities In Biotech Industry

Although biotechnology is said to be used as tool for cleaner production there is a scope for cleaner production in biotech industry itself. There are few processes which are common in each industry where there is scope of cleaner production. Major processes where cleaner production can be applied are heat transfer, mass transfer, unit operations etc. heat transfer operations includes conduction, convection, condensation, etc. use of shell and tube heat exchanger in case of such operation where heating and cooling required continuously, lot of energy in separate heating and cooling can be saved by using single reactor for same purpose. Mass transfer operations like distillation, evaporation, extraction, drying, etc where cleaner production opportunities can be generated. In case of mass transfer operations, by changing method or composition of processing product, efficiency of production can be increased. There are Mechanical operations such as size reduction, sedimentation, and filtration where in cleaner production opportunities are there. Several separation techniques are used in biotech industry such as

Heat transfer	Conduction, convection, condensation
Mass transfer	Distillation, extraction, drying
Mechanical operations	Size reduction, sedimentation, filtration
Separation techniques	HPLC, GLC and other chromatographic techniques
Fermentation	Lab scale and industry scale.

Table 2: Operations in biotech industry where cleaner production can be possible.

HPLC, GLC, and other chromatographic techniques for the separation of pure compound. By changing concentration and flow of material through system can result in to efficient and energy saving process. Fermentation is widely used in industrial biotech companies; if batch process is used instead of continuous process fewer raw materials is required comparatively. Likewise adoption of few basic techniques of cleaner production such as good housekeeping, use of waste as raw material for other product, material recovery from waste, product reformation, change in product composition if possible and energy conservation may lead to drastic benefits like increased productivity, high efficiency, lower waste generation, energy conservation, gaining economical benefits, improving environmental situations, etc.

V. Conclusion

Biotechnology as an emerging field has large scope of new technologies with cleaner production in order to minimize waste and conserve energy. Although biotechnology is repeatedly being viewed as tool for cleaner production there are numerous chances of cleaner production in process of biotechnology itself. It is mutual benefit process when biotech used as tool to cleaner production or cleaner production used in biotech process. Considering the benefits obtained from it like waste minimization a reuse, energy conservation, pollution reduction adoption of cleaner production in every industry is convincing including biotechnology. Limitation in biotech industry is there are certain process where process cannot be altered, parameters to be strictly followed and reutilization is strictly prohibited. By developing better attitude towards cleaner production in this field numerous benefits can surely be achieved.

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