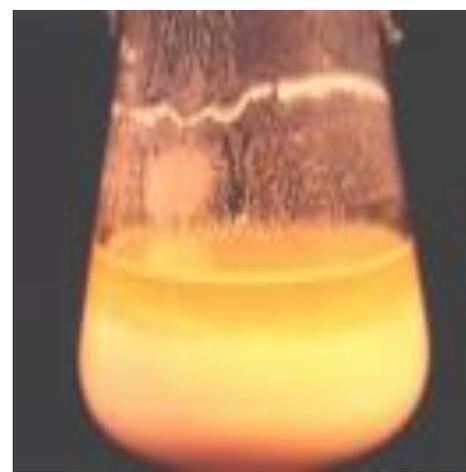


Abstract for Fermentation Technology

Ensymm Abstract for Fermentation Technology



INTRODUCTION

The term biotechnology came into general use in the mid 1970s, gradually superseding the more ambiguous 'bioengineering', which was variously used, to describe chemical engineering processes using organisms and/or their products, particularly fermenter design, control, product recovery and purification.

In simpler words, biotechnology means the industry-scale use of organisms and/or their products. Nowadays, biotechnology virtually includes the scientific, technological and commercial aspects of almost every area of human welfare from agricultural production to pollution control.

Fermentation

Fermentation technology is the oldest of all biotechnological

processes. The term derives from the Latin verb *fevere*, to boil the appearance of fruit extracts or malted grain acted upon by yeast, during the production of alcohol.

Fermentation is a process of chemical change caused by organisms or their products, usually producing effervescence and heat. In biotechnology, the microbiological concept is widely used.

Microbial Growth

Requirements for artificial culture

The growth of organisms involves complex energy based processes. The rate of growth of microorganisms depends on several culture conditions which should

provide energy required for various chemical reactions. The production of a specific compound needs very precise cultural conditions for specific growth rate. Many systems now operate under computer control.

Protein	Soybean meal, Corn steep liquor, Distillers soluble
Ammonia	Pure ammonia or ammonium salts
Nitrate	Nitrate salts
Nitrogen	Air
Phosphorous source	Phosphate Salts

PHASES OF MICROBIAL GROWTH

Main phases

Inoculation: Medium is inoculated with the particular organism.

Lag phase: The period of adaptation considering that the inoculum does not grow immediately.

Log or exponential phase: The rate of growth of the organism steadily increases, for a certain period.

Deceleration phase: After a certain time of exponential phase, the rate of growth slows down.

Stationary phase or a steady state. The biomass remains constant, except when certain accumulated chemicals in the culture lyse the

cells (chemolysis). Unless other micro-organisms contaminate the culture, the chemical constitution remains unchanged. Mutation of the organism in the culture can also be a source of contamination, called internal contamination.

Fermenters and Bioreactors

A fermenter is the set-up to carry out the process of fermentation. Fermenters vary from laboratory experimental models of one or two liters capacity, to industrial models of several hundred liters capacity, which refers to the volume of the main fermenting vessel. A bioreactor differs from a fermenter relating to the culture of plant or animal cells, instead of microorganism.

The chemical compounds synthesized by these cultured cells, such as therapeutic agents, can be extracted easily from cell biomass.



Design of Industrial Fermentation Process

The fermentation process requires the following:

- a) A pure culture of the chosen organism, in sufficient quantity and in the correct physiological state
- b) Sterilized, carefully composed medium for growth of the organism

DESIGN OF INDUSTRIAL FERMENTATION PROCESS

c) A seed fermenter, a mini-model of production fermenter to develop an inoculum to initiate the process in the main fermenter

d) A production fermenter, the functional large model

e) Equipment for (i) drawing the culture medium in steady state, (ii) cell separation, (iii) collection of cell free supernatant, (iv) product purification, and (v) effluent treatment. Items (a) to (c) above constitute the upstream and (e) constitutes the downstream, of the fermentation process.

Fermenters and bioreactors are equipped with an aerator to supply oxygen in aerobic processes, a

stirrer to keep the concentration of the medium constant, and a thermostat to regulate temperature, a pH detector and similar control devices.

Types of Cultural System

a) Batch Processing or Culture

At the onset of the stationary phase, the culture is disbanded for the recovery of its biomass (cells) or the compounds that accumulated in the medium (alcohol, amino acids), and a new batch is set up. The best advantage of batch processing is the optimum levels of product recovery. The disadvantages are the wastage of unused nutrients, the peaked input of labour and the time lost between batches.

b) Continuous Processing or Culture

The culture medium may be designed such that growth is limited by the availability of one or two components of the medium. Since the initial quantity of this component is exhausted, a certain amount of the whole culture medium (aliquot) can also be added periodically at the time when the steady state sets in.



Commercial adaptation of continuous processing is confined to biomass

CONTINUOUS PROCESSING OR CULTURE

production, and to a limited extent to the production of potable and industrial alcohol.

The steady state of continuous processing is advantageous as the system is far easier to control.

c) Fed-batch Culture or Processing

In the fed-batch system, a fresh aliquot of the medium is continuously or periodically added without the removal of the culture fluid. Production of baker's yeast is mostly appears by fed-batch cultures, at which biomass is the desired product. Diluting the culture with a batch of fresh medium prevents the production of ethanol at the expense of biomass at the moment traces of ethanol were detected in the exhausted gas.

d) Products of Fermentation Processes

The growth of microorganisms or other cells results in a wide range of products. Each culture operation has one or few sets of objectives. The process has to be monitored carefully and continuously, to maintain the precise conditions needed and recover optimum levels of products. Accordingly, fermentation processes aim at one or more of the following:

- Production of cells (biomass) such as yeasts
- Extraction of metabolic products such amino acids, proteins (including enzymes), vitamins, alcohol, etc., for human and/or animal consumption or industrial use such as fertilizer production.

- Modification of compounds (through the mediation of elicitors or through biotransformation)
- Production of recombinant products
- Production of biopolymers such as polysaccharides, polyesters, and polyamides, are produced by microorganisms

GENETIC IMPROVEMENT OF FERMENTATION, MUTATION AND RECOMBINATION

Genetic Improvement of Fermentation

The genome of the organism ultimately controls its metabolism. Although improved fermenter engineering design and optimal cultural conditions can quantitatively enhance the microbial products, this process is limited. Genetic improvement of the organism is fundamental to the success of fermentation technology. Mutation and recombination are the two ways to bypass genetic limitations.

Mutation

A certain amount of mutational change in the genome occurs as a natural process though the probability is low. Exposing a culture of microorganisms to UV light, ionising radiation or certain chemicals, enhances the rate of mutations. But it is a tremendous task for the industrial geneticist to screen the very large number of randomly produced mutants and to select the ones with the desired qualities.

Recombination

Recombination is defined as any process that brings together genes from different sources.

A number of human proteins, such as insulin, human growth hormone, bone growth factor, blood clotting factor VIII, epidermal growth factor, granulocyte colony stimulating factor, erythropoietin, etc., are being produced through recombinant microorganisms.

DNA MANIPULATION AND CONCLUSION

DNA Manipulation

In vitro DNA technology was used to increase the number of copies of a critical pathway gene as for example the production of threonine in *Escherichia coli* at rates 40 to 50-fold higher than usual.

Conclusion

Fermentation technology is a very vibrant and fast growing area of biotechnology, absorbing an ever-increasing number of processes and products. With a longer history than any area of biological sciences, fermentation technology has a bright future in the service of mankind, covering such important areas as food and medicine.

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