Appendix

Traditional Industrial Bioprocesses

Enzymes and microbial cells are used for production of chemicals, pharmaceuticals, foods, flavors and fragrances, and vitamins and for waste treatment. Each of these bioprocesses has unique characteristics in terms of the processing and separation technologies involved. Having covered the basics of bioprocess engineering, this appendix presents some examples of industrial bioprocesses and technologies used for production of various chemicals and pharmaceuticals. Waste-treatment aspects of bioprocess engineering are covered in Chapter 16.

A.1. ANAEROBIC BIOPROCESSES

A.1.1. Ethanol Production

Ethanol has many applications as a raw material, solvent, and fuel and is utilized in large quantities in the chemical, pharmaceutical, and food industries. Worldwide, four million tons of industrial ethanol are produced annually, 80% by fermentation. It is expected that the demand for ethanol as a fuel oxygenate will increase. An annual growth of U.S. ethanol consumption of 3.2% over the next 20 years has been predicted by the Energy Information Administration.