Appendix I-C

Chemical and Biological Processes

A comparison was made of waste stream pollution for chemical and biological processes. Ideally, the comparison should be between the two processes used in the production of the same end product. Since such data do not currently exist at the industrial level, the comparison was made between the chemical production of a mixture of chemicals and the biological production of alcohol and antibiotics. one noteworthy parameter is the 5-day biochemical oxygen demand (BOD5) —the oxygen required over a 5-day period by organisms that consume degradable organics in the waste stream. If the oxygen demand is too high, the discharge of such a stream into a body of water will deplete the dissolved oxygen to the point that it threatens aquatic life. An important variable that must be considered along with the BOD is the COD (the chemical oxygen demand). Large differences between the COD and BOD of a waste system can indicate the presence of nonbiodegradable substances. Although the conventional process stream shown in table 1-C-1 has less BOD5 than the biological process stream, its COD content probably means that non biodegradables are present, and specialized waste treatment is necessary.

BOD is one area where traditional fermentation based processes have posed pollution problems. Batch fermentation processes typically generate large quantities of dead cells and residual nutrients that cause a large BOD if they are dumped directly into a dynamic aquatic environment. (See table I-C-1.) This difficulty can be circumvented by the use of spent cell material as an animal feed supplement or as a fertilizer. These applications have been intensively investigated and have met with success.

Table I-C-1.— Waste Stream Pollution Parameters: Current Processes v. Biological Processes

Compounds: Mixed chemicals, including ethylene oxide, propylene oxide, glycols, amines, and ethers

Pollution parameters	Current processes	Biological processes
Alkalinity (mg/l).	4,060	0
BOD5[a](mg/l).	1,950	4,000-12,000
Chlorides (mg/l)	430-800	0
COD[b](mg/l).	7,970-8540	5,000-13,000
Oils (mg/l)	547	0
pH	9.4-9.8	4-7
Sulfates (mg/l)	655	0
Total nitrogen (mg/l).	1,160-1,253	50-200
Phosphates (mg/l)	0	50-200

[a]5-day biological oxygen demand.
[b]Chemical oxygen demand.

SOURCE: Office of Technology Assessment.

Because of the renewed interest generated by the potentials of genetic engineering, some traditional fermentation systems are being redesigned. Immobilization allows the reuse of cells that would otherwise be discarded. These systems can be used continuously for several months as compared with the usual fermentation time in a batch process of about one week or less. [remobilized operations create waste cells much less often than batch systems, and therefore generate less BOD.