a membrane in electrolytic units. An example of an electrolytic ED unit is a chlor-alkali cell in which an NaCl solution is electrolyzed and converted to NaOH and Cl.

11.5. FINISHING STEPS FOR PURIFICATION

The major finishing steps in fermentation-product purification are crystallization and drying.

11.5.1. Crystallization

Crystallization is usually the last step in producing highly purified products such as antibiotics. Crystallization operates at low temperatures, which minimize thermal degradation of heat-sensitive materials. Operations are conducted at high concentrations and, therefore, unit costs are low and separation factors are high. The determination of optimal crystallization conditions is a matter of empirical experimentation, since phase diagrams and pertinent kinetics for specific systems are usually not available.

High-purity crystals are recovered by using batch Nutsche-type filters or centrifugal filters. The following equation is used for the filtration of crystal slurries, assuming the crystals are noncompressible and the resistance of the filter medium is negligible.

$$\frac{dV}{dt} = K\frac{A\ \Delta P}{\Delta X} \tag{11.97}$$

where ΔX is the thickness of crystal layer, t is time, V is liquid volume, ΔP is pressure drop, A is surface area, and K is the transfer coefficient. Substituting $W \propto V$, where W is the solids concentration in the cake, and integrating eq. 11.97, we obtain

$$t = K\frac{W^2}{\Delta P \cdot A^2} \tag{11.98}$$

A typical centrifugal filter combines a bowl centrifuge with a filter, and the following relationship is used to determine the filtration–crystallization rate for centrifugal filters.

$$\frac{dV}{dt} = \frac{(2\pi N)^2 \rho L(r_0^2 - r_L^2)}{2\mu(\alpha W/A_m^2 + R_M/A_0)} \tag{11.99}$$

where N is the rotational speed, α is the specific cake resistance, W is the solids concentration in the cake, A_m is the log mean area, and R_M is the medium resistance.

The nature and size of crystals affect the centrifugation and washing rates; therefore, crystallization and recovery steps are interrelated and should be considered together in the optimization of crystallization operations. After washing, the crystals are discharged for drying.

11.5.2. Drying

The removal of solvent from purified wet product (crystal or dissolved solute) is usually achieved by drying. In selecting drying conditions, the physical properties of the product, its heat sensitivity, and the desirable final moisture content must be considered. The parameters affecting drying can be classified in four categories: physical properties of the