11.2 Theoretical Basis

Similar to other crystallization processes, phase diagrams are the thermodynamic basis for the design and optimization of melt crystallization and will determine the separation limit. Crystallization kinetics as well as the model establishment are helpful for better understanding of the process and to provide a design basis for industrial melt crystallization.

11.2.1 Phase Diagram

The most basic two types of equilibrium phase diagrams for binary mixtures are the eutectic and solid solution systems, as shown in Figure 11.1.[1,13,14] And other complicated systems could always be divided into several parts, which are either eutectic ones or solid solution forming ones.

As for the eutectic system (Figure 11.1a), when the mixture (C) is cooled down from the liquid phase region (L) into the solid phase region (S), pure A will crystallize out from one crystallization step ideally and the composition of melt liquid will gradually move along to the eutectic point. The highest separation limit would be the eutectic composition for the melt residue, which means that mixture with eutectic concentration is not separable any more under the same operation conditions. However, in real processes, crystallization is not happening under the phase equilibrium state, and the separation efficiency would be decreased by kinetic effects. As a result, mother liquor could be trapped in or adhere to the fast-growing crystals. Therefore, multiple crystallization steps or post crystallization processes, such as washing or sweating, are necessary to get high purity crystal products.

As we can see from Figure 11.1b, for solid solution forming systems, it is not possible to get pure crystals from only one crystallization step. Theoretically, cooling of melt C_0 could only give crystals with composition of C_1. By melting the crystals and cooling it again, crystals with composition of

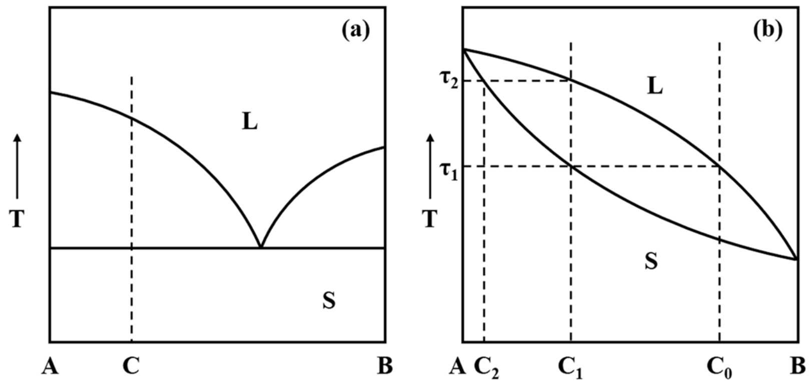

Figure 11.1 Phase diagrams of (a) eutectic and (b) solid solution systems.