production rate and residence time is estimated from the required mass of crystals in the crystallizer (see Eqn. (6.2)) and the volumetric hold-up of crystals in the suspension, must be accommodated for as well in a linear arrangement (pipe or cascade of stirred vessels) as in the well-mixed crystallizer. This may lead to very long linear apparatuses which then are designed as coils.[43] Besides the cost issue, sedimentation of solids in these long pipes and slip between the solid and the liquid phase are problems of ongoing research and development endeavour,[44] see several of the other Chapters of this book.

Obviously, the particle size distribution of these two extreme types of crystallizers is different. In the latter case, all crystals are of the same age when they leave the crystallizer, and hence, in theory represent a perfectly narrow particle size distribution. The well mixed crystallizer exhibits a wide residence time distribution, and hence, a wide particle size distribution.

Population balance modelling teaches,[10] that even though the inventory of a crystallizer may be well mixed, either the product exit stream may be classifying, or one or more additional classifying exit stream may be installed for fines removal, mother liquor withdrawal or other purposes like removal of a second liquid phase (VLLS-system). The latter is the case in the cyclohexanone oximation of the caprolactam process.[45]

Rather common is the case that a classifying exit stream takes out from the crystallizer only crystals that are larger than a certain minimum size. This measure narrows the size distribution of the product crystals by cutting off and rejecting the fines back into the crystallizer. Also common is that a second exit stream is used to wash-out crystals below a certain size from the inventory and dissolve them (fines dissolution). This measure reduces the number of crystals in a crystallizer and hence, leads to a considerable increase of the particle size distribution, see Figure 6.1.

Figure 6.1 Different samples of bulk $(NH_4)_2SO_4$-crystals from continuous crystallization with fines dissolution (left) and without fines dissolution (right).