

16 Case study

In this concluding chapter the application of certain aspects of the preceding knowledge will be illustrated. The case study is entirely fictional, but it includes many aspects appropriate to a large number of industries. Recently, process engineering industries have moved towards high value, relatively low throughput and batch identifiable compounds and this is the strategy that will be used for this example.

An organic compound is produced in a batch reaction between a mixture of liquids. The solvent in the reaction is an alcohol. The organic compound forms a precipitate that needs to be recovered and cleaned of unreacted species, and the presence of residual solvent must be minimised, before being stored as a dry powder, or granule. The solubility of the precipitate in the reactor is temperature sensitive; dissolving at elevated temperature. Each batch produces approximately $\frac{1}{2}$ tonne of dry powder product. The product is to be put into a 2 tonne storage vessel and then mixed with other powder products to provide a particulate product with total mass of 20 tonnes, per batch. The intention is to sell this product in 50 kg drums, or kegs, as a chemical intermediate for further processing. The specifications on the product state that it must flow easily and reliably, and that it must not provide a serious health risk from dust during any further processing. Given the nature of the organic compound produced in the batch reaction, it is desirable to minimise operator contact with the reactor product and subsequent operations.

Let's assume that the particle size distribution of the crystallised product has been analysed and is as shown in Figure 16.1, marked before recrystallisation. Being a batch system, there is probably the intention of moving the product out of the reactor as quickly as possible to allow for another batch, or cleaning, or a different product to be formed in the reactor. This would make good economic sense as the most expensive capital item could be highly utilised. However, *downstream processing*; i.e. unit operations following on from the reactor may provide a bottleneck, if fed with material that is difficult to process. In general, finer particles are more difficult to process than bigger ones and one possibility is that the original precipitate could be reheated, to dissolve the particles, then gently cooled again to grow larger crystals. On reheating the finer particles will preferentially dissolve, as they have a high surface area to volume ratio. On cooling, the particles remaining in suspension will provide sites on which the solid material, coming out of solution, can deposit onto thus forming bigger particles. This is represented by the second curve shown in Figure 16.1. Appropriate data for the two curves are included in the caption. The effectiveness of this strategy can be evaluated by considering the downstream process of filtration.

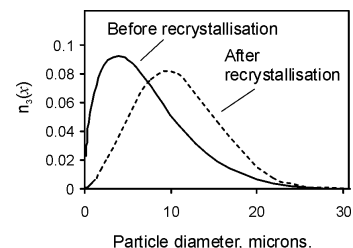


Fig. 16.1 Comparison of two size distributions provided by initial crystallisation and after recrystallisation by heating and cooling - RRB parameters are: $x_{63.2\%}$ of 8 and n of 1.5, and $x_{63.2\%}$ of 12 and n of 2.5, respectively, see equation (2.5)