**Table 12.3** Purities and productivities (eqn (12.7)) of different batch and continuous processes carried out for the substance threonine[62,68] (first number: L-Thr, second number: D-Thr); productivity in gram pure product/volume of solution and dead (2 h) + process time except for the cyclic (dead time 1.3 h) and the continuous operation (no dead time).

| | Process | Purity [%] | Productivity [g ($h^{-1}$ $L^{-1}$)] |
|---|---|---|---|
| Batch | Conventional PC (polythermal) | 99.5 | 1.3 |
| | Cyclic PC (auto-seeded polythermal) | 99.4/98.8 | 13.0/12.9 |
| | CPC (polythermal) | 99.4/99.6 | 5.3/5.2 |
| | CPC-D | 95.3/98.8 | 5.9/3.1 |
| Continuous | single MSMPR | 99.1 | 8.4 |
| | coupled MSMPR | 99.6/99.1 | 6.6/6.6 |

PC, CPC, CPC-D and continuous MSMPR), the single continuous crystallization is the most productive. However, it is operated off the racemic state of the liquid phase, which increases the risk of product contamination by nucleation of the counter-enantiomer over time. Hence, for the long-term operation desirable in industry, the coupled MSMPR crystallization process is seen to be advantageous due to the increased process robustness caused by the liquid phase exchange together with comparable high productivities.

When considering the above case-specific statements, it should be noted that each of the compared options is not yet fully optimized. A more rigorous optimization could cause still different trends. Here, we also do not provide process yields, which are of course another important process characteristic. Respective numbers can be found, however, in the cited references.

## 12.5.2 Resolution of Racemic Asparagine Monohydrate

Regarding the separation of the second system, namely the enantiomers of asparagine monohydrate, results from the application of two coupled and continuously operated fluidized bed crystallizers (FBC) are presented here, as introduced in Section 12.4.2.2. A brief comparison with other batch process variants is given at the end.

DL-asparagine monohydrate is known to be a conglomerate. L-asparagine is one of the nonessential proteinogenic amino acids used in the human body for nitrogen transport and toxin excretion. Its structure is shown in Figure 12.19. Medically, it is applied in cases of low blood pressure, kidney problems, or liver damage. D-asparagine, included in the peptide fullicin, is an example of a variation in the biological activity of a snail protein. Fullicin, which contains a D-asparagine residue, shows higher bioactivity than fullicin containing the L-species.[82] From water, L- and D-asparagine crystallize as monohydrates, *i.e.* L-(−)-Asn·$H_2O$ and D-(+)-Asn·$H_2O$. The racemate, DL-Asn·$H_2O$, is a mechanical mixture of the latter.