Scheduling the Conching Stage of a Semi-Continuous Cream Production Line with Simulated Annealing: Neighbourhood-Based Iteration Budgeting and Move Scheduling

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Abstract:

Purpose: This study schedules the conching stage, the bottleneck of a semi-continuous cream production line classified as $FF_c \mid r_j, s_{jk}$, no-preempt, block $\mid C_{max}$, where 30 batches are processed on four identical parallel conches with color-dependent cleaning times, to minimize makespan.

Methods: Solution representation encodes single 33-cell array with three zero separators. Simulated annealing starts an initial solution and obtains neighbourhood solutions by using 3-swap (10,912 moves) and insert (1,024 moves) operators. The iteration budget is derived from the neighbourhood size (55 tries per move, 600,000 iterations), and three different moves are compared.

Results: An analytical lower bound of 2,501 min and an obtained optimum of 2,508 min are established; all runs ended within 1 min of it. Runs from six starts (2,814.5–12,524 min) converged by 200,000 iterations. Splits close to the neighbourhood ratio (500/50 and 600/56 blocks) reached the optimum in 8 and 9 of 30 runs, whereas the reversed split (50/500) reached it once and converged 56,000 iterations later.

Conclusions: In this study, a robust method is proposed for such scheduling problems. It has been shown that a very good solution can be found in less than 1 second.

Keywords:
Hybrid flow shop, parallel machine scheduling, simulated annealing, food industry.