Two-Stage Flexible Flow Shop Scheduling with Blocking Constraint and Batching Machines

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Abstract

In this dissertation, a two-stage flexible flow shop scheduling problem is investigated with batch and discrete processors in stages 1 and 2, respectively. Batch and discrete processors perform pre-heating and casting processes, respectively. A blocking constraint exists between the two stages. Batch processors have capacity limit, which is determined by the batch processor size, job size and shape, and also by their layout pattern. Job availabilities are affected by their pattern positions. During the casting process, pots are used to pour molten metal. A pot change may be required due to succeeding job requiring a large volume of molten metal or due to the life span of the pot. A pot wash is required if the succeeding job uses a different alloy type. In order to satisfy customers’ due dates, reduce waiting times, increase the pot efficiency, and reduce throughput time, the weighted-maximum completion time of all jobs is minimized.

Four mixed-integer linear programming (MILP) models are developed and implemented using GUROBI. In small-size problems, optimal solutions were found, but large-size problems cannot be solved to optimality. Due to strong NP-hardness of this problem and incapability of the mathematical models in solving large-size problems, three different search algorithms i.e. TS, LTM_MAX, and LTM_MIN are developed and implemented. In addition, two lower bounding mechanisms i.e. iterative selective LP relaxation and branch-and-price (B&P) are developed and implemented to validate the search algorithms’ results. The average gap of LTM_MIN from the optimal solution in small-size problems is 2.81%. In large-size problems, the average gap of lower bound obtained by B&P from that by B&B (Branch-and-Bound) is -14.07%, confirming that B&P outperforms B&B in large-size problems. Also, the average gap among best of all three search algorithms against the best available lower bound is 14.2%.

June 6, 2014
9:00 am, KEC 1007

School of Mechanical, Industrial, and Manufacturing Engineering