Algorithmic and Complexity Results for Flowshop Scheduling in Steel Manufacturing

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Abstract: We consider a flowshop problem, that is, a multistage scheduling problem where all jobs are processed in identical machine stage order, which is motivated by the process of strand casting in steel production. Due to temperature-related constraints, jobs are not allowed to wait between consecutive machine stages. We seek to minimize the number of idle times on the last machine in this process, the so called strand interruptions, since they cause time-consuming cleaning operations.

Unlike the well understood problem of minimizing the makespan for no-wait multiprocessor flowshops, the problem of minimizing the number of strand interruptions was not yet studied in the flowshop context. In fact, these two problems exhibit a fundamentally different behavior. For the latter problem we show that the special case with two machines and the restriction to fixed job orders on the last machine are polynomially solvable. For slightly more complicated machine arrangements the problem immediately becomes inapproximable.

The above problem formulation, originating from practitioners' descriptions, totally ignores the makespan of the solutions. There are examples where the makespan varies a lot between schedules which are optimal with respect to the number of strand interruptions. We propose a new model which combines the minimization of the makespan and the number of strand interruptions, and discuss basic properties.

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