582f A Comparative Study of Continuous-Time Models for Short-Term Scheduling in Multipurpose Batch Plants

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The problem of short-term scheduling for multiproduct and multipurpose batch plants has received a considerable amount of attention during the last two decades. An extensive review comparing different models and formulations of time was recently published in [1]. Most of the proposed approaches for short-term scheduling can be classified into two main groups based on time representation: discrete-time models and continuous-time models. Discrete-time models discretize the time horizon into a number of time intervals of equal duration which corresponds to an approximation of the time horizon and can result in an unnecessary increase in the overall size of the model. Thus, to address the inherent limitations of discrete-time models, methods based on continuous representations of time have been developed.

One of the first methods used to formulate continuous-time models for the scheduling of network-represented or sequential processes is based on the concept of time slots. Time slots represent the time horizon in terms of ordered blocks of unknown, variable lengths, or slots, as presented by [2]-[4]. In addition, alternate methods have been developed which define continuous variables directly to represent the timings of tasks without the use of time slots. These methods can be broadly classified into two different representations of time: global event based models and unit-specific event based models. Global event based models use a set of events that are common for all tasks and all units, as demonstrated in [5], while unit-specific event based models define events on a unit basis, allowing tasks corresponding to the same event point but in different units to take place at different times, as presented in [6] and [7]-[11]. In [6], the model developed utilizes a nonuniform time grid with restrictions which effectively transforms the time grid to a uniform (or global event based) one for batch tasks that involve the same material state. This is accomplished by relaxation of the task durations using buffer times. In contrast, the unit-specific event based model developed in [7]-[11] is considered the most general and most rigorous representation of time used in short-term scheduling models. This formulation introduces the original concept of event points, which are a sequence of time instances located along the time axis of a unit, each representing the beginning of a task or the utilization of the unit. The location of event points are different for each unit, allowing different tasks to start at different times in each unit for the same event point. The timings of tasks are then accounted for through special sequencing constraints.

In this work, we compare the above mentioned short-term scheduling formulations (i.e., time slots in [2], global event based models in [5], and unit-specific event based models in [6] and [7]-[11]) to study the computational effectiveness of each. Both network-represented and sequential processes are considered along with two scheduling objectives: maximization of sales and minimization of the makespan.

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