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A matheuristic decomposition approach for the long-term scheduling of a single-source multiproduct pipeline system with pumping interruptions

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ABSTRACT

Pipeline systems are one of the most used distribution modes for crude oil and oil derivatives, where the optimization of transport operations can impact considerably in the economy of oil companies. We focused on the scheduling of pumping and delivery activities on unidirectional straight multiproduct pipeline systems connecting one source to multiple-destinations. We propose the improvement and expansion of the matheuristic decomposition approach from Meira et al. [European Journal of Operational Research 2018, 268(2), 665-687]. The previous formulation assumed that the source operates pumping continuously during the entire scheduling horizon. It is a reasonable assumption since the minimum allowed pumping rate is usually high enough to operate at adequate levels without the need to stop the pipeline, which is not operationally desired. However, instances with low total demand rate would inevitably increase the inventory levels even if pumping at the minimum allowed flow rate. In this circumstance, critical inventory capacity violations can be avoided if periods of pumping interruptions (pipeline stoppages) were scheduled along the horizon. An improvement on the mixed integer linear programming (MILP) formulation for the allocation and sequencing module (ASM) was proposed. It was introduced a new set of constraints to allow for pumping interruptions, taking into account the following conditions: maximum number of pumping interruptions, minimum and maximum hours of a pumping interruption, and minimum distance in hours between pumping interruptions. Also, the preprocessing was improved to better estimate the delivery operations for the initialization batches. A simulated annealing (SA) metaheuristic was developed to provide a more robust input data for the ASM model. For this reason, the constraints related to the initialization batches were also reviewed. To validate the proposed new MILP model, the previous and the extended formulation were compared using real-world instances and other derived instances with lower total demand. All solutions were obtained at a reasonable CPU time. The previous formulation was able to obtain solutions faster. However, the extended formulation, which allowed pumping interruptions, presented better results when facing low demand instances due to its capacity to propose pipeline interruption periods effectively.

KEYWORDS. Pipeline scheduling. Mixed integer linear programming. Simulated annealing.

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