RUNDOWN BLENDING OPTIMIZATION: A NOVEL APPROACH TO A CHALLENGING BLEND SCHEDULING PROBLEM

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Optimal product blending is a complex process that defines the profitability of refining operations, to a large extent. The goal of product blending in a refinery is to meet all the shipment commitments on time and with the required specifications, while operating within the inventory and production constraints both for the blending components and the blended products. An addition, numerous other operational constraints dictated by the hardware infrastructure of the blending apparatus have to be observed. Lastly, this operation should be executed in an optimal way in terms of operational margin. Rundown operations are a special class of refinery blending operations whereby there is one or more blending component that does not have intermediate storage tanks. This type of operation is common in many refineries, such as those in Eastern Europe and Asia as well as US refineries which blend diesel and fuel oil. For the latter, new environmental regulatory constraints, specifically with respect to sulfur, make the solution of the blending problem for diesel more challenging, hence the need for an optimization solution more apparent.

In this paper, we present a novel modeling and optimization approach that determines the optimal sequence and timing of blend events and rundown component tank switches in order to handle blending of hot streams coming directly off of a process unit to a finished product tank, without the benefit of intermediate storage.This system incorporates multiple blend headers and multiple blends in a multi-period, event-driven campaign, using open-equation based optimization and modeling technology. It produces the optimum schedule for multi-period blending along with optimum recipes and volumes for each blend, addressing the underlying inventory optimization problem. In addition, it manages all of the production blending operations including external component and product receipts and shipments, as well as relevant intra-refinery transfers.This new modeling formulation allows for the determination of the optimum split ratio for any rundown splitters, the duration and timing of the rundown components to the blends, and the amount of each static component for each blend.The resulting problem is a large MINLP that is solved using the Aspen XSLP Optimizer. The proposed model combines a continuous-time formulation with operationally dictated time periods. In this context, we also present an example problem based on an actual commercial blending operation. The solution of the example problem maximizes the profit while taking into account all of the economic factors including additives, rundown components, storage costs, and the robustness of the schedule.

The proposed approach is far superior to the current practice, which is typically based on trial-and-error methods using Excel or other heuristic tools and used primarily to obtain a feasible blend schedule including rundown operations. The optimal blend schedule provides for stream containment and ensures that all products meet their specifications. It also minimizes the use of slop tanks (used only for containment purposes) and the incidence of product giveaway. This approach is both comprehensive and practical as we are able to avoid these costly practices while finding a feasible and economically optimal blend schedule. Despite the large size of the resulting problem, which can be on the order of 50,000 continuous and several thousand discrete variables, the algorithm is very efficient and typically converges in less than a couple minutes even for complex refinery configurations.