Abstract

Dynamic scheduling of crude oil unloading and blending using genetic algorithm

Crude oil supply about 33% of the total energy consumption worldwide and is predominantly (>50%) processed in marine access refineries. Therefore, crude oil scheduling which enables the efficient processing of the crude to increase the profitability is an important problem. It often becomes challenging due to the presence of combinatorial constraints, discrete variables and uncertainties. The common uncertainties which are present in the refineries are product demand, ship arrival delay and tank unavailability. The schedule available for a nominal condition may not remain feasible under uncertain condition. Therefore, it is necessary to develop algorithms which can generate schedules under uncertain conditions.

First, the demand uncertainty in crude oil refinery is studied. A proactive two-stage approach is developed to solve such optimization problems. A discrete-time model is used with structure adapted genetic algorithm (SAGA) for solving single and multi-objective scheduling optimizations. In the first stage, an initial schedule is generated with the nominal parameters provided a priory. The same schedule is then checked and accepted in the second stage only if it is robust with respect to demand uncertainty. The increased demand of 10% can be utilized in robust schedule to improve the profitability by 9, 9, 8 and 5.5%, respectively compared to nominal schedule for examples 1, 2, 3 and 4. Second, a reactive approach is developed in which the uncertainty is not known before generating the schedule. The schedule is kept same up to the realization of uncertainty and after that the rescheduling is carried out to incorporate the uncertainty. Third, the pros and cons of using preventive and reactive scheduling approaches to handle a commonly encountered tank unavailability uncertainty are analyzed. Based on these, a new hybrid approach which combines both the features from preventive and reactive approach is developed. The comparison shows that the profit values of reactive and hybrid approaches of SAGA are close to the exact optimum solutions obtained using MINLP formulation with average deviations of 2 and 3 %, respectively. The comparison of the preventive approach shows 7 % average deviation compared to MINLP formulation. Fourth, the uncertainty in the downstream operation in a refinery is handled using graphical genetic algorithm. The uncertainties such as component quality and order demand fluctuations are handled. The objective function in the single objective formulation is the maximization of profit for first three case studies. However, in multi-objective optimization, an additional objective of minimization of fluctuation in crude oil supply to crude distillation units is used as it provides better control and operability of the plant for the first three case studies. The objective function for the fourth case study is to minimize operating cost for single objective formulation. On an average, results show 10, 10, and 5% reduction in operating cost by rescheduling with respect to that for without rescheduling for example 1, 2, and 3, respectively. Also, the obtained reschedules are 83, 85, and 86 % similar to the nominal schedules for example 1, 2, and 3 respectively which facilitate the smooth implementation of the reschedule. However, in multi-objective optimization, an additional objective of minimization of fluctuation in blender processing rate is added along with minimizing operating cost.