

Refinery Operations Planning

Andy Hill, Sarah Kuper, Sarah Shobe

EXECUTIVE SUMMARY

This report is a refinery planning model to optimize crude purchasing and unit operations to meet an uncertain demand over a three month timespan while maximizing profit. The model involves seven typical refinery processes and a blending section. Each unit has been modeled off of existing correlations and kinetic data. An optimization model (run using GAMS/CPLEX) was used to best determine purchasing requirements and operating conditions.

Six crudes were available for purchase: Oman (OM), Tapis (TP), Labuan (LB), Seria Light (SLEB), Phet (PHET), and Murban (MB). The product prices for each of the crudes is \$27.40, \$30.14, \$30.14, \$30.14, \$25.08, and \$28.19 per barrel, respectively. Two additives are also available, MBET and DCC, and are purchased for \$44.13 and \$35.01 per barrel, respectively. Product demands and prices vary over the three month timespan.

An existing LP model was used as the groundwork for this project. The existing model treated all units using input/output relationships in order to keep the model linear. This is an effective method to model crude processing, but compromises any unit operations decision making.

Modeling unit operations is highly nonlinear. Nonlinear unit models were added to the LP model unsuccessfully. The refinery model was not able to handle the nonlinearities in multiple units. To linearize the model, all unit operations variables were discretized. This converted the existing LP model to a MIP model. Now, all nonlinear equations can be evaluated as parameters and not as variables. Additional work to make the refinery model more user friendly was done by running all unit models in separate programs and producing tables, which are then called by the refinery model. This addition was also projected to reduce the run time of the program.

Inconsistencies concerning mass balances for each of the units were allowed due to their minimal effect. The units can become more balanced by simply adding additional flow rate scenarios for each unit. A balance must exist in the amount of scenarios because additions require a longer run time by the program, which currently requires around two hours to determine the optimal solution.

The results comparing a LP model without unit operations and a MIP program with unit operations shows that modeling unit operations drastically increases the gross refinery margin, which is the objective function. The profit margin for the LP model was approximately \$16.5 billion, while the margin the unit operations model was nearly \$34 billion – over twice as large. The recommendations changed significantly for the crude purchasing decisions. Specifying unit conditions (mimicking a LP model) places additional constraints on the optimal solution. This project shows that the addition of unit operations to pre-existing LP models will make the process more profitable and more accurate.