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CASE STUDY

Fractionation of Oil Mixture Into Jet and Diesel Fuel

CHALLENGE

Petroleum-derived jet and diesel fuels originate from complex multicomponent hydrocarbon mixtures. Efficient separation of these fractions is energy-intensive, and suboptimal column design can significantly increase operating costs. The challenge was to model a jet–diesel fractionation process and identify operating conditions that minimize energy consumption while maintaining high-quality separation.

SOLUTION

A rigorous simulation of the rectification process was developed using the ChemCad Universal Modeling Program (UMP). The TOWR distillation column module was selected. Thermodynamic behavior and phase equilibrium were modeled using the Grayson–Streed model for vapor–liquid equilibrium and the Lee–Kesler model for enthalpy calculations. The model included a distillation column, reflux condenser, and bottom-product cooler.

Process optimization focused on minimizing energy demand by adjusting three key parameters: number of trays, reflux ratio, and feed tray location. Sequential Quadratic Programming (SQP) was applied to determine optimal operating conditions.

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Petroleum Refining*

- **Business Type:** Petroleum refining / process engineering
- **Project Type:** Process simulation and energy optimization of a distillation unit
- **Plant overview:** Conceptual refinery distillation unit for jet and diesel fuel production, simulated using CHEMCAD UMP
- **Location:** Ukraine-based research

RESULTS

Simulation results showed that a 24-stage distillation column provided smooth temperature profiles without stagnant zones. Optimization identified an optimal reflux ratio of 0.6 and an optimal feed tray at stage 11. The bottom (reboiler) temperature was optimized to approximately 508 K.

Under optimized conditions, total energy consumption for the rectification process was calculated as 12,949 MJ/h. The resulting separation achieved clear fractionation: lighter aromatics and paraffins were concentrated in the jet fuel overhead product, while heavier hydrocarbons were concentrated in the diesel bottom product.

TANGIBLE BENEFITS

- Reduced energy consumption through optimized reflux ratio and feed tray location.
- Improved process efficiency without increasing equipment complexity.
- Clear guidance for modernization of refinery distillation units.
- Lower operating costs and reduced thermal load on condensers and reboilers.
- High-quality jet and diesel fuel fractions meeting compositional expectations.

Key Process Drawings & Data

Figure 1: Process flow diagram of the simulated distillation unit including column, condenser, and cooler.
Figure 2: Temperature profile along the distillation column stages.
Table A: Optimized distillation column parameters (number of stages, reflux ratio, feed tray).
Table B: Energy balance summary for optimized operation.

FIGURE 1 - The temperature profile of the column

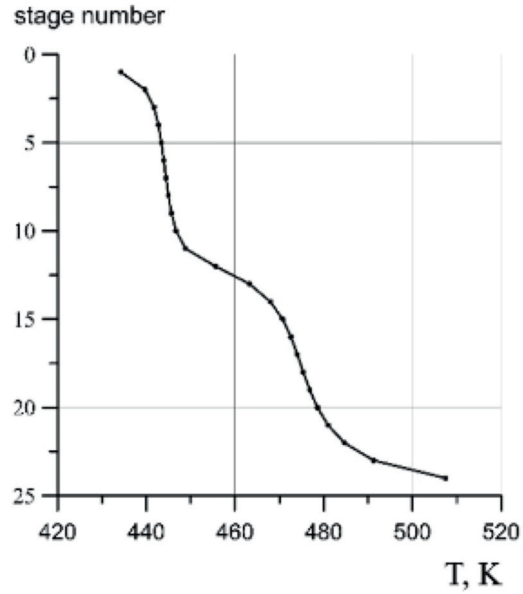

FIGURE 2 - Amount of heat consumed in the upper (curve 1) and bottom (curve 2) part of the column vs. feed tray