CASE STUDY

Energy, Quality, & Yield Improvements in Alkylation

APST Inc., a system integrator in Seoul, South Korea, improves process and control performance for chemical and petrochemical plants. In this case study, APST founder D.H. Lee shows how alkylation plants reduced energy consumption an average of 2%, saving millions of dollars, by applying PlantTriage performance monitoring software. Installations showed an ROI of less than two months, as well as a simultaneous increase in production rate and product quality.
Implementing Loop Optimization in Alkylation Units

The complex alkylation process in refining presents a challenging control application. In the race to create faster burning fuel, the alkylation unit is no longer driven simply by volume, but by a combination of volume, octane, and clean air specifications.

Rapidly changing environmental regulations, fluctuating crude oil prices, and burgeoning economies in China and India have a tremendous impact on demand.

Today, the primary goals of alkylation are to significantly improve unit performance by:

- Maximizing throughput and propane and isobutene recovery
- Increasing product quality
- Decreasing variability
- Reducing energy consumption.

PID Loop Optimization and Control System KPIs are important tools to stabilize the process and improve performance.
PID Loop Optimization: Setup and Baselines

The process begins by assessing the control loops in the alkylation unit. Up to 120 variables are typically controlled, including olefin feed; iC4 circulation rate; propane, butane, and pentane product purities; and akylate RVP.

PlantTriage is fed basic control information, then generates diagnostics and suggestions for improvement, including:
- Tuning issues
- Hardware configuration changes
- Process characteristics
- Operator actions
and more.

Baseline measurements are made of KPIs:
- Energy consumption
- Unit cost
- Product rate
- Loop health

At this point the optimization process starts: tuning PID parameters, fixing hardware problems, collecting input from plant operators, applying process simulation and data mining tools. PlantTriage reports provide a clear picture of process performance, and a prioritized summary of suggestion for improvement.
Transitioning to Automatic Loop Control

Typically, 30% of control loops run in manual mode, another 30% have tuning problems, and 10-40% exhibit severe oscillation. These problems combine to drive loss of efficiency, reduced production rates, increased energy costs, and increased quality problems.

Throughout alkylation, heat integration allows the refinery to reduce energy consumption. The Figure below illustrates some of the improvements. On the left, automatic control was introduced to stabilize the flash drum level in the refrigerant cycle. On the right, the reboiler temperature control, which had been in manual mode, was tuned and stabilized the column.

Temperature variation is reduced, resulting in the following business benefits:
- Improved Propane Quality
- Decreased Loss of High-value Isobutene
- Decreased Propane Loss

The refineries had big opportunities to improve performance. They had been unable to move beyond manual operation. PlantTriage allowed APST to introduce process improvements, step by step, and then convert to automatic mode.

Actions for Improvement

- Increase Controller Usage

  Flash Drum Level-Refrigerant Recycle

  Temperature Control (Manual -> Auto), DeC3 #38
Improvements: New Controllers, Soft Sensors

APST targeted specific areas for improvement, including installation of new controllers and building of soft sensors. A new temperature controller was installed to separate isobutene from butane, another byproduct of the alkylation unit.

On the right, soft sensors were used to provide a virtual analysis of the alkylate product qualities D90%, RON, and RVP.

As with the improved temperature control, the transition to automatic stabilized the process. In this case, the results was an 2.7% reduction in energy use.

On the left, the range of the Y-axis is from 67 to 72°C, each block being the equivalent of 0.5°C. Upon installation of the controller, temperature variation was reduced from about 1°C to 0.5°C.
Improved KPI Trends: Process Conditions

Excessive variability almost always leads to a loss of efficiency. Process capability decreases, making it easier to exceed operating limits.

As additional controllers came online in the refineries, I/O ratios stabilized. The goal is no differential between set points and actual measurements.

On the right, we can clearly see the impact of the PlantTriage application on stability. The improved stability is also reflected in improvements in some important KPIs:

- The overall loop health for the plant improved by 40%, the highest level measure of economic health and control in a plant
- Valve travel
- Manual mode (not in normal mode)
Improved KPI Trends: Production Rate

Process optimization using PlantTriage produced the desired end results. This report shows the composition of the end products. More uniform product quality was obtained for alkylate and all by-products.

Finely-tuned automatic control replaced manual mode, stabilizing the process, and bringing the plant to a more efficient operating point.

Overall improvements included:
- 2.1% increase in production of NC4, a valuable by-product that is treated to make Isobutene again
- 2.0% reduction in energy use, amounting to millions of dollars per year
- 1.9% increase in production of alkylate
- 0.1% reduction in propane impurities
What is PlantTriage?
Control Performance Monitoring

PlantTriage monitors your plant 24x7, automatically identifying opportunities to improve.

**Expertise Built In**

ExperTune has specialized in control performance software for over 25 years.

The expert systems in PlantTriage capture engineering knowledge, and put it to work for you.

**What’s Included with PlantTriage Software**

With PlantTriage, you get all the training and service you need, to start getting value from PlantTriage right away.

**For More Information**

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