KIPIC
البترولية المتكاملة

Refinery-Wide Simulation in Aspen HYSYS®: A Game Changer for KIPIC's Al Zour Refinery

aspentech | Case Study

An increase in aviation turbine kerosene yield by minimizing by-product rates, resulting in savings of **$950K in just two weeks.**

CHALLENGE

As the third mini refinery at Al Zour completed construction, operators faced a challenge: predicting refinery performance was difficult due to the wide range of crude oils it was designed to process. The variability in feedstock made effective operational planning and optimization challenging. A robust solution was needed to forecast refinery capabilities across diverse feedstocks and operating conditions, which would be crucial for a reliable startup plan and stable, efficient operations.

SOLUTION

The Al Zour refinery team developed an integrated, refinery-wide simulation model using Aspen HYSYS®, enabling detailed analysis and optimization of all major process units. This holistic model supported startup planning, operational decision-making and performance optimization across varying crude blends, leading to improved efficiency, cost savings and enhanced product yields.

VALUE CREATED

The simulation model enabled optimized startup planning, improved product yields, efficient hydrogen and sulfur management and operational cost savings—delivering $950K in savings within two weeks and enhancing overall refinery performance.

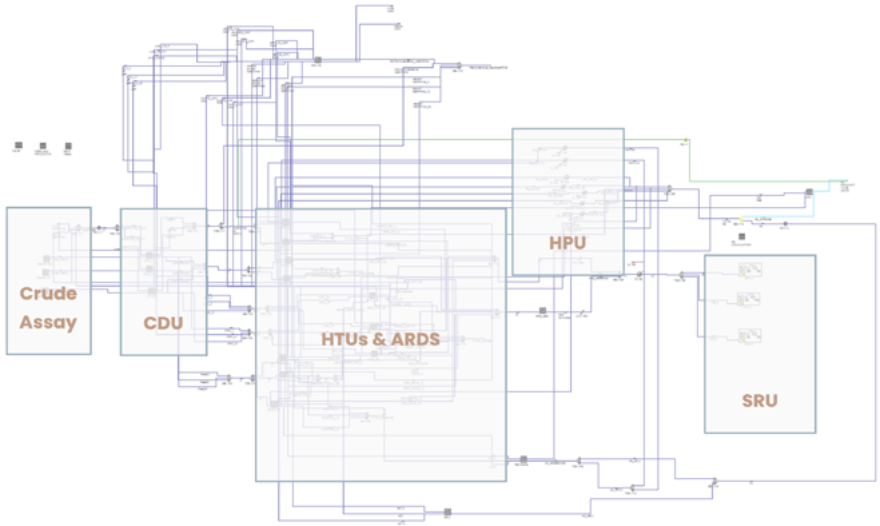
Challenges

Kuwait Integrated Petroleum Industries Company (KIPIC), a subsidiary of Kuwait Petroleum Corporation (KPC), operates the Al Zour refinery, the world's largest grassroots refinery with a capacity of 615,000 barrels per day. KIPIC also manages an LNG importing facility and plans to build a petrochemical complex downstream of the Al Zour refinery, which is expected to become one of the world's largest integrated refining and petrochemical complexes.

The Al Zour refinery is designed to process a wide variety of Kuwait crude oils, including the Kuwait heavy crude oil. The third mini refinery at Al Zour had just completed construction and was about to start up. The operators needed a solution to help them develop a startup plan, optimize operations and guide them in managing the refinery amid significant variations in feedstock crude assays. This required a solution that could predict refinery performance under different potential feedstocks and operating conditions.

Solution

The team at KIPIC's Al Zour refinery addressed their challenge by developing a refinery-wide simulation model using **Aspen HYSYS®**. This model integrated detailed simulations for each major process unit within a single flowsheet, allowing for a holistic view of the refinery's operations as shown in Figure 1.



The refinery-wide model essentially consists of 5 groups of processing units:

Crude Distillation Unit: The crude distillation unit model enabled the team to analyze how changes in operating conditions, such as crude assay ratio, feed flow, product cut points and recycle streams from the ARDS and Naphtha Hydrotreater, impacted product yields, qualities and overall process performance.

Hydrotreater Units: The hydrotreater units, which included models for diesel, kerosene and naphtha hydrotreaters, allowed the team to evaluate feed conversion, diesel yield and other critical parameters. The kerosene hydrotreater model provided a comprehensive view of aviation turbine kerosene production.

Atmospheric Residue Desulfurization (ARDS) Unit: The ARDS model comprised two reactors, enabling a more comprehensive analysis of process performance and revealing valuable opportunities for optimization.

Hydrogen Processing Unit (HPU): The hydrogen processing unit (HPU) model ensured an efficient balance between hydrogen supply and demand.

Sulfur Recovery Units: The sulfur recovery unit model offered a holistic view of the sulfur management process, helping monitor hydrogen sulfide generated from amine regeneration and sour water stripper units.

The refinery-wide model enabled the team to perform comprehensive analysis and optimization studies across the refinery, improving operational efficiency and profitability. For instance, it allowed the team to adjust the feed to the naphtha hydrotreater based on the operations of the hydrogen production unit and estimate hydrogen generation within the ARDS units, which impacted the HPU feed and, consequently, the naphtha hydrotreater's processing capacity. Modeling the HPU within the refinery-wide model ensured an efficient balance between hydrogen supply and demand, which is critical for various refining processes. The model provided insights into the HPU's performance and optimization opportunities, helping identify areas of high hydrogen usage and optimize processes to reduce consumption, leading to cost savings and efficient hydrogen management.

By accurately tracking and analyzing hydrogen sulfide generation across all units, the refinery-wide model assisted in optimizing sulfur

recovery processes and ensuring compliance with environmental regulations. It also enabled the estimation of off-gas quantities generated by each unit, facilitating efficient treatment of off-gas, reducing waste and maximizing the value of off-gas-derived products.

In particular, the model allowed the team to analyze various operating scenarios within the crude distillation unit, such as the impact of changing crude blends and assay variations on refinery performance. This analysis also led to an increase in aviation turbine kerosene yield by minimizing by-product rates, resulting in savings of $950K in just two weeks. Additionally, the model helped develop a plant start-up plan that considered acid gas removal and hydrogen management. It also enabled the team to perform what-if scenarios, simulating various operational scenarios and assessing their impact on performance, providing valuable insights for decision-making and process optimization.

Conclusion

In conclusion, the implementation of the refinery-wide simulation model at KIPIC's Al Zour refinery has significantly enhanced operational efficiency and decision-making capabilities. By integrating detailed simulations for each major process unit, the team was able to optimize operations, manage feedstock variations and develop effective startup plans. Key results include improved hydrogen management, optimized sulfur recovery processes and increased aviation turbine kerosene yield, leading to substantial cost savings and compliance with environmental regulations.

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Aspen Technology, now part of Emerson, is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance life-cycle. Through our unique combination of deep domain expertise and innovation, customers in asset-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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