Optimizing BP's Crane Gathering and Processing System

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ABSTRACT

BP America Production Company (BP) commissioned eSimulation℠'s eSimOptimizer℠ web-based process optimization system on the Crane Gathering and Processing System in Upton and Midland Counties, TX, in February 2005. This technology has been applied previously by eSimulation to several gas processing facilities. Though the processing capacity at Crane is only 30 MMSCFD, smaller than any previous eSimulation optimizer application, BP chose the Crane Plant because it was well instrumented and staffed to support the project implementation. Although the initial project pay-out was projected to be small, it was still adequate for this pilot application.

As the scope of the application was developed, BP and eSimulation identified a key tradeoff in coordinating delivery of unprocessed gas from the Midland compressor station to the Crane gas plant, approximately 20 miles away. BP's typical mode of operation was to bring as much gas from Midland to Crane as possible, rather than utilizing other processing options. BP and eSimulation agreed that expanding the optimizer system to manage the gathering and processing options was feasible and would increase the value of the application to BP. This application would become a first for the optimizer to extend the scope outside the plant fence.

This paper will report how the eSimulation optimizer guided BP's plant operators to effectively process more gas at the Crane Plant. The resulting increase in residue gas and NGL production will be discussed.

Market Drivers

There are several business issues that must be addressed in order to maximize value from gathering and processing facilities. These include maximizing Operational Profitability and Resource Productivity.

Operational Profitability

In order to maximize operating profits in all economic scenarios, it is essential that gathering and processing assets are run at maximum economic efficiency. Maximum economic efficiency is achieved when the plant is operating at the proper NGL recovery target given current economic conditions and the fuel required to achieve the proper recovery is minimized. This balance is a function of the current capability of the process, current contract structures with producers, and fluctuating commodity prices for Natural Gas and Natural Gas Liquids (NGL).

In addition to maximizing profit at a single NGL recovery facility, mid-stream processors also may have the opportunity to process gas in multiple locations, such as super system type gathering systems with multiple plants or other processing options. In this case, it is important that each processing option be considered in light of the process capability and the processing economics associated with each facility. The analysis must also consider the costs associated with moving the unprocessed gas to the processing facility, moving recovered NGL's to the best sales point, and moving processed gas (residue gas) to the best pipeline sales point for each processing option.

The NGL extraction process is a highly non-linear and heat integrated process. Likewise, the compression fuel cost required to move the gas around the gathering and processing system is highly non-linear. Therefore, simplified approximations of the energy costs associated with moving the gas, and extracting the next gallon of NGL, may not represent the mid-stream processor's true operational costs. This could result in the mid-stream processor making decisions that lead to lost profits and reduced commercial viability for the asset.

Accurately calculating the economic efficiency associated with each processing option, and the compression costs associated with transferring gas from one processing point to another, requires a first-principles chemical engineering model of the plant and compression system. This chemical engineering model must be tied to a detailed economic model that reflects the mid-stream processor's gathering and processing economics. The results must then be presented to process operations staff so that they can make the required moves to maximize economic efficiency and profitability. This is the function of web-based optimization.

THE CRANE WEB-BASED OPTIMIZATION SOLUTION

eSimulation℠ met with BP to discuss ways that web-based optimization could improve BP's Operational Profitability and Resource Productivity for their mid-stream business. BP decided to pilot eSimulation's eSimOptimizer℠ web-based optimization system at its Crane gas plant.

The Crane gas plant, which processes approximately 30 mmscfd of gas, had the electronic instrumentation in place that was required to support the web-based optimization project. Selecting the Crane plant supported BP's strategy of piloting the eSimOptimizer system on one of their smaller facilities, and using this as a test bed to qualify web-based optimization for their larger gas processing plants.

During the kickoff meeting for the eSimOptimizer project, BP suggested that managing a key tradeoff would require the web-based optimization system to be expanded to consider multiple processing options. eSimulation decided that including a gas movement advisory to help BP determine the best place to process the gas was feasible and agreed to include it in the scope.

BP placed the order for the eSimOptimizer system in September 2003. eSimulation℠ initially installed the eSimOptimizerSM system in January 2004 to show BP that eSimulation can deploy its web-based optimization system quickly. However, some instrumentation was not available to support the gas movement advisory at that time. BP made the decision to put the eSimOptimizer project on hold pending installation of the required instrumentation. In February 2005, eSimulation and BP commissioned the eSimOptimizer system with the gas movement advisory included.

During changes in operations strategy at the Crane plant, eSimOptimizer was available to help the operations staff to quickly determine if the plant is running optimally and to provide the guidance required to optimize the facility.

WEB-BASED OPTIMIZATION DESCRIPTION

Process data such as pressures, temperatures, flows, and analyzer signals are gathered from the plant's Wonderware control system using eSimulation's DataPumpTM software. The DataPump software is resident in a stand alone PC (not the Wonderware PC). The DataPump is an industry standard database application that can communicate to most electronic control systems.

The DataPump averages the plant data and sends the five minute averages over the internet to eSimulation's data center. eSimulation utilizes sophisticated encryption technology to securely transfer the plant data over the internet.

eSimulation's data center consists of computer server equipment and software that it owns (no commingling of data outside of the eSimulation enterprise). The computer server hardware is located in a professionally managed co-location and hosting facility in Austin, Texas. This facility has redundant internet communications and power to assure robust operation of the eSimOptimizer℠ system.

During the ½ day kickoff meeting, eSimulation's engineers gathered all the information needed to build the process model. The kickoff meeting included a detailed P&ID review, screen captures of the control system screens were printed, and equipment design information was gathered from the process design books. For the Crane application, this kickoff process included assimilating gathering field information and being sure that all optionality and constraints were understood.

eSimulation's engineers then began building the eSimOptimizer system, and its chemical engineering process model, with the scope described in Figure 1 below:

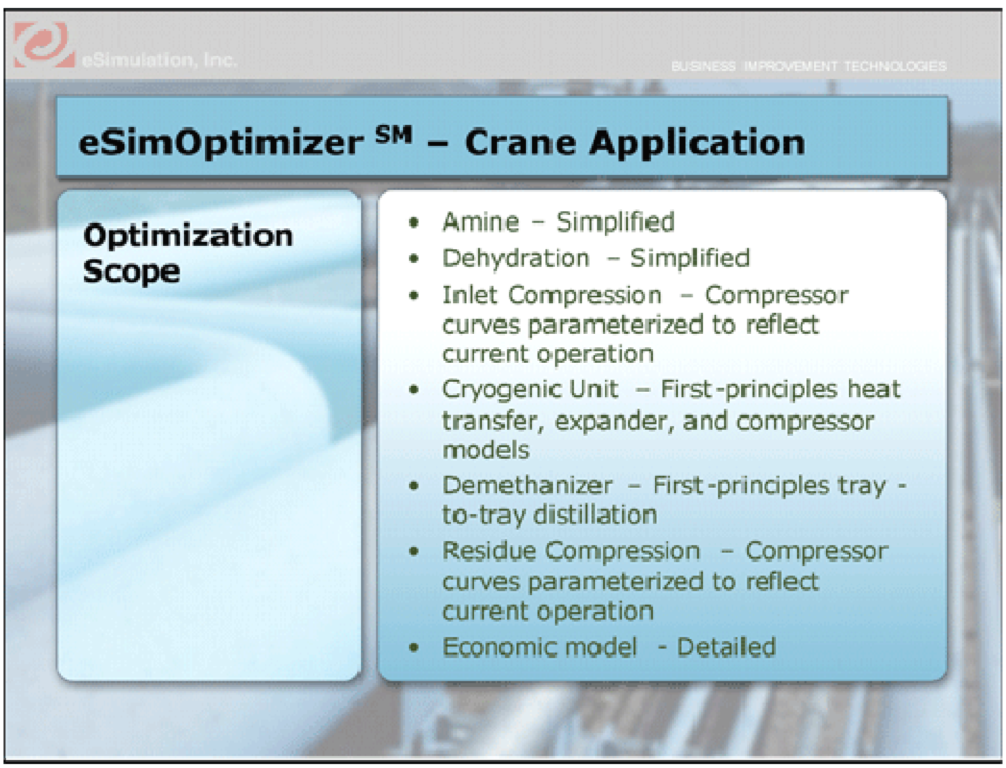

Figure 1 – Optimization Scope

Midway through the model building effort, eSimulation met with BP to understand the producer contract structure and BP's other processing options. eSimulation's engineers discussed how to access the system, how to update contract terms, and how to enter residue and NGL prices. eSimulation’s engineers then built the economic model for the facility.

A key step in the implementation process is the integration of plant data with the process model and the economic model. This step takes the longest amount of time because the completed eSimOptimizer℠ system must be tuned to converge robustly over the range of operating conditions. The system must also be tested to assure that all economic and process constraints are modeled properly. Model data included the following:

- 90 Continuous process measurements (press, temp, flow)
- 30 Discontinuous composition inputs
- 45 Manual entry Process Limits (high, low, step)
- 15 Commodity prices and other economic input
- 35 Contract definition inputs

eSimulation℠ configured the eSimOptimizer database and web interface to allow BP to access the optimization results. Once the eSimOptimizer system was working properly, eSimulation’s engineers activated login passwords and the system was made available to BP. Login passwords are assigned with access levels. For example, management and engineering have unrestricted access to set process limits and update commodity prices. Operators see all the process related screens, but do not have the ability to change limits or adjust prices.

In February 2005, eSimulation helped the BP operations and engineering staff to begin online commissioning of the eSimOptimizer system. At this time, the operators began making set point changes based on targets suggested by the eSimOptimizer.

There are two primary web pages that are used by the operations staff to view the suggested optimization results. The first of the two primary web pages is the Profit Sensitivity screen that is shown in Figure 2 on the following page. The Profit Sensitivity Screen defines the value to be derived (“Delta from Optimal”) when the operators make the suggested optimization moves. In this case, the Delta from Optimal is $42/day which shows that the plant is now running at near optimal conditions.

The Profit Sensitivity screen is updated automatically every three hours with suggested optimization move targets. Commodity prices and contract information can be updated by BP as often as required to reflect market conditions. All plant process data and calculated values are available for ad-hoc viewing as a trend, datasheet, or for downloading to an Excel spreadsheet by BP’s operations and engineering staff.

Downloading plant data or calculated values to Excel is especially helpful to analyze information and to prepare reports.

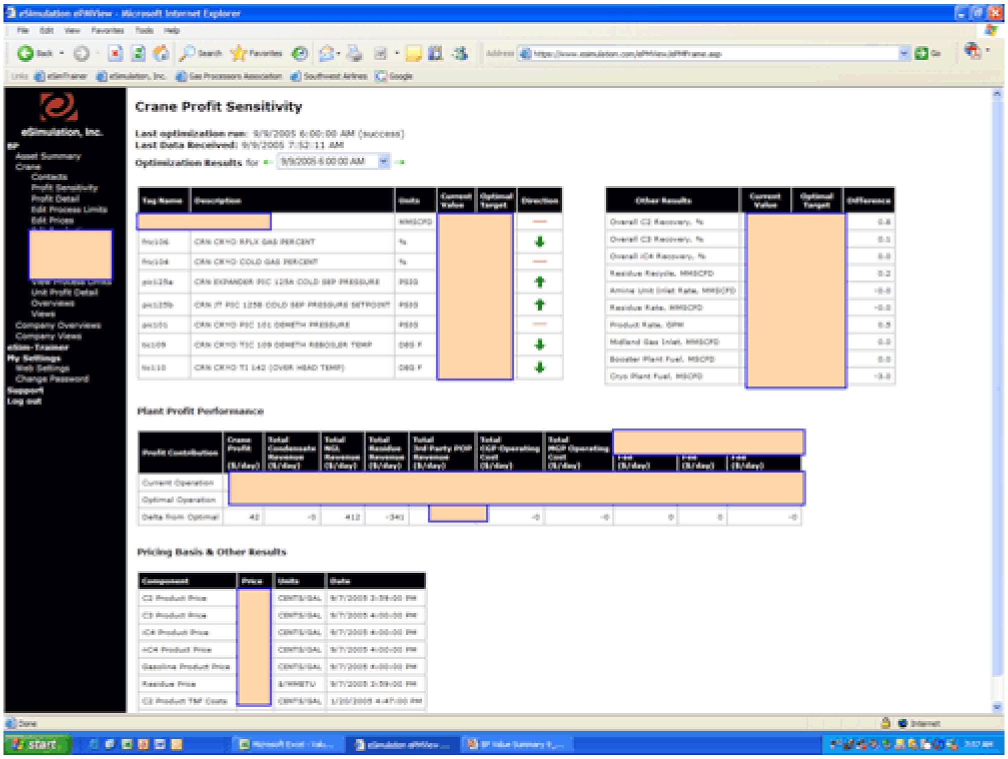

Figure 2 – Profit Sensitivity Screen

The second web page that is used by BP's operations and engineering personnel is the Process Limits screen shown below in Figure 3:

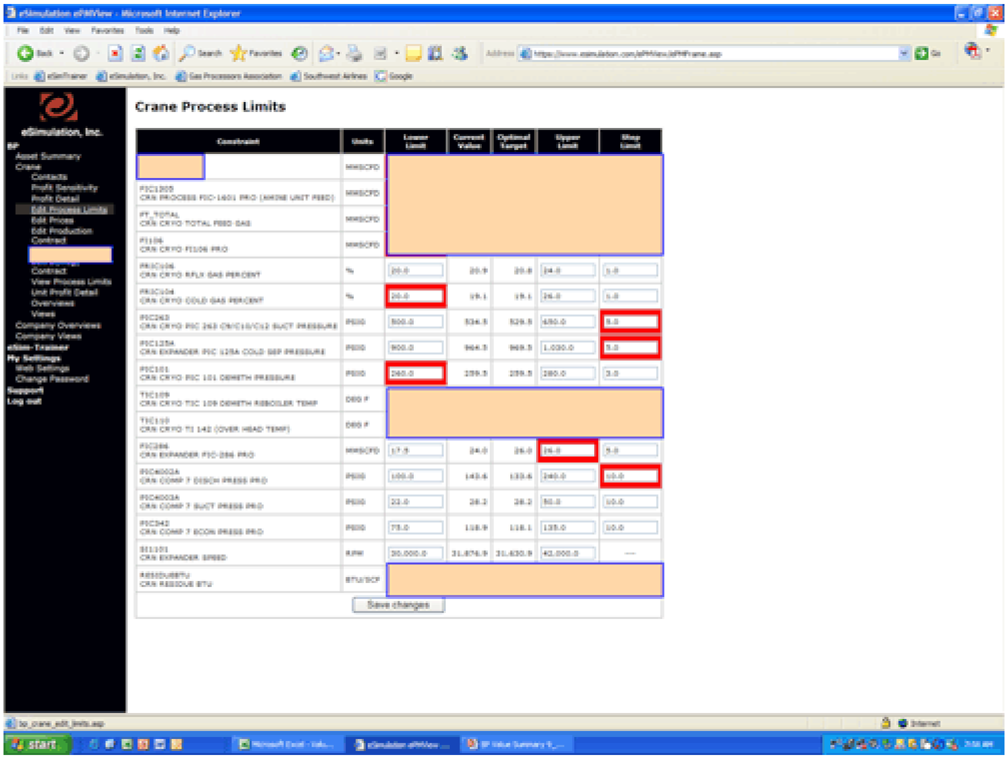

Figure 3 – Process Limits Screen

The Process Limits screen is used to manage all of the operating constraints that the plant must work within. The red highlighted boxes indicate when the plant is operating at a lower, upper, or step limit. The step limits define the magnitude of the move that the optimizer is able to take for each variable for the next optimization run.

Prior to making the optimization moves, BP's corporate modeling and engineering group updated the existing offline simulation model and ran some cases to make sure that the optimization moves made sense. BP used the Management of Change (MOC) process to assure that changes proposed by the eSimOptimizer would be within the safe operating parameters of the plant equipment. After these efforts were completed, BP's operators began making the suggested moves.

As the operators began making the optimization moves, eSimulation's engineers tuned the model to be sure that all constraints were modeled properly and that the optimizer's move predictions were tracking actual plant responses. As the plant was moved closer towards optimal operation, the step limits were no longer constraining the optimizer and the lower limits and upper limits started to become active.

The process engineering challenge was then to confirm that the lower and upper limits were set correctly. Often, eSimulation℠ finds that plant constraints were set in the past and very few people understand why they are set the way they are. BP examined the plant's constraints to determine if the Process Limits should be modified. This would allow the eSimOptimizer system to add more value by allowing it to search for a solution within a larger optimization regime.

A key aspect of the eSimOptimizer application is that all the engineering services required to keep the system functioning properly are provided by eSimulation and are included in the price. eSimulation charges an upfront Activation Fee to get the model built and the system commissioned online. eSimulation then charges a monthly Service Fee to keep the eSimOptimizer model matching plant conditions and updating results properly. BP did not have to add the highly specialized resources required to build and deploy the rigorous, online, process optimization system.

CRANE RESULTS

The eSimOptimizer system generated economic benefits for BP from a series of optimization moves. In one example, the eSimOptimizerSM system called for the elimination of a process recycle stream. The optimizer determined that reducing or eliminating this recycle stream would allow more gas to be processed at the Crane facility. The optimizer demonstrated that, while there were drawbacks to shifting additional gas to Crane, the economic benefit of processing at Crane more than offset these drawbacks.

In a second example, the eSimOptimizer system called for an increase in the inlet compressor discharge pressure. The optimizer demonstrated that an increase in inlet compressor discharge pressure of approximately 18 psig would result in increased NGL recovery.

In a third example, eSimOptimizer called for a decrease in the sub cooled reflux flow. Prior to optimization due to the plant's configuration, a small amount of heavier components were lost to residue at the top of the column. While the optimized ethane recovery was decreased slightly, the recovery of heavier components increased by a small amount. The optimizer balanced the cost vs. benefit based on the pricing and on thermodynamic equilibrium flash limitations.

In September 2005, BP and eSimulation worked independently to validate the benefits of the Crane optimization project and came up with very similar results. The methodology utilized required a historical baseline to be established for NGL recovery and fuel usage. Monthly post optimization performance was then compared to the baseline. The resulting changes in plant performance were then calculated at that month's commodity price deck. **The approximate resulting benefits to BP equated to 4.5 cents/mcf, at 30 MMCFD = $1350/day**. The benefit from the plant-only view could be less, depending on the processor's contract structure.

In addition to the tangible economic benefits outlined above, the Crane optimization project resulted in several less tangible, but no less significant, benefits to BP. The Crane optimizer project resulted in a greater understanding and awareness of factors that affect plant economics. It resulted in greater scrutiny of process limits and aided in the enhanced development of written, consistent operating procedures.

The project increased communication between engineers and operators and increased management focus on maximizing utilization of the Crane facility. Additionally, the Crane plant is now equipped with tools such as trending of historical data, ad-hoc reporting, and remote access to plant data which will increase operational integrity and ultimately could result in additional economic benefits to the plant.

The Crane optimization project provided a strong Return on Investment for BP and a significant increase in Operational Profitability for such a small facility. The Crane facility has sustained these optimization moves, and the value they provided, since the eSimOptimizer system was commissioned in February 2005.

eSimOptimizer also helped to improve Resource Productivity at the Crane site. BP's reduced operations staff can quickly evaluate the plant's current performance and make the necessary moves to keep the plant optimized. BP's staff can refer to the eSimOptimizer system at anytime, on or off-site, to understand how the plant is performing.

BP's corporate modeling and engineering support managers can be assured that daily optimization of the facility is being addressed. This allows them to focus on higher value expansion and process improvement projects for the company.