Safeguarding Offshore Operations: Eliminating Sulfur Risks in Gas Lift Systems

aspentech | Case Study

"The Aspen HYSYS Dynamics and Aspen Simulation Workbook tools played a pivotal role in shaping the outcome of our study. Their ability to integrate with real-time operations data significantly enhanced the accuracy of our calculations and increased our confidence in the results. Moreover, AspenTech products continue to support our daily operations, enabling us to make informed, strategic decisions with greater precision."

— Hatem Dawoud, Engineer, Process ADNOC

CHALLENGES

- ADNOC offshore facilities faced operational risks from gas lift disruptions and compressor failures.
- Elemental sulfur deposits accumulated in compressors, flare headers, choke valves and piping systems.
- Yellow powdery sulfur buildup caused unstable flow rates and equipment failures across multiple wells.

SOLUTION

The team used Aspen HYSYS Dynamics™ simulations to identify oxygen contamination in nitrogen as the root cause of sulfur formation. Solutions included installing a high-purity PSA nitrogen generation unit (99.99%) and implementing electric heaters with heat tracing to maintain seal gas temperatures above the sulfur desublimation point.

BENEFITS

The integrated approach prevents elemental sulfur deposition, eliminates compressor seal failures and ensures stable gas lift operations. Dynamic process simulations enable accurate thermal design calculations for all operational scenarios, while calibrated models provide reliable performance predictions for improved operational reliability.

Company Overview

The Abu Dhabi National Oil Company (ADNOC) is a state-owned energy enterprise headquartered in Abu Dhabi, United Arab Emirates. Established in 1971, ADNOC is one of the world's leading diversified energy groups and the largest oil company in the UAE. It operates across the full energy value chain—upstream, midstream and downstream—and is recognized globally as one of the lowest-carbon-intensity oil and gas producers. With a production capacity exceeding 4 million barrels per day, ADNOC ranks among the top 12 oil producers worldwide.

Challenge

ADNOC's offshore production facilities were experiencing significant operational and financial risks due to disruptions in gas lift operations and frequent **compressor seal failures.** These issues were traced to the accumulation of elemental sulfur deposits within the gas handling systems.

Sulfur buildup was observed in several critical components, including gas lift compressors, flare headers, gas lift choke valves and downstream piping leading to gas lift wells. One wellhead tower exhibited unstable gas lift flow rates, and inspection revealed that the choke valve was clogged with a yellow, powdery substance. Similar deposits were found in three other gas lift wells and within the compressor's seal gas system. Laboratory analysis confirmed the substance to be elemental sulfur.

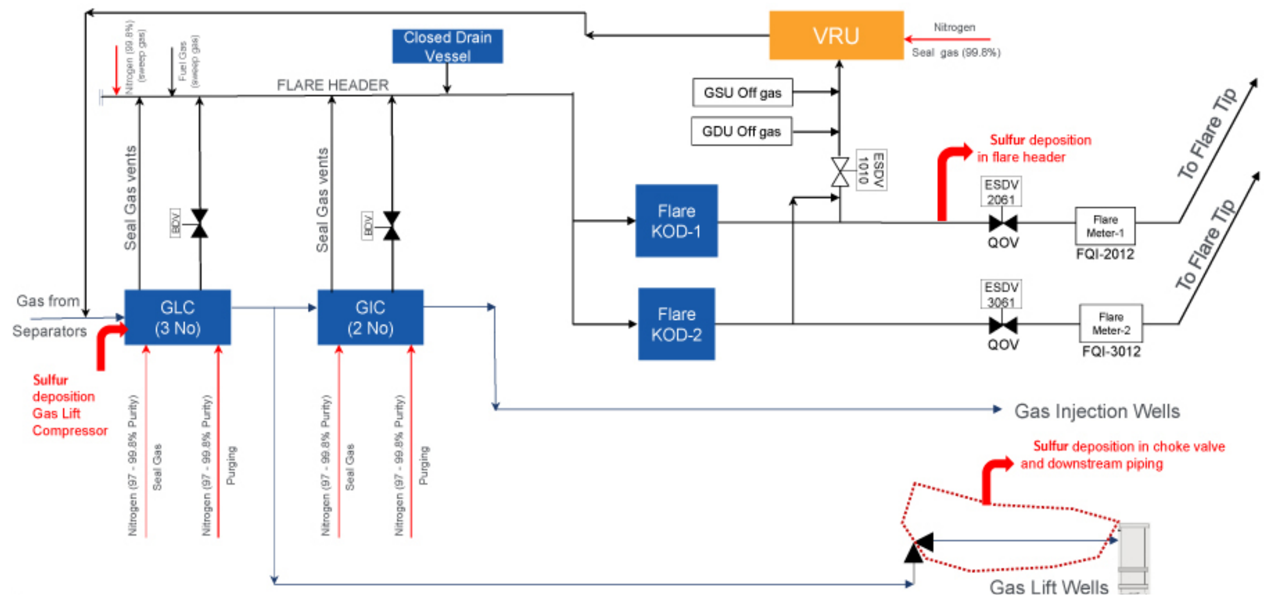

Figure 1: Process Schematic

Solution

To improve operational reliability and prevent sulfur formation and deposition, the team first needed to identify the root cause. This was accomplished through a combination of targeted field trials and theoretical assessments, supported by dynamic process simulations using Aspen HYSYS Dynamics.

The primary cause of sulfur formation was identified as oxygen contamination in the nitrogen supplied to the compressor seal system. The nitrogen contained approximately 3% oxygen, which, when mixed with hydrogen sulfide in the natural gas stream, led to the formation of elemental sulfur. This sulfur then deposited throughout the system.

Field trials determined that a nitrogen purity of 99.99% is optimal for preventing sulfur deposition in both the gas lift and compressor seal gas systems. While operations can continue at a slightly lower purity of 99.8%, sulfur buildup in the seal gas system is likely to persist. Consequently, the team decided to install a high-purity PSA nitrogen generation unit (99.99%) on the utility platform.

To mitigate risks during PSA unit maintenance or periods of increased nitrogen demand—when purity may temporarily drop to 99.8%—the team proposed a secondary solution: maintaining the seal gas system temperature above the sulfur desublimation point. This would prevent sulfur from precipitating even if it forms in the gas phase.

To maintain the seal gas temperature above the minimum threshold, the team proposed installing a new heater along with heat tracing for the seal gas system.

To achieve this, a new electric heater and heat tracing system were proposed for the seal gas line. The required heating duty was calculated for all operational scenarios, including normal operation, startup and shutdown blowdown. These calculations were supported by a detailed dynamic simulation model developed in Aspen HYSYS Dynamics, ensuring accurate thermal design under varying conditions.

The model developed in Aspen HYSYS Dynamics was calibrated using operational data to accurately reflect real-world conditions. This was achieved through Aspen Simulation Workbook™, which provides a Microsoft Excel® interface for seamless interaction with Aspen HYSYS Dynamics.

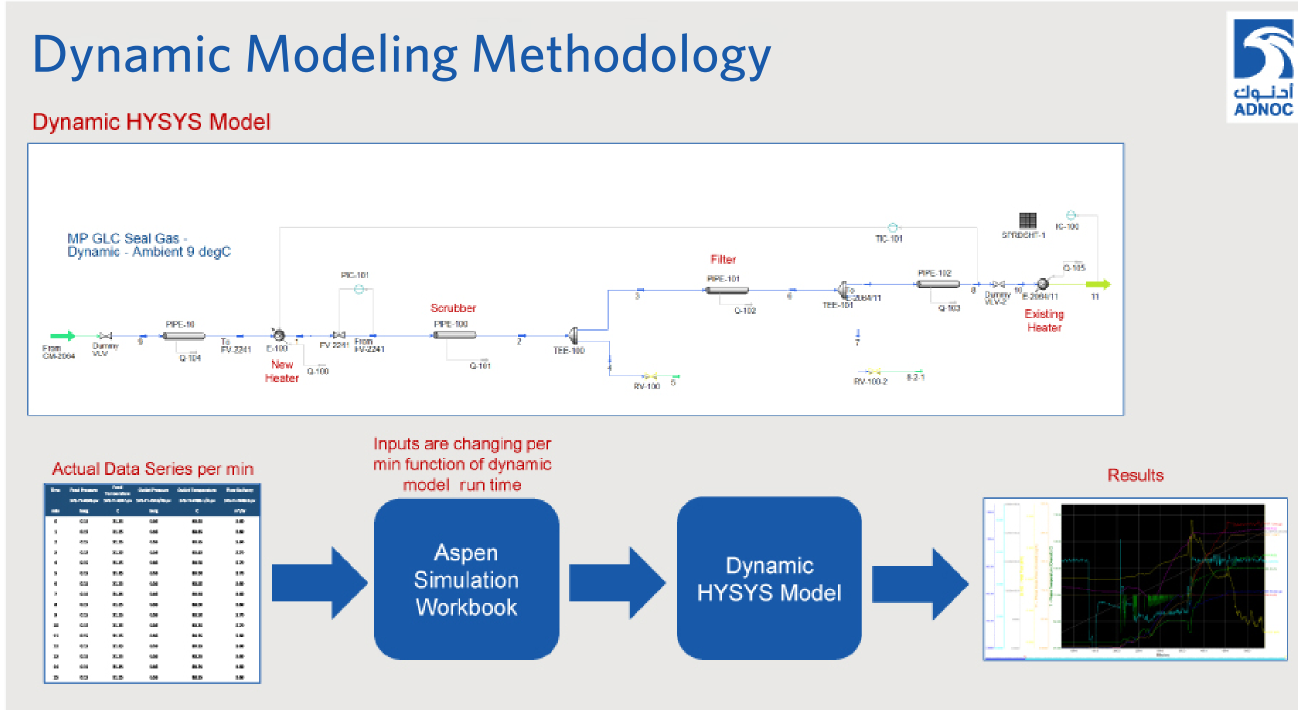

Figure 2: Methodology followed in calibrating and using dynamic process simulation

Results

Case	Sc. No.	Scenario	Minimum Temp.(°C)	Prevent Sulphur de-subimation	New Heater Process Duty (kw)
GLC-MP_Normail Operation	1.1.1	Without New Heater	80	✓	N/A
GLC-MP_Start-up	1.2.1	Without New Heater	15	✗	N/A
	1.2.2	Without New Heater Only	40	✗	6
	1.2.3	With HT Only @ 75°C	40	✗	N/A
	1.2.4	With HT Only @ 120°C	40	✗	N/A
	1.2.5	With HT and New Heater	75	✓	4.8
GLC-MP_Depressurization	1.3.1	Without New Heater	30	✗	N/A
	1.3.2	Without New Heater Only	43	✗	12
	1.3.3	With HT Only @ 75°C	55	✗	N/A
	1.3.4	With HT and New Heater	75	✓	10.5
GLC-MP_Normal Operation	2.1.1	Without New Heater	77	✓	N/A
GIC_Start-up	2.2.1	Without New Heater	9	✗	N/A
	2.2.2	With New Heater	9	✗	8.3
	2.2.3	With HT and New Heater	75	✓	8
GIC_Depressurization	2.3.1	Without New Heater	23	✗	N/A
	2.3.2	With New Heater Only	40	✗	4.5
	2.3.3	Without HT and New Heater	75	✓	3.2

Figure 3: Results obtained through the analysis of multiple operating scenarios

Conclusion

The study revealed that even trace amounts of oxygen in sour gas systems can lead to elemental sulfur formation under certain conditions. However, sulfur only precipitates when temperatures fall below its desublimation point.

Key findings included:

- Maintaining nitrogen purity at 99.99%* is essential to prevent sulfur formation in the compressor seal gas system.
- If nitrogen purity drops to 99.8%, gas lift operations can continue, but sulfur deposition in the seal gas system becomes likely.
- Installing a heater and heat-tracing system ensures the seal gas temperature remains above the sulfur desublimation threshold, mitigating deposition risks.

This comprehensive approach significantly enhances system reliability and reduces the risk of unplanned downtime due to sulfur-related issues.

*** Note: The recommended nitrogen purity levels and temperatures presented in this case study are tailored to ADNOC's specific operating conditions and compositions, and should not be interpreted as best engineering practices for other systems.**

About Aspen Technology

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 lifecycle. 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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