Near-Field Exploration and Development: A Holistic Look at Leveraging Digital Technologies to Increase Productivity and Profitability

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Accelerating Digitalization to Face Present and Future Complex Challenges

With the need to support an ever-increasing global population and a rising standard of living, together with the growing effects of climate change, today's energy industry faces the unprecedented challenge of balancing energy security, affordability and environmental sustainability. Hydrocarbons are expected to remain major components of global energy demand for at least the next two decades. The upstream oil and gas sector will play a critical role in meeting demand, but will be increasingly challenged to maintain capital discipline and minimize the impact of their operations on the environment. In light of this, producers must find ways to reduce costs when bringing new production online and during operation, while simultaneously minimizing emissions, water use and other environmental impacts.

The upstream energy industry segment is capital-intensive and environmentally challenging. It requires an accurate assessment of lifecycle costs and uncertainties at the very front end, when significant investments must be made. Digital solutions can be extremely valuable planning tools, providing a competitive advantage for those companies that have adopted them. This paper presents an end-to-end digital solution approach that can reduce project costs and timetables, accelerate time to revenue, optimize production, leverage existing assets and infrastructure, and reduce the carbon intensity of products.

Increase Performance with Near-Field Exploration and Development

Near-field or infrastructure-led exploration is growing in popularity, with lower discovery costs and a higher likelihood of faster time to market. Additionally, near-field exploration enables upstream companies to leverage already depreciated costs in operating infrastructure while simultaneously extending the life of a declining field through access to new or previously bypassed reservoirs near existing facilities. Workflows for qualifying near-field opportunities are divided into the sections that can be used collaboratively to obtain a comprehensive feasibility analysis for evaluating new projects and bringing them online.

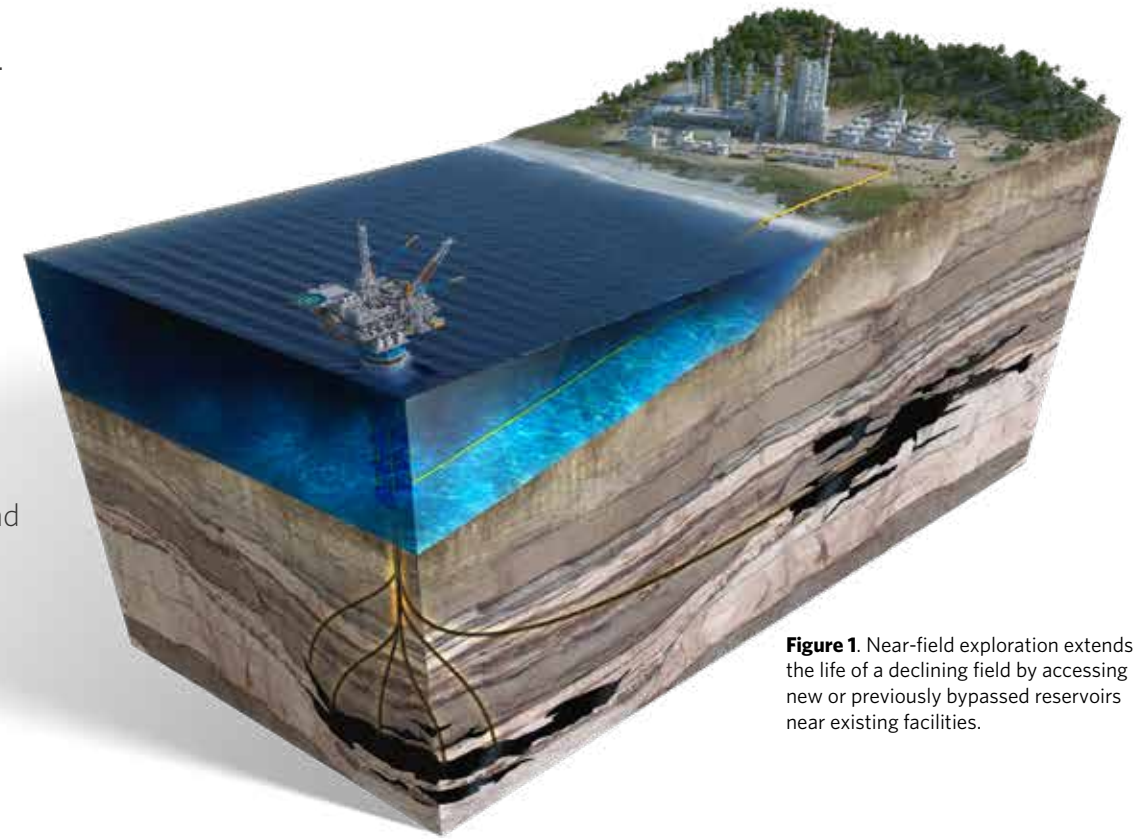


Figure 1. Near-field exploration extends the life of a declining field by accessing new or previously bypassed reservoirs near existing facilities.

Reduce Geological Risk with Advanced Geophysics and Petrophysics

Digital technologies have proven to be valuable when exploring opportunities for near-field expansion. Advanced seismic imaging solutions like those available from AspenTech®, help geoscientists gain previously unattainable levels of subsurface knowledge by extracting maximum information from both modern and legacy data. These visualization tools deliver highly accurate images from beneath complex structures, such as shallow low-velocity anomalies like gas pockets, subsalt, sub-basalt and high-velocity carbonate rocks. They optimize reservoir characterization and fracture detection, and help companies prioritize investment, accurately delineate stratigraphic features of formations to decide on placement of future wells, and reduce time to first production.

OFFSHORE AUSTRALIA

Customer Success: Reduce Drilling Uncertainty and Risk

In offshore Australia, the AspenTech Subsurface Science & Engineering (SSE) patented, full-azimuth specular imaging technology allowed an operator to greatly enhance the seismic image in a complex basin (Figure 2), resulting in increased confidence in the overall structure of the reservoir and the successful drilling of new wells. The outcome of this project demonstrated the advantages that modern seismic imaging technologies can offer in providing additional insights into legacy seismic data, even data acquired years ago using older techniques, without the need for significant additional CAPEX investments.

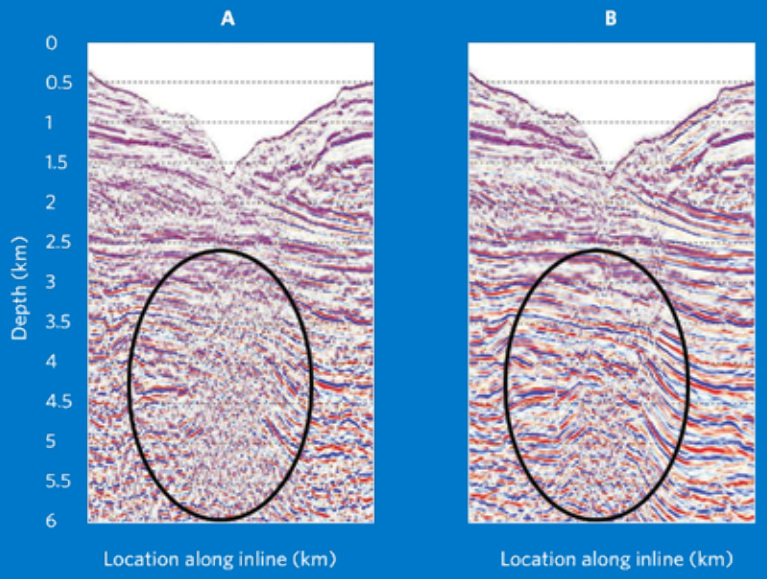


Figure 2. Imaging a "hidden" structure in offshore Australia: Kirchhoff depth image (left) and improved full-azimuth specular weighted image with Aspen EarthStudy 360™ (right).

Another major challenge in producing hydrocarbons is predicting rock types and the distribution of fluid content throughout the reservoir away from wells. High variability in reservoir properties results in geological uncertainties and risks for subsequent well placement. An integrated analysis of multi-scale geological, geophysical and seismic information using machine learning provides reliable prediction of rock types away from the well and helps specify promising zones. As a result, geological risk is greatly reduced and an optimal well location can be defined.

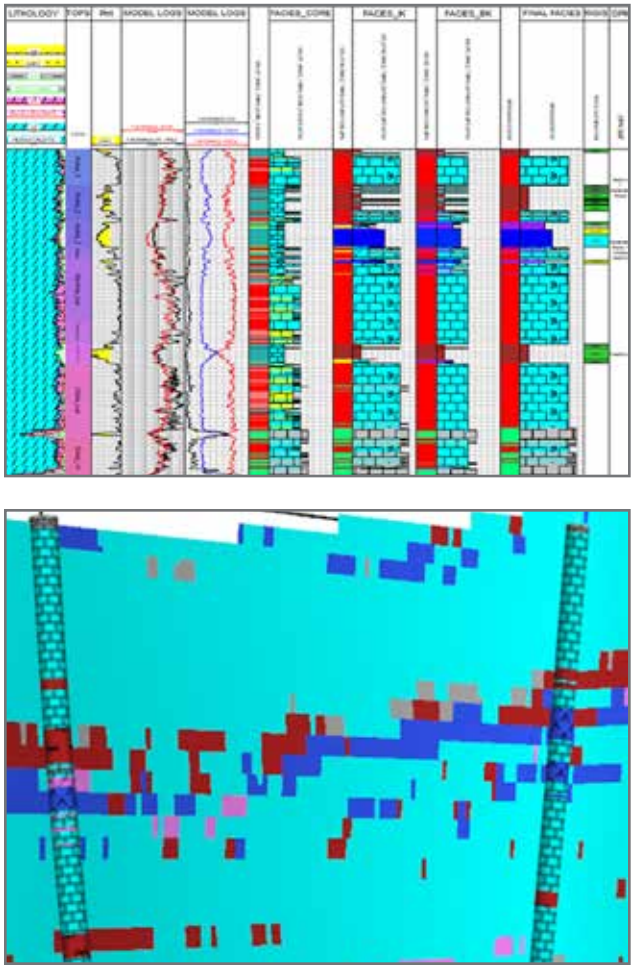
EASTERN EUROPE

Customer Success: Reduce Geological Risk During Well Planning and Drilling

A client based in Eastern Europe encountered a problem in one of its main development projects. In the central area of the field, where extensive drilling had taken place, oil saturated reservoirs were mainly found within the target horizon, while the marginal areas of the field, complicated by reservoir caps and several hydrodynamically isolated deposits, had not been sufficiently studied and were of great interest in terms of prospects.

Prior to drilling new wells in the peripheral areas of the field, the customer requested a more accurate assessment of the reservoir due to high rock type variability and uncertainties in the position of water-oil contact levels. Using AspenTech's comprehensive platform for integrating petrophysical, geological and borehole geophysical workflows, the customer was able to use a reliable prediction of the subsurface facies to confirm the accuracy of additional exploratory well placement and increase oil production (Figure 3).

Figure 3. Reliable interpretation based on the integrated analysis of borehole and seismic studies through machine learning helped define optimal drill trajectories and locations.



Accelerate Feasibility Studies with Integrated and Automated Subsurface Workflows

One of the greatest challenges in oil and gas exploration and production is to forecast recoverable volumes of hydrocarbons and drive production scenarios in the face of a high degree of uncertainty regarding the subsurface and its dynamic behavior. Traditionally, multiple disciplines have been required to iterate through various scenarios based on assumed parameters to gain insights into uncertainties that might hamper project development. This iterative process is time-consuming and can lead to inaccurate production forecasts and jeopardize the economic viability of connecting a new field to existing infrastructure. AspenTech's integrated subsurface modeling solutions enable users to validate the technical feasibility and economic viability of further development. These solutions are using comprehensive and sophisticated uncertainty assessment methods to provide increased insight into the subsurface and perform risk estimation as a part of project feasibility.

Qualification of the geologic structure, reservoir size, rock quality, fluid composition, net quality sands and other risks can be determined to understand the impact on future production and optimize the field development plan.

CASPIAN SEA

Customer Success: Maximize ROI by Reducing Uncertainties

A major operator in the Caspian Sea region used AspenTech's modeling and reservoir simulation solutions to assess the technical and economic feasibility of developing a gas field close to other producing assets. A holistic model of the field, from the reservoir to the topside, was completed to simulate production rates and assess uncertainties in the formation that could impact flow efficiency (Figure 4). This workflow included reservoir modeling, reservoir flow simulation and flow simulation in wells and surface networks, enabling the simulation of projections covering a broad range of possible gas and condensate production scenarios. A sensitivity analysis identified those subsurface uncertainties with the greatest impact on future cumulated gas production and confirmed the decision to continue exploration drilling. The operator was able to leverage these insights to reduce exploration costs by up to 20% by focusing the data acquisition campaign on the most significant uncertainties affecting the quality of the production forecast.

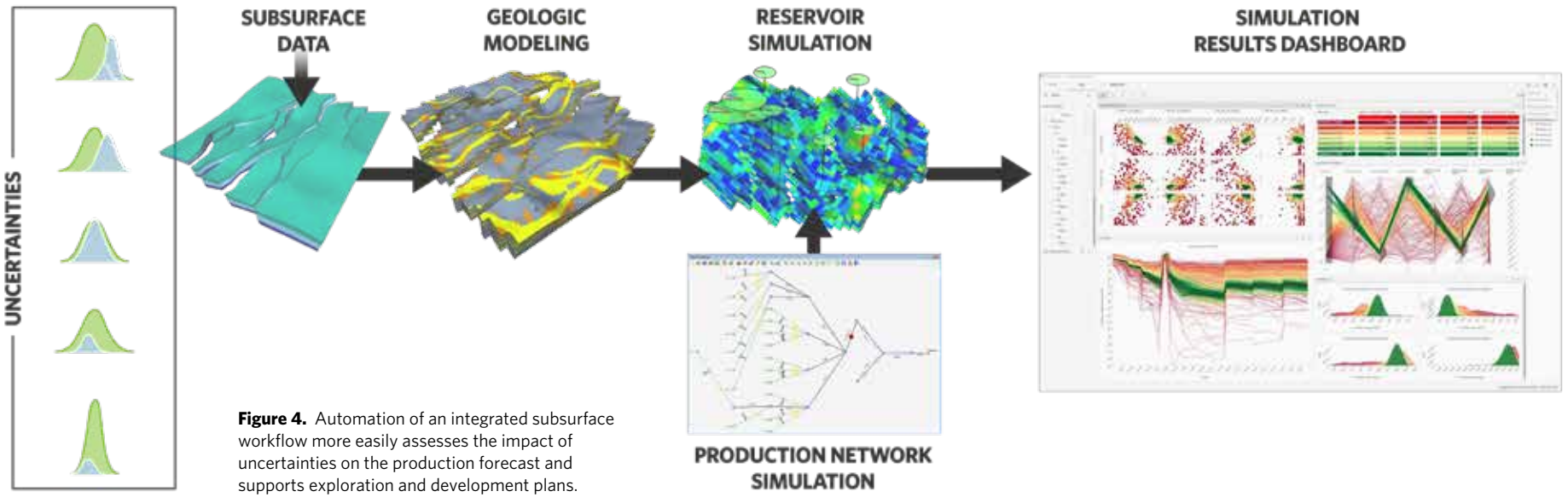


Figure 4. Automation of an integrated subsurface workflow more easily assesses the impact of uncertainties on the production forecast and supports exploration and development plans.

Enhance Well Construction with a Comprehensive Design

When evaluating near-field expansion and development, a typical challenge is designing wells that require a complex trajectory to reach the productive zones while ensuring optimal recovery from a single well. More specifically, drilling engineers need to ensure that a safe distance is maintained from previously drilled wellbores and that wellbore stability, adequate weight transfer and hole cleaning requirements are met to prevent drilling risks.

AspenTech solutions help evaluate the near wellbore stresses encountered during offset well construction by developing a geomechanical model for new well development within optimum operational parameters (Figure 5). A digital well planning environment supports the design and engineering of complex well paths for optimal placement based on a combination of seismic, geological and reservoir data. Real-time data transfer and visualization solutions in conjunction with the geologic model enable reliable decision-making during operations to adjust the trajectory as needed and reduce preventable downtime by mitigating risk through continuous monitoring.

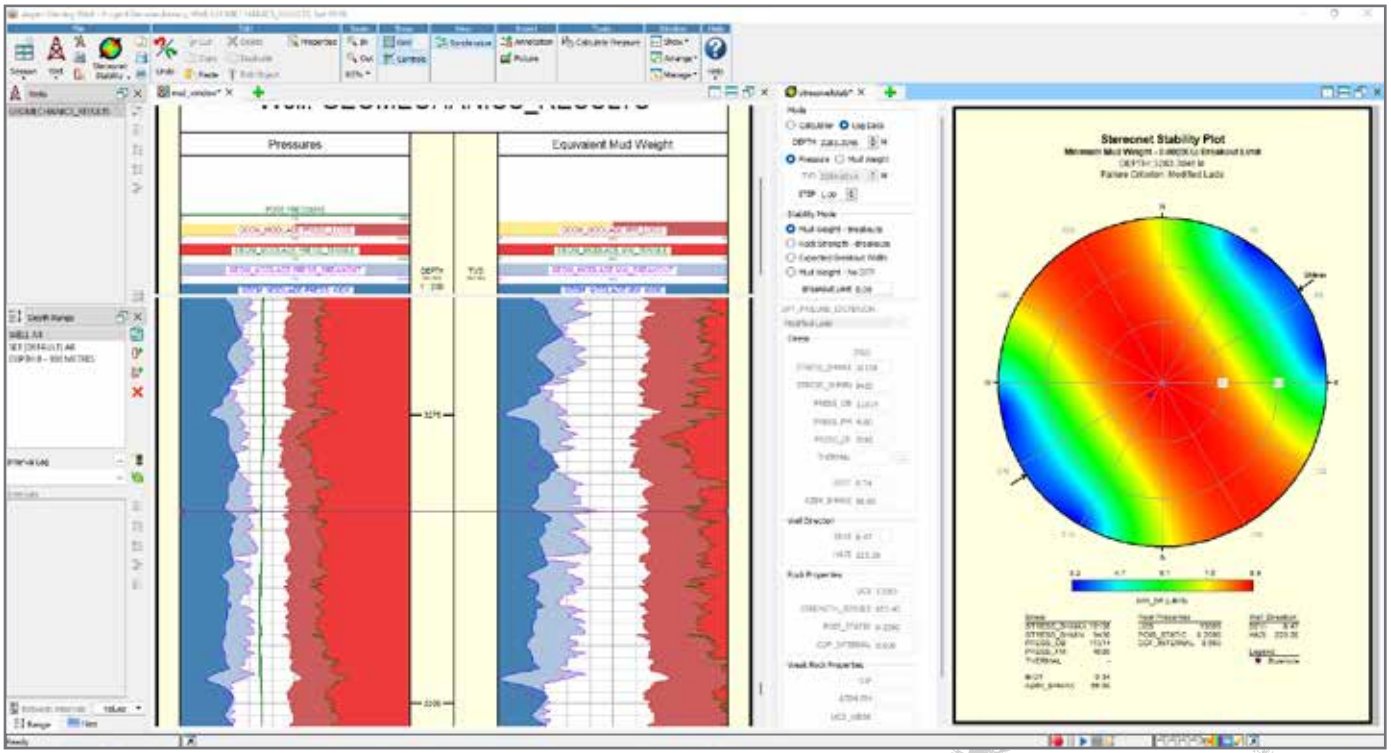


Figure 5. A polar plot using Aspen Geolog™ for near wellbore stability analysis provides safe drilling operational parameters.

Optimize Production at Existing Facilities Post Near-Field Expansion

Using existing facilities for a new production regime requires a holistic overview of the system to incorporate all the constraints when planning the tie-in of new production wells. The tight integration of subsurface and surface assets that is enabled using AspenTech's integrated flow assurance and production modeling software lets the operator anticipate the impact that a new tie-in will have on the process facility in the short and longer term. Building a fieldwide model allows collaboration between multiple teams, enabling them to optimize the entire system, define operational best practices and reduce tie-in time. The ability to quickly achieve steady-state operations can result in a net savings of at least four days of production.

Accelerate Decision-Making and Project Delivery by Integrating Wells, Flowlines and Process Simulations

A production network simulator is key to ensuring the safe and cost-effective transportation of fluids. Such a simulator can consider the multiphase network response of multiple wells feeding into a common production system, where the response of one well will affect the flow rate of another. From complex individual wells to a vast network, AspenTech's production modeling and optimization software can be leveraged to ensure optimal flow over the entire lifecycle and improve margins.

OFFSHORE OIL FIELD OPERATOR

Customer Success: Increase Oil Production with Comprehensive Modeling

An operator of an offshore oil field comprising approximately 200 wells was looking to leverage network simulation capabilities to increase production of liquid hydrocarbons. The objective was to fine-tune equipment operating conditions to increase oil production without also increasing gas production, which had been on the rise as the field aged. The network simulation results, accounting for subsurface and surface constraints, provided the operator with the optimal set points to reprioritize well production while accounting for the increasing gas/oil ratio. As a result, oil production increased by 5.7% with no additional CAPEX and OPEX requirements.

Optimize Operations and Increase Production by Leveraging Digital Twin Models

Rigorous process simulation-based digital twins provide accurate insights into a spectrum of process parameters—often in real time—which typically cannot be directly measured in an operating facility. More importantly, these insights are displayed in intuitive, easily readable and easily accessible user interfaces and dashboards, enabling stakeholders across the enterprise to make informed decisions that reduce risk, while improving the efficiency and agility of their operations to increase profitability and advance sustainability efforts.

Operations optimization is a critical area in which digital twins have helped companies worldwide achieve tremendous gains. For example, production optimization opportunities may be hidden behind the design set-up and operation of processing facilities. Understanding and optimizing around such constraints and bottlenecks can help significantly improve the production capabilities of the entire asset.

YPFB—BOLIVIA

Customer Success: Leverage Digital Twins to Debottleneck and Optimize Countrywide Gas Production

YPFB, a Bolivian national oil company, had seen a considerable production decline in two of its major gas fields, jeopardizing its ability to meet existing contractual obligations to customers. The fields were already operating under "full open well" and "full flow production" conditions to cover market demands, and conceptual projects for well compression were still in development.

The company developed an integrated digital twin model that encompassed all field processing plants, sales and export pipelines, compression stations, etc., situated around the country. The integrated model was used to debottleneck the processing plants, run checks on compression station capacities and efficiencies, and conduct pipeline capacity and flow assurance analysis (Figure 6). In addition, the model was used during project conceptualization, driving considerable savings on well and inlet plant compression projects. The analysis helped them identify a way to decrease pressure by 35% in the gas processing plant. As a result, the two oil fields increased gas production by an estimated average of 8% and 10%, respectively, equivalent to an increase of approximately $250M USD in revenues from production in one year.

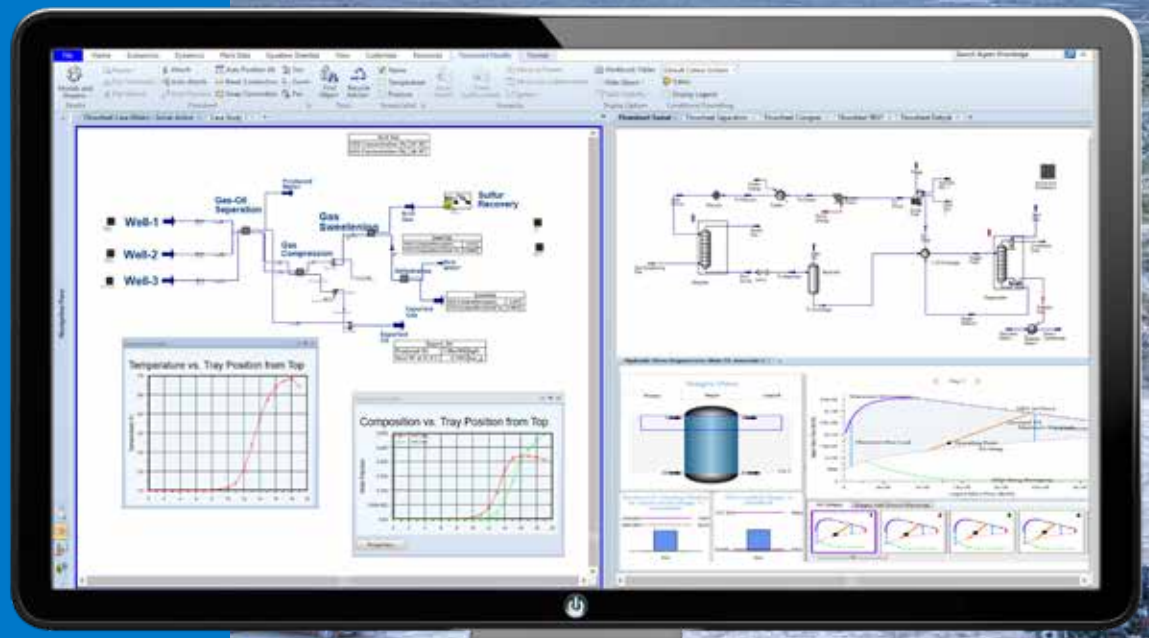


Figure 6. Flowsheet with various indicators, including composition/temperature vs tray position for a fractionation column.

Gain Critical Insights into Operations to Streamline Decision-Making

Operations monitoring is another critical functional area where digital twin solutions can be of significant help, enabling operators to respond quickly to changing conditions such as varying composition, slugging and hydrate or wax formation. Equally important is the ability to help operators continually monitor their emissions and take appropriate action to ensure they remain within limits.

ADNOC—MIDDLE EAST

Customer Success: Leverage Deeper Insights to Increase Energy Efficiency with Digital Twins

The Middle Eastern oil and gas company ADNOC was looking to improve overall performance and efficiency in one of its largest gas fields in Abu Dhabi. ADNOC deployed multiple digital twins to gain insights into its production facility and energy management system. The digital twins allowed operators to track, identify and troubleshoot production, equipment performance and utility systems. ADNOC deployed 80+ sustainability dashboards using digital twin solutions. These dashboards have provided them with role-based insights and streamlined the company's decision-making, from wellhead operators to the executive level. The enhanced visibility enabled ADNOC to reduce its hydrocarbon loss and energy use by nearly 10%.

Optimize Plant Design to Meet Increased Production Rates

Reconfiguration of existing processing facilities is inevitable in the long run for many upstream assets, as the yield and characteristics of production streams change with the aging of wells, or with the addition of new wells. Process simulation-based digital twins of the processing facility are crucial in determining a reconfigured design of the facility that ensures safe and sustainable operation, while minimizing CAPEX and maximizing operational efficiency.

CHINA PETROLEUM ENGINEERING

Customer Success: Increase Oil Production by 400K BOE/D by Developing an Existing Onshore Field

China Petroleum Engineering is a subsidiary and the technical support center of the oil and gas facilities of China National Petroleum Corporation, a major national oil and gas company in China. The center was helping an operator increase production of an existing onshore facility from 1.1 to 1.5 MBPD. The team concluded that achieving this goal would require adding a new production train to the central degassing station. When designing the new train, they wanted to avoid oversizing equipment such as slug catchers, and reduce the long start-up time they had experienced in the existing field. The team built a single dynamic process simulation model of the asset, covering everything from the upstream boundaries of the well to the downstream boundaries of export gas lines. This included oil lines, water injection networks and the entire top-side process facilities. Using the simulation, they optimized the plant inlet configuration to maximize production, avoid overdesign of slug catchers and optimize the start-up procedure, reducing start-up time by 40% and saving $20M USD.

Drive Operational Excellence by Connecting Subsurface Intelligence and Surface Operations

Upstream companies today must achieve operational excellence by reducing emissions and utility demands, improving production at existing assets, and replacing and expanding reserves while exhibiting capital discipline. This requires optimization across the upstream value chain and further automation to reduce dependencies on scarce skilled resources. Digitalization is a strategic and necessary focus. AspenTech's end-to-end digital solution, spanning the subsurface to the well, to the gathering network to the processing infrastructure, uniquely provides the upstream operator with the ability to optimize production across the entire value chain.

When the subsurface and surface are considered one system that can be optimized, the benefits become significant. Subsurface engineering solutions can be leveraged to qualify opportunities for production enhancement, increase confidence in reserves estimation and producibility, and minimize risk associated with further exploration and production. A fieldwide simulation model of a producing field can reduce CO_2 emissions and energy use by 10–15%. A fully integrated model, tying reservoir engineering objectives to production, gathering and processing operations, can achieve an additional 5-10% increase in yield.

Citations

[1] Global Energy Perspective 2022, McKinsey, 2022, https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2022

About Aspen Technology

Aspen Technology, Inc. (NASDAQ: AZPN) 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 capital intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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