INDUSTRIAL CLOUD TRANSFORMS THE REFINERY OF THE FUTURE

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discuss how IIoT technologies optimise operations to improve efficiency and reliability.

Investments in the oil and gas industry have been cyclical for decades, with waves of booms and busts. Each downturn has severely affected investments in new developments or retrofitting operating assets. Historically, the industry has adapted and recovered quickly. As new technologies have emerged, the industry has progressively adopted them to improve efficiency and stabilise production while reducing emissions.

Currently, energy costs are high while availability is low. Industry sources predict the global demand for energy consumption will steadily increase. This scenario emphasises the need for innovative solutions to meet the rising demands for energy.

A paradigm shift

Even while investments drop, technologies continue to evolve. The adoption of these disruptive solutions that boost automation and offer remote control capabilities are becoming more common. Simultaneously, there is a renewed focus on hybrid solutions that combine hardware and software. This includes blending the strengths from traditional physics-based models with new data-driven techniques. The overarching goal is to improve automation and control, while enhancing overall safety and production. This is like the trend seen in other industries referred to as Industry 4.0, or digitalisation, or digital transformation.

In the oil and gas industry, digitalisation involves:

- Acceptance of cloud solutions.
- Cybersecurity improvements.
- Capability to support Industrial Internet of Things (IIoT) from the ground up.
- Interest in integrated solutions.
- The need to simplify work processes and improve productivity.

Forces behind digitalisation

What is the key to deciphering vast troves of data? A fresh data-centric approach is needed to bridge the gap between identifying problems and creating solutions. Past experiences highlighted challenges in extracting value from large datasets in the field that technology could not overcome a few years ago.

Now, operators recognise that large datasets collected in the field can reveal

new paths to greater efficiency and safety while reducing greenhouse gas emissions. Furthermore, companies are moving toward digitalisation because they need to streamline work processes and increase productivity. The motivation behind this shift is fuelled by the capability to facilitate IIoT, since it enables real-time monitoring and optimisation. For example, obtaining insights on production behaviour enhances efficiency, as shown in Figure 1.

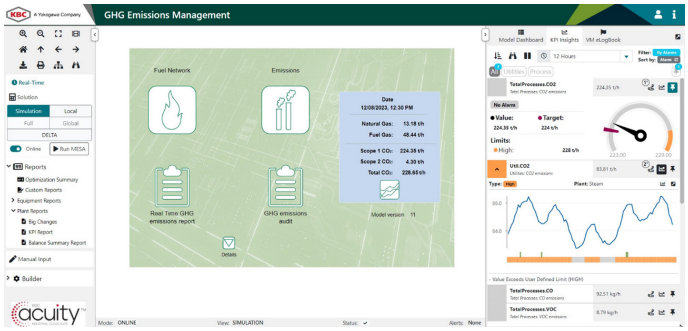

Figure 1. Advanced technology analyses datasets to uncover untapped opportunities.

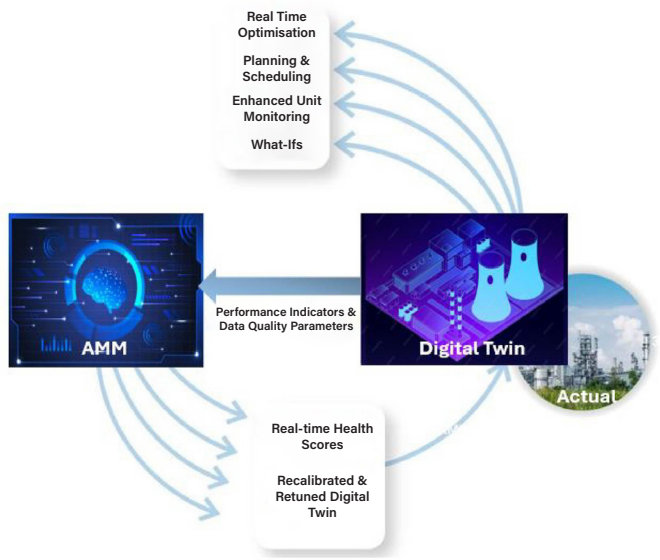

Figure 2. AMM unlocks true value of digital twins.

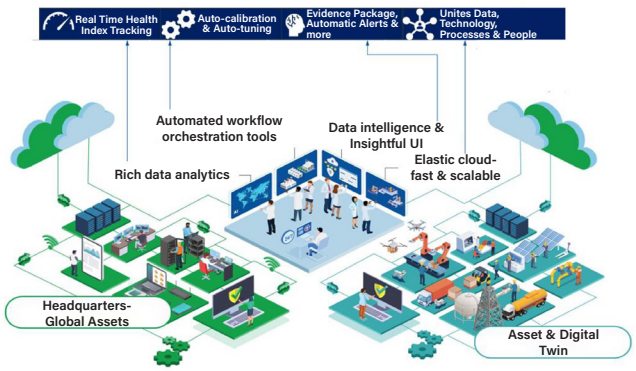

Figure 3. AMM for data-driven decision-making and operational effectiveness at enterprise level.

Digital twins

A 'digital twin' is a dynamic, virtual representation of a physical asset or system created using real-time data. This technology has already proven to have the potential to revolutionise the oil and gas industry, providing unparalleled insights into operations.

In the complexity of process engineering, digital twins serve as virtual replicas of physical assets such as fluidised catalytic cracking units (FCC), reformers (REF), hydrocrackers (HCR), and delayed coker (DC) units. Digital twins enable engineers to run intricate 'what-if' scenarios, conduct profitability analyses, and perform optimisation studies with accuracy and efficiency. By using simulation tools, engineers can mirror real-time operations, thereby enhancing their understanding of the system's behaviour under different conditions.

Digital twins are leveraged to establish an automated system that collects data and executes daily sets to run predictions. The automated system helps engineers continuously monitor the assets' performance in real-time and make timely adjustments to optimise operations.

Digital twins help track model performance by comparing measured results from the plant against predicted outcomes. This comparison provides valuable insights into the accuracy of these models and helps identify potential areas for improvement.

Managing on-premise complexities

One of the use cases derived from customer feedback and surveys is the continuous struggle of maintaining the digital twins for zero value leakage.

Continuously tracking a model's health requires a more rigorous system, given the need to manually analyse multiple datasets and KPIs. The goal is to ascertain whether the issue pertains to the model or data.

Maintaining the models' digital twins and ensuring their accuracy for a large number of assets is a time and labour-intensive task. This task becomes even more daunting when factoring in the need for domain expertise to handle growing complexities within a unit. On the other hand, a lack of a single version of truth across business units or using dated models can negatively influence economic decisions, as different models of the same asset may not accurately reflect the current situation or potential future scenarios. This can lead to a disparity between planned outcomes and actual results. Such disparities can not only create internal confusion and miscommunication, but can also undermine strategic decision-making processes, ultimately impacting the overall performance and profitability of the organisation.

Overcoming this situation requires not only rigorous systems and processes but also the right mix of domain expertise and technological capabilities.

Integrated solutions

The acceptance of cloud solutions across various industries is fuelled by their greater flexibility, scalability, ease of deployment and maintenance, and increasing emphasis on cybersecurity. Like digitalisation, a significant driver for adopting cloud solutions is the ability to support the IIoT from the ground up. This growing interest extends to integrated solutions, including Data as a Service (DaaS),

Software as a Service (SaaS) and Solutions as a Service (SolaaS), as well as the incorporation of artificial intelligence (AI) and machine learning (ML).

So, what role do cloud solutions play in simplifying work processes, as well as boosting productivity for businesses working toward reducing emissions while maximising production and minimising operating costs? Ultimately, the adoption of new tools and technologies plays a crucial role in predicting failures and anomalies.

Cloud platforms facilitate ways to bridge the gap between data collection, transformation, and derive meaningful insights. An important element to achieve the company's mission involves creating synergies among different personas and consolidating them via a single pane of glass. Now, data or interfaces from several different sources can be unified and presented in a single view.

This paves the way for democratisation of modelling and analytics, previously confined to specialists. New terms such as 'enterprise platform' take on a new and deeper meaning in this context.

Automated model maintenance (AMM)

An automated model maintenance (AMM) application is a SaaS designed to enhance the user experience via automating the workflows, as shown in Figure 2. Built on top of digital twin, the AMM web application consistently measures the health of a digital twin and recalibrates and/or retunes the digital twin of the process unit with a few clicks. Subscribers can monitor either one asset or multiple assets across various refinery sites and integrate the data and model performance analysis for each asset from one centralised location. This application delivers rich data modelling capabilities, offering users a platform to leverage advanced analytics to unlock powerful and meaningful insights about the data and the model. An updated digital twin when utilised in real-time optimisation, planning and scheduling, enhanced unit monitoring and 'what-if' scenarios aid decision-making and strategic thinking in process units.

The value achieved from using the AMM application helps reduce the time spent on monitoring the digital twin, as well as calibrating and tuning it when it deviates from actual operating responses. Moreover, with the models consistently maintained and updated, it is expected that the digital twin will produce more accurate results that can be leveraged to find missed opportunities. This can potentially lead to a significant potential for increased profitability.

Digital transformation at enterprise level

The emergence of advanced technologies is revolutionising how asset managers operate and track the health of their assets, resulting in a surge of rich data ready for analysis. Cloud infrastructure not only provides a scalable solution for data storage, but also facilitates big data analytics and intelligence that unites data, technology, processes, and people.

The flexibility offered via cloud infrastructure is instrumental in fostering industrial autonomy via auto-calibration and auto-tuning, thereby supporting business growth, enhancing decision making agility and bolstering operational effectiveness to drive more value. Moreover, AI/ML techniques expedite data analysis and data-driven recommendations. When applied with first-principles models and engineering expertise, these techniques help ensure that the system supports efficient decision-making and operational effectiveness, as summarised in Figure 3.

Companies are keenly aware of the need to invest in digital infrastructure and skills but are often restricted by budget or resources. Transitioning to a fully digital environment is complex; it requires robust security measures, data recovery strategies, strict compliance protocols, and effective environment management techniques.

Companies understand the value of data but express reservations about data management and utilisation practices. Transforming raw data into actionable insights requires significant time and effort. Along with digitalisation, change management strategies are required at the enterprise level to simplify software and technology via improved integration for adoption and scalability. The cloud-based services need to ensure that the user experiences a seamless transition from on-premise tools to cloud applications, particularly when transitioning from legacy tools. Moreover, first principles models are laying a solid foundation for automation. These models aid in analysis that can foster trust and facilitate effective decision making.

Overall, the effectiveness of the system ensures that current opportunities are fully exploited, and no promising opportunities are missed. It helps maintain the engineers' focus on designated targets, while scanning for attractive opportunities that may demand their attention.

Conclusion

Identification, integration, and implementation of technologies can provide the scalable and agile approach needed to improve the operators' ability to monitor and optimise assets. Transitioning simulation software to a fully cloud-enabled state makes it accessible via APIs. These solutions can then be easily deployed through an integrated SaaS platform. This scenario opens opportunities for seamless integration with data management, contextualisation, and visualisation technologies.

Leveraging a light and pervasive infrastructure, refiners are equipped to define and execute their digitalisation roadmap. By incorporating purpose-oriented and integrable modules, operators have access to a suite of practical tools that seamlessly integrate with existing systems. This malleable solution emphasises flexibility and cost-effectiveness that avoids the need for an all-encompassing commercial platform.

Looking ahead, the roadmap for digital solutions continues to evolve. Development plans include deploying additional analytics and capabilities tailored to detect production anomalies, leak detection, trend analysis, and optimising operation. As the scope expands, production, processes, energy availability, and greenhouse gas emissions will be managed and optimised across the facilities. The overarching philosophy remains grounded in full openness, with standard architectural solutions and APIs, to ensure integrability and ease of deployment. This commitment is designed to help operators achieve their goals of improved efficiency, reduced carbon footprint and enhanced control and automation.