ARTIFICIAL LIFT ON THE EDGE

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Abstract:
Artificial lift systems in the oil and gas industry have long relied on Supervisory Control and Data Acquisition (SCADA) technology for monitoring and control. However, as the digital landscape continues to evolve, artificial lift systems must adapt to more dynamic and autonomous operations. In particular, leveraging cloud-native edge computing, microservices, and the Industrial Internet of Things (IIoT) offers the potential to enhance the real-time responsiveness and optimization of artificial lift systems. This paper discusses the transition from traditional SCADA systems to edge computing-driven architectures in artificial lift applications, highlighting the capabilities, challenges, and future potential of this technological shift.

Introduction:
Artificial lift methods such as rod pumps, electric submersible pumps (ESPs), plunger lifts, gas lifts, gas-assisted plunger lifts, and plunger-assisted gas lifts are widely used to enhance production from both conventional and unconventional wells in the oil and gas sector. Traditionally, these systems are integrated with SCADA platforms, enabling remote monitoring and control of well operations. However, as oil and gas production increasingly involves complex, dynamic well conditions, there is a growing need for more responsive and adaptive control systems. The concept of "Artificial Lift on the Edge" utilizes edge computing devices to acquire real-time data, process it locally, and implement automated adjustments. These systems, empowered by machine learning algorithms and microservices, offer the potential for real-time, autonomous optimization of artificial lift operations.

Part One: Traditional SCADA Architecture vs. New Edge Computing Architecture
Traditional SCADA systems rely on polling methods to acquire data. In these systems, remote telemetry units (RTUs) periodically request data from surface controllers or downhole sensors, with polling intervals ranging from minutes to hours. While this architecture allows for basic monitoring, it is limited by inherent latency and the lack of real-time decision-making capabilities. Moreover, updates or changes to the system often require significant downtime, and scalability is constrained by the monolithic nature of traditional SCADA systems.
In contrast, modern edge computing architectures are designed to operate asynchronously, enabling immediate execution of commands without waiting for other processes to complete. This reduction in latency translates to faster response times, enabling real-time adjustments to artificial lift systems. Additionally, edge computing, when integrated with microservices, offers significant scalability benefits, allowing for seamless expansion of operational capacity without requiring costly infrastructure overhauls. Unlike traditional systems, edge computing platforms also support continuous updates and modifications without service interruption, providing operators with real-time data visibility down to the second.

Part Two: Capabilities of Edge Computing in Artificial Lift Operations

Edge computing, coupled with IIoT cloud-based platforms, offers a range of benefits for artificial lift systems, including autonomous optimization, extended equipment lifespan, and reduced service requirements. By processing data locally at the wellhead, edge devices minimize latency and the volume of data that needs to be transmitted to the cloud, improving efficiency and reducing operational costs.

One of the key advantages of edge computing is its ability to make real-time decisions without relying on cloud-based analysis. With the "on-change" protocol, edge devices only transmit data when changes occur, significantly reducing bandwidth requirements. Additionally, edge devices can store data locally and backfill any gaps in communication if connectivity is lost, ensuring continuous monitoring and control.

The true potential of edge computing lies in its ability to execute complex control algorithms that autonomously optimize artificial lift operations. By implementing closed-loop control systems, edge devices can continuously monitor and adjust parameters, such as pump speeds, gas lock modes, and motor current, without human intervention. This capability becomes particularly valuable when managing large fleets of artificial lift assets, where human oversight becomes increasingly impractical.

Part Three: Case Study – Implementing Edge Computing for ESP Optimization

In a recent deployment in the Midland Basin, fifteen electric submersible pumps (ESPs) were equipped with edge computing devices as part of a closed-loop optimization system known as *Thermocool*. ESPs, which are highly sensitive to operational conditions, often require frequent manual adjustments to optimize performance. With edge computing, these adjustments—such as fluid level drawdown, gas lock mode, and motor current control—can now be made autonomously, based on real-time data.

The *Thermocool* system incorporates a custom algorithm that monitors live streaming data from the ESPs and autonomously adjusts setpoints to prevent motor overheating and equipment failure. This algorithm was remotely updated directly to the edge devices and demonstrated significant operational benefits. In its first four weeks of deployment, the system prevented approximately 24 hours of downtime, saving the operator an estimated 200 barrels of oil and 300 MCF of gas.

Conclusion:

The transition from traditional SCADA systems to edge computing-driven artificial lift operations marks a significant advancement in oil and gas production technology. As industries across the globe embrace digital transformation, the integration of edge devices into artificial lift systems will become increasingly commonplace. The ability to autonomously optimize well performance in real-time not only improves operational efficiency but also reduces downtime, enhances safety, and drives profitability. Edge computing is no longer a futuristic concept but a practical and essential step toward the future of oil and gas operations. In the coming years, it is expected that edge devices will be standard on both new and existing wells, representing the next logical evolution in artificial lift technology.