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Artificial Intelligence–Driven Predictive Maintenance for Liquefied Natural Gas Dehydration Systems Using Seeq Analytics

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This paper presents a predictive maintenance framework for molecular sieve bed dehydration systems in LNG facilities, leveraging machine learning and advanced analytics via the Seeq platform. The methodology targets early detection of failure indicators such as premature moisture breakthrough, abnormal pressure drops, valve (KV) actuation faults, and sensor degradation.

Key operational parameters, including inlet/outlet moisture content, temperature profiles across the adsorption beds, pressure differentials, valve actuation states, and regeneration cycle durations were acquired and contextualized using Seeq Workbench. Feature engineering was performed to derive diagnostic indicators such as moving averages, dynamic pressure gradients, valve switching frequency, and signal stability metrics. Historical anomaly events, including valve sticking, moisture breakthrough, and sensor drift, were labeled and utilized to train a supervised machine learning model (Random Forest) using Python. The trained model was subsequently integrated into Seeq to process live data streams and issue predictive alerts for emerging process deviations and equipment malfunctions.

The model effectively predicted breakthrough events, valve actuation anomalies, and identified sensor degradation trends. Valve performance was assessed through actuation time analysis and switching behavior, while sensor reliability was monitored via noise and drift patterns. Intelligent analytics were incorporated into Seeq's live dashboards, enabling proactive response and data-driven maintenance decisions. The incorporation of AI-derived anomaly scores into Seeq's visualization and alerting platform empowered operators to initiate corrective measures before functional failures occurred. This predictive framework improved maintenance planning, increased asset reliability, and minimized unplanned downtime.

Beyond monitoring bed performance, the framework extends fault detection to critical auxiliary components, establishing a scalable and intelligent maintenance strategy. By identifying subtle degradation trends before functional failures occur, this approach shifts plant maintenance from reactive to predictive, improving safety, reliability, and operational efficiency.

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