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Customer Success Story

PREDICTING ESP FAILURES WITH VARIABLE DATA QUALITY

PROBLEM

A major oil and gas company wanted to predict electric submersible pump (ESP) failures but was challenged by sporadic sensor data.

SOLUTION

Unsupervised machine learning approaches—normal behavior modeling (NBM) and clustering—were determined to be the best way to predict failures using the data available.

RESULTS

The two approaches would have saved the company an estimated 45 and 27 days of deferred production time, respectively.

PROBLEM: INSUFFICIENT DATA FOR ESP FAILURES

Electric submersible pumps (ESP) are critical assets that are expensive to purchase, operate, and maintain. The average pump is worth roughly $100-$150K, and a rig pull for maintenance may cost $300-$400K even before factoring in deferred production. This makes it crucial for oil and gas operators to find ways to predict issues with ESPs and take action before they fail.

One major oil and gas company was looking for a way to predict ESP failures but was struggling with poor data quantity and quality. Because ESP sensors are often thousands of feet underground, it is frequently not feasible to repair them. Additionally, the ESPs are typically in remote locations without a stable electrical power source, leading to sporadic power outages that can damage sensors and cause them to fail more quickly. Compounding these issues, the oil and gas company had been running out of memory space for sensor data and, therefore, had stopped recording data from many of its sensors.

All of these factors seemed to present an insurmountable barrier to implementing predictive analytics for the ESPs. Analytics and machine learning require large amounts of clean data, with minimal missing values, in order to produce good results. But by partnering with Avathon, an artificial intelligence (AI) solutions provider and expert in the AI space, the oil and gas company was able to avail itself of a wide range of possible approaches to AI-powered predictive maintenance, tailoring its implementation to the quality of data the company had available.

SOLUTION: TWO CUSTOM MACHINE LEARNING APPROACHES

This project aimed to construct machine learning models that could predict impending electrical or mechanical ESP failures in advance, thereby increasing asset life and helping maintain production standards. Using the data the company provided, two approaches were employed to determine the best way to address this problem.

Normal behavior modeling

Using a semi-supervised approach, normal behavior models (NBM) were trained to recognize normal, healthy operating conditions for each asset, using parameters provided by the oil and gas company's subject matter experts (SME), as well as patterns learned from historical data. The resulting model identified intake pressure, discharge pressure, intake temperature, motor temperature, current leakage, and wellhead pressure as the variables most predictive of abnormal behaviors. These variables were then used to identify periods of abnormal behavior that could lead to failure in the data.

Based on test data and the company's activity logs, the model successfully identified 5 out of 7 historical ESP failures 13 to 35 days in advance. This means the model could have saved 45 days of production from being lost to unscheduled downtime, or roughly $1.35M in deferred production.

However, because of the high number of electrical trips from the unstable power supply, the

NBM approach was difficult to scale across a large number of wells, as the frequent power outages made it difficult for the model to establish a history of normal behavior from data that all appeared abnormal. Therefore, Avathon took a second approach.

Clustering and classification

For this approach, power trip intervals were removed from the training data. Then wells were clustered based on reservoir zone to account for zonal differences. Then a supervised classification model was created to learn from failure types across all 400 wells, classifying each well's current state as failure or not based on its sensor data relative to other wells within its zone. The data most heavily used in the process included electrical sensors such as motor current, motor voltage, current leakage, and apparent power. Based on this model's average detection rate, it could have saved the company 27 days of deferred production due to unscheduled downtime.

RESULTS: PREDICTIVE ANALYTICS FOR ANY OPERATION

Identifying ESP failures in advance allows companies to decrease well downtime, reduce the need for costly maintenance, and increase overall production. By working with an experienced AI partner, the oil and gas company SMEs were able to iterate through tailor-made models until they found an approach that worked for them, despite their lack of complete data.

ABOUT AVATHON

Avathon, a leader in Industrial AI, extends the life of critical infrastructure while advancing the journey toward full autonomy. Avathon's Industrial AI platform empowers commercial and government customers with scalable, secure, and value-driven solutions that enhance efficiency and resilience across heavy industry.

To learn more about how Avathon's AI solutions can unlock the power in your data, visit www.avathon.com.

FIGURE 1

In this example visualization, individual wells (represented by dots) are first clustered by reservoir zone. The model then classifies each well's current state as failure or not based on its sensor data relative to other wells within its zone.