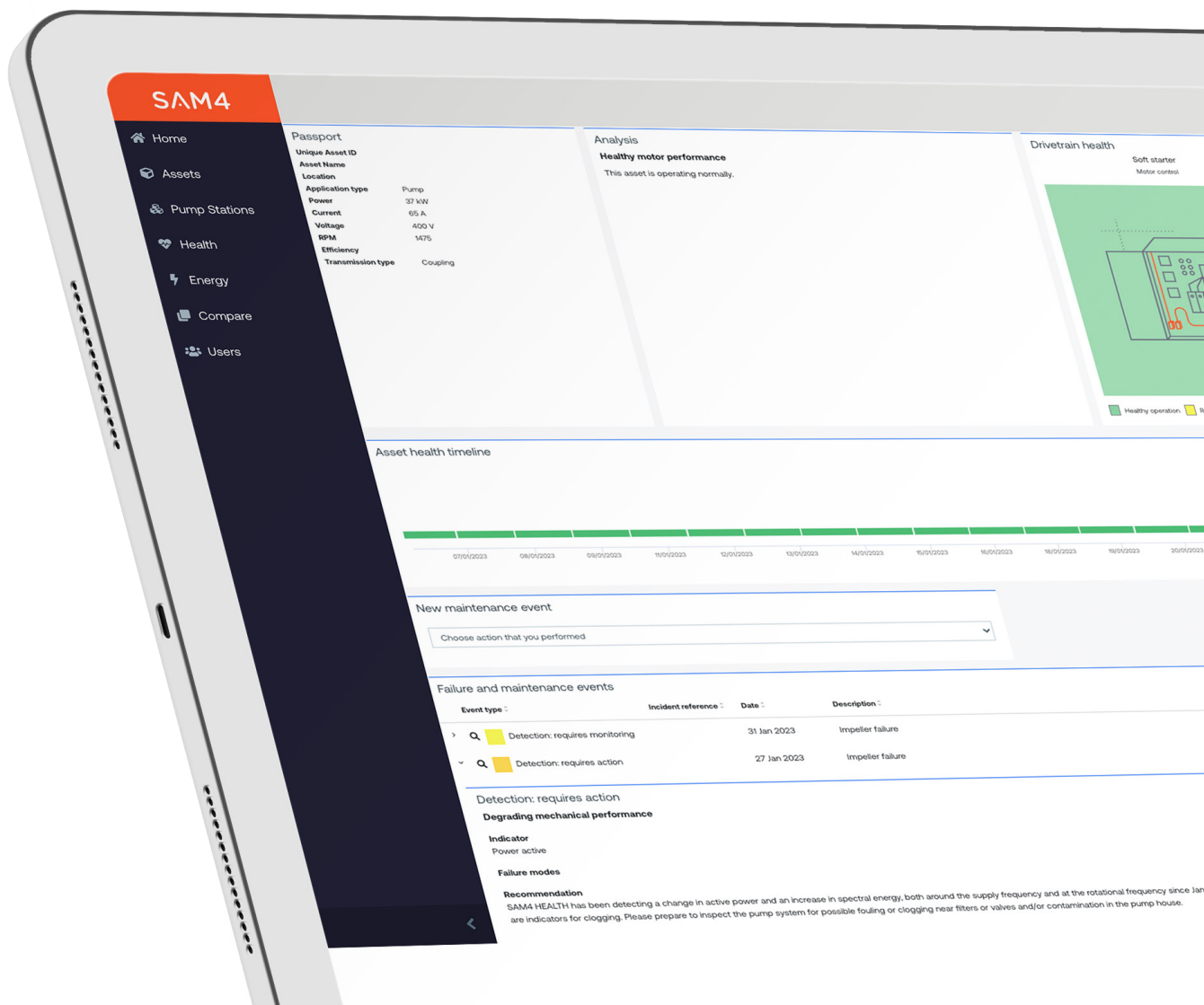**Samotics**

SAM4 automated clogging detection feature

Learn how advanced analytics can help water companies detect pump clogging remotely, preventing pollution events and leading to optimized maintenance planning

Automated, remote clogging detection to transform wastewater maintenance

Resolving and preventing sewage pump blockages is a significant operational challenge for wastewater companies. Currently, thousands of visits are taken every year to preventively inspect and reactively unclog these pumps. Our customers told us that a way to reliably track pump clogging from afar would transform their maintenance strategies. We were already monitoring their pumps remotely with SAM4 Health; could we build additional analytics specifically to spot clogs? We could, and with our customers' gracious sharing of their data and experience, we did.

Since the feature's launch, we've provided early warning on hundreds of clogging events, and our customers are now able to start making the operational changes they envisioned. As they do, we continue to mature our clogging detection feature to match their evolving needs.

In this document, we explain how SAM4 Health's clogging detection works, then show the feature in action using a real detection from September 2022.
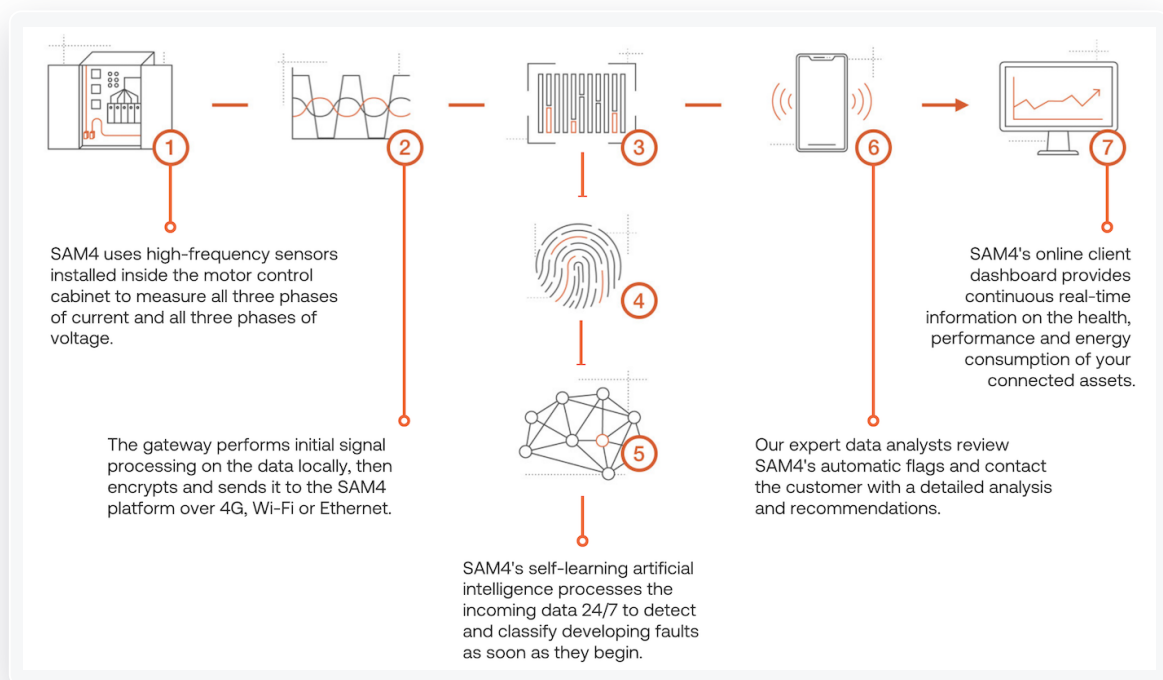

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About SAM4 Health

SAM4 Health is part of our SAM4 industrial analytics platform based on electrical signature analysis (ESA). ESA is a suite of analytical tools developed in the 1980s specifically to monitor the health and performance of critical equipment from a distance. SAM4 brings the technique into the 21st century through the use of wireless sensors and artificial intelligence. Noninvasive current and voltage sensors install in the motor control cabinet rather than on the machines themselves, where they capture high-frequency, high-resolution data around the clock. This vast amount of data is continually processed, transformed and analyzed on SAM4's AI platform to provide (among other things) early warning of asset health degradation — such as the start of a clogging event. (Read more about how ESA works in our ESA explainer.)

How SAM4 Health is able to detect the start of clogging

SAM4 Health uses machine learning to map subtle changes in current and voltage onto the specific type of degradation they represent. Both electrical and mechanical faults affect the current and voltage signals, and each fault has its own characteristic "signature." By developing AI models to track relevant features in the signal and training them with historical data, SAM4 Health can identify not only beginning degradation, but also the component that's degrading. SAM4 Health's clogging detection model tracks several features that, used together, reliably indicate the start of a clogging event.

1 SAM4 uses high-frequency sensors installed inside the motor control cabinet to measure all three phases of current and all three phases of voltage.

2 The gateway performs initial signal processing on the data locally, then encrypts and sends it to the SAM4 platform over 4G, Wi-Fi or Ethernet.

5 SAM4's self-learning artificial intelligence processes the incoming data 24/7 to detect and classify developing faults as soon as they begin.

6 Our expert data analysts review SAM4's automatic flags and contact the customer with a detailed analysis and recommendations.

7 SAM4's online client dashboard provides continuous real-time information on the health, performance and energy consumption of your connected assets.

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Inside SAM4 Health's clogging detection model

The data captured by SAM4's current and voltage sensors is first sent through a feature extraction phase, which uses basic signal processing to calculate metrics related to the mechanical and electrical health of both the pump and its motor. For example, one such feature might isolate the component of the data coming in around the supply frequency, while another focuses on frequencies related to the motor's rotational speed. Each of SAM4 Health's fault detection models uses one or more of these features, depending on the fault the model is designed to detect. These detection models are where the machine learning (or "artificial intelligence") takes place.

When a new pump is first connected to SAM4 Health, the initial data coming in train SAM4's detection models on what normal behavior looks like for that pump. For the clogging model, this means "this is what the relevant features look like when no clog is present." Once the model has been trained, deviations from the model's predictions will cause SAM4 to generate an alert.

Because the clogging model uses multiple features, it can not only detect a developing clog, but also distinguish where it's occurring. For example, a rise in the noise floor around the pump's supply frequency plus a drop in load indicates a problem in the suction line. A change in two other features points to a clog between the impeller and the motor, while simultaneous changes to other features indicate a clog in the volute. SAM4's clogging model integrates all the incoming information to determine when a clog is present and where.

Figure 1   A developing suction line clog produces characteristic effects in two features: a drop in load, and a rise in noise floor.

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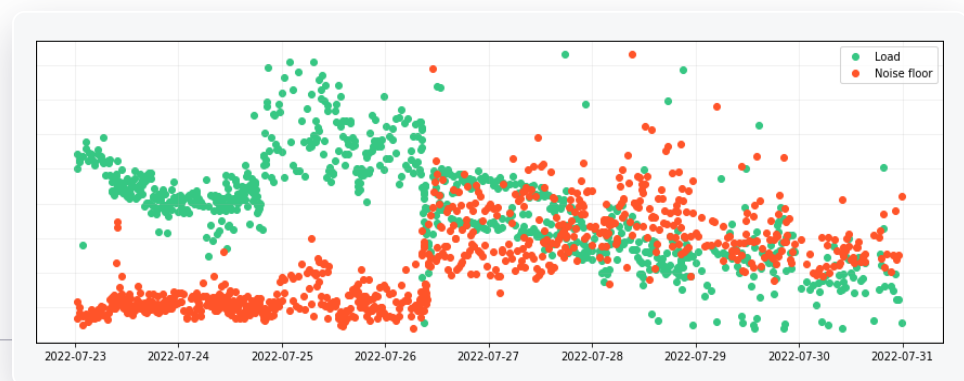
Once the AI model flags a developing clog, SAM4 Health then looks at the status of the whole pumping station to determine when and what severity it should report to the customer. If the clogging pump is one of three, for example, and the other two are operating normally, SAM4 will generate a low-priority notification. If, however, another pump at that station starts showing signs of trouble, SAM4 will send a high-priority alert. This automates the mental work of prioritizing notifications so the customer can directly plan the most efficient, effective response.

Figure 2

SAM4 Health takes the whole pumping station into account to determine the timing and severity of its notifications. (SAM4 Energy, also seen here, provides its recommendations for the whole station as well.)
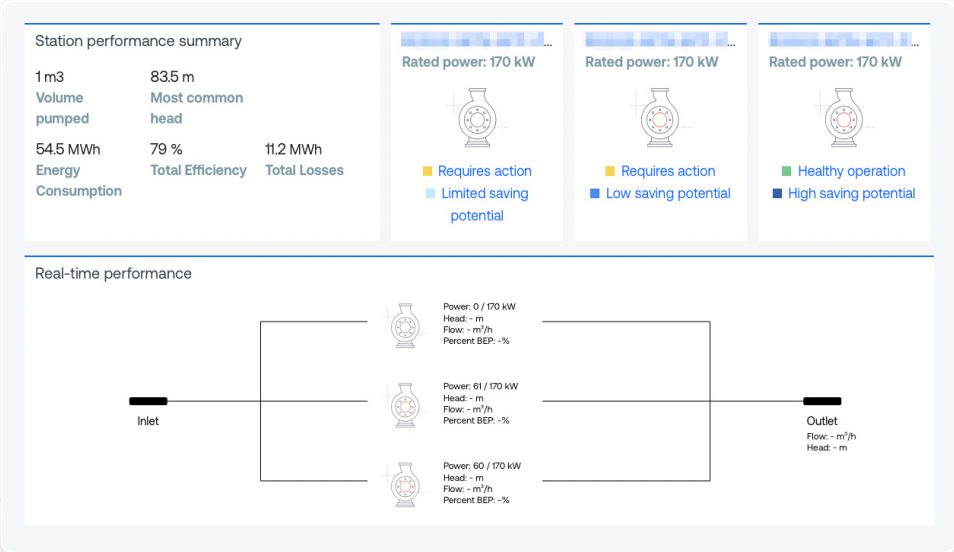
Note that clogging is only one kind of trouble the second pump could start showing — all of SAM4 Health's other detection models are also continuously running, simultaneously tracking other electrical and mechanical faults such as voltage imbalance, impeller damage and misalignment. Catching all these issues early not only reduces total maintenance cost and environmental impact, but also extends machine lifetime and raises efficiency for the long term.
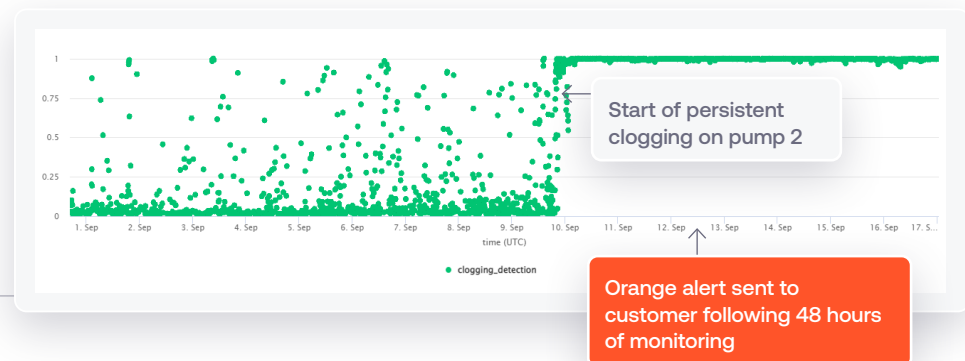
Early alert on clogging incident developing across two pumps

At a sewage pumping station two co-located pumps operate in an alternating pattern to meet required demand and provide system redundancy. One night one of the pumps (pump 2) displayed characteristics of clogging. This could be seen in Figure 3 below where the clogging scores remained continuously high following the start of the incident.

Figure 3

From the generated data, you can clearly see the start of a clogging incident during the night of 9-10 September 2022. Hereafter, the clogging score remained at the highest level of clogging indication (around 1.0) until a maintenance crew cleared the blockage on 20 September.

Start of persistent clogging on pump 2

Orange alert sent to customer following 48 hours of monitoring

With one other working pump at the station, this did not create an emergency response situation at the time. Monitoring of the situation continued for 48 hours to observe if the blockage would clear itself in this timeframe or alternatively generate advice as to when a site visit would be necessary. With no improvement seen at the end of this monitoring period, an orange alert was generated and sent to the customer indicating a clogging incident at the pump. The alert stated that same-day action was not required and that the situation could be resolved in the following week without impacting pump station operations.

Approximately one week later, data also indicated signs of developing clogging on the other pump at the station (pump 1). With two clogged pumps this did create an emergency response situation due to an increased risk of a pollution event. As a result, a red alert notification was sent to the customer.

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A maintenance team was immediately sent to the site and lifted both pumps out of the pumping station. They found that both pumps were indeed partially blocked confirming the detections by SAM4 Health and its clogging feature. After the blockages were cleared and the pumps were put back in operation, the clogging scores and other supporting metrics returned to healthy operating levels. This can be seen in Figure 4 below.

Figure 4

You can clearly see the resolution of the clogging incident on 20 September 2022. Once the maintenance crew removed the blockages, the continuously high clogging scores on pump 2 and the signs of developing clogging on pump 1 dissipated, reverting to healthy clogging score levels.

The SAM4 Health automated clogging detection feature successfully pinpointed the developing issues. It provided continuous insight into the severity of the situation and alerted to when action needed to be taken. **This enabled the customer to optimize maintenance planning and prevent a potential pollution event from occurring.**

Next steps

CONTACT US

If you'd like to explore how SAM4 Health could help you transform your maintenance strategy, please reach out! We'd be happy to show you around the system and discuss your specific needs in a no-obligation conversation at your convenience.

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Business Development Manager
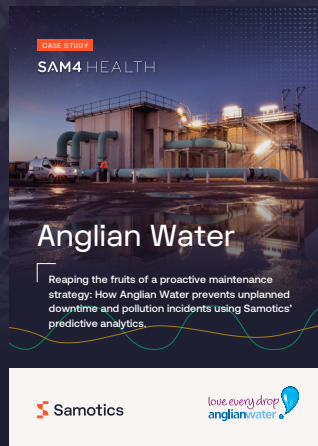rogierdegroot@samotics.com
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