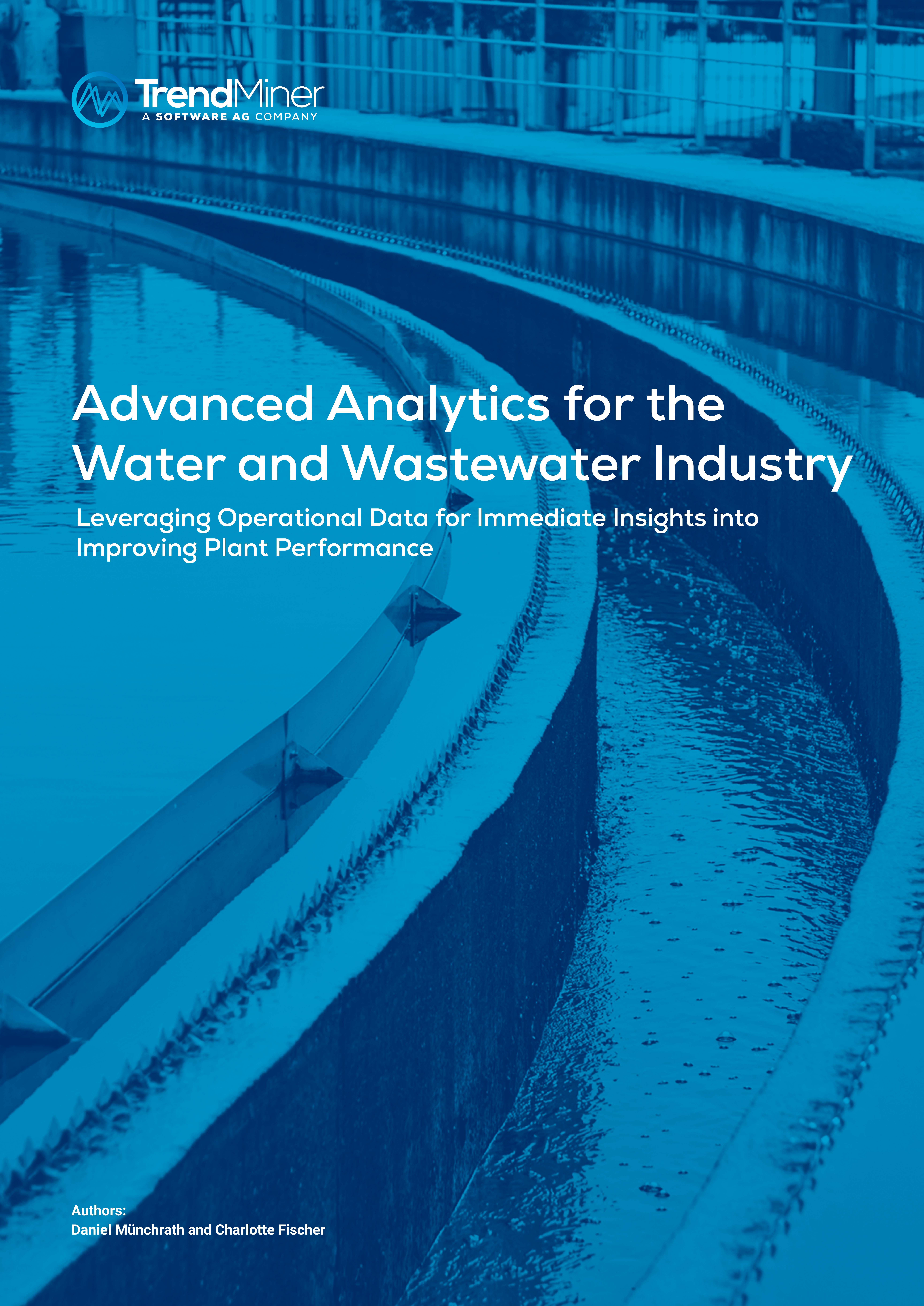

TrendMiner
A SOFTWARE AG COMPANY

Advanced Analytics for the Water and Wastewater Industry

Leveraging Operational Data for Immediate Insights into Improving Plant Performance

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Contents

Introduction

ADDRESSING WATER & WASTEWATER CHALLENGES

Clean water is one of the most essential requirements for human health, environmental sustainability, and economic development. As societies become more urban and the population continues to rise, industries that rely on water for manufacturing processes and Water & Wastewater treatment plants are integrating technologies to accommodate the increase in demand.

While many industries have adopted digitalization and Industry 4.0 to monitor and improve their processes, those that use water and wastewater as a process or in their processes have been slow to adapt. Today, process engineers are realizing the benefits of digitalization and growing their maturity models. They are learning that advanced data analytics can optimize processes, improve performance, reduce operational costs, and eliminate regulatory fines.

Securing clean water for the 21st century is a pressing challenge. Companies are making changes to ensure better water treatment management. Advancements include embracing the Industrial Internet of Things (IIoT), automation, and analyzing data they already collect.

Manufacturers that use water and the Water & Wastewater Industry also face stricter environmental quality standards. They include restrictions on water and energy use, and on how a plant treats wastewater. Global, national, and regional regulations focus on protecting the environment. Government leaders also know that monitoring effluents in water has become precise—down to the nanogram per liter—with the use of advanced analytics.

Fit for Processes

Providing clean drinking water is not the only industrial challenge. While Water & Wastewater treatment facilities and the corresponding infrastructure provide clean water for human consumption and the environment, other industries that use water in their processes face challenges of their own.

For example, the quality of water needs to be precise for certain process. Furthermore, regulations sometimes require reports of water discharge from plants to ensure compliance. Processes that use water also can be energy intensive when they are not optimized. And while recycling or reusing process water are trending options, the treatment requires a large facility and is best suited for areas that have a viable energy supply but a water shortage.

Industries that use water and wastewater are adapting to these challenges. Because they frequently require quick action and process expertise, water and wastewater management are prime candidates for a self-service data analytics solution.

Safe to Drink

The global population is about 7.65 billion people and growing. Providing clean drinking water for everyone is complicated and challenging. Societies also are changing their norms. More people are moving from rural areas to larger urban areas and cities. This population shift creates an extra demand for efficient water treatment processing.

Water and Wastewater process engineers are no strangers to challenges. They continuously address water scarcity and related environmental concerns. Long-term poor management of Water & Wastewater treatment facilities, water usage, and an aging water and sewerage infrastructure complicate sustainability goals. The industry has had little to work with to address these concerns.

Heavy precipitation also correlates with climate change, according to the EPA. As a result, flooding is on the rise. This can lead to problems in water quality, but also in wastewater backup. Process engineers in the Water & Wastewater Industry have an extra challenge to control different parameters when potentially unknown elements flow into a treatment plant because of heavy rain, snow, or flooding.

> "Urban areas are expected to absorb all of the world's population growth over the next four decades, as well as accommodating significant rural-to-urban migration. The vast majority of these people will be living in overcrowded slums with inadequate, often non-existent, water and sanitation services. Safe drinking water systems and adequate sanitation that effectively disposes of human waste will be essential to ensure cities and towns grow sustainably. Extending these services to the millions of urbanites currently unserved will play a key role in underpinning the health and security of cities, protecting economies and ecosystems and minimizing the risk of pandemics."
>
> **Water Facts**
> UN-Water website

In the United Nation report **Transforming our world: the 2030 Agenda for Sustainable Development**, the international organization adopted 17 goals to achieve by 2030. They include:

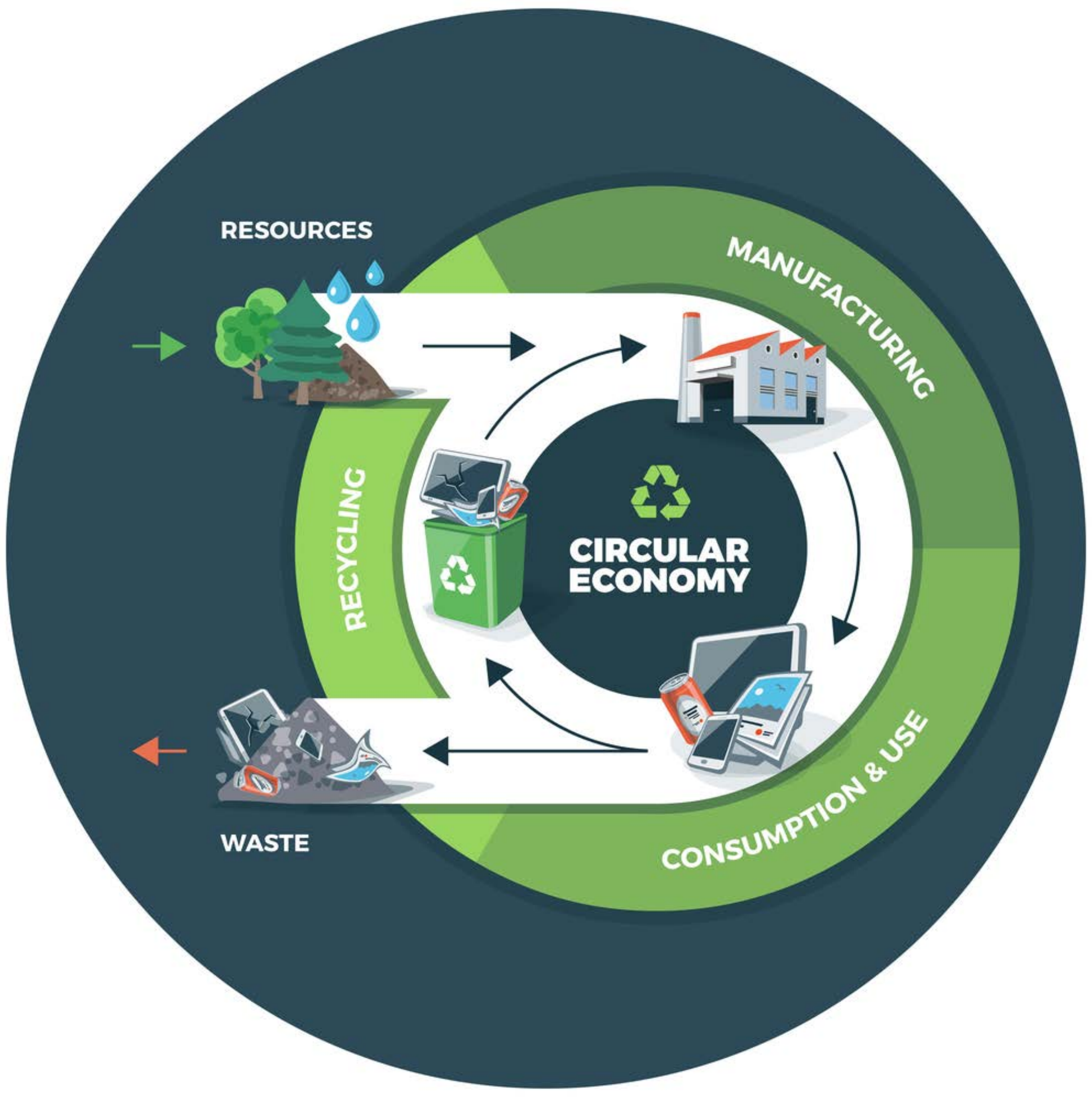
- Providing clean water and sanitation (Goal 6),
- Building a resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation (Goal 9),
- Making cities and human settlements inclusive, safe, resilient, and sustainable (Goal 11),
- Ensuring sustainable consumption and production patterns (Goal 12), and
- Taking urgent action to combat climate change and its effects.

REASONS TO ADAPT

Sustaining clean water and wastewater is not the only mission. Because water treatment is one of the most energy-consuming processes, it also has a high carbon footprint. High energy consumption, which is a result of extremely high water or wastewater volume flows through pumps, taxes power grids and can have greater environmental effect. According to a U.S. Environmental Protection Agency (EPA) study on Climate Impacts on Water Utilities.

To reduce energy costs and further prevent climate change, industry leaders can place captured data in the hands of water and wastewater treatment specialists. Process engineers can use self-service data solutions and other digitalization technologies to find trends in energy spikes. They can compare historical data and find areas of production that require optimization to reduce those spikes. This, in turn, can lead to less energy consumption.

Finally, recycling, reusing, or reducing industrial wastewater is another trend that falls under the term Circular Economy. Minimizing the amount of water used in a process also falls within this trend. In this context, the Circular Economy describes a regenerative system in which process engineers minimize energy and material cycles. These include resource use and waste production, emissions, and energy waste.



The Circular Economy describes a regenerative system in which process engineers minimize energy and material cycles. These include resource use and waste production, emissions, and energy waste.

Big Data Analytics for Water Experts

A CASE FOR PROCESS EXPERT DATA CONTROL

Industries have been capturing process time-series data and storing it within historians for years. This data can be leveraged for continuous process improvement and for optimizing operations. The problem? Interpreting the data is an issue itself.

Major companies already use some analytics for their larger on-site energy issues. Traditionally, this has required significant, time-consuming resources. Companies turned to centrally led data modeling for all processes. But this method is less suited for processes that require subject matter expertise.

Engineers often turn to data scientists to gain insight on their processes. There are some disadvantages to this approach, however. Not all data scientists are familiar specific process, or the captured data associated with them. Process experts find themselves using valuable time to explain the process to a data scientist so he or she can run the analysis. Another disadvantage to this approach is finding a data scientist because they are scarce.

Many water and wastewater treatment plants have fewer employees, including engineers, than other industrial plants. These employees often lack an understanding of data science. With fewer hands on deck, time becomes a precious commodity.

A BETTER APPROACH: USING SELF-SERVICE ADVANCED ANALYTICS

Self-service analytics empowers subject matter experts. It allows them to analyze time-series data themselves. This puts the power of data analytics in the hands of the people who know the processes best.

A self-service solution allows process experts to leverage a plant's data to analyze, predict, and monitor processes and other factors, such as energy consumption. With a self-service data analytics solution, process engineers use their knowledge and skill sets to advance their plants along their digitalization journey.

This is where TrendMiner can help.

TrendMiner comes with a high-speed search engine, pattern recognition technology, and advanced filter options. Process experts can use it to analyze captured data and provide fast and interactive insights into treatment processes and asset performance. If the process experts can access, search, and analyze the sensor generated data quickly, they can determine the root cause of an anomaly—such as a power spike—and make necessary adjustments efficiently and effectively.

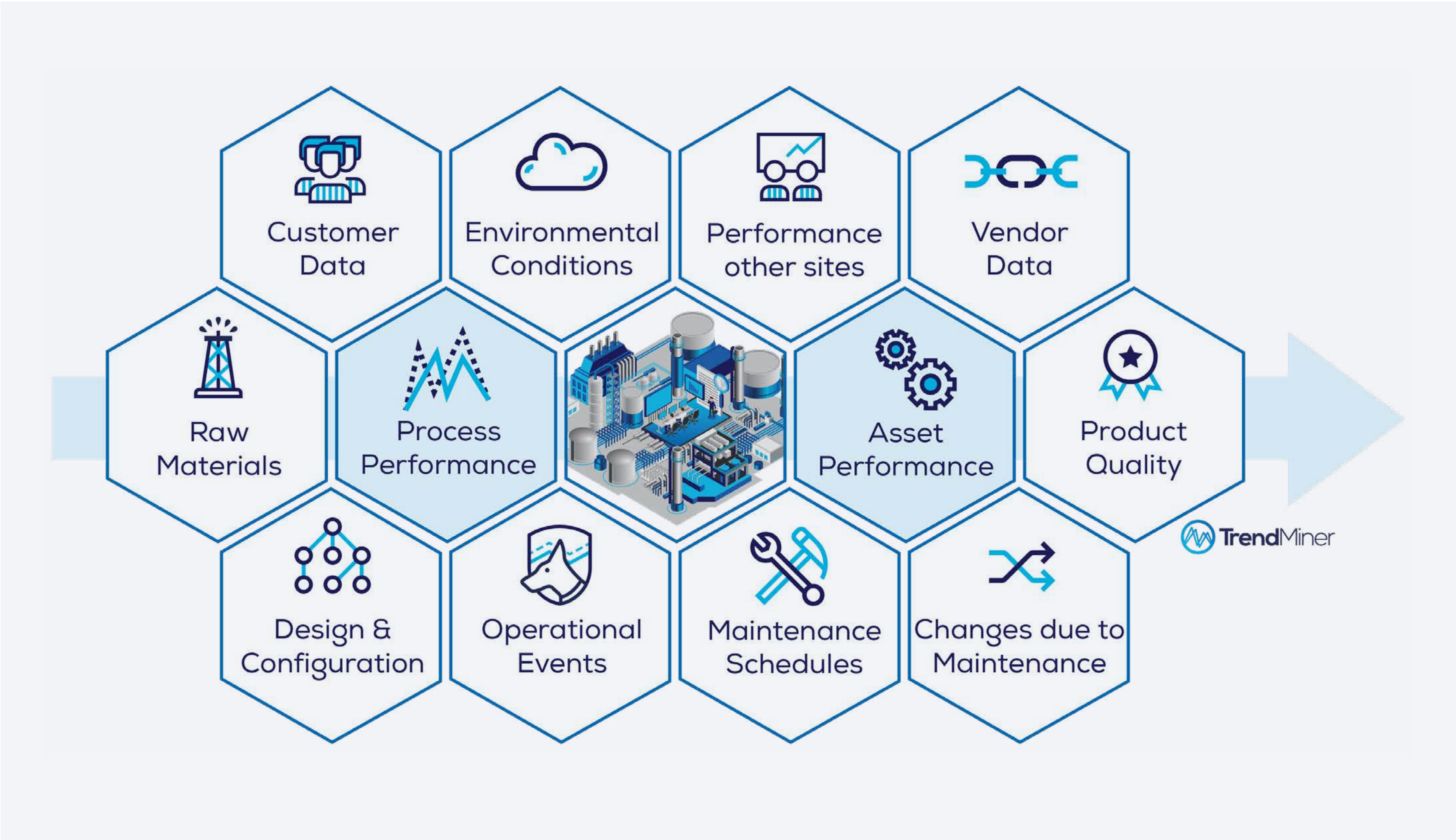
Here is a glimpse of what process experts can achieve with TrendMiner:

- Data visualization to view operational behavior and anomalies.
- Algorithm and pattern recognition to gain process behavior insights.
- Overlay trends for comparison to see how a process is changing over time.
- Solutions to compare time-series data and determine the root cause of an anomaly.
- Process monitors and alarms that can be set to alert personnel in time to take corrective action about potential deviations.
- Predictions about future process behavior based on past trends.
- A clearer understanding of operations throughout the entire company by incorporating process contextual information.

In short, self-service analytics provides proactive recommendations to the process experts so they can uncover previously hidden correlations and identify possible root causes of process issues. Using TrendMiner, process experts can calculate possible process trajectories and predict future evolutions of key variables. They also can use the solution to monitor degrading asset performance over time. The best part? Process experts without a data science background can use it easily to do their jobs better and faster.

With TrendMiner, engineers and subject matter experts can answer critical process questions, such as:

- How is our treatment process performing?
- What is the root cause of this issue?
- How often has this problem occurred?
- What is likely to happen next?
- How can we solve this and prevent it from happening again?
- Can we monitor deviations from good behavior?
- How are our pumps performing?
- What are the statuses of our pumps?
- How can we reduce energy consumption?
- Can we schedule maintenance better?



Contextual information can reside in various sources and can be used to better understand operational performances.

Moreover, process experts can important contextual information residing in various sources (maintenance data, operator logs, or third-party systems) to enrich the time-series data to understand operational performances better. This also eliminates data silos (Figure 1). Water and wastewater engineers can analyze processes separately to get deeper insights into them and other assets. Analytics-driven dashboards can be created with live data, so that each stakeholder can contribute to business outcomes.

These features also help process experts identify new areas for optimization. With direct access to analytics insights, actionable information becomes available at all levels of the plant. Companies can use this information to improve asset performance and reliability while actively participating in improvement projects. This, in turn, enhances the treatment process across all stages of production.

According to **ML Journal**, optimization projects do not necessarily require large capital investments. Those companies that already are collecting data and advancing their digitalization models by applying advanced analytics. The Manufacturing Leadership Council said:

> **"Regardless of the industry or use case, the common thread among these examples is that these projects don't require significant capital investment. Instead, positive impacts can be realized through better use of existing assets, specifically by analyzing existing data to create insights and perform actions."**

Industrial Water Treatment Opportunities – Practical Use Cases

Water is an integral part of most industrial processes. In some manufacturing industries–such as Food & Beverage and Pharmaceutical–it is used as a raw material. For other manufacturing industries–such as Oil & Gas and Chemicals–water is used within the production process Uses include acting as a cooling agent or providing an energy source after it is converted into steam. Plants also use water as a cleaning agent for reactors and other equipment, which becomes wastewater when the chore is complete. This wastewater must be treated before it is reused or discharged into the environment. Treatments, which can vary significantly depending on the type of water and pollutant, could include releasing the water into a sewerage system or cleaning it inside the plant. In some cases, a third-party service provider treats wastewater across an industrial site.

Industrial manufacturing is energy intensive and sensitive, as consumption and costs can mount quickly. Improving a process' energy efficiency is a top priority in all industries. Therefore, companies must manage industrial water, wastewater, and energy properly and carefully. Controlling these factors ensures asset reliability, adherence to energy and environmental regulations, and efficient and economic production processes.

Self-service data analytics is an ideal solution for these challenges. The following use cases demonstrate how industries can use TrendMiner to optimize water, wastewater, and energy.

Use Case 1

MONITORING A PLANT'S PUMP INFRASTRUCTURE

Pumps are an integral part of the Water & Wastewater Industry. They are used to move massive amounts of water. It is important to monitor the pumping system to ensure smooth plant operation. However, process experts can have difficulty observing multiple pumps for different purposes simultaneously.

Keeping pumps operational is necessary to ensure processes remain online. A breakdown of an important pump can lead to serious problems. Process experts must maintain them regularly to avoid an unplanned shutdown. Using existing methods, engineers cannot avoid all breakdowns because they do not have a way to monitor the pumps closely. Process and asset experts often do not have the required solutions or time to follow-up on every process simultaneously. Solving this common operational issue requires access to an easy, reproducible, and reliable approach to monitor the operation state of important assets.

At a European treatment facility, process experts used TrendMiner to monitor the plant's pump infrastructure. The engineers easily translated their process knowledge into monitoring criteria using the search functionalities of the software. They looked for potential problems in the normal operation of the pumps, for example, using vibrations in a pump as an indicator of a malfunction. Process experts then set alerts to notify operators and engineers of a problem in cases of high vibrations. TrendMiner then automatically wrote process contextual information about the asset. Finally, the engineers created a live dashboard to provide a clear view of every pump (Figure 2).

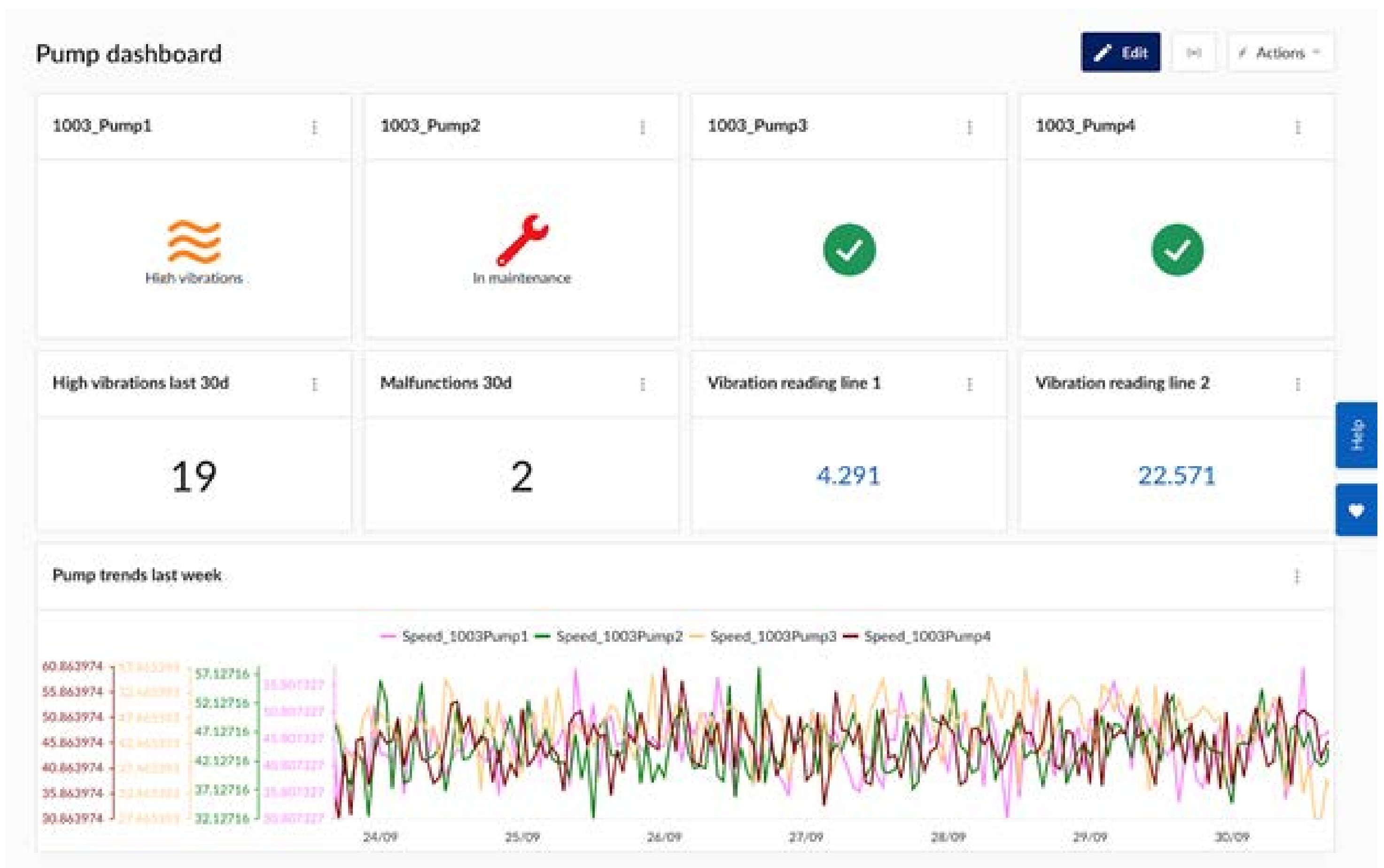


Figure 2. Dashboard for live monitoring of all plant pumps.

TrendMiner also created a Gantt chart for an overall view of all the pump runs in a defined timeframe. Process experts then knew which pumps were running, which pumps had malfunctioned, and the frequencies of pump problems (Figure 3).

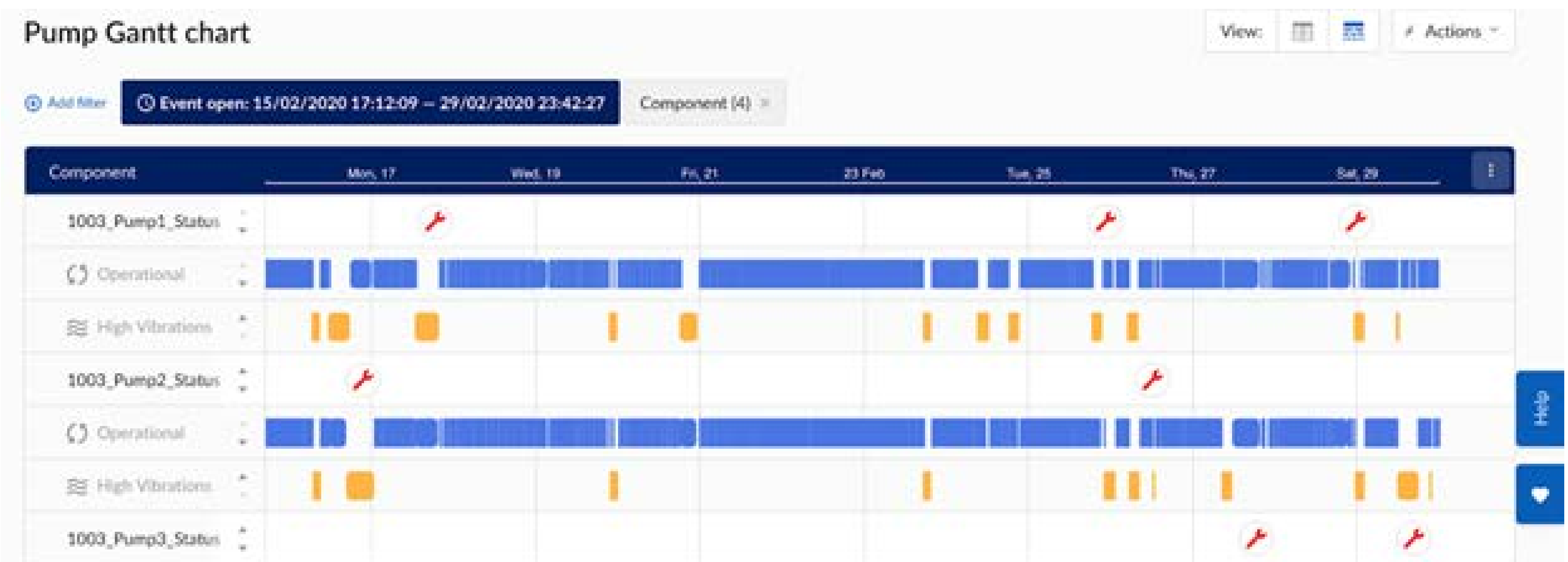


Figure 3. Pump Gantt Chart

Use Case 2: In Detail
DETECTING & REACTING TO PIPE NETWORK ANOMALIES

Challenge

Treated clean water leaving the plant the must comply with regulatory standards, such as in terms of concentrations of certain pollutants, or regarding a neutral pH value. In this case, in the context of pH neutralization, a steady supply of caustic soda and hydrochloric acid needs to be added to increase or decrease the pH level to the desired range (see Figure 4 for a schematic drawing of the process). The hydrochloric acid not only is used to help with downstream regulatory compliance, but also prevents possible damage to equipment. It is transported via a pump in different quantities into the pH neutralization unit. The amount is determined by the pH sensor at the end of the unit.

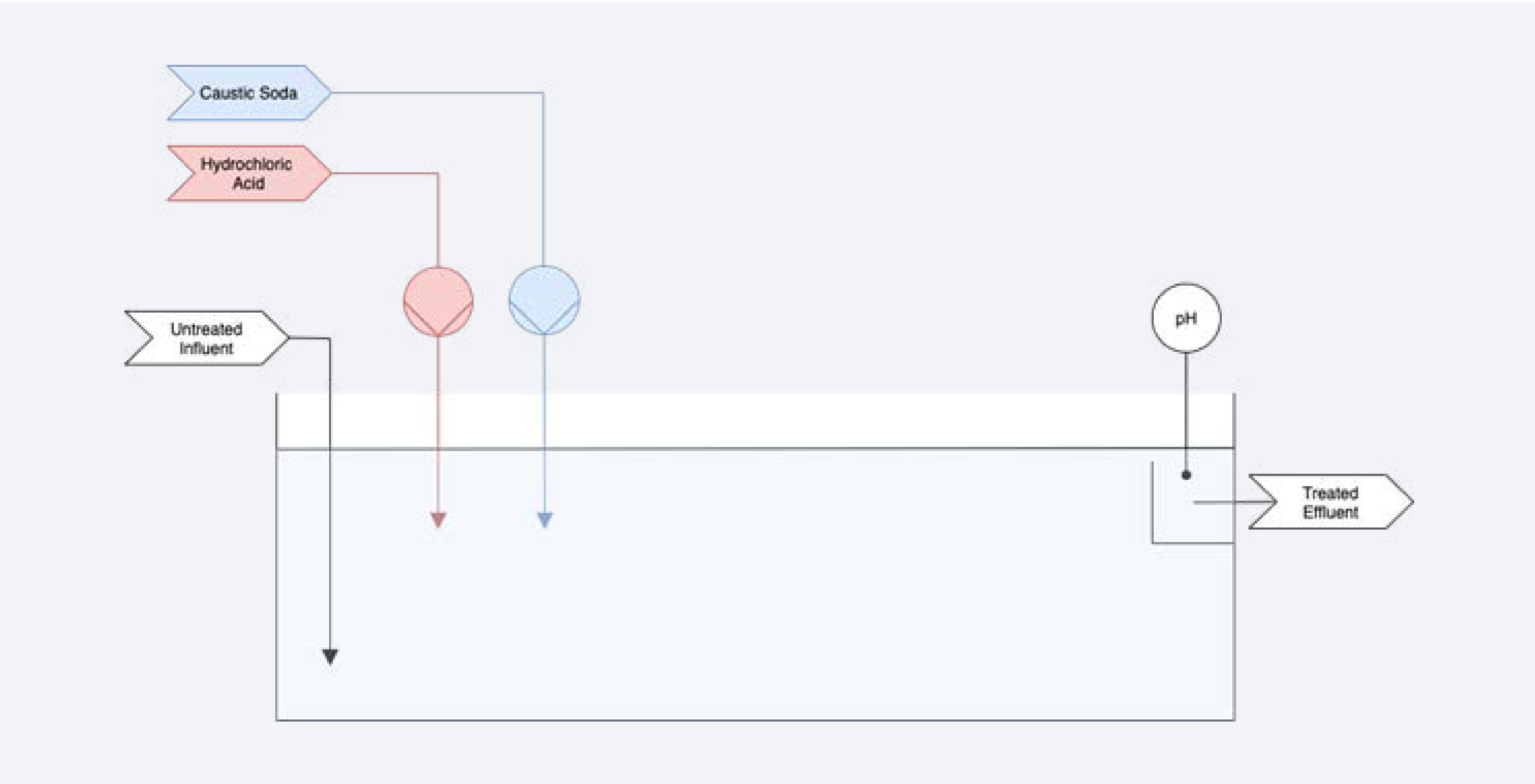


Figure 4. Schematic drawing of the continuous pH neutralization with caustic soda and hydrochloric acid.

In this case, the company had replaced the pipes for transporting hydrochloric acid during a maintenance and construction phase just prior to the visual analysis. After manually examining the deconstructed pipes, engineers determined that the pipes had been degrading for a long time. With TrendMiner, engineers can visualize anomalies from their process data before discovering such conditions during a design phase.

Solution

The company decided to move to the self-service analytics platform to determine the root cause of the degraded pipes and prevent the degradation from continuing. The first step was to evaluate the operation state of the hydrochloric acid pump. Pressure difference is a good indicator of a pump operation state, and therefore can be used as the basis for further analysis and monitoring.

Because the pressure difference had a lot of noise, process experts used an aggregation to smooth out the trend visualized in a new tag (red trend, following the yellow pressure difference, Figure 5). The other red tag in the figure displays the flow rate, which is roughly constant during operation. The pressure difference rises throughout its lifecycle until the next maintenance cycle, which can be seen as the flow rates suddenly drop and pressures change. By knowing this behavior, engineers can create a monitor to inform the process experts about pump statuses in time to take corrective action if necessary. When flow rates are not constant as in Figure 5, the analysis of the overall operation state becomes more complex.

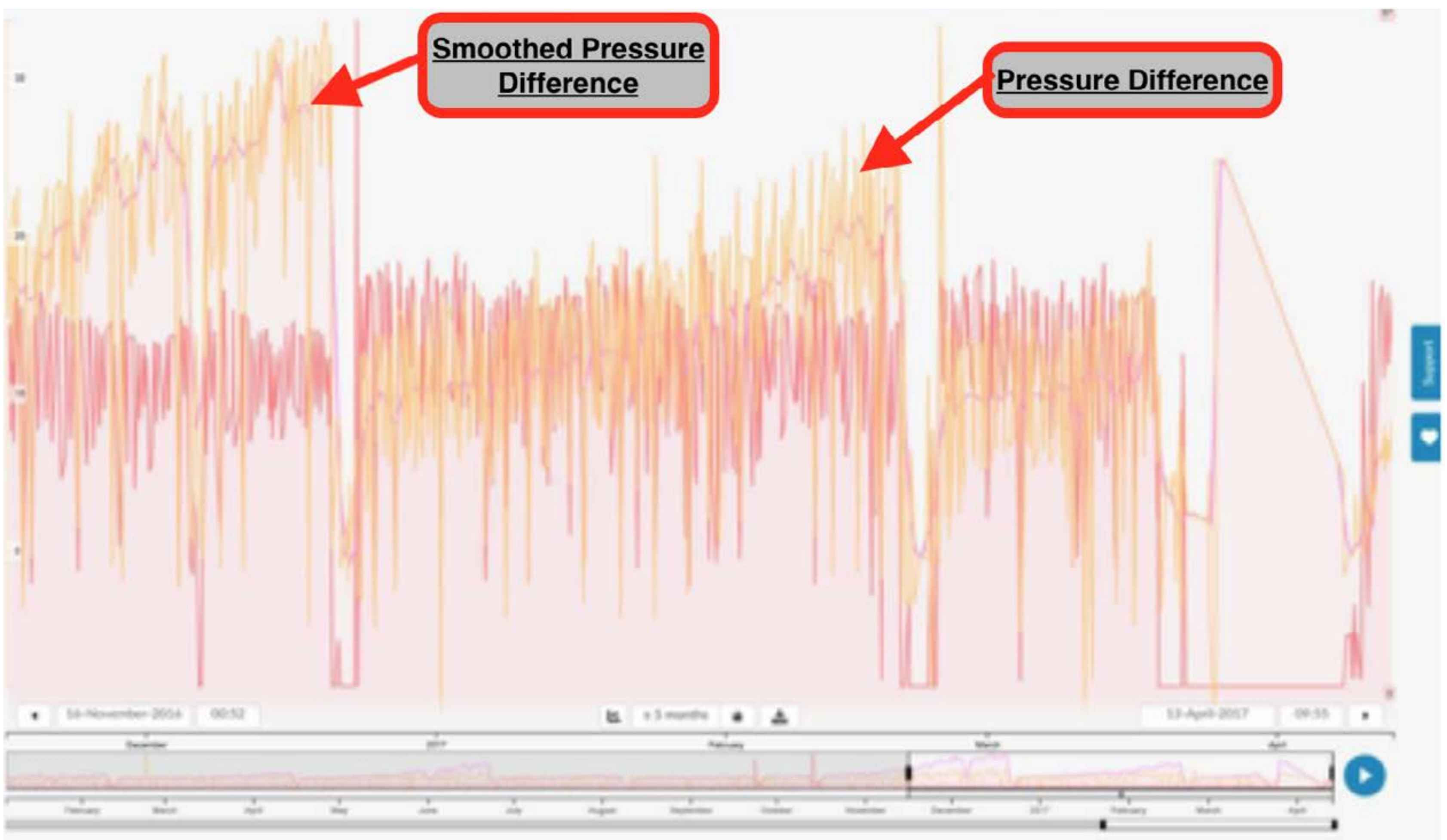


Figure 5. A display of months of pump operation. The yellow (original) pressure difference was smoothed out to make it easier to analyze the operation state. The shutdowns for maintenance are clearly visible by the sudden drops.

The next step was the evaluation of the relevant relationships within such a piping network. One was the behavior between differential pressure and the flow rate. Because historical data was available, the differential pressure was found to correlate with the corresponding flow rate of the hydrochloric acid. The plot below shows the relationship between the flow rate (X-axis) and differential pressure (Y-axis) (Figure 6).

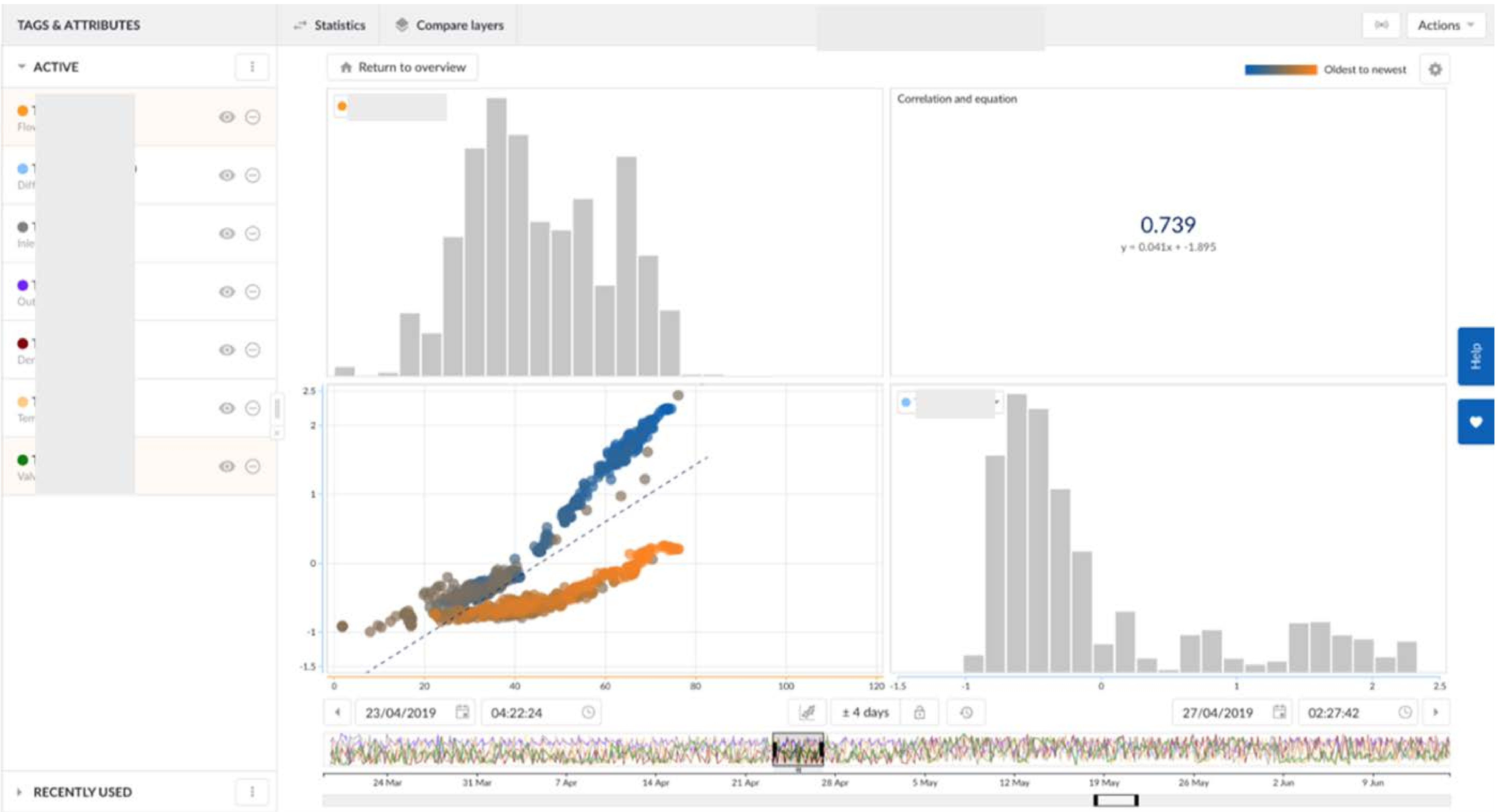


Figure 6. The scatter plot shows the relationship between flow rate (X-axis) and differential pressure (Y-axis). Two operation zones are visible with the blue points showing the behavior before the maintenance and the orange points showing the current operation state after maintenance.

Results

Engineers realized they were working with two operating zone conditions: One from before the maintenance, and one after. From the two identified operating zones, the engineers could see that after some construction work, the friction in a pressure pipe was significantly lower for the same flow rate.

Based on this knowledge, engineers created a golden fingerprint of the normal operation region. They used it to set up a monitor for the two zones to notify personnel of any changes in the overall behavior in a particular zone (Figure 7). This monitor not only would detect anomalies, such as increased friction, but also other changes, such as clogging, fouling, or significant leakages. With the help of this monitor, engineers could act quickly to correct the problem when abnormal operating conditions triggered the monitor. Improving pipe network operations contributes directly to overall plant performance. The company not only saved time, but also achieved greater sustainability by complying with regulatory requirements.

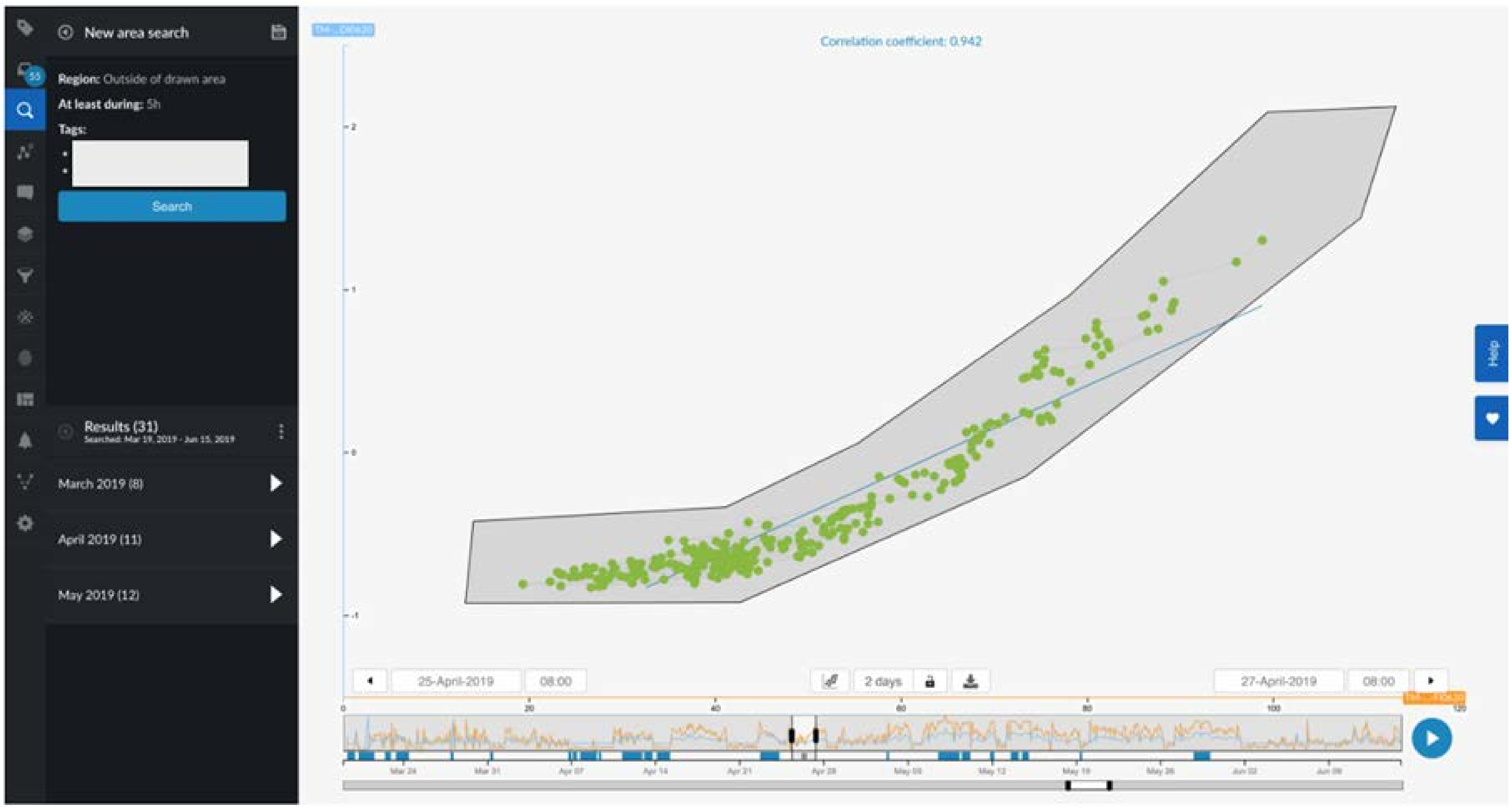


Figure 7. The operation zone of flow rate and pressure is used to indicate the desired zone, which engineers used to create a monitor and alert system.

Use Case 3
CORRELATING WATER QUALITY WITH LIVE PROCESS DATA

Monitoring concentrations of wanted and unwanted substances is essential to ensure water quality. Online concentration measurements often are complex and expensive. For some substances, taking online measurements can be difficult or impossible. Therefore, many parameters of wastewater monitoring often are not available as live process data. Instead, they are determined by sampling and lab analysis. Lab analyses can take hours or days. As a result, plant operators do not receive the analysis until it is too late to adjust the process operation.

Correlating lab analysis results with available live process data can help overcome this obstacle. The correlation can act as an indicator for adjusting the process operation in the future. A chemical company wanted to review the correlation between various process and wastewater parameters. Process engineers especially were interested in learning the influence factors on the concentration of organic acids, and in particular acid A.

To identify the correlation among the different parameters, the company established a self-service data analytics solution. Because organic acid concentrations were not part of the company's historian, the first step of the solution was to import the lab reports into TrendMiner. This allowed process engineers to evaluate lab concentration measurements as time-series data. The second step was to find influence factors for the organic acid concentrations. In this case, the redox value, available as live process data, was expected to have an influence on organic acid concentrations (especially acid A). The influence factor functionality of the self-service analytics solution allows linear regression to correlate multiple parameters at once.

Process experts used this function to search for parameters that explain acid concentrations. The company also used the solution's time-shift function to search for optimal correlation. Process experts determined there was a clear correlation between the redox value and the acid A concentration five days later (Figure 8). They also found a correlation with other organic acids. With this knowledge, process engineers learned the redox value could be used to determine the acid concentration and intervene in the process in time if the water quality was not optimal.

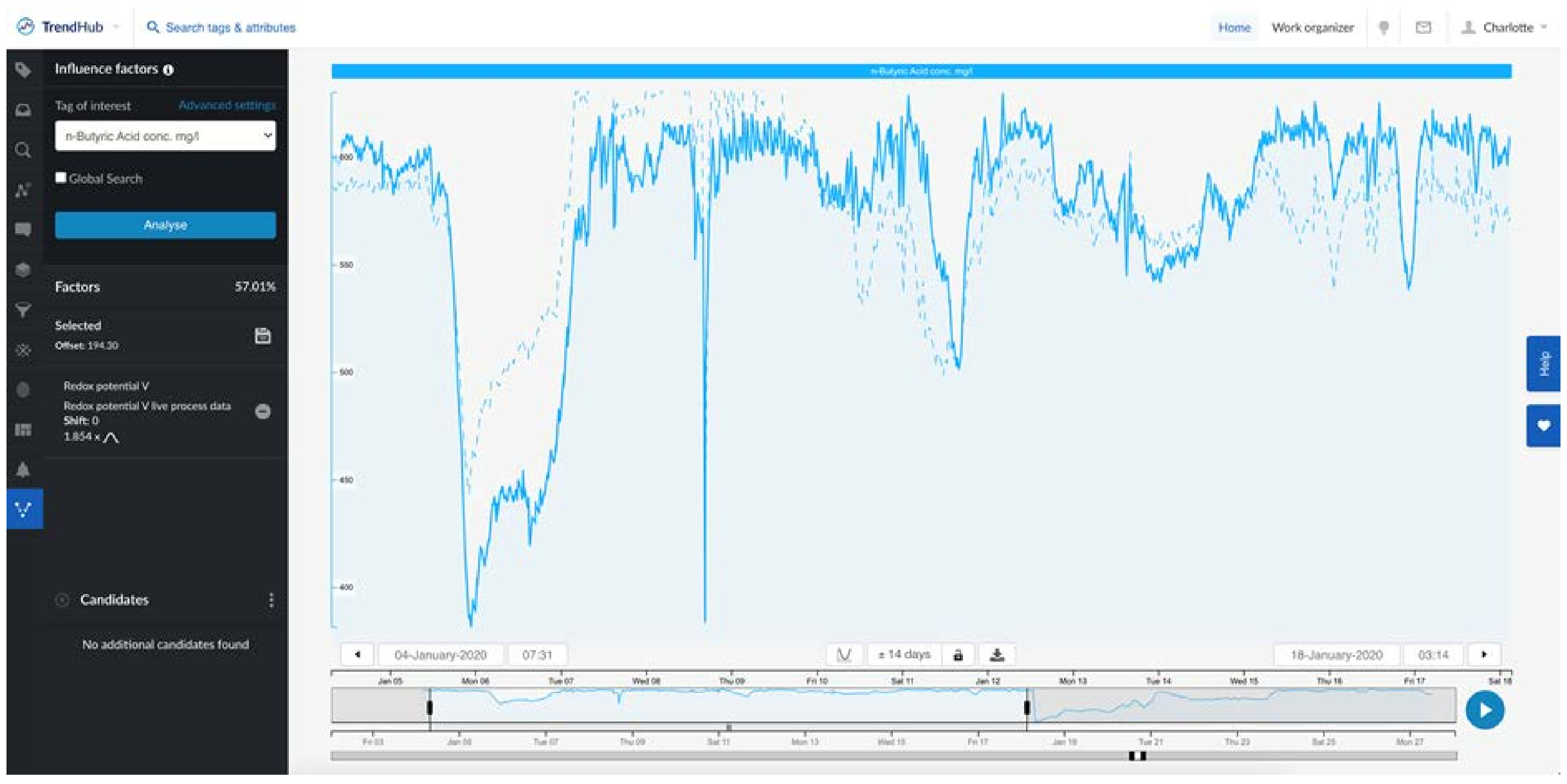


Figure 8: Correlation between acid A-concentration (from lab analysis) and redox potential (live process data) found with the Influence factor-functionality of TrendMiner. It indicates a clear correlation of 57.01% during the timeframe of interest.

The company saved time and money by ensuring it was complying with quality requirements.

Water & Wastewater Treatment Opportunities – Practical Use Cases

The first step in any energy management project is to identify high-energy processes. Process experts can use descriptive analytics to benchmark optimal operating conditions. Such benchmarks or reference periods then can be used to assess cost-saving opportunities and set priorities for optimization projects. With discovery analytics, engineers also can use optimal operating conditions to configure monitors and set alerts for process issues.

Water process experts can use TrendMiner to find operations that need to be optimized, such as:

- Detecting leaks if levels in tanks decrease abnormally fast. When this happens, TrendMiner can send alerts to process experts so they can take corrective action.
- Analyzing the captured data when flow control valves start to wear out or become plugged to give insights into the root cause.
- Detecting anomalies, such as when membranes become fouled and cause losses on hydraulic heads. This change of behavior is captured in time-series data, which engineers can identify in different operating windows as scatter plots generated by the data analytics software.

The following use cases demonstrate how the Water & Wastewater Industry can use self-service data analytics to address its challenges effectively and advance its digitalization journey.

Use Case 1

REDUCING ENERGY CONSUMPTION WITH IMPROVED MAINTENANCE SCHEDULING

At this treatment facility, the aeration elements in the biological wastewater treatment process suffer from fouling effects that can decrease oxygen concentration and nitrogen/carbon conversion rates.

Process experts needed to find a way to gain a clear overview of the oxygen concentration within the plant. They used TrendMiner functions to monitor oxygen levels constantly. When the level dropped and the nitrogen/carbon conversation rates were incorrect, process experts knew it was time to clean the aeration elements, as seen in Figure 9.

Figure 9. Oxygen Concentration of a Biological Wastewater Treatment Plant Over Time.

With the achieved situational awareness, engineers then could schedule maintenance and cleaning at an optimal time. The benefits included greater regulatory compliance and reduced energy costs.

Use Case 2
MONITORING PUMP PERFORMANCE

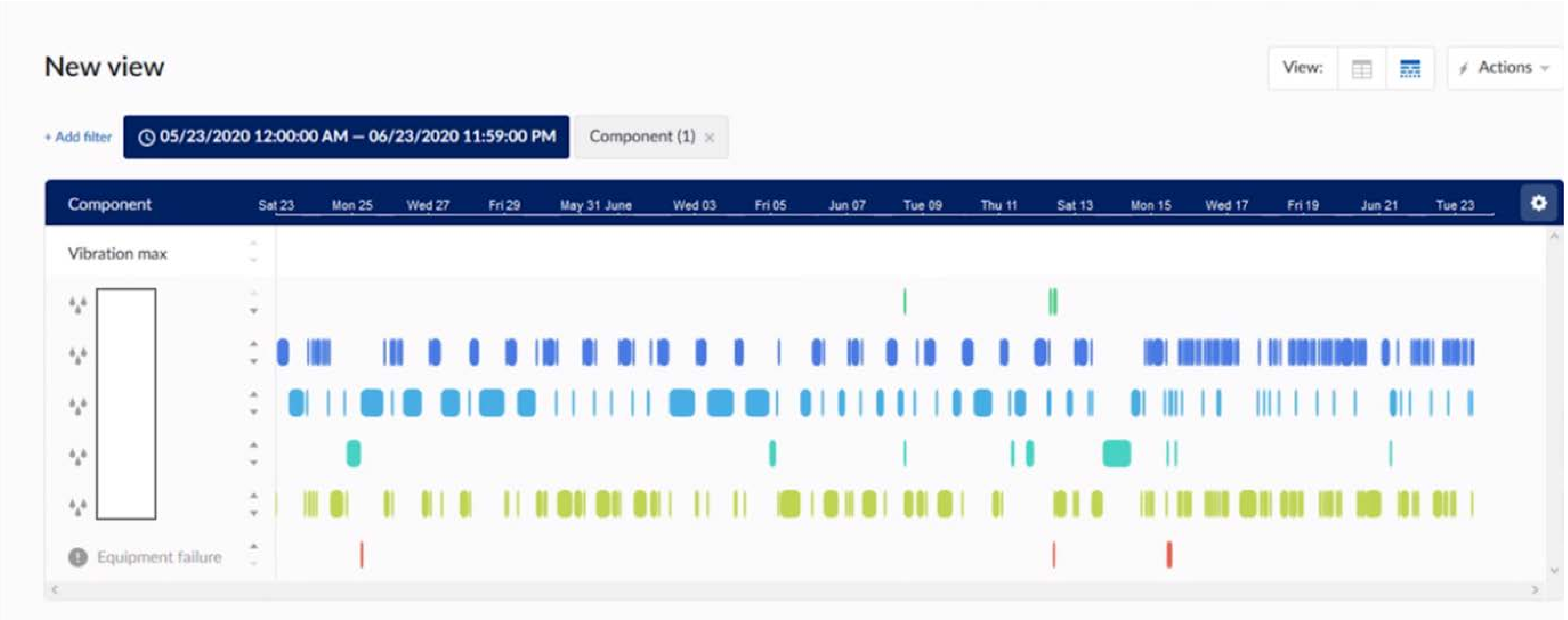


Figure 10. Asset Monitoring Over Time.

Self-service analytics allows process experts to monitor their assets based on a desired operation zone. In turn, this allows them to schedule maintenance to avoid downtime or unwanted process issues. For example, they can monitor equipment, such as pumps, for an increase in differential pressure. The pressure increase is a sign that there could be fouling issues.

Process experts can analyze the data using TrendMiner to check if the deviating pressure condition led to fouling (or any other unwanted behavior). If the analysis confirms this hypothesis, TrendMiner users can turn the conditions into a monitor that can be set to notify the process experts and/or any other relevant stakeholders. The result? Reduced downtime and unwanted processes.

Use Case 3

OVERCOMING HIGH-INPUT VARIANCES TO CREATE A CONDITION-BASED MAINTENANCE SCHEDULE

A wastewater treatment plant must overcome high-input variances of the incoming wastewater stream to create a condition-based maintenance schedule. Depending on weather conditions and the time of the day and year, the incoming wastewater can have high variances in throughput and composition. Gaining insights into deviations in the process and equipment performance can be extremely difficult.

At one European treatment plant, process experts wanted to improve the maintenance schedule for the aeration elements of biological wastewater treatment. Because the aeration elements suffer from fouling, they need to be cleaned regularly. The goal was to transition maintenance planning from a time-based schedule to a condition-based schedule. However, the high variance of input variables made it difficult to have a clear indicator.

Figure 11. Maintenance Dashboard to monitor the fouling state of aeration elements.

To overcome this hurdle, the company used TrendMiner to create a dashboard that monitors the oxygen concentration during nitrification of the wastewater treatment (Figure 11). The monitor enabled process experts to see if the aeration elements needed to be cleaned. This allowed a just-in-time approach to treating the elements and to plan accordingly, which led to savings in both maintenance and energy costs.

Hit Plant Targets with TrendMiner

Industries can make the most of their process data to achieve plant water and wastewater sustainability goals. The software solution puts data analytics in the hands of water experts so they can turn data-driven insights into data-driven decisions. As a result, engineers can optimize processes across a production site and directly contribute to achieving business goals.

Companies can reduce safety risks through early warnings, use predictive maintenance to reduce MRO (maintenance, repairs, overhauls) costs, and determine the effect of equipment/process changes. Furthermore, TrendMiner allows process engineers to create monthly or yearly reports and ultimately create an active learning organization.

For more examples of how TrendMiner can advance digital maturity models, check out these **Inspirational Use Cases** and **Value Use Cases**.

Process experts gain a deeper understanding of process behavior. They can optimize those processes to prevent history from repeating itself. This allows them to manage by exception rather than by reaction. In cases of process anomalies, however, the solution also empowers engineers to determine a root cause quickly and avoid costly upsets.

Adding a self-service data analytics platform to existing digital infrastructure allows water and wastewater treatment experts to fine-tune their processes. Companies will find TrendMiner enables them to adhere to strict and ever-changing compliance regulations, increase overall production efficiency, and reduce their carbon footprint.

Industries using TrendMiner to improve daily operations are assisting global efforts to ensure H2O has a bright future.

The benefits are clear. Water and wastewater process experts will be empowered to:

Solve day-to-day questions
without the help of data scientists.

Prevent major
leaks, sinkholes, and clogging.

Improve maintenance scheduling
to reduce maintenance costs and energy consumption.

Monitor pump infrastructure
to prevent pump failure and ensure smooth plant operations.

Automate findings into early warnings
to reduce costs and avoid nitrogen/carbon emissions.

Make data available
instead of storing it in silos.

Increase knowledge sharing,
which results in more solved cases and employee efficiency.

Make Your Digitalization Journey a Success

Want to know more about self-service analytics?

- **Watch this short, 2-minute video by Nick Petrosyan**, TrendMiner Customer Success Manager, in which he briefly explains how to get started with self-service analytics.
- Download our **Key Capabilities White Paper**.
- **Speak to a Customer Success Manager** for a one-on-one explanation of how TrendMiner can help you improve your water and wastewater processes.

SEE TRENDMINER IN ACTION BY REQUESTING A DEMO

Ready to see how TrendMiner can help you improve water and wastewater management? Click here to reach a Customer Success Manager and see a demo of the software in action.

REQUEST A DEMO

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