

Optimised Wastewater Treatment at WWTP Bonn-Salierweg Through Hach RTC Acid Capacity Control

Problem

With stricter requirements for nitrogen and phosphorus removal, maintaining sufficient acid capacity has become increasingly important. During nitrification, acid formation can lower pH below 7.0, negatively affecting nitrification, oxygen use, and floc formation.

At the Bonn-Salierweg wastewater treatment plant, lime milk has been used for stabilization since the 1980s, but dosing was manual. Demand-based adjustment required significant operator effort, and unpredictable rainfall events often led to the risk of underdosing.

Solution

To address this, the plant implemented a Hach[®] Real-Time Control (RTC) solution. At the heart of the system is the EZ4004 Analyser, which provides continuous and precise data on acid capacity. This analyser works together with the RTC-ALK module to automate the dosing of lime products. By continuously monitoring conditions and predicting acid capacity consumption, the system proactively adjusts dosing, ensuring the biological process remains stable even during unpredictable rainfall events.

Advantages

Automating this critical process provides stability and peace of mind. The Hach solution ensures optimal conditions for nitrogen removal and improves sludge settleability, leading to more reliable plant performance. It also frees up operating personnel from demanding manual adjustments and optimizes lime consumption, which reduces operational costs and improves resource efficiency. Continuous monitoring and remote support from Hach experts help the plant maintain and further refine process performance.



Figure 1: Aerial view of the Bonn-Salierweg wastewater treatment plant (Bildrecht Bundesstadt Bonn)

The Bonn-Salierweg Wastewater Treatment Plant

The Bonn-Salierweg wastewater treatment plant treats wastewater from two sub-catchment areas with a total area of around 3,871 hectares. It is the largest sewage treatment plant in Bonn and discharges its treated wastewater into the Rhine. The plant was commissioned in 1934 and was last expanded and extensively modernised in the 1990s.

The capacity of the biological stage is 285,000 population equivalents (PE); in 2024, the actual load was 275,164 PE with an annual wastewater volume of 19,093,015 m³.

The biological stage consists of an aeration tank with a depth of approx. 13m and a total useful volume of 52,750 m³. This is divided into four parallel lines, each with ten chambers connected in series.

The secondary clarification consists of three circular and one rectangular tank. The biologically treated wastewater is then fed via four screw pumps to a filtration plant with a filter area of 1,000 m² before being discharged into the Rhine.

The Initial Situation

As early as the 1980s, milk of lime was used to improve the floc structure and stabilise the acid capacity. For this purpose, the lime stored in the silo is prepared with water in a lime preparation station to form a 10 % milk of lime solution and dosed into the aeration system via a peristaltic pump (1.0 - 2.5 m³/h). Dosing was previously carried out manually based on the acid capacity determined in the laboratory. Especially during rain events, the operating staff had to closely monitor the values and responsibly adjust the addition of lime. A drop in the pH value due to insufficient acid capacity can change the biocenosis and significantly impact the settling properties of the activated sludge in the secondary clarifiers.

In addition, the dosing of iron salts for phosphate elimination influences the acid capacity. During rain events, the precipitant dosage often has to be increased, which increases the loss of acid capacity in the biological reactor. In the event of prolonged precipitation, the precipitant dosing into the aeration system is therefore stopped and the installed secondary precipitation is switched on instead. This change in operation is carried out by the operating personnel depending on the respective weather conditions.

However, this mode of operation was very labour-intensive and carried the risk of a significant drop in acid capacity.

Solution

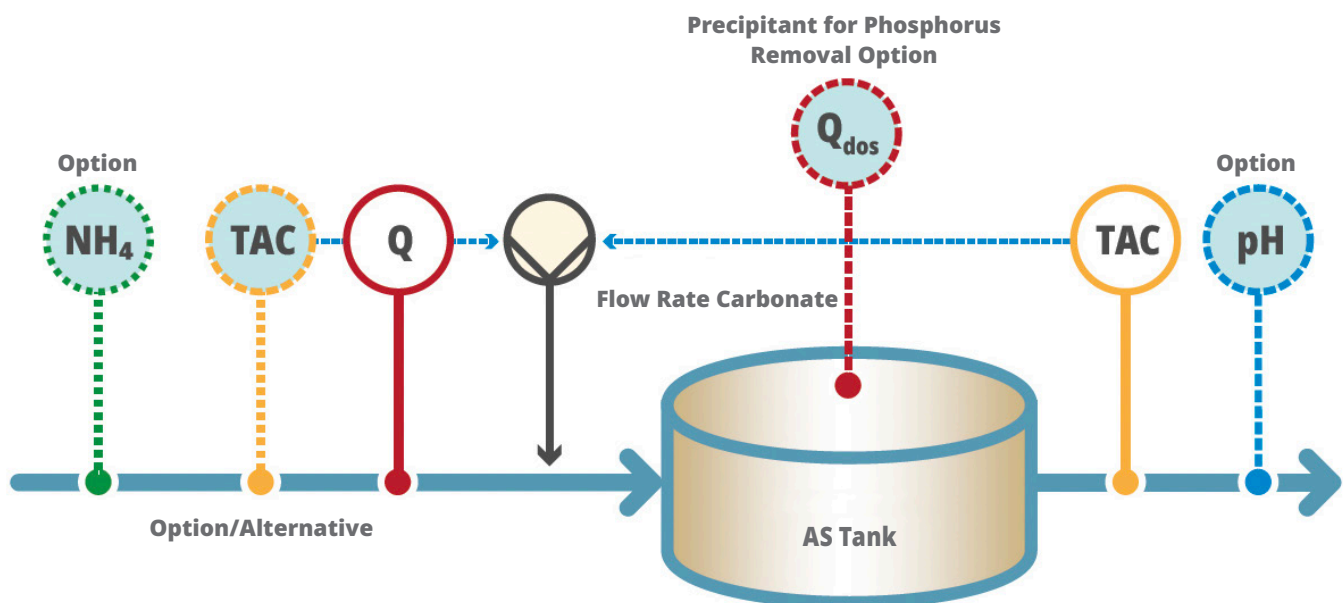
With the introduction of the Hach Lange EZ4004 analyser for determining acid capacity and the ALK RTC control module, the idea of automating the previously labour-intensive and complex process of dosing milk of lime quickly emerged. A six-month trial run with the EZ4004 analyser and the ALK-RTC control module was carried out to test the possible applications. The aim was to clarify the following questions:

1. Can the acid capacity be reliably and precisely recorded using online measurement technology?
2. Can the milk of lime be dosed as required and event-driven with the aid of the control module?
3. Does automation lead to a reduction in the quantity of milk of lime and thus to measurable cost savings?



Figure 2: Lime silo and precipitant tanks

Figure 3: Principle of the Hach ALK-RTC



Description of the Hach RTC module for controlling the acid capacity (alkalinity) by dosing lime or chalk products

The RTC-ALK (alkalinity) regulates the acid capacity in the biological stage effluent to the required level. The control variable is the dosing quantity of lime or chalk products. The module can be operated as a regulator, a controller or a combination of both.

Control System

The controller can be parameterised flexibly and is based on measured values in the feed that indicate a typical drop in acid capacity (e.g. conductivity, pH value, temperature, ammonium concentration, alkalinity).

The consumption of acid capacity in the biological stage (through nitrification/denitrification) and through precipitant dosing for phosphate precipitation is calculated. Ideally, existing online measured values (ammonium, nitrate, phosphate) are included in the calculation.

The control system enables a rapid response to changing feed conditions.

Control

The control is based on an alkalinity measurement in the effluent of the biological stage. The control system is used to precisely set the desired, ideal acid capacity in the outlet of the biological stage.

The required dosing quantity of lime or chalk products is calculated from the sum of the control and regulation results and output as a target value.

Implementation at the Bonn-Salierweg WWTP

At the Bonn-Salierweg wastewater treatment plant, the combination of open and closed loop control can be used very well due to the existing measurement technology.

Closed Loop Control

An analyser (EZ4004) for continuous measurement of the acid capacity was installed in the aeration process. The permanent recording enables precise control and stabilisation of the optimum acid capacity in the biological stage effluent.

Open Loop Control

The open loop control component of the RTC-ALK is of central importance as it allows a very fast reaction to changes in the inflow. The acid capacity drops rapidly, especially during rain events. The module reacts immediately by increasing the lime milk dosage in the inlet and thus building up a sufficient buffer of acid capacity. This ensures that the biological processes are supplied and prevents a critical drop in acid capacity and pH value in the outlet.

The available online measured values (ammonium, nitrate, pH, inflow water quantity, precipitant quantity) are used to calculate the acid capacity consumption by biological and chemical processes.

A two-month measurement programme also showed a close correlation between acid capacity and conductivity ($\mu\text{S}/\text{cm}$) in the inflow. This means that there is no need for an additional analyser in the inlet. The conductivity measurement reacts in real time and thus enables an even faster adjustment of the dosing and the early build-up of the necessary buffer in the biology.

Additional safety is provided by monitoring the pH value in the outlet: If the pH value falls below a defined minimum value, the RTC-ALK can react automatically with increased or maximum dosing and raise the pH value back to a stable level at short notice.



Figure 4: Industrial PC with ALK-RTC module and EZ4004 analyser

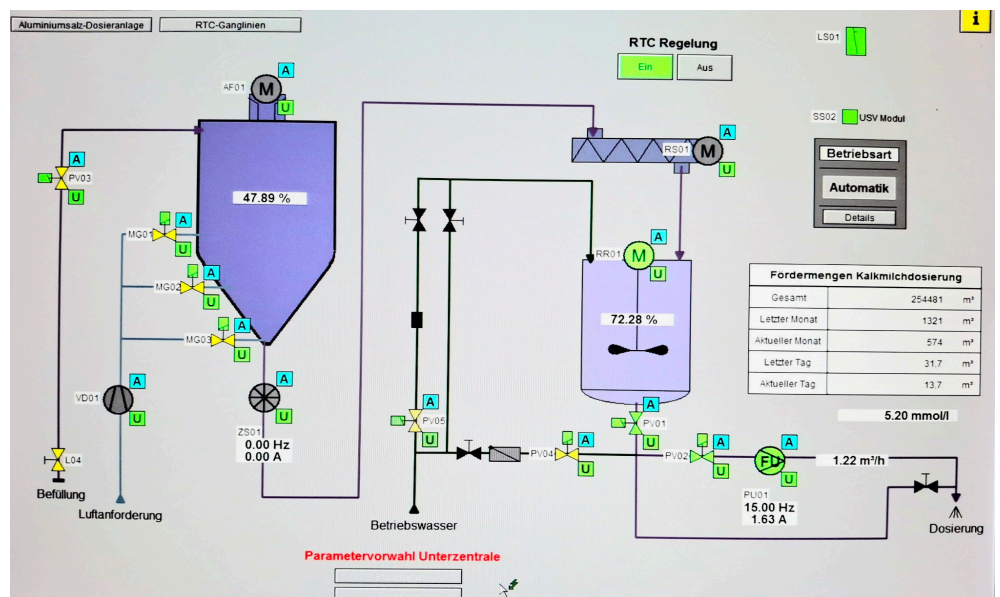


Figure 5: Schematic: Dosing station with activated Hach RTC control

Results

Through parallel measurements in the operating laboratory and regular comparison with the EZ4004 analyser, it was possible to demonstrate close agreement between the online measured values and the laboratory analyses after some time. The online measurement technology thus proved to be reliable, meaning that the measurement results and the control system based on them can be used without restriction. The device was integrated into the routine checks carried out by the operating personnel, thus ensuring continuous quality assurance.

The test operation showed that not only the automated recording of the acid capacity, but also its process-based control is possible. A stable residual acid capacity of 3 mmol/L was maintained over the entire period.

The sludge quality remained constant and the settling properties unchanged. The fast and adapted reaction of the RTC controller to rain events, which was supported by the flexible parameterisation, is particularly noteworthy. This enabled event-controlled and efficient milk of lime dosing.

The user interface proved to be clear and user-friendly. Hach Remote Support was and is a valuable support for the optimal setting of the control parameters.

The positive results are also reflected in the lime consumption. Based on the continuous online measurement, it was possible to define a minimum dosing quantity that is sufficient to keep the acid capacity stable at at least 3 mmol/L, especially on dry weather days. By lowering this minimum dosage in particular, lime consumption could be significantly reduced and operating costs sustainably lowered.

The Figure 6 shows the typical course of the calculated **acid capacity in the inlet (purple)** and the **acid capacity in the outlet (blue)** with the **requested dosing quantity (green)** in the month of October 2024, in dry weather and during rain events.

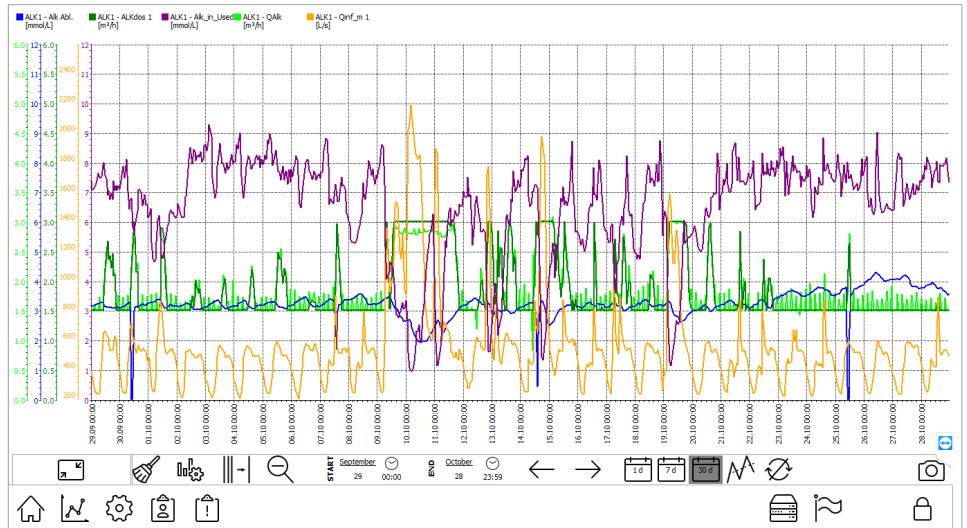


Figure 6: Hydrograph display (...a valuable feature of the RTC user interface)

Conclusion and Further Optimisation Steps

The use of the ALK-RTC and the EZ4004 analyser to measure the acid capacity proved to be a complete success during the six-month trial operation:

- noticeable relief for the operating staff thanks to automation,
- stabilisation of both nitrification and sludge settleability,
- significant savings in lime consumption.

Based on these results, the installation was fully adopted and permanently integrated into the operation.

Subsequently, it is planned to couple the acid capacity controller with the precipitant dosing controller. This will allow the complex operating process of iron salt dosing to be optimised during rain events by dynamically adapting the prioritisation of the dosing points to the respective acid capacity in the aeration system.

Another six-month trial operation is planned for this expansion. The company is confident of achieving successful optimisation here too - with the aim of safely complying with the discharge limit value for phosphorus and at the same time making the use of precipitants highly efficient without impacting the biological processes.

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