

Tissue Plant Maintains Tight Discharge Limits by Automating Nutrient Dosage Based on TOC/TN/TP

Background

A Tissue Paper producer situated close to an environmentally vulnerable waterbody invests to guarantee the best environmental practices, namely with regards to discharge limits. The facility deals with variable organic and nutrient concentrations in its wastewater, depending on the raw material used. Critical to the improvement of the treatment process is maintaining an optimal Carbon: Nitrogen: Phosphorus (C:N:P) ratio.

Solution

A Hach® real-time control (RTC) nutrient and precipitant dosing system driven by two BioTector TOC/TN/TP analysers was installed. Now, automated adjustments of the C:N:P ratio are made based on measured TOC, TN, and TP measurements at the influent and effluent. Effluent values are then continuously transferred to the relevant environmental agency.

Benefits

The implementation of the Hach RTC and BioTector TOC/TN/TP analysers has allowed the plant to more effectively maintain the desirable C:N:P ratio, resulting in healthier sludge and a significantly improved treatment process. This outcome has inspired confidence in management and reduced operator workload up to 7.5 hours per week.

Background

The Navigator Company is a Portugal based, globally operating pulp, paper and tissue company, with a productive capacity of 1.5 million tonnes of pulp, 1.6 million tonnes of paper and 130,000 tonnes of tissue per year. The company uses eucalyptus wood as the prime raw material to produce pulp, fine printing and writing paper, and tissue paper. It is one of the five largest European producers of uncoated, wood-free paper.

Tightening Emission Limit Values

The Navigator Company operates four production sites across Portugal, including one site, which discharges wastewater upstream of a natural monument. To safeguard this pristine area, Navigator complies with very stringent emission limit values for many parameters. Moreover, emission values of some of those parameters, such as total organic carbon (TOC), temperature, pH, conductivity and effluent flow are reported to the Portuguese environmental agency (APA) every 15 minutes.

Varying Nutrient Content of Wastewater

To reliably meet the demands of the set limits and as part of its pursuit of continuous improvement, the site's wastewater treatment plant was modernised and its process automation was optimised. Previously, automatic nutrient dosing had been triggered by a timer.

Microorganisms of a biological wastewater treatment process require a balanced nutrient ratio to function at maximum efficiency. The most important of these nutrients are nitrogen and phosphorus. The optimal CNP-ratio in this case is C:N:P = 100:5:1.

While the carbon content of paper producing sites is generally high and the nitrogen and phosphorus content is usually negligible, the very tight discharge limits for nutrient parameters in the effluent make it challenging to dose enough nutrients to keep the sludge in optimal conditions while avoiding overdosing. This overdosing could result in exceedance of the discharge limits.

Balancing the phosphorus content is particularly challenging in this case, because the Navigator Company uses pulp made of eucalyptus as raw material, a wood that tends to be rich in phosphorus and grows quickly under Portuguese climatic conditions. The significant variations in phosphorus content (0.0 to 2 mg/L) of the influent wastewater require the plant to occasionally remove phosphate with FeCl_3 in order to keep the low limit value of 0.82 ppm (this limit can be lowered to 0.5 ppm during exceptional periods). It is also necessary to add Nitrogen. Its dosage depends on the TOC content of the wastewater.

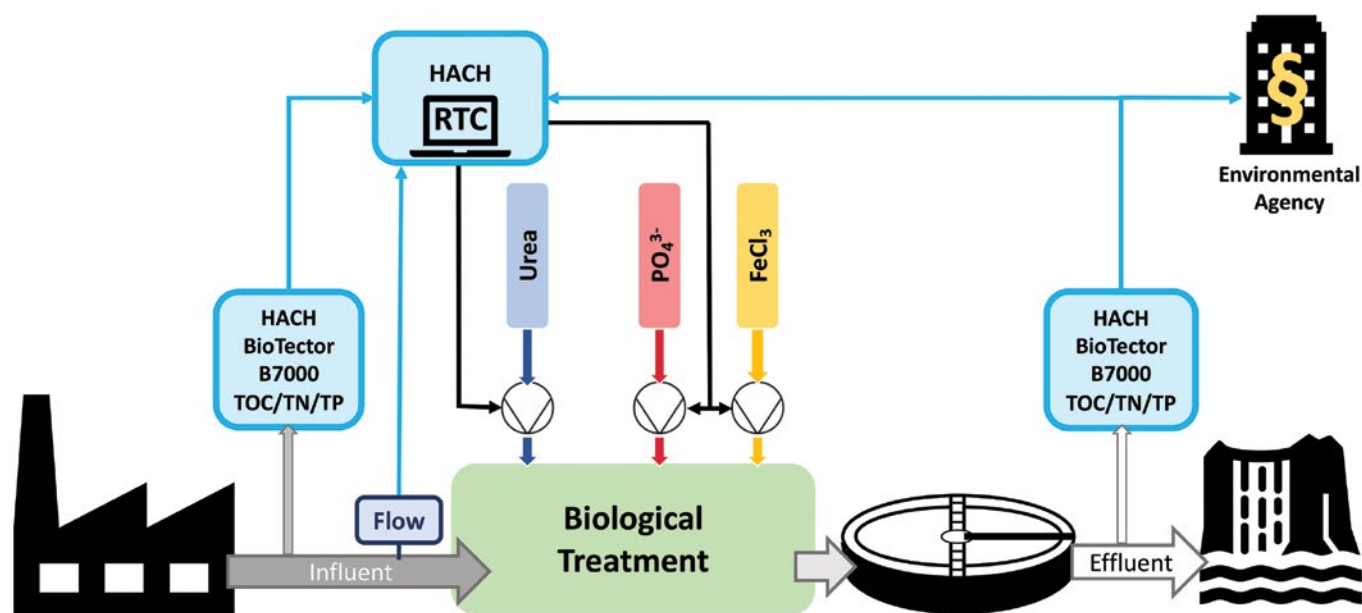


Diagram of the installed Hach analyser-RTC solution at a site of The Navigator Company: 2 x Hach BioTector B7000 TOC/TN/TP combined with Hach RTC controlling addition of nutrients, urea (source of N) and phosphoric acid (source of P) or P-precipitation agent FeCl₃, depending on what is coming at the wastewater treatment plant.

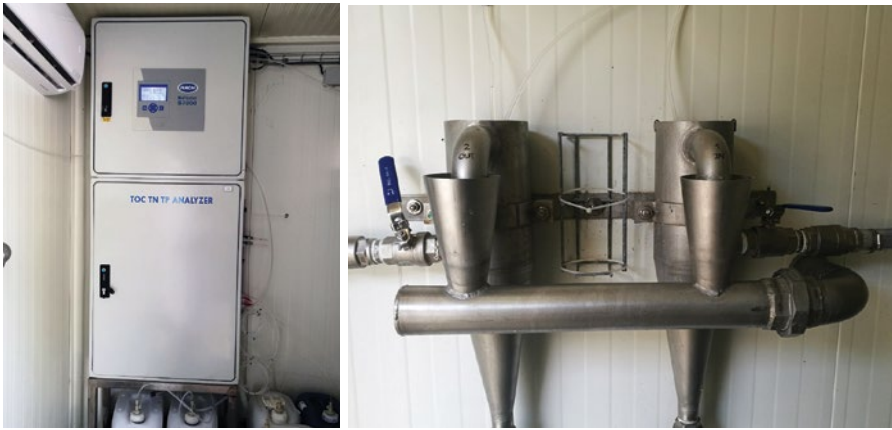
Solution and Improvements

Nutrient Analysis and RTC Adjustment

In 2019 the plant installed an automated control solution by Hach. It consists of a Hach BioTector B7000 TOC/TN/TP online analyser monitoring the carbon and nutrient content at the inlet of the biological wastewater treatment process coming from production. A second Hach BioTector B7000 TOC/TN/TP online analyser is located at the outlet of the treatment plant, reporting the measured TOC values directly to regulatory authorities. Both nutrient value-sets are fed into a Hach RTC unit (CNP- and P- modules), which regulates reagent dosing pumps to adjust the content of ammonium and phosphate to an optimal C:N:P ratio. The ammonium concentration, which is usually too low, is adjusted relative to the TOC content by adding urea. The phosphate concentration fluctuates and is either added into the aeration basin or its concentration is reduced by adding the precipitation agent, FeCl₃.



Container on the plant premises containing measurement instrumentation and control unit.

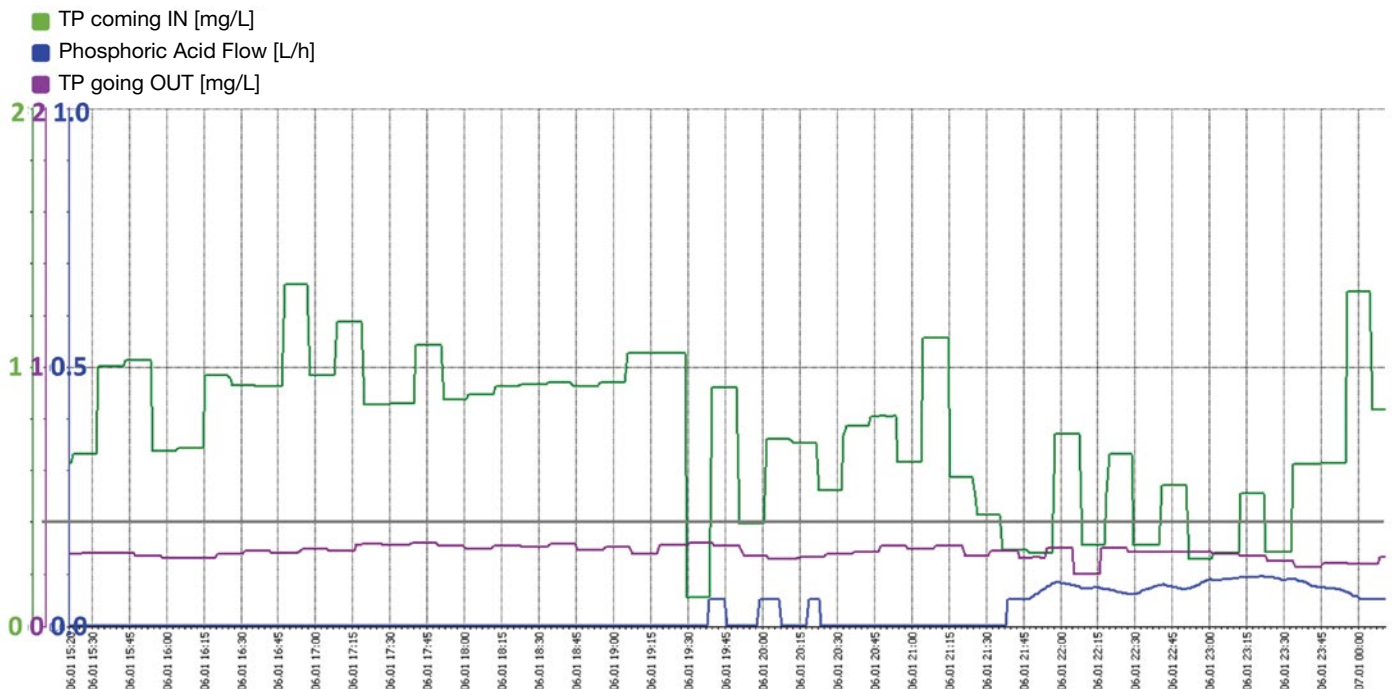


Left: Hach BioTector B7000 TOC/TN/TP installed inside the container at the site.
Right: Overflow vessels providing sample of the inlet and the outlet of the wastewater treatment plant.

The Real Time Control Unit

The real time control unit implemented to adjust and maintain the specified C:N:P ratio is the RTC-CNP module from Hach. The RTC-CNP combines a TOC load-based feed forward algorithm with a proportional integral derivative (PID) type feed-back control loop based on the residual TN and TP concentration in the effluent of the secondary clarification (which is a DAF unit in this example).

The feed forward part of the control algorithm enables a swift reaction on incoming load changes. It calculates the dosing rates for urea and phosphoric acid based on the TOC inflow load and the desired ratios for N:C = kg N / kg TOC and P:C = kg P / kg TOC, which can be adjusted to suit the specific waste water treatment process. The characteristics of the dosed chemical compounds can be adjusted to any nutrient agent. To compensate for changing wastewater composition and sludge characteristics as well as to avoid unwanted nitrification, a closed-loop PID control is applied to reach a pre-defined TP and TN set point in the effluent. To avoid ammonium overdosing in case of nitrification the TN concentration of the aeration effluent is considered in the feedback control loop. The feedback control part also ensures effluent quality under unforeseen conditions (e.g. varying process speed, nutrient agent quality, etc.)



Load curve of total phosphorus (TP) at the inlet (green curve) and the outlet (violet curve) of the WWTP at The Navigator Company. The phosphoric acid pump (blue curve) switches on, when the phosphorus level gets too low and switches off, when the phosphorus level of the incoming water is high enough. The pumping speed is adjusted based on the incoming load. This way overdosing of phosphoric acid is prevented. The limit for the TP concentration at the outlet is set to 0.4mg/L.

Conclusion

The fully automated measurement and control solution installed at The Navigator Companies site is an ideal solution for paper producing sites with stringent wastewater effluent limits. The Hach BioTector B7000 analyser series was designed to handle industrial wastewaters with high particle content, which is typical in the pulp and paper industry. Its sample lines have an inner diameter of 3.2 mm, which allows the instrument to handle soft particles as large as 2 mm and to take a representative sample of several mL. An implemented self-cleaning feature in the analyser leads to very low maintenance requirements of the online analyser. Together with the Hach RTC controlled dosing automation of nutrient adjustment, the solution reduced the staff's overall workload and responsibilities.

As a result of the permanently maintained optimal C:N:P ratio, the sludge has improved greatly, meaning, that it consists of a good mix of desired microorganisms working at optimal efficiency. Asked what he sees as the greatest improvement over the previous situation, the environmental manager of The Navigator Company stated, that it gives him **peace of mind**, that he can rely on the monitoring and controlling equipment and the wastewater treatment process as a whole. Since the full implementation of the automation, the low set discharge limits have never been exceeded, and **full environmental compliance has been attained**. He added, it should not be forgotten, that a dependable wastewater treatment process secures the core business of the company, the paper production, as well as our commitment to comply with all environmental standards and thus minimise our impact in all Portuguese water bodies.

Due largely in part to the success of the Hach solution at this site, The Navigator Company is currently incorporating similar solutions to some of its largest sites.

Summary

- TOC, TN, and TP monitoring of the wastewater with the Hach BioTector B7000 TOC/TN/TP
- Nutrient concentration control with Hach RTC based on BioTector measurements
- Improved treatment efficiency due to optimised C:N:P ratio
- Reduced workload by 7.5 hours/week for plant personnel achieved by automation with low maintenance equipment
- Reliable compliance with strict limits

About the customer

The Navigator Company is the leading European manufacturer of uncoated printing and writing paper, tissue and bleached eucalyptus pulp. Based in Portugal, the company operates globally and has a productive capacity of 1.5 million tonnes of pulp, 1.6 million tonnes of paper and 130,000 tonnes of tissue per year.



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