Small-medium plant for nutrients removal – Controls N, MOV, RASi, SRT

SANT FRUITÓS DE BAGES-NARVARCLES-SANTPEDOR WWTP (Spain)

Createch 360° provides an intelligent platform for water and wastewater facilities that includes real-time control and decision making tools to reduce operational costs, enhance reliability and comply with quality consent limits.
With over 100 installations worldwide, our broad experience and continuous innovation guarantee high added-value solutions enabling municipal and industrial users to achieve efficiency and facilities performance.

Summary

Plant features

- Small-medium plant
- Plug-flow configuration
- Blowers + reg. valves
- Nutrient removal

Challenge

- To ensure effluent quality
- To optimize and monitor treatment performance
- To reduce aeration costs

Results

- **100%** quality compliance, despite a **30%** increase of TN treated load
- **49%** reduction of kWh/kg NH_4
- **15%** reduction of kWh/m^3

The wastewater treatment plant (WWTP) of Sant Fruitós del Bàges is located NE of Spain, was operating at the half the design flow capacity, and has to deal with uncontrolled industrial discharge leading to high nitrogen inlet loads. The WWTP generally operates with one of the two biological treatment lines, equipped with an independent aeration system coupled with blowers and automatic regulation valves, previously operated with a fixed DO setpoint control strategy. Historically, the plant was not able to reach the discharge limits in terms of total nitrogen, especially during winter periods because of the limited nitrification capacity. In order to achieve compliance, the plant was upgraded with the installation of the CREA control platform and new measurement instrumentation in order to optimize the control of aeration system, internal recirculation and also biomass levels. As presented below, the results of the control platform has not only allowed to fully meet the quality requirements imposed, but has also improved the overall operation of the system, increasing treatment capacity and energy efficiency, as well as improving the biomass stability and quality.

Plant characteristics

- **Design flow:** 16.000 m^3/d
- **Biological treatment:**
  - 2x plug-flow reactors
- **Aeration system:**
  - 2+2+1Rx blowers with VDFs.
  - Automatic regulation valves
  - Airflow and pressure meters
- **Effluent discharge consent**
  - BOD_5 < 25 mgO_2/L
  - COD < 125 mgO_2/L
  - TSS < 35 mg/L
  - TN < 15 mgN/L
  - TP < 2 mgP/L
- **Measurement equipment (already in the plant)**
  - Dissolved oxygen in bioreactors
  - Airflow and pressure meters

Technical solution

- **Platform solution: CREApro®**
- **Control modules:**
  - N-Control
  - Time-zone
  - SRT-Control
  - MOV-Control
  - RASi-Control
- **Measurement equipment (new instrumentation)**
  - Ammonia ion-selective probe
  - Nitrate ion-selective probe
  - MLSS optic probe.

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Solution implemented

N-CONTROL (intermittent aeration cycles)

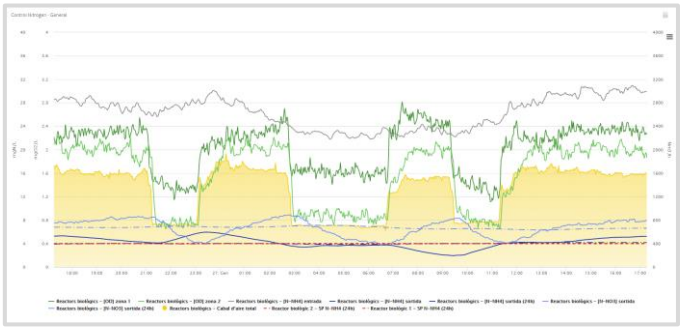
The control module is based on **N-NH_4^+, N-NO_3^- and DO** and includes:

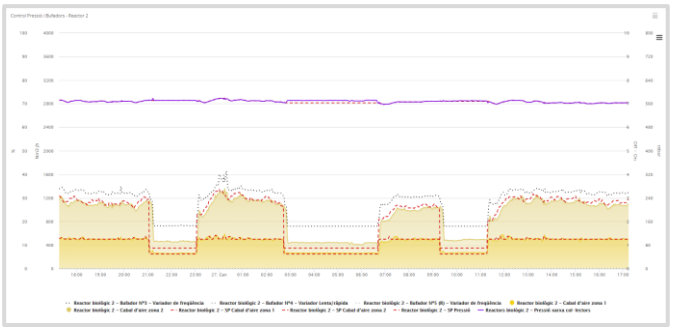
a) **Dynamic DO setpoint strategy** to optimize oxygen demand.
b) **Dynamic NH4 setpoint strategy** to ensure effluent quality requirements are achieved.
c) **Intermittent aeration cycles** to ensure an optimized balance of nitrification and denitrification processes.
d) **Energy prices consideration** to displace energy consumption peaks to increase monetary savings.

MOV-CONTROL (Most-Open-Valve and Pressure control)

This module is based on **DO, Airflow and Pressure** and includes:

a) **Most Open Valve strategy** to reach the target airflow to achieve the desired DO setpoint.
b) **Dynamic pressure control** to ensure maximum aeration system efficiency.
c) **Dynamic blowers control** to ensure optimal working frequency and performance.
d) **Advanced blowers management** with different safety factors and rotation criteria.





RASi-CONTROL (Internal recycling control)

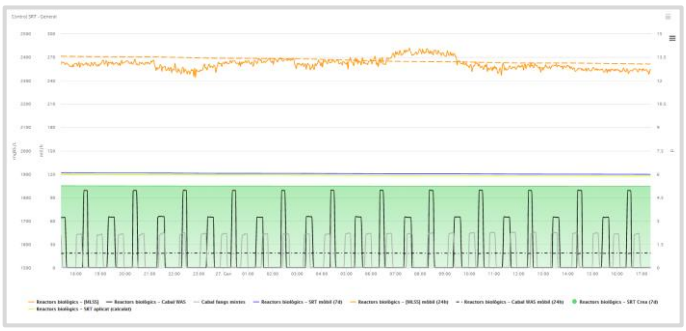
This module is based on **N-NO_3^- and Hydraulic load** and includes:

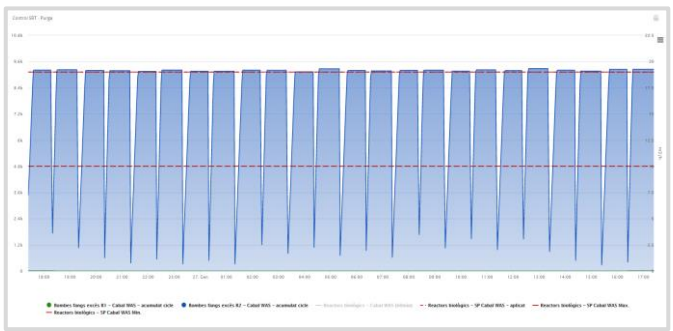
a) Dynamic RASi setpoints strategy to achieve optimal nitrate recirculation while generating savings on pumping energy

SRT-CONTROL (Sludge Residence Time control)

This module is based on **DO, N-NH_4^+, Temperature, MLSS and Waste Activated Sludge (WAS) mass** and includes:

a) **Calculation of SRT and SRT required** to ensure sufficient treatment capacity at minimum energy costs.
b) **SRT control mode** to maintain a calculated or selected SRT.
c) **MLSS control mode** to maintain a desired MLSS in the biological treatment.
d) **WAS mode** to maintain a desired sludge flow-rate or time-based operation.
e) **Safety factors** levels to ensure slow changes to the process.





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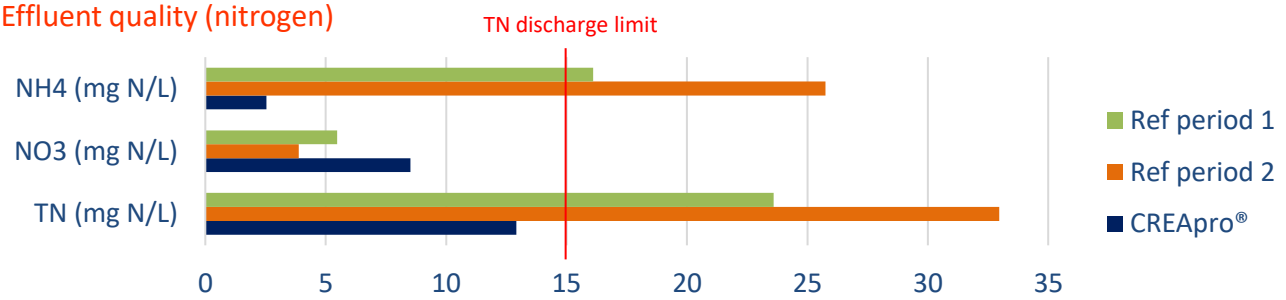
Results

This section presents the differences in operation between a reference period 1 (1st January – 1st April 2019), period 2 (1st November 2019 – 1st April 2020) and period running with the CREApro® control platform (1st November 2020 – 1st April 2021).

Inlet loads

	Ref. period 1	Ref. period 2	CREApro®	Difference
Treated flow (m^3/day)	4.761	5.086	6.547	+38% // +29%
Treated load (kg NH_4/day)	201	242	284	+41% // +17%
Treated load (kg TN/day)	280	339	443	+58% // +30%
Temperature (ºC)	10,8	14,5	15,1	+40% // +4%

Effluent quality (nitrogen)

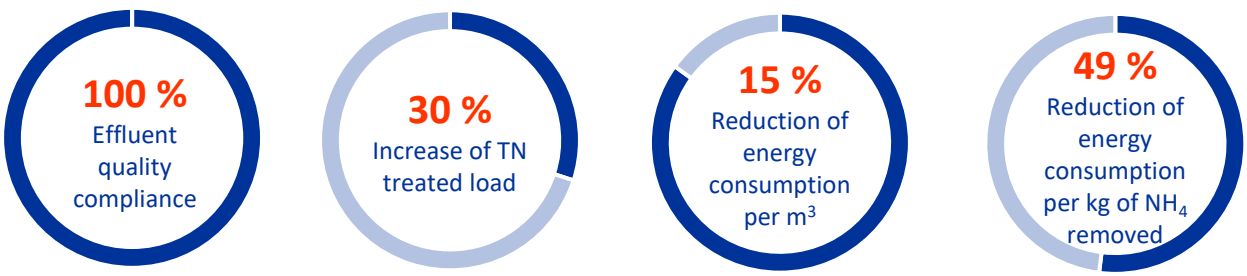


Process performance

	Ref. period 1	Ref. period 2	CREApro®	Difference
NH_4 removed (kg NH_4/day - %)	125 / 59%	117 / 46%	309 / 95%	+146% / +61% // +164% / +105%
TN removed (kg TN/day - %)	164 / 57%	192 / 55%	359 / 80%	+119% / +41% // +87% / +55%
MLSS concentration (mg SS/L)	2.842	2.679	2.612	-8% // -3%
SRT (d)	12,2	7,4	7,2	-41% // -3%
V30 – IVF	771 / 266	1.013 / 389	607 / 236	-21% -11% // -40% -39%
FM	0,07	0,09	0,11	58% // 25%

Energy performance

	Ref. period 1	Ref. period 2	CREApro®	Difference
kWh/m^3	0,57	0,47	0,4	-30% // -15%
kWh/kg NH_4 removed	24,6	17,2	8,8	-64% // -49%
kWh/kg TN removed	23,3	16,4	8,5	-63% // -48%



(vs. Ref period 2)

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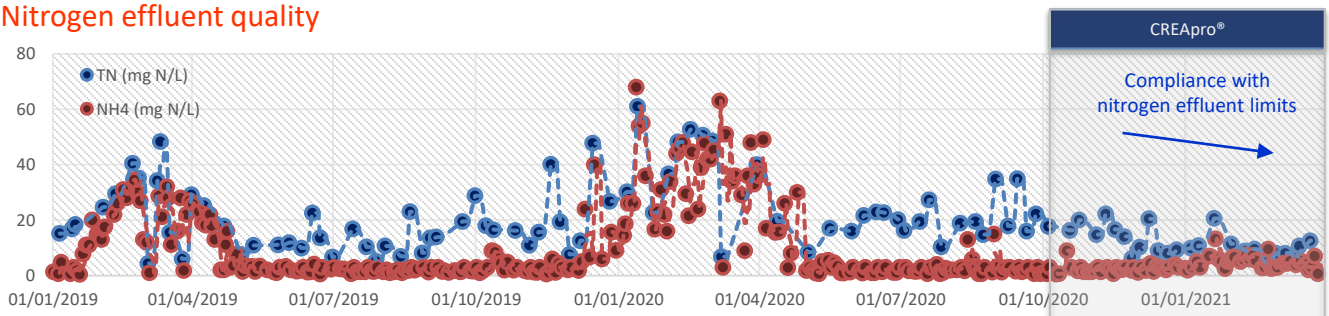
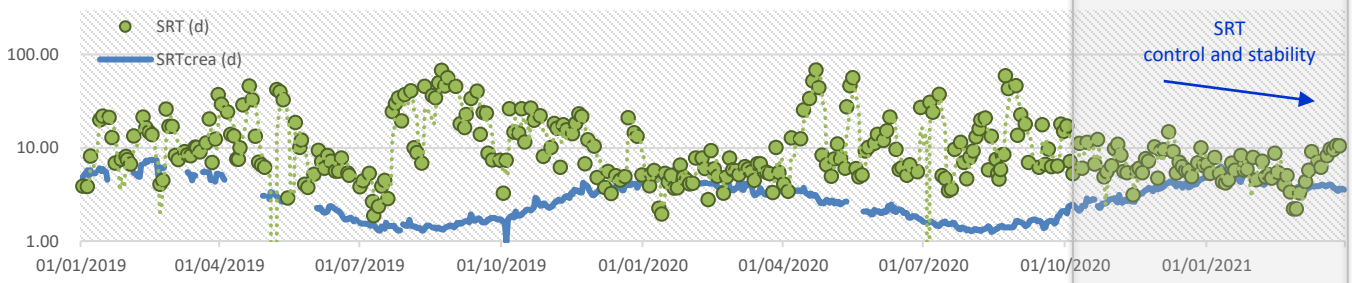
Support data

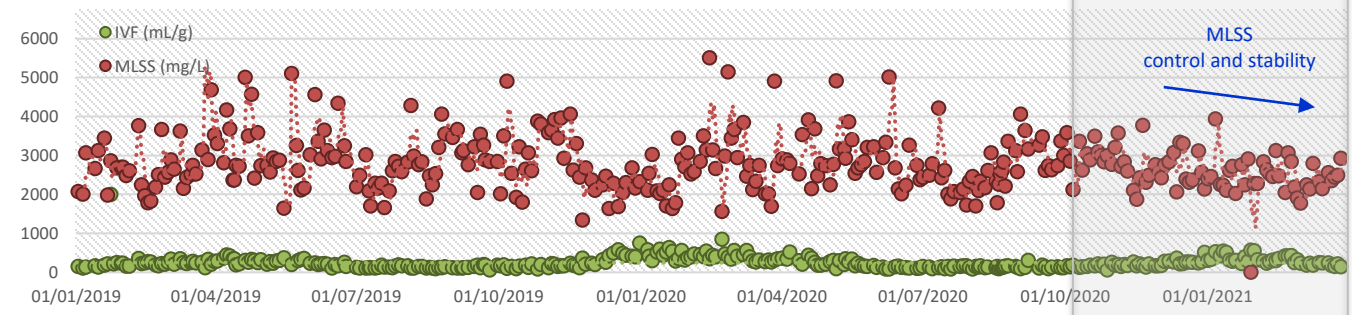
Nitrogen effluent quality



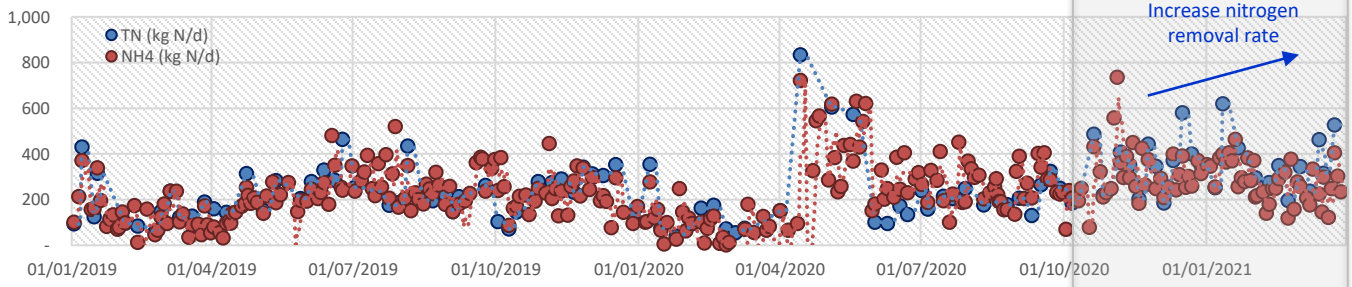
Sludge residence time (SRT)



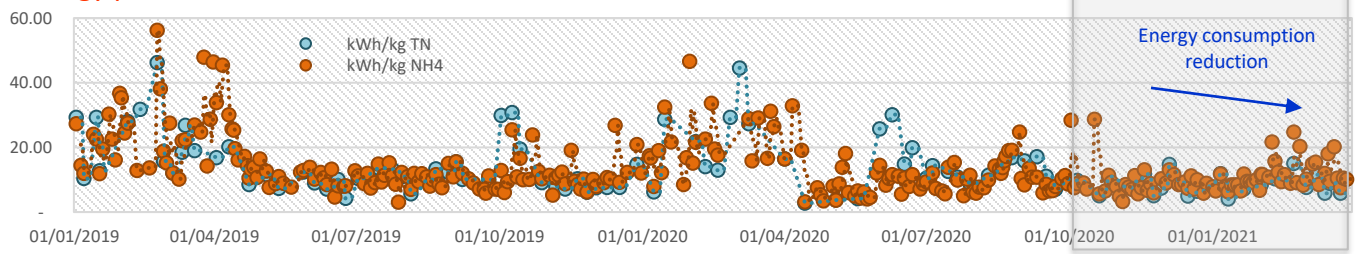
MLSS and SVI



Nitrogen removal



Energy performance



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Client conclusions

Antoni Ventura
General Manager
Aigües de Manresa

AIGÜES MANRESA
GESTIÓ PÚBLICA DE L'AIGUA

"The aim of the implementation of the control platform was to overcome the existing limitations with the nitrogen removal and non-compliance events. The results of the platform have gone over and beyond our expectations, allowing us to meet nitrogen discharge limits without the need to make any significant investment in the plant. The combination of aeration and biomass control was also demonstrated, as it improved the overall performance of the biological treatment operation enabling to work under stable and optimal biomass and sludge age conditions. All in all, this not only resulted in increased treatment capacity and energy efficiency, but also in optimal process stability and sludge quality."