Createch intelligent control solutions 360°

CASE STUDY

Large size plant for nutrients removal

LLEIDA WWTP (Spain)

Createch360° provides an operational intelligence platform for water and wastewater facilities that supports smart monitoring, advanced process control and decision making to reduce operational costs, enhance reliability and achieve quality consent limits.

With over 150 installations implemented by our teams worldwide, experience and continuous innovation guarantees high added-value solutions enabling utilities and industrial users to achieve maximum efficiency and best performance.

SUMMARY

Plant features

- Large plant
- 2-stage Bardenpho configuration Blowers + reg. valves
- Nutrient removal

Challenge

- To reduce the energy consumption (aeration, internal and external pumping, SRT) and chemicals (Ferric chloride) costs whilst ensuring the effluent quality
- To monitor, optimize and stabilize treatment performance

Results

- **100%** quality compliance
- **22%** reduction of kWh / kgN_{rem}
- **+44%** in Bio-P removal
- **20%** reduction of $kgFeCl_3$ / $kgTP_{rem}$

PLANT CHARACTERISTICS

LLEIDA WWTP is located in the West part of Catalonia, Spain.

- **Design Flow:** 160.000 PE (87.500 m^3/d)

- **Biological treatment:**
  - 2x stage 1 Bioreactors (AO)
  - 4x stage 2 Bardenpho reactors (AOA)

- **Aeration system:**
  - 6x turbocompressors
    - 2x shared for stage 1
    - 4x shared for stage 2

- **Effluent discharge consent:**
  - BOD_5 < 25 mgO_2/L
  - COD < 125 mgO_2/L
  - TSS < 35 mg/L
  - TN < 10 mgN/L
  - TP < 1 mgP/L

CREApro® PLATFORM - OVERVIEW OF CONTROL MODULES IMPLEMENTED

Aeration control: individual dynamic DO SP, based on spot and 24h $N\text{-}NH_4^+$, N/DN cycles in 2nd stage bioreactors, individual control of blowers and valves to implement the desired dynamic DO SP.

RAS control based on treated flow.

Extension of the aeration control to upgrade A/NA flushing in 1st stage to increase EBPR through synergies with the 2nd stage.

Upgrade of RAS control to include sludge blanket level, MLSS, WAS TSS / MLSS and SRT estimate.

Internal recirculation pumps control, individual / reactor based on $N\text{-}NO_3^-$ and ORP.

Aeration Control modification to adjust to equipment replacement on site.

P-Control: replacement of a prior dosing controller. Based on $P\text{-}PO_4^{3-}$ and synergies with N/DN cycles to optimise dosing per lane.

IDM: signal reliability assessment and soft sensors to further increase robustness and reliability.

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CREApro® PLATFORM - CONTROL MODULES IMPLEMENTED

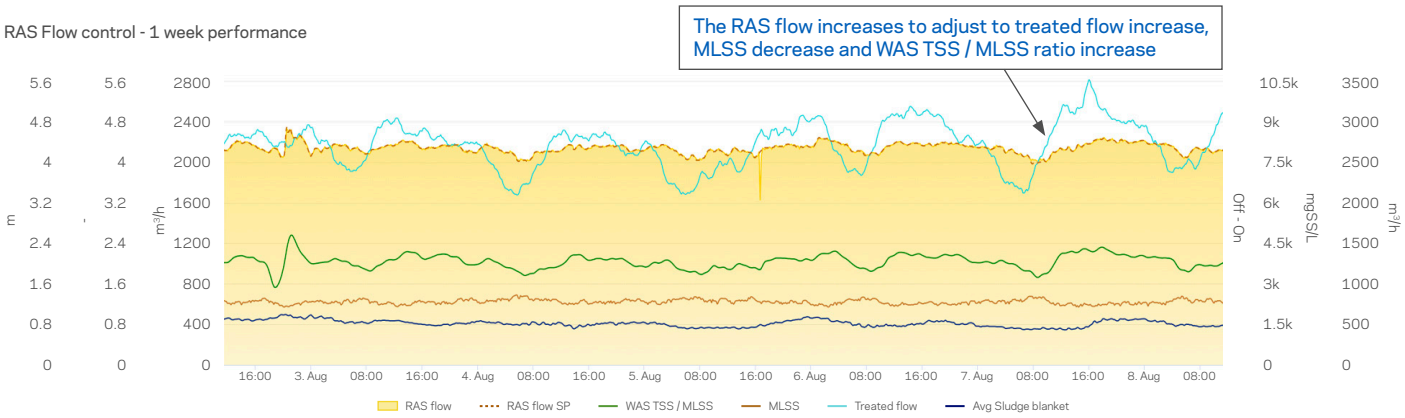
RASe-CONTROL (External recycling control)

How does it work?

This module **controls external sludge recycling (RAS) depending** on:

a) **Sludge blanket level in the clarifiers:** the higher the sludge level in the clarifiers, the higher is the recycled flow.
b) **Treated flow**, increasing recycling with higher treated flow, but also reducing the pumping in case this situation occurs when the sludge blanket is very high (to avoid high hydraulic velocities).
c) **MLSS in the bioreactors**, increasing the recycling pumping if the MLSS in the bioreactors drops below a certain level.
d) **WAS TSS/ MLSS ratio**, used as an indicator of the settlement properties of the sludge.

The control algorithms uses a Fuzzy Logic tool to adjust the recycled flow to self-adapt to all scenarios, to maintain plant performance.

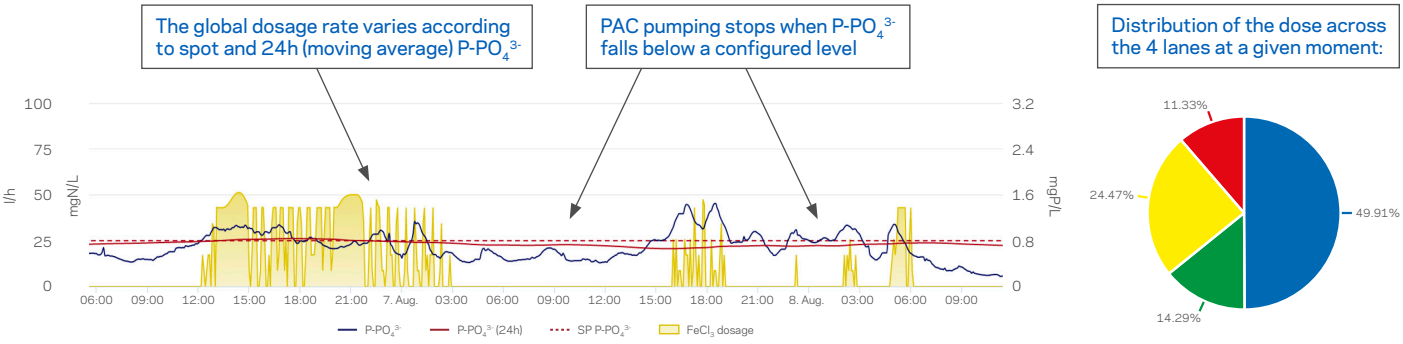


P-CONTROL ($FeCl_3$ dosing control)

How does it work?

This module controls the $FeCl_3$ **dosing pumps**. based on the bioreactor's effluent **$P\text{-}PO_4^{3-}$**, and also adjusted based on **$N\text{-}NO_3^-$** in each reactor (indicator used to estimate **$P\text{-}PO_4^{3-}$** release potential in each lane).

The control module applies dynamic dosage setpoints individually in each lane, to ensure that orthophosphates concentration (spot sample and 24h) are below the target defined, with a global dose as well as a smart individual bioreactor dose (based on nitrates) to ensure optimum efficiency of the of the chemical dosage.



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CREApro® PLATFORM - DATA ANALYTICS MODULES IMPLEMENTED

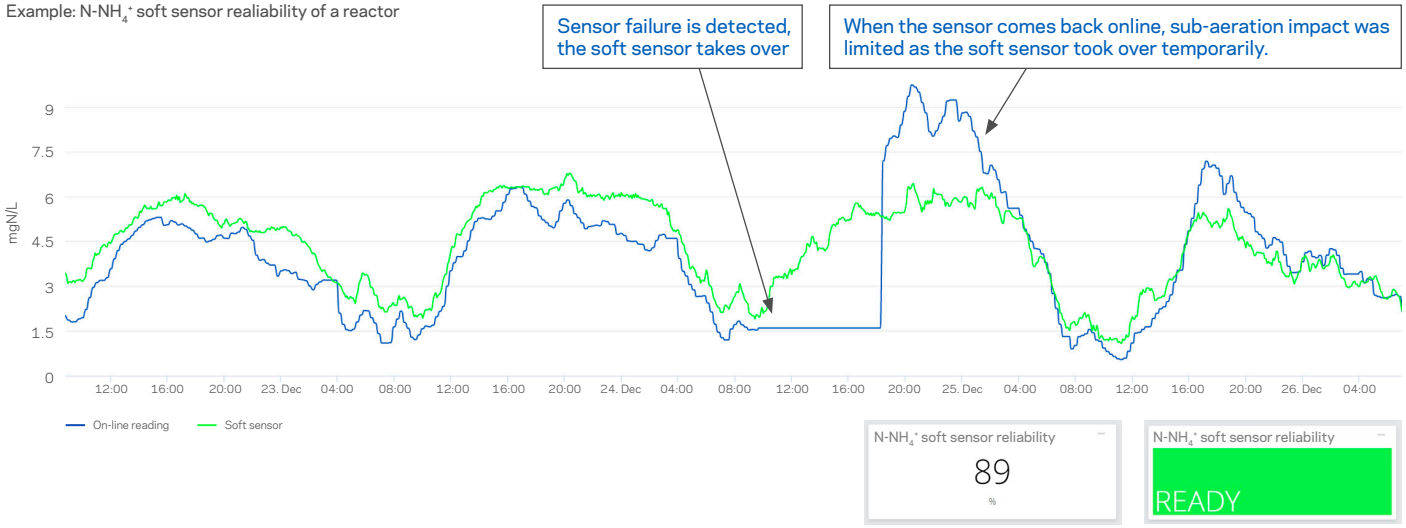
IDM and Soft sensors (Advanced data management and simulation)

How does it work?

The IDM module assesses in real-time the **reliability of key signals**, using a combination of **analysis functions** including assessment of slope, ground level, standard deviation amongst others. It then rates the reliability of each signal in real-time using a KPI in %. It also builds in real time soft sensors of the key signals, using **Artificial Intelligence** by building **self-adjusted models** by **Machine Learning**, and also assess in real time the reliability of each soft sensor to determine whether they are ready or not to be used.

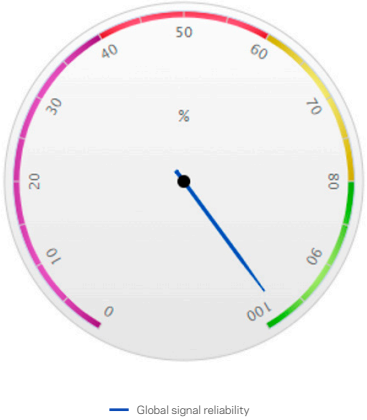
When the reliability of signal falls below a minimum level, the system deems it unreliable and uses in its place a replacement. Depending on user configuration, this alternative signal can be selected automatically based on highest reliability alternative by CREA, or manually. For example, such alternative signals for a bioreactor NH_4 sensor can be: the soft sensor, NH_4 sensor of another bioreactor or effluent NH_4 analyzer. It therefore enhances the **robustness** of the input data for the control, and therefore enhances the reliability and precision of the control itself.

Example: N-NH_4^+ soft sensor realiability of a reactor

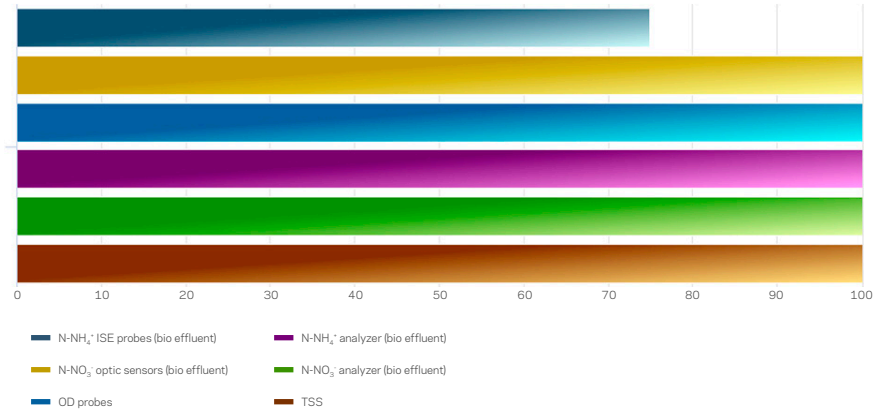


Overall signal reliability overview

Global signal reliability KPI



Signal reliability KPI per category



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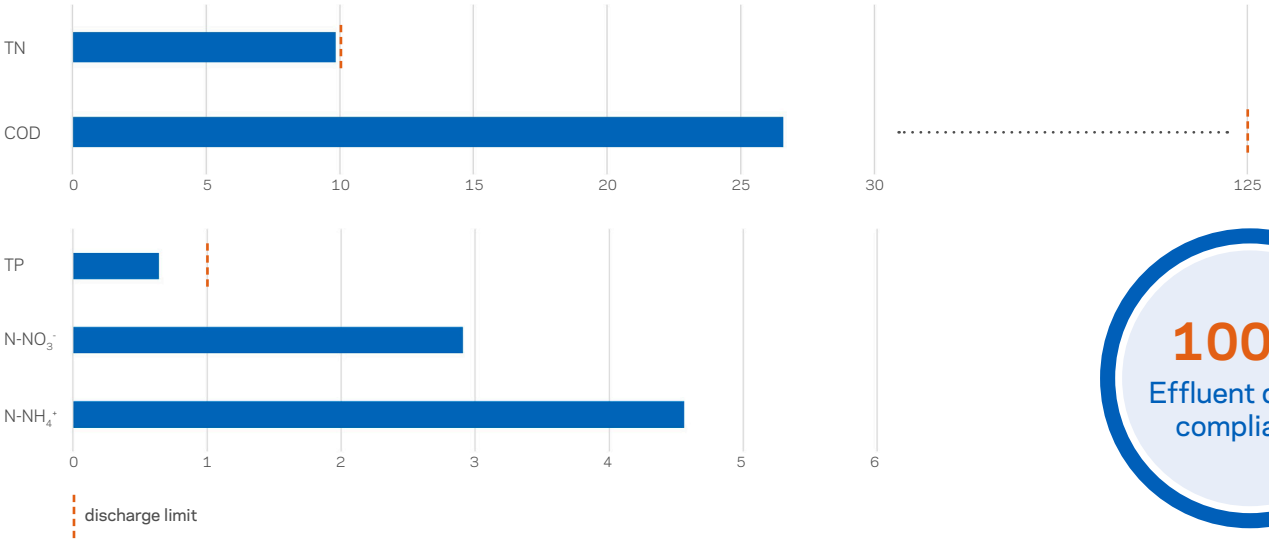
RESULTS

This section presents the results obtained with the platform performance in terms of effluent quality compliance, and the main KPIs related to process optimization comparing the performance of the site prior to starting optimization, and the final results after several steps of optimization (some modules and additional control logic were implemented later).

Effluent quality



100%
Effluent quality compliance

Energy and sustainability KPIs

	Reference	CREApro® complete installation	Difference
kWh / m³	0,231	0,239	3,3%
kWh / kg removed (NuR)	6,57	5,14	-21,8%
kWh / kg removed (Aeration)	4,72	3,67	-22,3%
kg$FeCl_3$ / kgTP removed	1,30	1,04	-20,0%
% TP removal (estimate)	29,3%	42,1%	43,9%

CLIENT CONCLUSIONS

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WWTP Manager
Aqualia - Aigües de Lleida

aqualia

"Different Creapro control modules implemented over 7 years of WWTP operation proved to be an affordable alternative to the upgrading and optimization of an existing WWTP and to comply with more stringent effluent quality."

"We consider Createch360 remote monitoring/assistance service an added safety benefit in process control. The Createch360 team is open minded, innovative and always open to new proposals and development. Each solution is fully customized and adapted to specific WWTP requirements".

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