

BIOCLOC: On line titrimeter as an innovative aeration control system in an industrial WWTP in Prato Textile District

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**G.I.D.A. S.p.A

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Since in a conventional activated sludge plant the energy demand is dominated by the aeration, attention has been focused on the development of new technologies, process configurations, and operational strategies aimed at **reducing energy consumption for oxygen transfer**



BIOCLOC Project



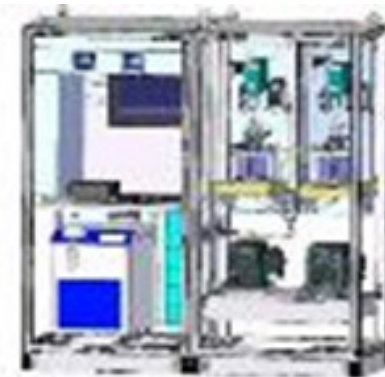
European Commission Programme LIFE+ Environmental Policy and Governance | LIFE 12 ENV/IT/000120
BIOprocess Control through Online titrimetry to reduce Carbon footprint in wastewater treatment



Validate an **innovative control strategy** which overcomes the disadvantage of delay in obtaining information about the nitrification due to the use of semi-batch offline respirometers/titrimeters and the monitoring of the process through direct (ammonia and nitrate sensors) or indirect (DO, pH, redox) measurements



A continuously fed online differential titrimer was designed, manufactured and installed within an industrial WWTP



The SITE : CALICE WWTP

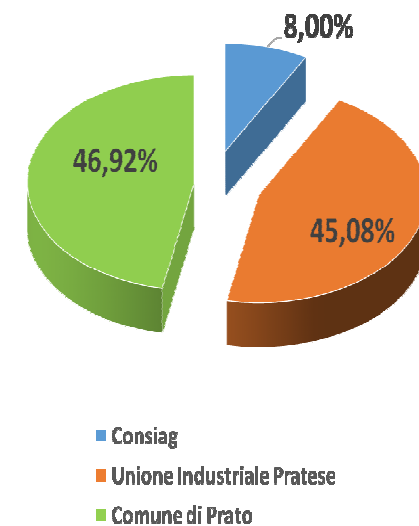
GIDA spa



Gestione Impianti Depurazione Acque S.p.A

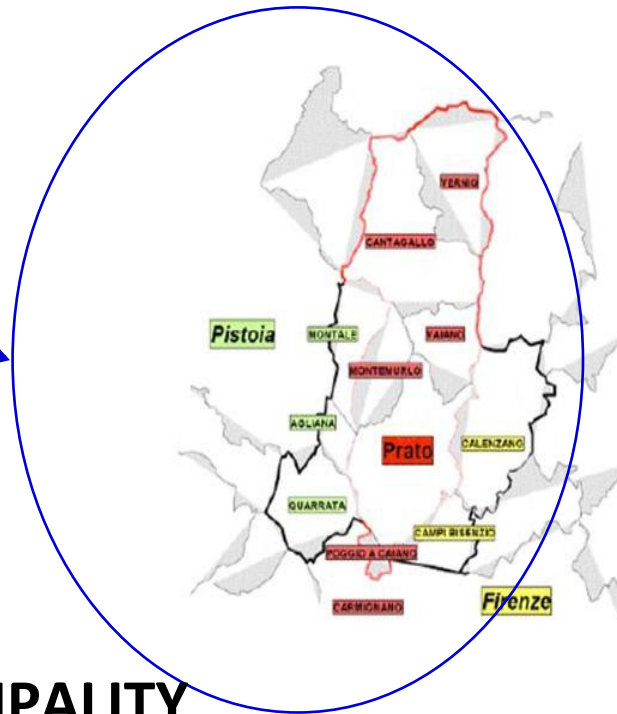
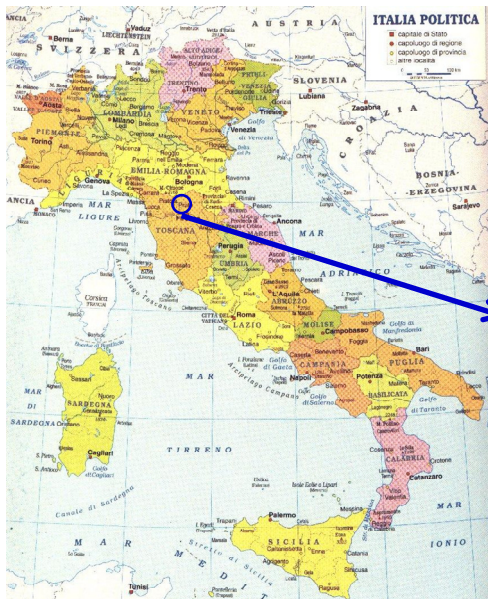
Private and public limited company consisting of three members:

- the Municipality of Prato
- the Confindustria Toscana Nord Lucca Pistoia Prato
- the CONSIAG Group

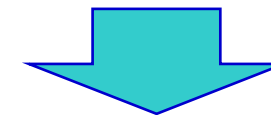


The territory

PRATO: TEXTILE AND FASHION DISTRICT



- 7.247 firms
 - 34.746 employees
 - 4.270 mln€ sales volume
 - 2.342 mln€ export
- ISTAT – UIP 2013 data*



PRATO MUNICIPALITY

- 248.292 inhabitants
 - 365 km²
 - Bisenzio river: 47 km
- ISTAT 2010 data*

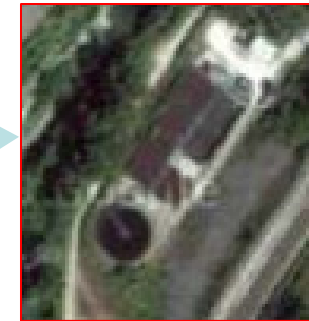
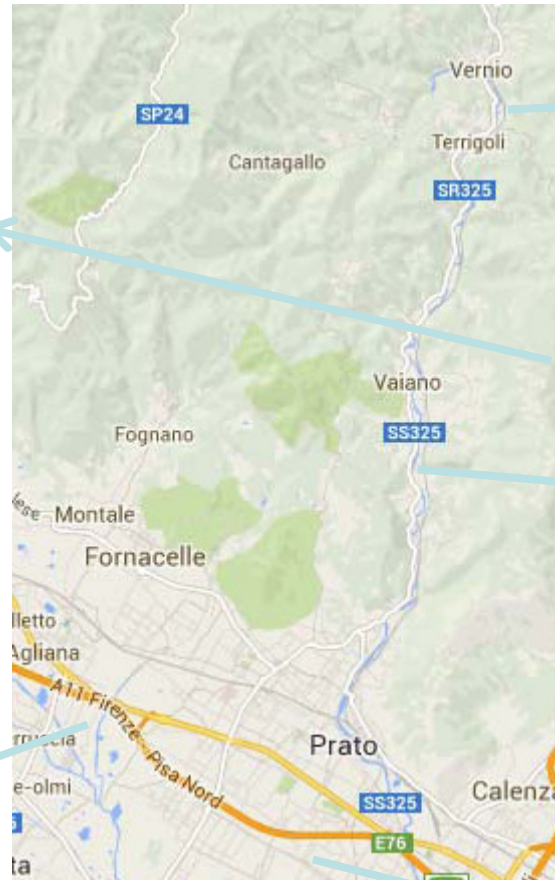


more than 50 mil m³
WASTEWATER
produced

GIDA SpA: the WWTPs



IDL CANTAGALLO



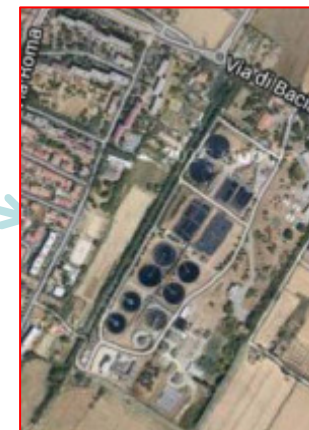
IDL VERNIO



IDL VAIANO



IDL CALICE



IDL BACIACAVALLO

G.I.D.A. SPA VISION



- To ensure workers safety and environment respect and protection through continuous improvement of
 - performance
 - energy - environmental certifications
- To invest in applied research on
 - new engineering and process technology
 - the development of the WWTP chemical and biological knowledge
- To become the reference WWTP in Europe

G.I.D.A. SPA : MISSION



- To provide the citizens and industries of the Province of Prato with environmental services in the field of wastewater and liquid waste.
- To offer recycling and distribution services for wastewater.
- To carry out the disposal of a large part of the residues from product treatment and provide services at a competitive rate.
- To conduct business in an environmentally friendly way and respecting environmental legislation.

G.I.D.A. SPA: Research and Development



- GOAL: increase theoretical and applied knowledge, investigate and implement new solutions, maintain a role of excellence in the field of water purification
- GIDA has achieved a high standard on advanced and applied research by a long-term cooperation with several partners:
 - University Departments
 - international and local suppliers
 - design offices
 - private stakeholders (i.e. Industrial Association)
 - public associations

GIDA SpA: the WWTP of Calice

The second treatment plant in Prato in size is Calice, located in the western part of the area, bordering the municipality of Agliana.

It flows into the sewage drained in the west of the city and those from the neighboring municipality of Montemurlo.

The plant was started in 1985.

In 2000 it was made a first structural adjustment, and then proceeded to a "doubling" almost mirror in 2002, with the creation of the new depurative line.

Lastly in 2007 it was made the refining system with sand filtration and ozone treatment.

GIDA SpA: the WWTP of Calice

Inside the Calice treatment plant perimeter there is a liquid waste treatment facility, in business since 1992.

The plant consists of two process lines, one dedicated to the processing of sludge from septic tanks and one for the treatment of landfill leachate (mainly).

The plant has undergone, during the 20 years of operation, a number of changes and adjustments, of which the main ones:

2007-2008

Realization of WWTP New Line and adjustment of liquid waste treatment plant, with construction of the ultrafiltration membrane section.

Treatment capacity: 6.000 m³/week;

Combined treatment of sludge from septic tanks and landfill leachate.

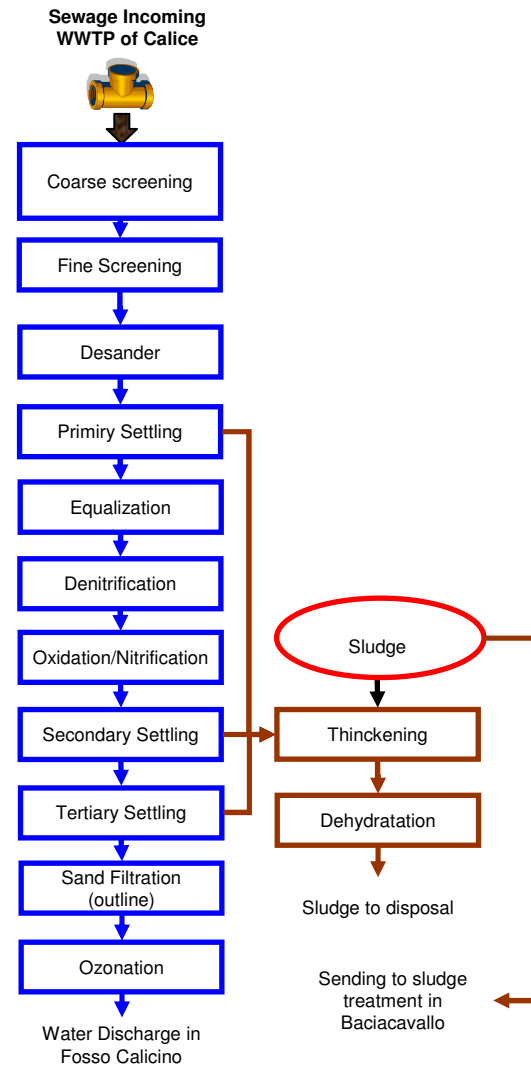
2009 - today

Separation of the treatment line one dedicated to the processing of sludge from septic tanks and one for the treatment of landfill leachate .

Treatment capacity : 6.000 m³/week;

Separated treatment of sludge from septic tanks and landfill leachate.

GIDA SpA: the WWTP of Calice



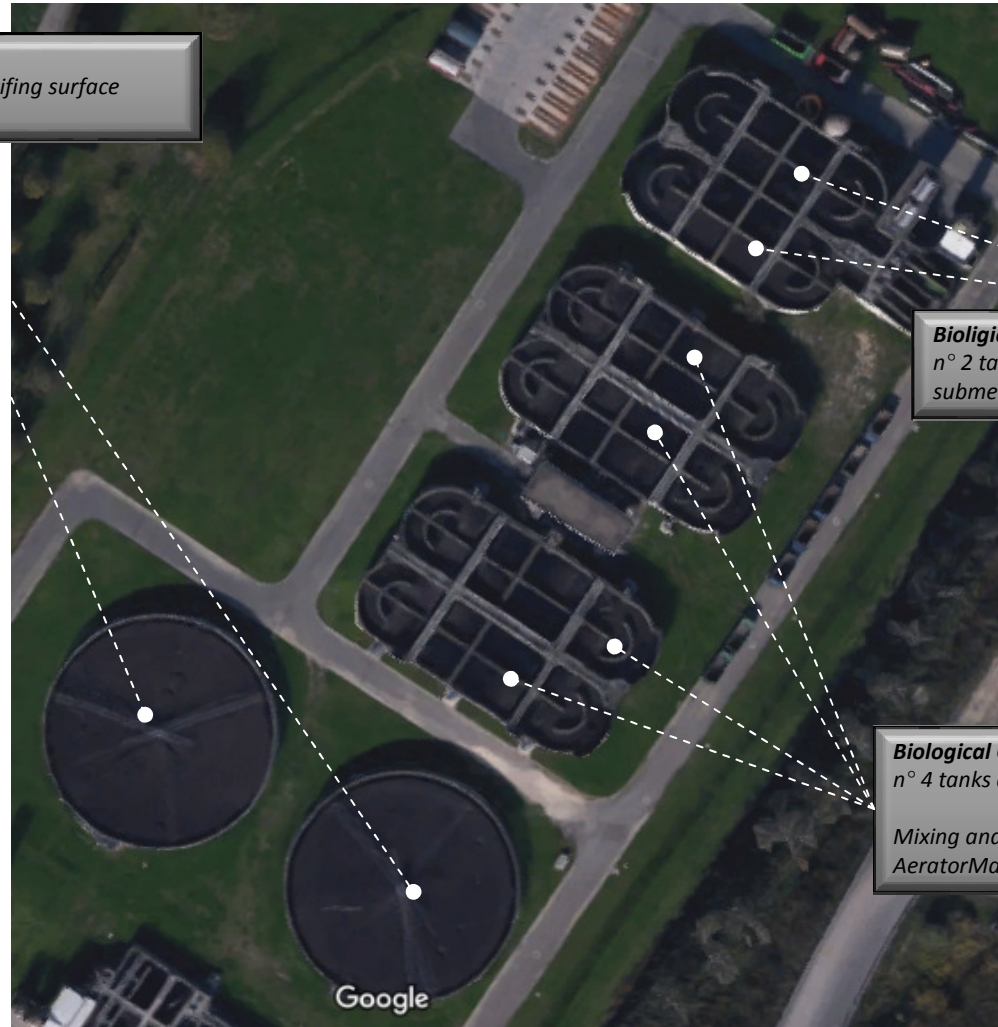
GIDA SpA: the WWTP of Calice – Secondary Treatment

Secondary settling

n° 2 tanks of 5.024 m³ each. Total clarifying surface about 2.514 m²



OUT 2°



Biological Denitrification

n° 2 tanks of 3.000 m³ each with electrical submerged mixers.

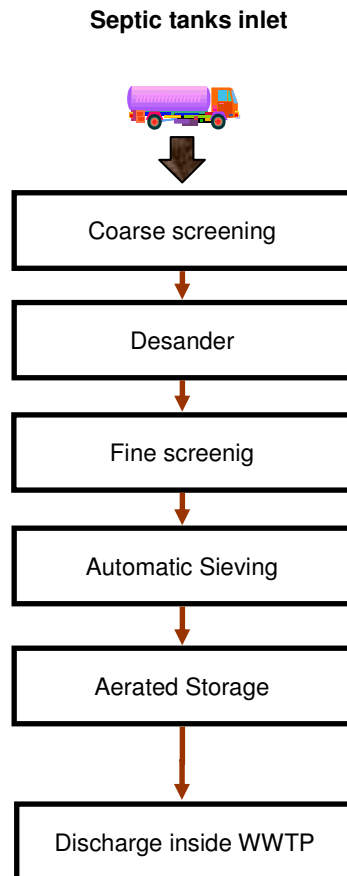
Biological Oxidation

n° 4 tanks about 3.750 m³ each.

Mixing and aeration system with compressors Jet AeratorManifold MTS.

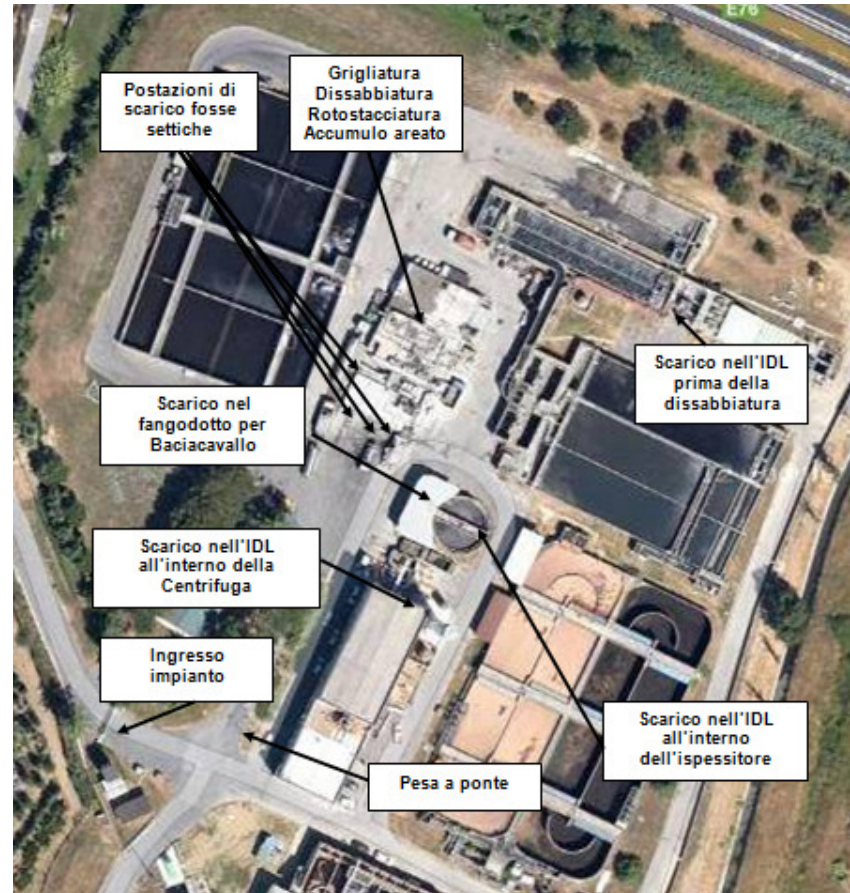
GIDA SpA: the WWTP of Calice – Liquid Waste Treatment (S.T.)

Process lines dedicated to the processing of sludge from septic tanks



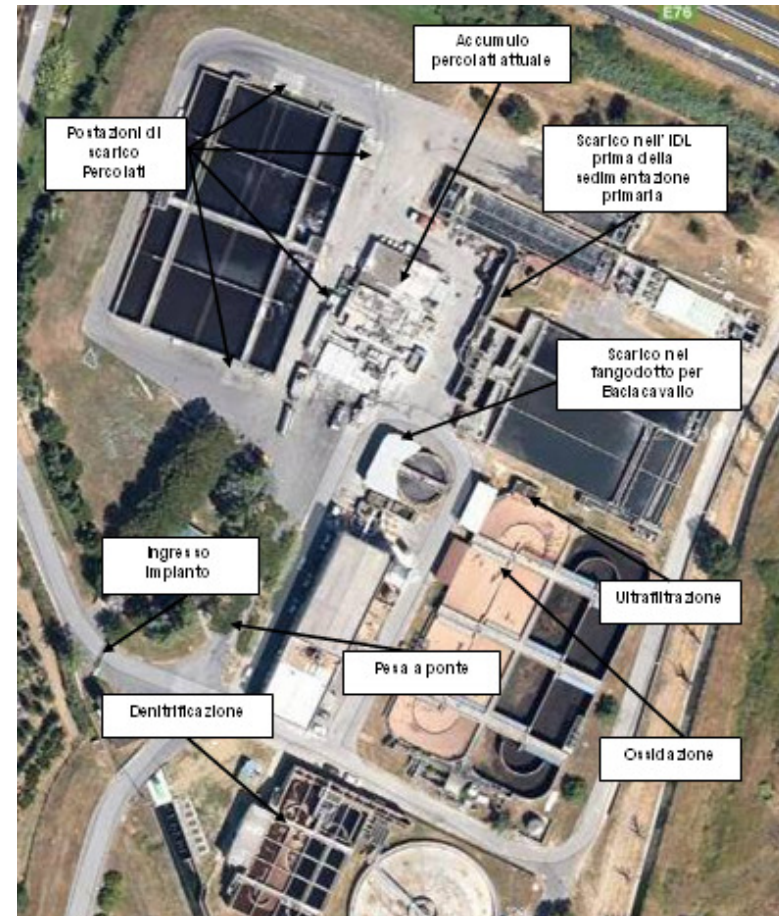
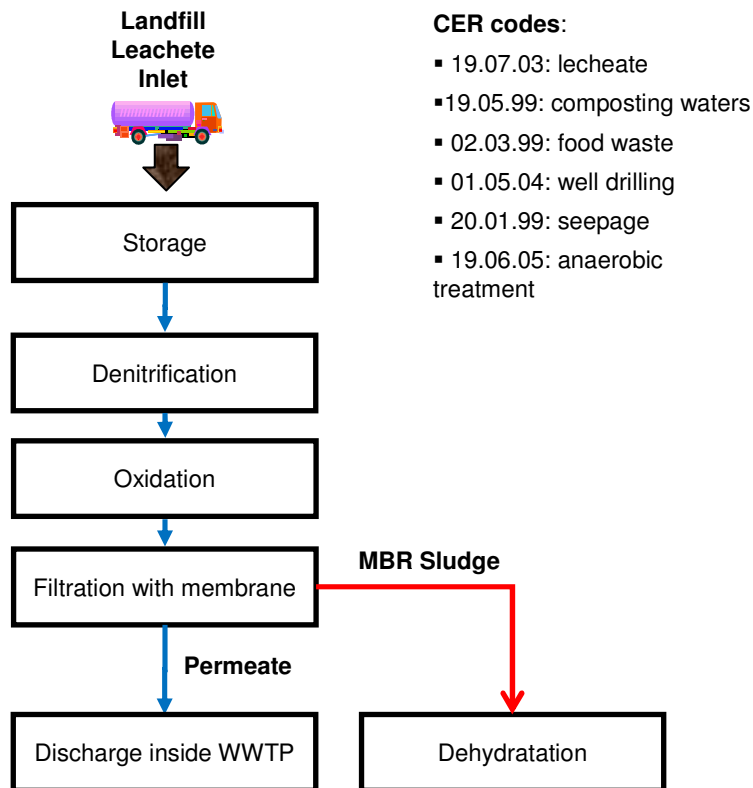
CER codes:

- 20.03.04: septic tanks
- 20.03.06: sewage cleaning



GIDA SpA: the WWTP of Calice – Liquid Waste Treatment

Process lines dedicated to the processing of landfill leachates (mainly)



GIDA SpA: the WWTP of Calice – Liquid Waste Treatment (L.L.)

Membrane Filtration Reactor (MBR)

Service: filtration of aerated mixture coming from the oxidation tank for solid-liquid separation with formation of a permeate flow free of solids in suspension and a retentate stream to be recirculated into the oxidation tank.

Membrane Features

Configuration: *aerobic MSBR [Membrane Separation Bioreactor]*

Geometry of the modules : *Reinforced Hollow Fiber*

- Filtration mode: Cross-Flow
- Filtration flux: OUT/IN
- Fiber external diameter: 1,9 mm
- Fiber internal diameter: 0,8 mm

Chemical Nature of the constituent materials: Polymeric
The support layer is made of a macroporous polymer coated externally by a further polymer filter element:

- Construction materials: PVDF

Structure: *Asymmetric*

The membrane is constituted by a support layer coated externally by a filter element:

- Nominal porosity: 0,04 μm
- Absolute porosity: $\leq 0,1 \mu\text{m}$

Molecular weight substances deductions:

Between 500 and 10,000 Dalton - Ultrafiltration (UF)



LIFE + Environmental Policy and Governance
BIOCLOC
Project n° LIFE12 ENV/IT/000120
Duration: Sep 2013 – Feb 2017



Objective of the project

1) TO DEMONSTRATE AN INNOVATIVE TECHNOLOGY

The project demonstrate the suitability of **an innovative instrument for activated sludge processes control based on the online measurement of nitrification rate.**

An innovative automatic control strategy

Both the instrument (the prototype) and the control strategy are new and allow to optimize the operation of the plant.

2) TO IDENTIFY OBSTACLES TO THE DIFFUSION OF INNOVATIVE TECHNOLOGIES AND TO PROMOTE THE APPLICATION OF SCIENTIFICALLY VERIFIED TECHNOLOGY

The **potential** of titrimetry in the automatic control of activated sludge processes, is still to be exploited. **This project overcomes this limit through the use of a new titrimer.**

Objective of the project

The instrument allows to **measure continuously the nitrification rate in the aerobic basin of the WWTP.**

The innovative process control strategy, based on the innovative monitoring approach, has been implemented in the aeration basin.

The variables controlled:

- oxygen concentration
- solids retention time in the aerobic basin.

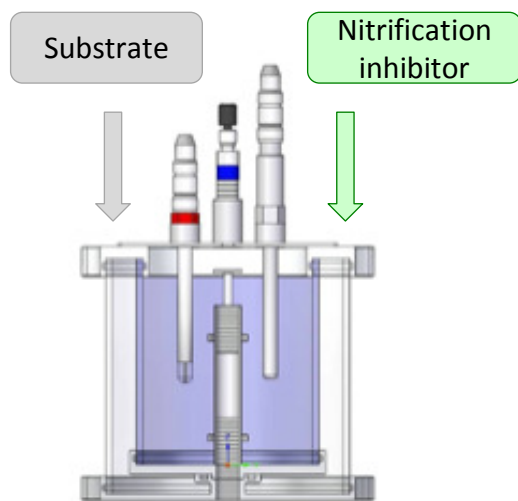
This strategy allows to **optimize the operation** of the plant in terms of **oxygen transfer efficiency, effluent quality and quality of the sludge.**

The occurrence of nitrification inhibition phenomena will be identified immediately.

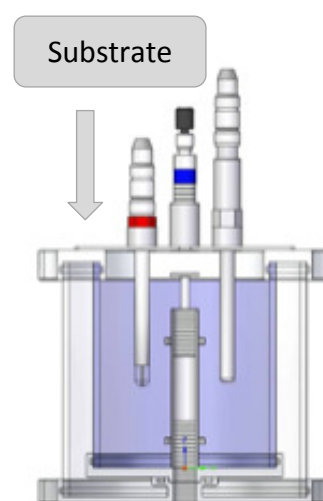
Continuous differential titrimetry

The estimation of the nitrification rate through **titrimetry** relies on the possibility of using nitrification inhibitors to compare the alkalinity consumption in both the presence and the absence of the inhibitor.

The difference between alkalinity consumption rates of inhibited and non-inhibited identical reactors enables identification of the **alkalinity consumption due to nitrification**, which is **proportional to the oxidized substrate** as a function of the stoichiometry of the process.



R1 (inhibited)



R2 (non inhibited)



Experimental results

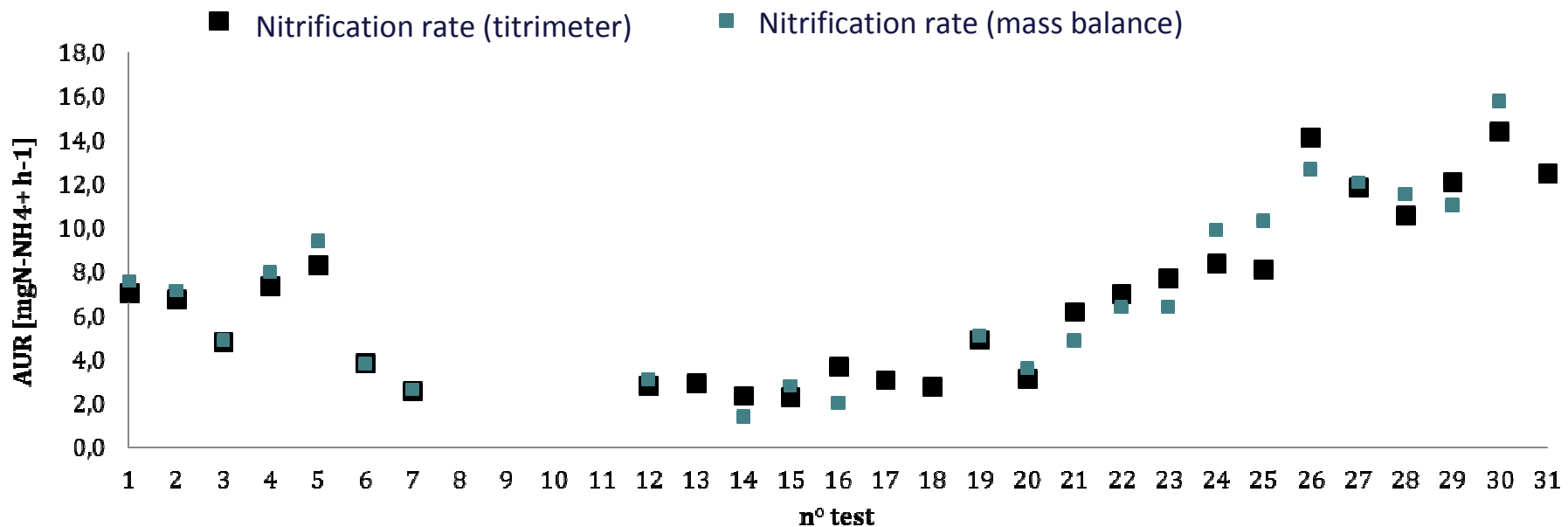
Comparison between the nitrification rate measured with the titrimeter and the nitrification rate obtained from the traditional nitrogen mass balance (colorimetric analysis of the inhibited and non-inhibited reactor effluents)



Very good agreement

The percentage difference between these values: below 5%

Nitrification rates obtained with the titrimeter were also confirmed by the results obtained from the mass balance on the experimental data of Calice WWTP



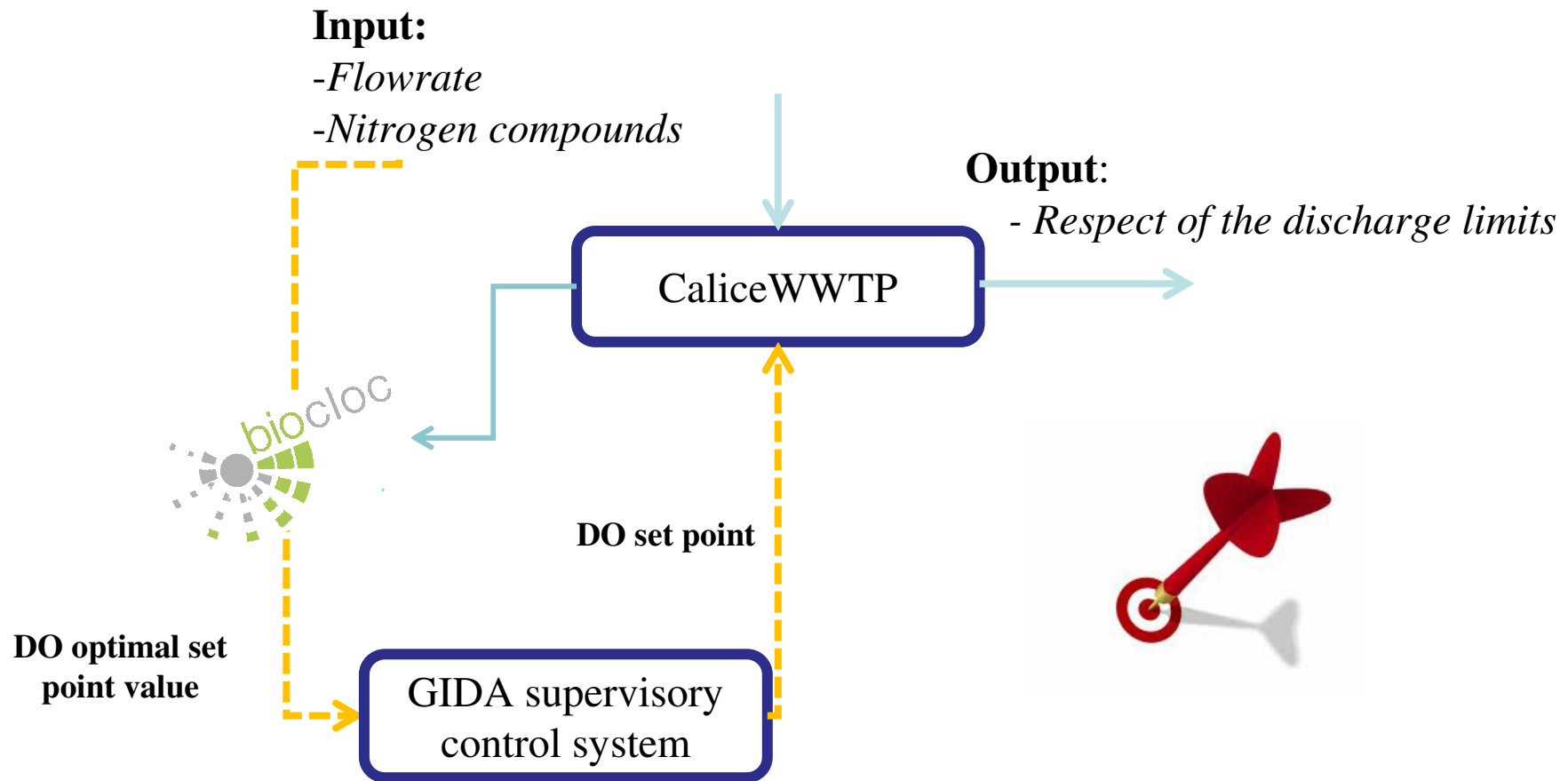
Titrimetry as tool for the aeration control system

The results demonstrated that **titrimetry is a suitable tool for continuously measuring the nitrification rate**

The results obtained during the tests allowed for optimizing the technology, in terms of **accuracy** of the measurements, the **stability** of the operation, **significance** of the results of the titrimetric test with those of conventional nitrification-control methods

Having validated the values obtained, the monitoring of the **Calice aeration system** will no longer be based on DO measurements and measurements of the effluent characteristics, but rather on the **values of the nitrification rate** calculated continuously and in real time

The application of the titrimer as the instrument for continuous monitoring of the aeration process of the Calice plant foresees a **calculation algorithm** which, given the value of the nitrification output rate from the titrimer, and in view of the objective of removing the nitrogen as well as the concentration of input nitrogen in the plant, restores the DO value to be used as the set point for the aeration



DO set point change: frequency and values

**THANK YOU FOR YOUR
ATTENTION**

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