


IWA International Water Association
IWA Task Group on "Benchmarking of Control Strategies for Wastewater Treatment Plants"
Watermatex2007 Workshop, 6 May 2007, Washington DC, USA

IWA TG on Benchmarking of Control Strategies for WWTPs

Why do we need control? Is control really needed? What are the benefits?

6 May 2007
Washington DC, USA

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Outline

- What is control ?
- Main Control Requirements in WWTPs
- Why on-line control ?
- Economical feasibility
- Four real life case studies
- Pros and cons of closed loop control


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What is control ?

Objective: keep it stable to land safely the planes

The disturbances



The process




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What is control ?

First option: "Make it big !"

The disturbances have small effects

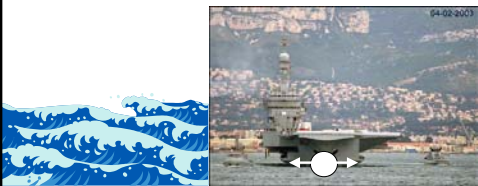


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What is control ?

Second option: use closed loop control



Active control to counteract the disturbances


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What is control ?

Active control (a "ball" inside)

Passive control ("big volume")



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Main Control Requirements in WWTPs

Objectives : Process regulation in the presence of internal/external disturbances and uncertainty

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What to control? Which control handles?

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Why on-line control ?

toy or tool?

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Why on-line control ?

toy or tool?

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Why on-line control ?

toy or tool?

Better respect of setpoints
Improve savings (e.g. aeration)

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Economical feasibility - Cost assumptions

Investment costs	Cabin + Sample Pretreatment	10 000
(in euros)	Analysers: NH₄ NO₃ PO₄	28 000
Operational costs	Man hours	4 000
(in euros)	Maintenance	2 000
	Reagents & Parts	2 000

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Economical feasibility - Return estimates


- On-line control results in **15 %** reduction of aeration energy (aeration energy estimated as **50 %** of total energy bill)
- On-line control results in **20 %** reduction of dosage

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Case study: Houthalen - Alternating plant

- Design load: 30.000 PE
- Increased load due to central sludge dryer condensate and centrate

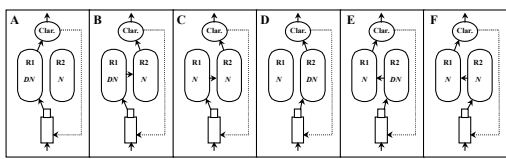


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Case study: Houthalen - Alternating plant

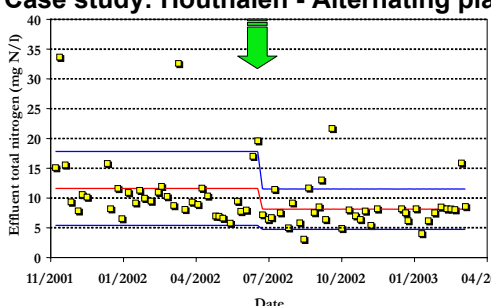
- Implementation of on-line NH_4 and NO_3 measurements
- Phases controlled based on these measurements



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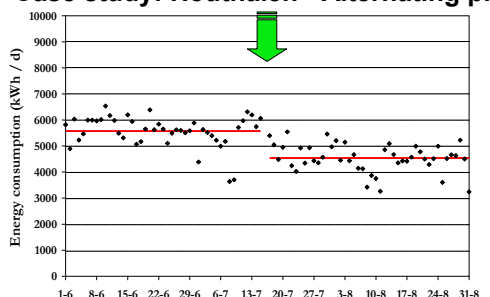
Case study: Houthalen - Alternating plant



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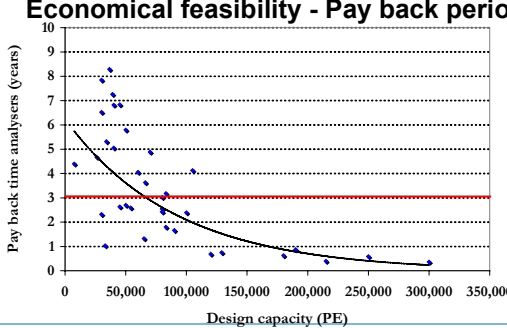
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Economical feasibility - Pay back period



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The WWTP of Galindo-Bilbao

Plant Characteristics (Secondary Treatment)

- Designed for C and N removal using RDN and DRDN processes
- Six parallel lines receiving a total maximum flow of 345.600 m³/day
- Effluent requirements: N-NH₄ < 2.0 mgN/l and N-NO₂ < 10.0 mgN/l

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The WWTP of Galindo-Bilbao

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The WWTP of Galindo-Bilbao

Objective

- Optimum use of the Plant Capacity improving **process stability** and **effluent quality** with **minimum cost**

Technical Solution: Control Strategy for

- Automatic selection of the references for:
 - DO Set-point in the aerobic reactors
 - Recirculation ratio of Nitrates to the anoxic zone
 - Excess of sludge extracted from the process
- Supervisory control conceived as a way to:
 - Select the Set-points for the conventional SCADA
 - Leaving the human decision for the top of the hierarchical plant control
- The Control Loops should be "transparent" for the people in charge of the Plant Operation

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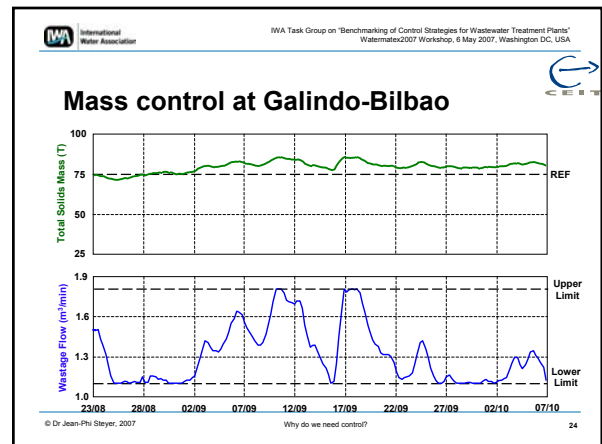
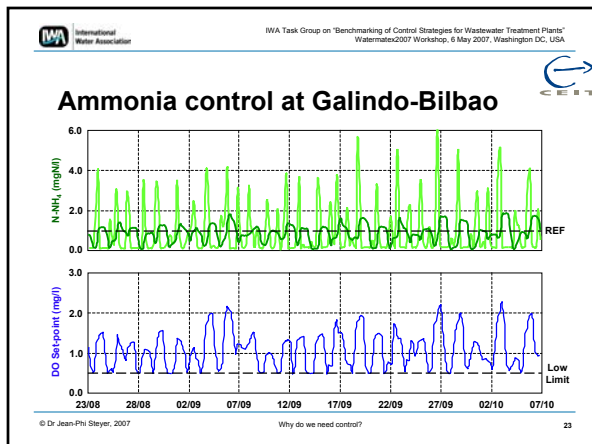
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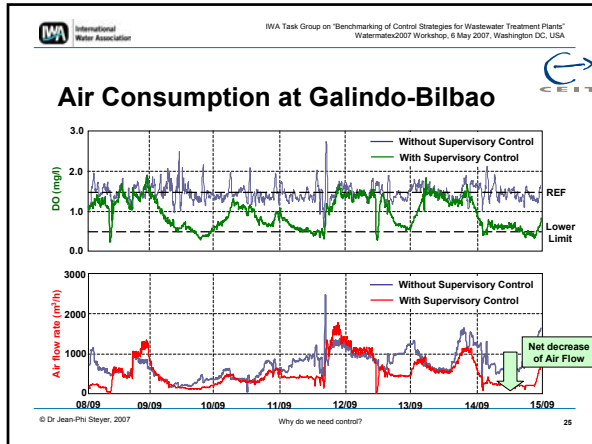
The WWTP of Galindo-Bilbao

Full-scale Experimental Validation

- Process stability**
- Reduction of total **Nitrogen** (1-2 mgN/l)
 - Optimum use of the Denitrification Potential
- Reduction of **Air Flow** (10-15%)
 - Use of higher amount of Nitrates as electron acceptor
 - Improved oxygen transfer at lower DO concentration
 - Removal of the Ammonia strictly required to accomplish the effluent requirements

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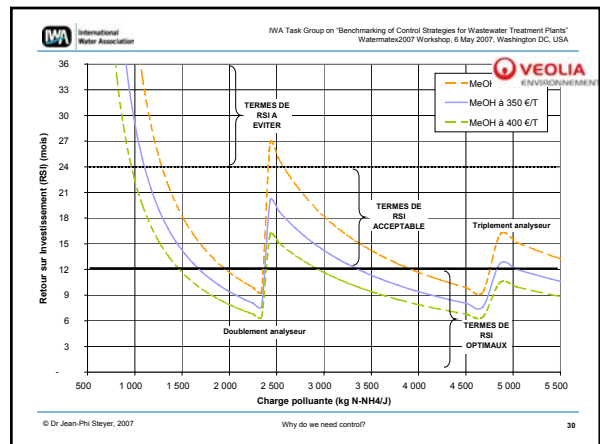
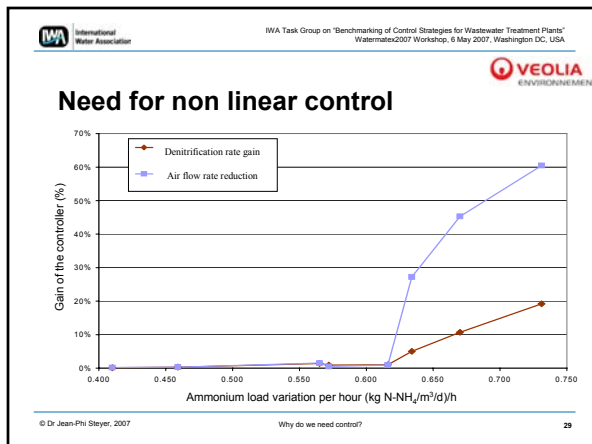
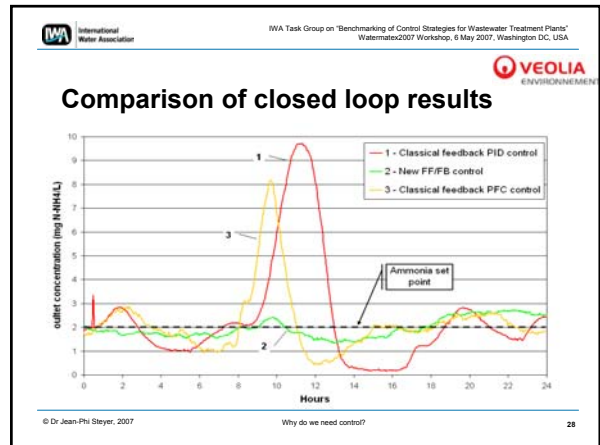
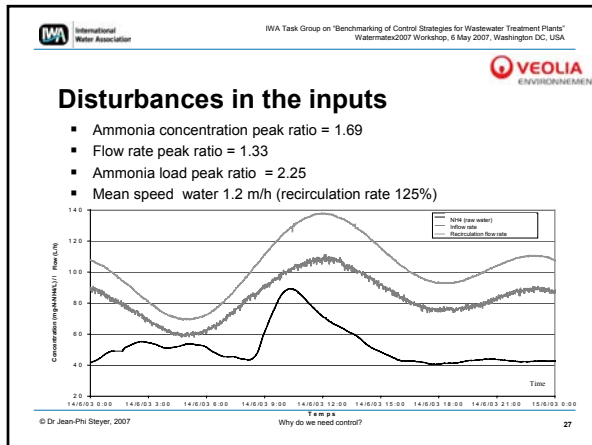
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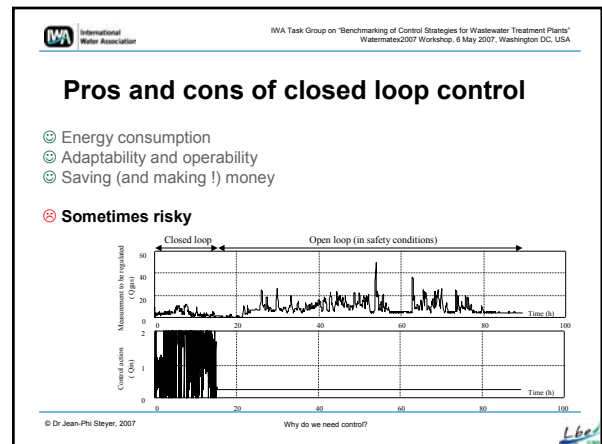
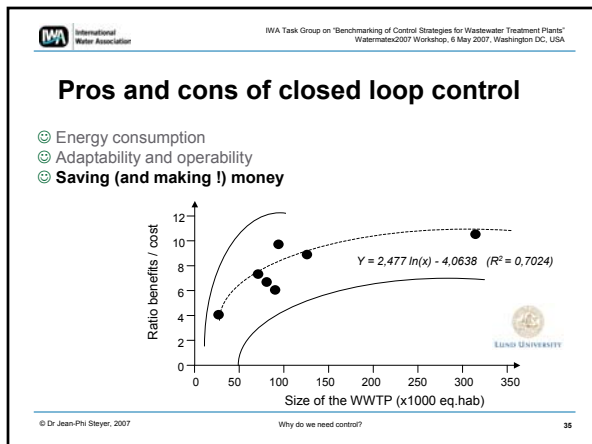
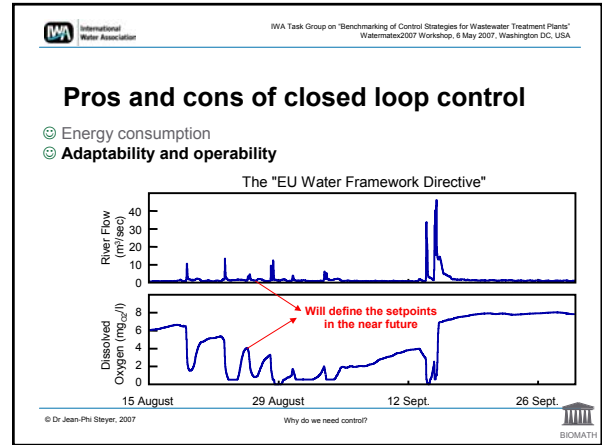
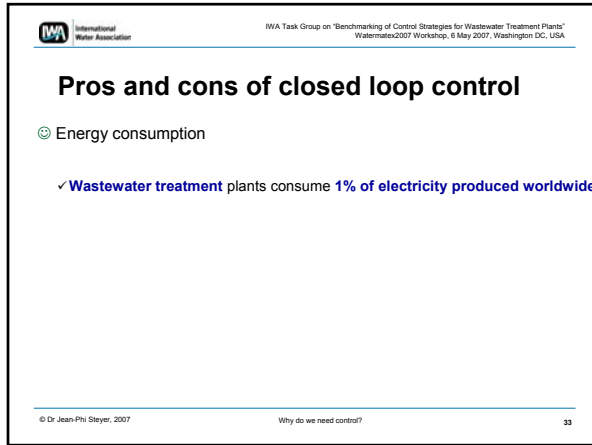
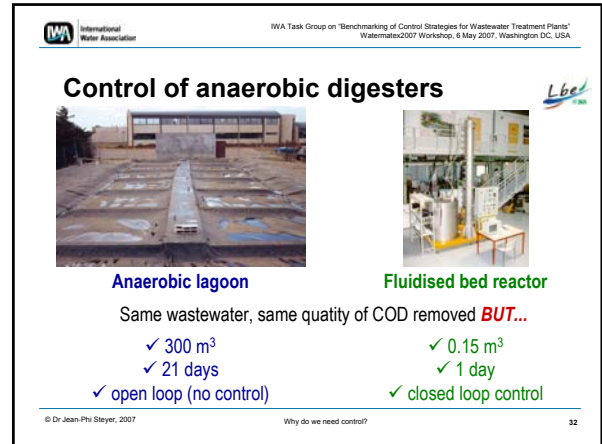
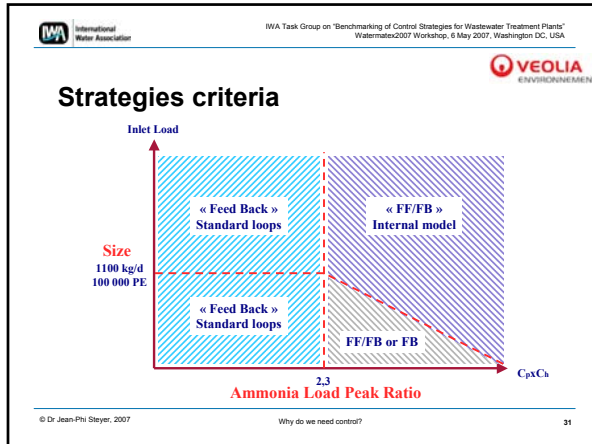
Advanced control for Biostyrs

Objective: Simultaneous Nitrification / Denitrification

- Performance constraints
 - Following precisely the Ammonium set point (2 mg N-NH₄/L)
 - Minimize the air flow rate
 - Minimize the nitrate production
- Cost effective solution
 - Optimize number and type of sensors
 - Sensor position
 - Maintenance (operating cost)

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Which control approach is the best ?

The smaller, the better ?
The more active, the better?



Needs for benchmarking !!!

In practice, let's keep in mind the "KISS" principle !

Many thanks to

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Cyrille Lemoine (Anjou Recherche, Veolia)
Eduardo Ayesa (CEIT)

And to you for your attention !

*We do not inherit our land from our ancestors
but we borrow it to our children*

