



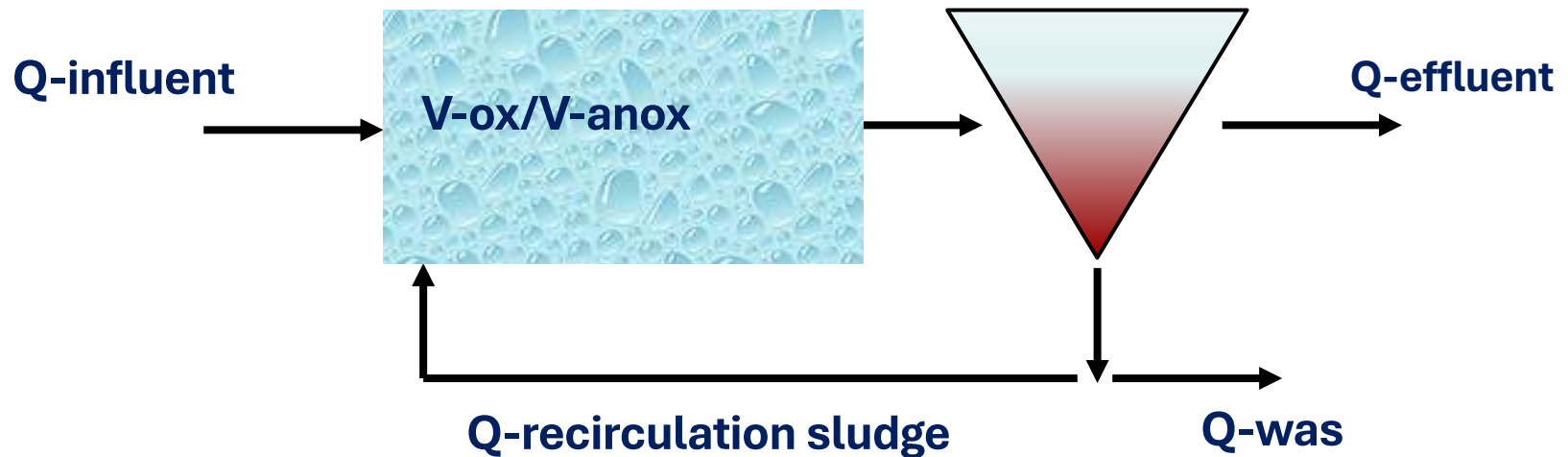
INGEGNERIA AMBIENTE (IA)

ALTERNATE CYCLES PROCESS FOR MUNICIPAL & INDUSTRIAL TREATMENT PLANTS



Definition of «Alternate Cycles»

The term «**Alternated Cycles (AC)**» refers to a software engineered for the biological process of WWTPs, to **control automatically – start and stop – oxic and anoxic phases** into the same reactor





ALTERNATE CYCLES (AC)

PROCESS SOLUTION & TECHNOLOGY > MUNICIPAL TREATMENT PLANT



What we obtain with AC process

**TN
Removal**



$\geq 80\%$

**Energy
saving**



$\geq 35\%$

**P
reduction**



$\geq 25\%$

**Sludge
reduction**



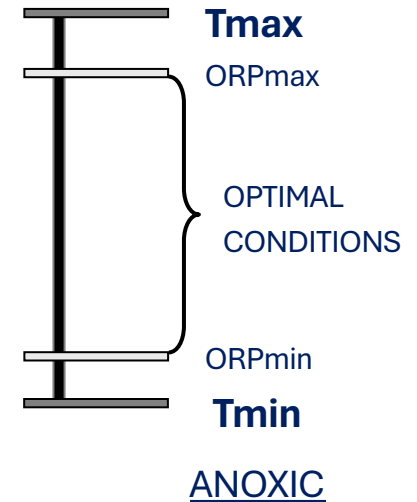
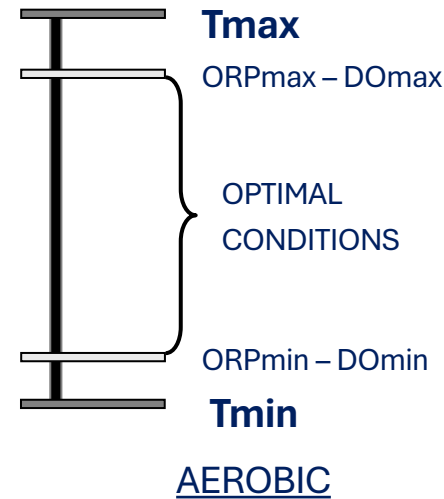
$\geq 10\%$



What do we set with AC ...

The AC control defends the process (Tmin and Tmax) and trusts in high performances searching OP conditions

- **The lenght** of the alternating oxic and anoxic phases (Tmin / Tmax)
- **Set-point** of OD and/or ORP probes (OD min – OD max – ORP min – ORP max)
- **Optimal conditions** for the aerobic or anoxic phase; once the optimal condition is achieved, the automatic control device switches phase from aerobic to anoxic and vice versa.



What do we set with AC ...

Aerobic panel

Parametri Cicli Alternati

Nitro OD Nitro ORP Denitro ORP

Settaggio Sonde OD Fase NITRO.

	S V	Valori di Riferimento OD			Valori di Riferimento ORP			Valori DH		
		Sonda Rif.	OD Max	OD Min	Sonda Rif.	ORP Max	ORP Min	ALFA	BETA	GAMMA
OD 1	☒	OD 1	5.0	0.0	ORP 1	1000.0	-1000.0	1.0	1.0	1.0
Misura	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
Misura	☐		20	0.0		1000.0	-1000.0	1.0	1.0	1.0
Misura	☐		20	0.0		1000.0	-1000.0	1.0	1.0	1.0
ODFIT1	☐		20	0.0		1000.0	-1000.0	1.0	1.0	1.0
ODFIT2	☐		20	0.0		1000.0	-1000.0	1.0	1.0	1.0
ODFIT3	☐		20	0.0		1000.0	-1000.0	1.0	1.0	1.0

Tempo Massimo (min): 120
Tempo Minimo (min): 30

Tempo Prolung. Fase Ottimale (min): 2

Applica Conferma Annulla

Set point
ORP Probes

Set point
OD Probes

Minimum and
Maximum Time

Anoxic panel

Parametri Cicli Alternati

Nitro OD Nitro ORP Denitro ORP

Settaggio Sonde ORP Fase DENITRO

	S V	Valori di Riferimento OD			Valori di Riferimento ORP			Valori DH		
		Sonda Rif.	OD Max	OD Min	Sonda Rif.	ORP Max	ORP Min	ALFA	BETA	GAMMA
ORP1	☒	OD1	20.0	0.0	ORP1	50.0	-200.0	1.0	1.0	1.0
ORP2	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
ORP3	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
ORP4	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
ORPFIT1	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
ORPFIT2	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0
ORPFIT3	☐		20.0	0.0		1000.0	-1000.0	1.0	1.0	1.0

Tempo Massimo (min): 110
Tempo Minimo (min): 15

Tempo Prolung. Fase Ottimale (min): 5
Tempo Prolung. Miscelazione (min): 0

Applica Conferma Annulla

Set point
ORP Probes

Minimum and
Maximum Time



«Statistics» in the panel control

Online and in real time you can control the process using the statistic panel (uploaded in the software) for control the **optimal conditions percentage at the end of each cycle**

Statistiche Cicli Alternati

Impostazione Filtro Rapporto

Periferica:

Data Inizio: **settembre 2007**

Data Fine: **settembre 2007**

Ora Inizio: Ora Fine:

Num.	Data / Ora	Causale	Durata ciclo (min.)	Stumentc
85	05/09/2007 9.32.08	C.Ottimale Nitro OD.	45	OD2
86	05/09/2007 10.36.29	C.Ottimale Denitro ORP.	64	ORP1
87	05/09/2007 11.42.55	C.Ottimale Nitro ORP.	66	ORP2
88	05/09/2007 12.50.36	C.Ottimale Denitro ORP.	68	ORP1

Fase Aerobica **Fase Anossica**

Numero Cicli Totali: **178**

Durata del Ciclo

Media: **40.57 min.**

Minima: **24.0 min.**

Massima: **94.0 min.**

Valutazione Fine Ciclo

Condizione Ottimale: **81.46 %**

ORP Min: **0.56 %**

Tempo Max: **17.98 %**

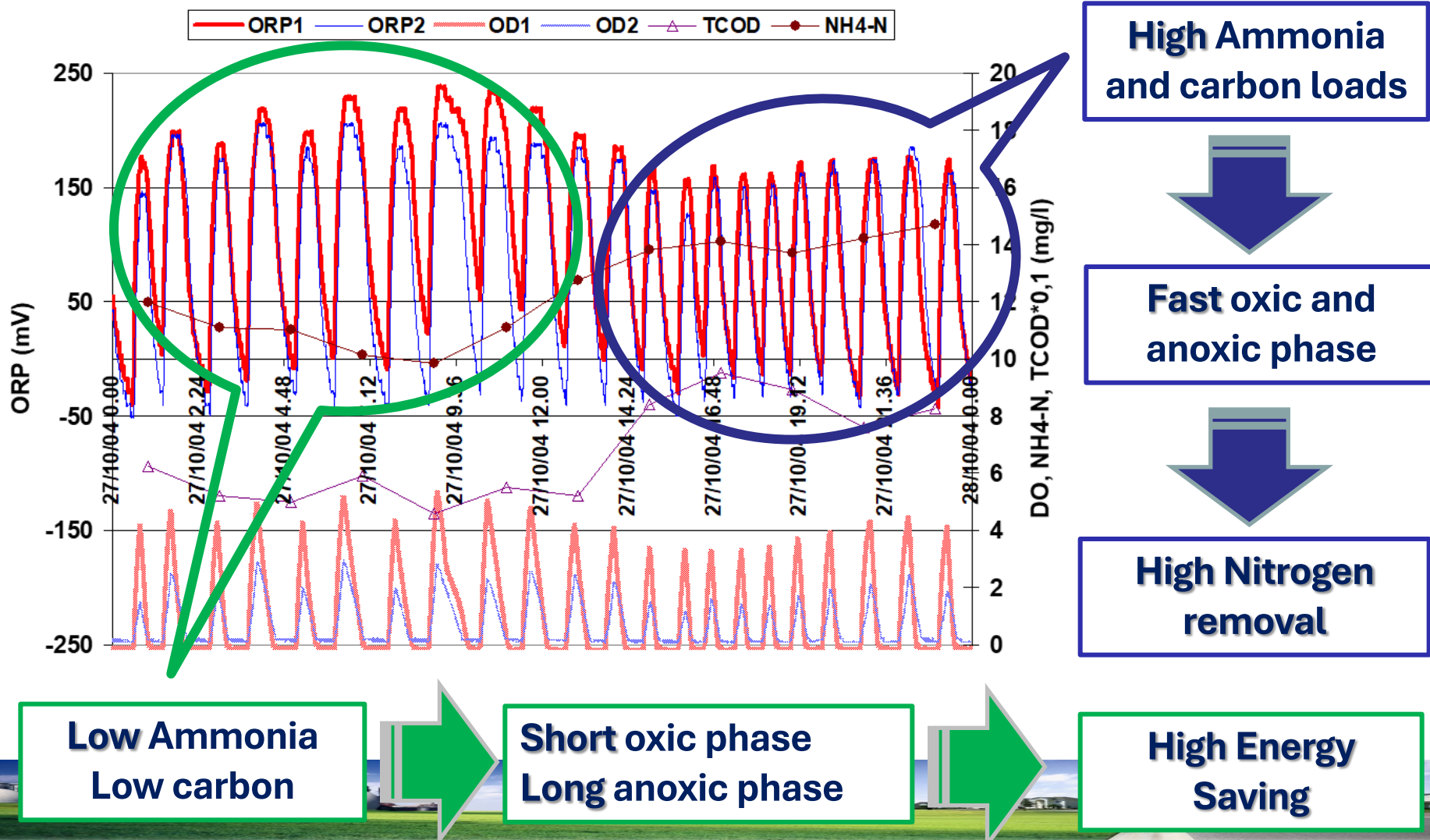
Select a period

You know in Aerobic and Anoxic phase>

- Number of cycles
- Length of the phase (med-min-max)
- Set Point, Tmax, or OC of end cycle

What «optimal conditions» are ...

The length of a phase depends on the Nitrogen and Carbon load in the reactor...Ammonia in Aerobic phase and Nitrates in Anoxic phase

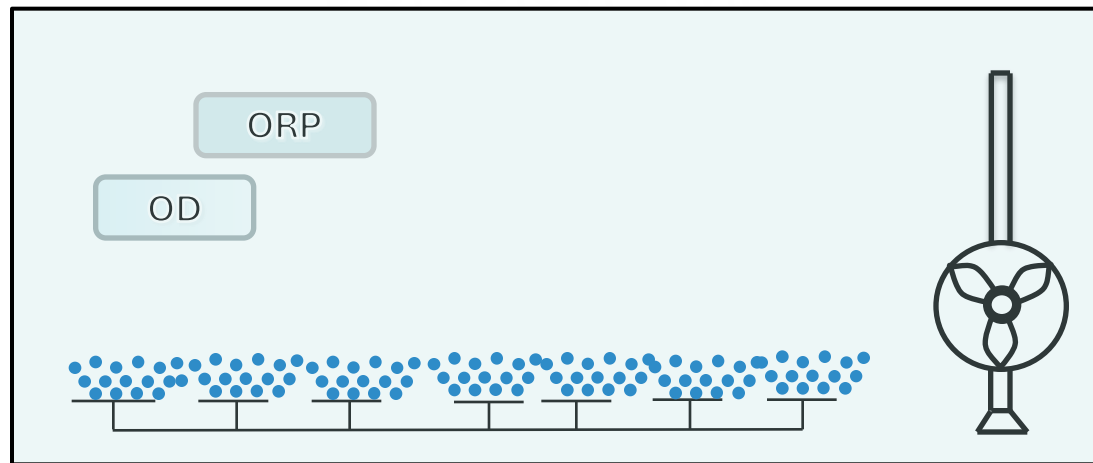


What is needed in the reactor ...

Mixer

BIOLOGICAL TANK

**Probes
DO & ORP
(& TSS)**



In long reactor two pairs of probes (DO and ORP) are used.
One TSS probe is enough.

Air supply



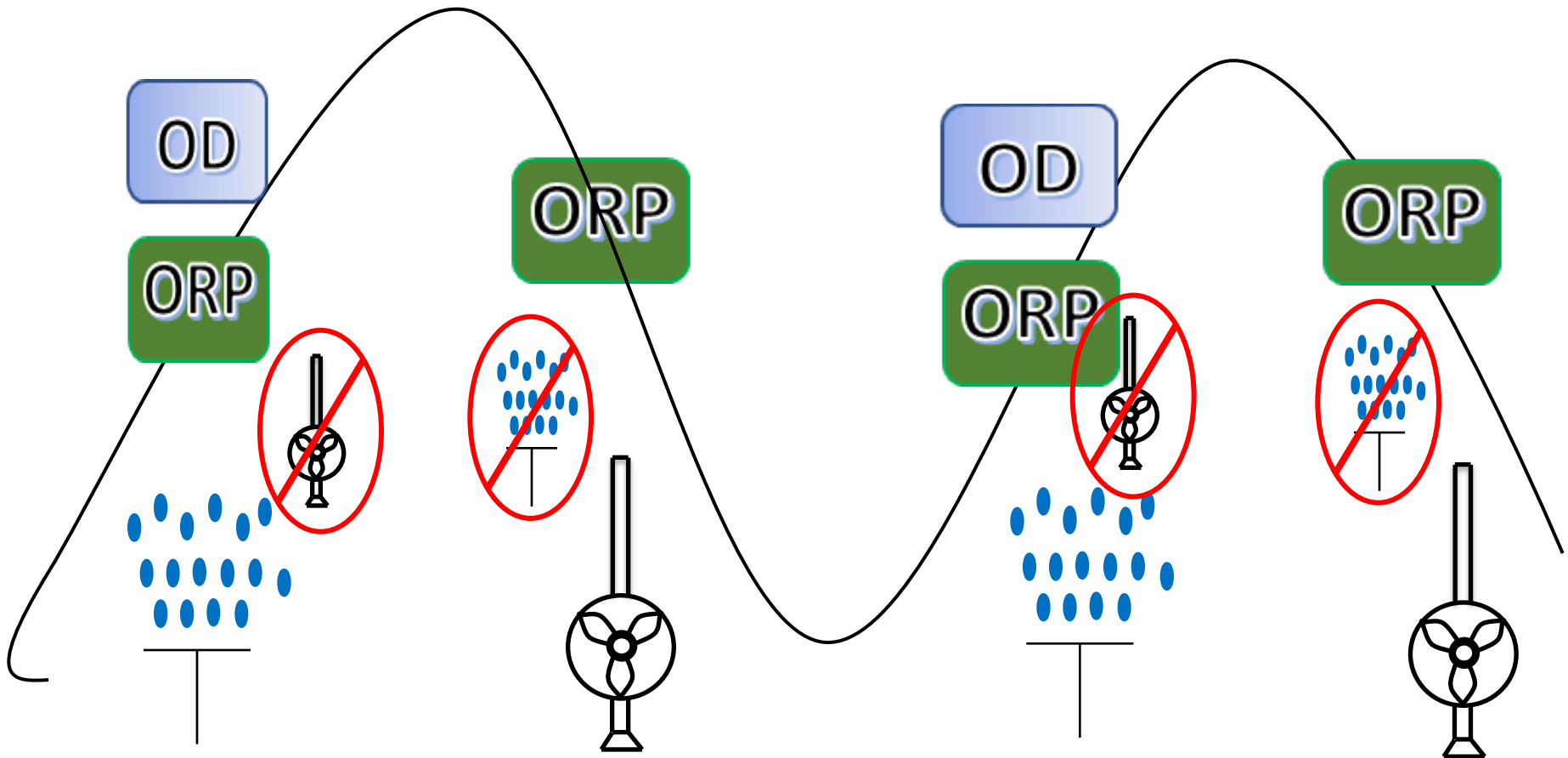
Alternate cycles in the reactor ...

Nitrification

Denitrification

Nitrification

Denitrification



Processes possible to upgrade ...

Deni

Nitrification

**Carousel
tank**

....any process!

**Activated
sludge**

SBR

MBR



Software architecture

PLC/PC Slave with
AC process

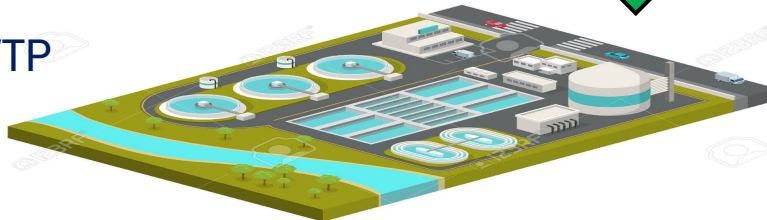


Remote control from Italy

PLC Master in STP



STP/WWTP



Supervisory Control in remote system
using VPN free software to ...

- Set the AC parameters control
- Monitor the biological process
- Change the process parameters (Tmin – Tmax – Probes Set point) if required



- Explain the AC control logics implemented for the process control
- Educate about the correct interpretation of the analog measurement system installed to obtain information for the management
- Explain the strategy and procedures to be followed to optimize performances
- Carry out the required periodic maintenance / calibration of the on-line probes
- Examine the functions of the various utilities monitored from the local and the remote-control system
- Discuss the results achieved and their correlation with statistic verdict

Remark: consolidated training protocols > virtual joint scientific platform





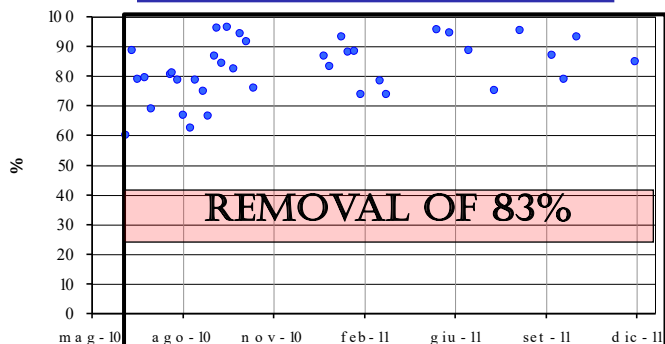
ALTERNATE CYCLES (AC)

BUSINESS CASES & RESULTS OBTAINED > MUNICIPAL TREATMENT PLANT

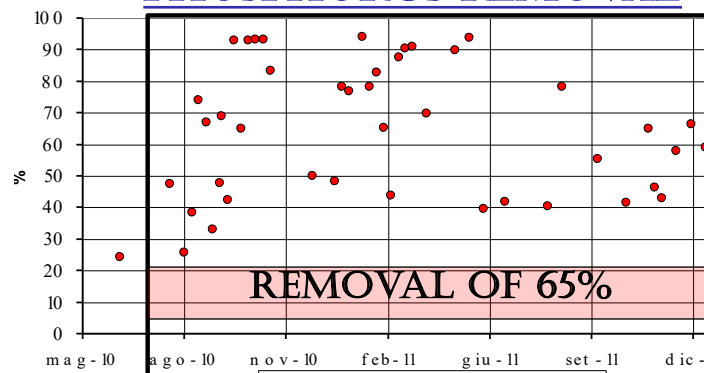


$36.000 \text{ m}^3/\text{d} > 180.000 \text{ PE (Italy)}$

NITROGEN REMOVAL



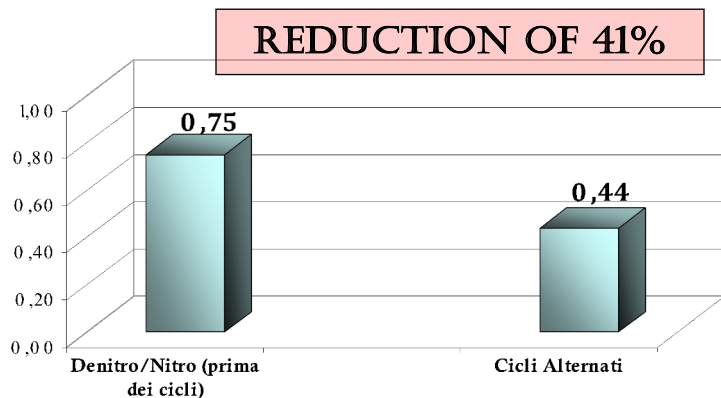
PHOSPHORUS REMOVAL



	Before Alternate Cycle	After alternate Cycle
Ntot influent (ppm)	27	30
Ntot effluent (ppm)	10	5
Reduction (E%)	64	83

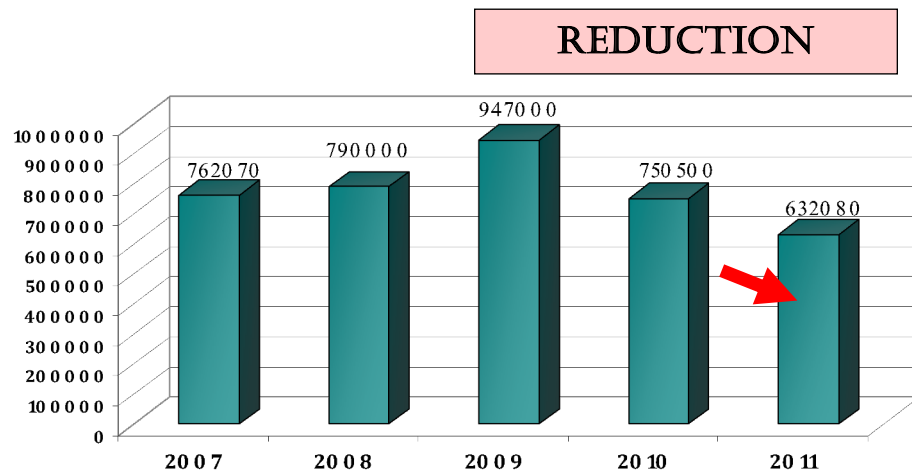
	Before Alternate Cycle	After Alternate Cycle
Ptot influent (ppm)	3,7	4,3
Ptot effluent (ppm)	2,8	1,4
Reduction (E%)	28	65

ENERGY SAVING



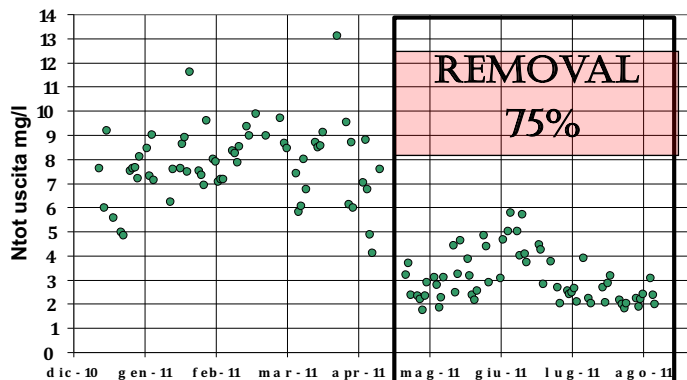
Specific Consumption	Before Alternate Cycle	After Alternate Cycle
kWh/m ³	0,75	0,44

SLUDGE REDUCTION



$140.000 \text{ m}^3/\text{d} > 700.000 \text{ PE (Italy)}$

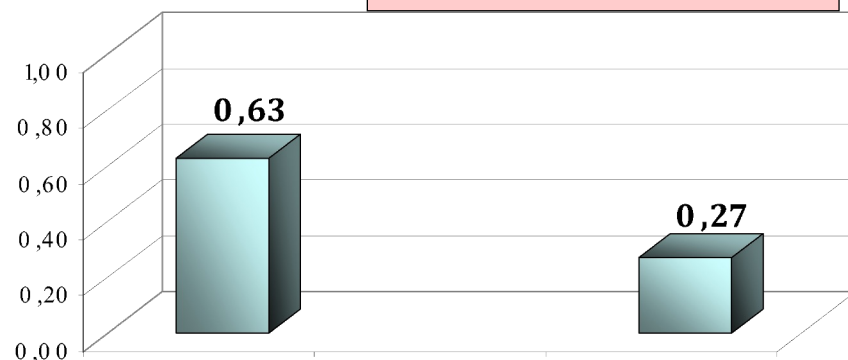
NITROGEN REMOVAL



	Ntot influent (ppm)	Ntot influent (ppm)
Ntot influent (ppm)	12	11
Ntot effluent (ppm)	8	3
Reduction (E%)	50	75

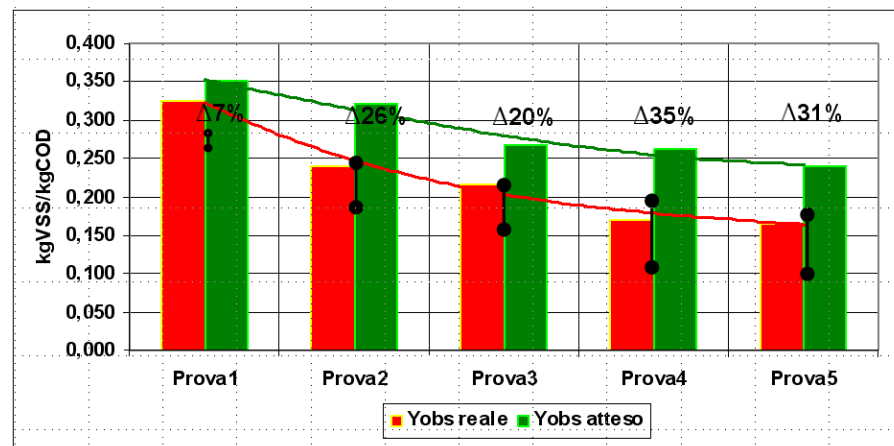
ENERGY SAVING

REDUCTION OF 57%

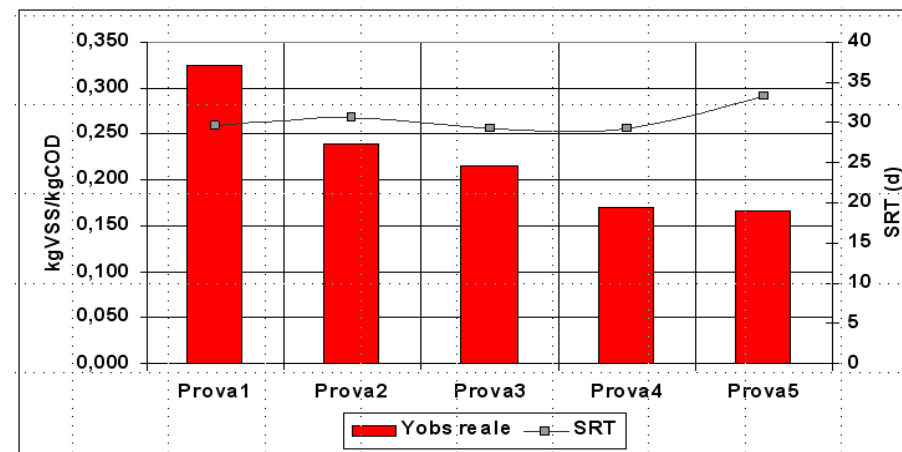


SLUDGE REDUCTION

COMPARISON BETWEEN REAL YOB - EXPECTED YOB



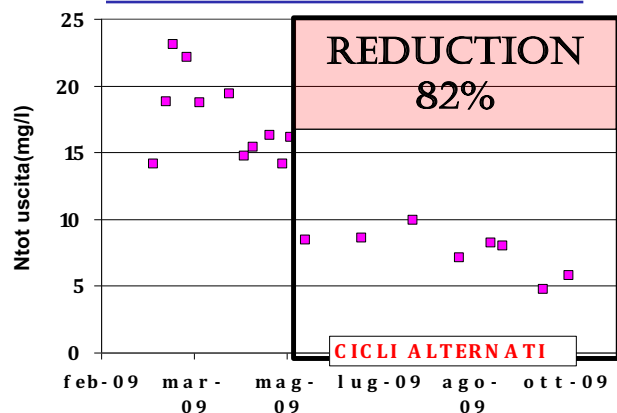
REAL YOBS



YOBS REDUCTED OF 51%

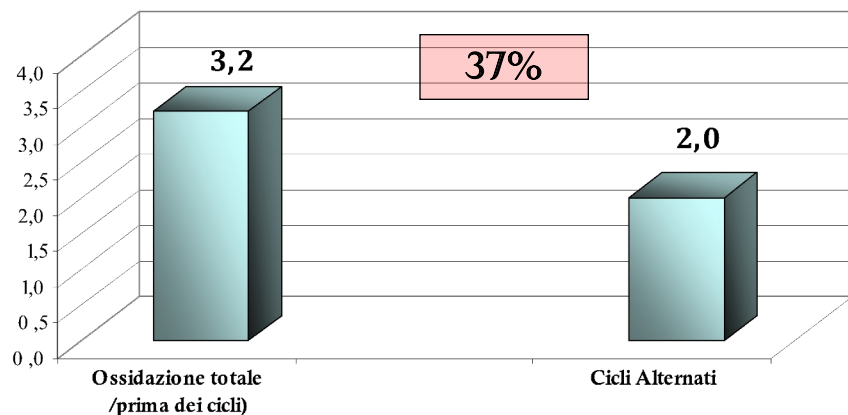
$6.000 \text{ m}^3/\text{d} > 30.000 \text{ PE (Italy)}$

NITROGEN REMOVAL

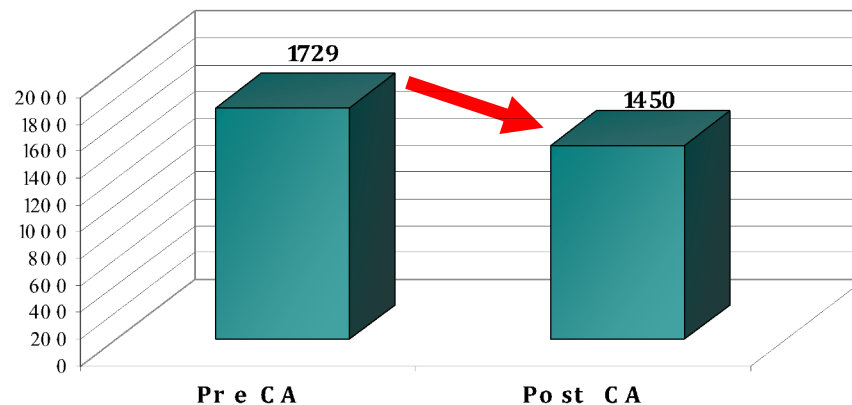


	Before AC	After AC
Azoto totale medio ingresso (mg/L)	42	38
Azoto totale medio uscita (mg/L)	18	6.3
Rendimento medio rimozione (%)	60	82

ENERGY SAVING



SLUDGE REDUCTION



SLUDGE
REDUTCION 16%



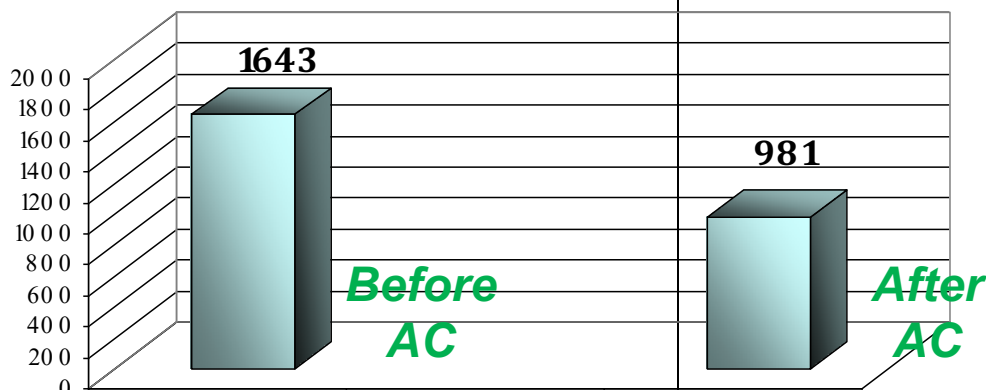
11.000 m³/d > 55.000 PE (Italy)

NITROGEN REMOVAL

	Before AC process	After AC process
Total Nitrogen influent (ppm)	72	75
Total Nitrogen effluent (ppm)	25	7
Medium Removal percentage (%)	65	90

REDUCTION 90%

ENERGY SAVING

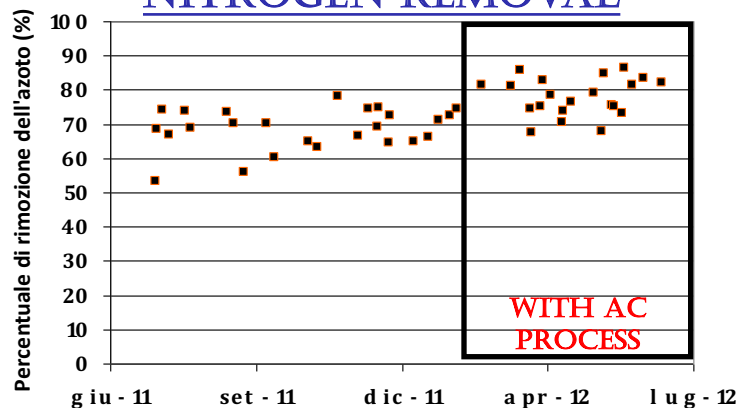


ENERGY
 CONSUMPTION
 KWH/D
 REDUCTION 40%



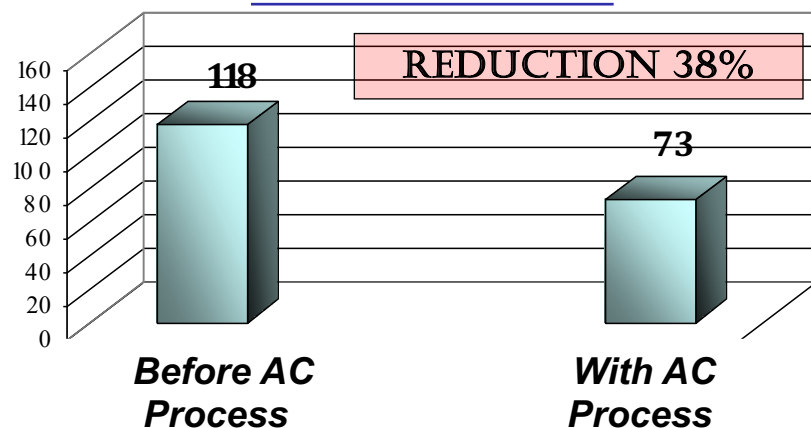
$50.000 \text{ m}^3/\text{d} > 250.000 \text{ PE (Italy)}$

NITROGEN REMOVAL

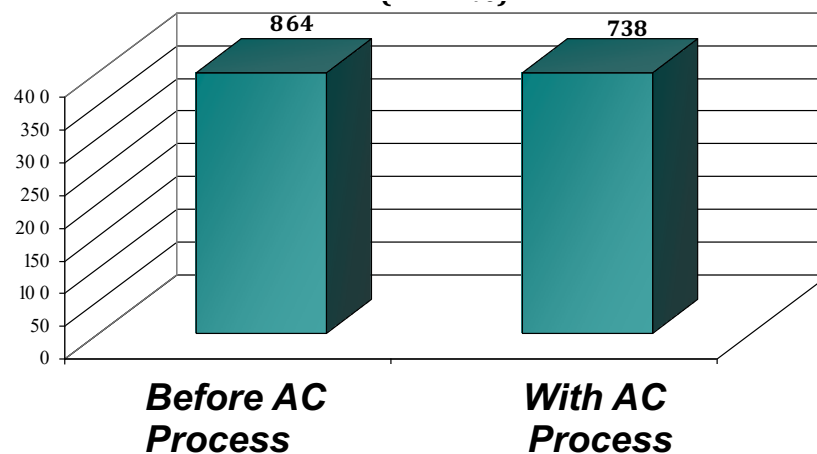


	Before AC	After A C
Ntot influent (ppm)	43	49
Ntot effluent (ppm)	14.3	8.8
Reduction (E%)	67	83

ENERGY SAVING



SLUDGE REDUCTION



REDUCTION 15%





ALTERNATE CYCLES (AC)

PROCESS SOLUTION & TECHNOLOGY > INDUSTRIAL TREATMENT PLANT



WHAT IS IT ?

A process control in biological tank for **HIGH NITROGEN LOAD LIQUID WASTE**

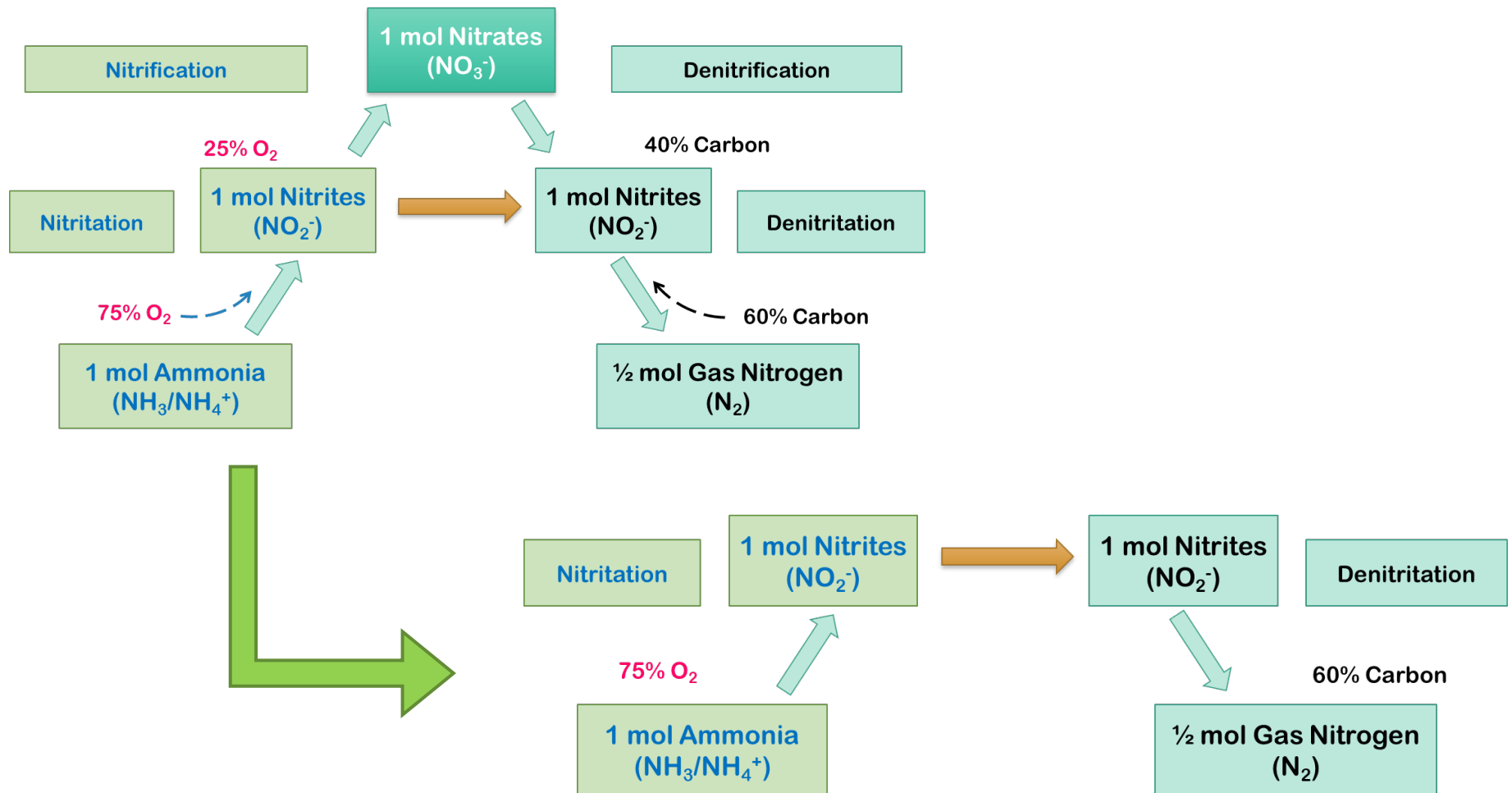
(such as landfill leachate – sludge line supernatant – liquid waste with high concentration of Ammonia)

WHAT CAN WE OBTAIN ?

- High Nitrogen Removal more than **85%**
- Less Carbon for denitritation **40%**
- Less energy for nitrification **25%**
- Less reaction volume **Kn up to 10 time faster**
- ***None kinetic effect of salinity up to 15 mS/cm***



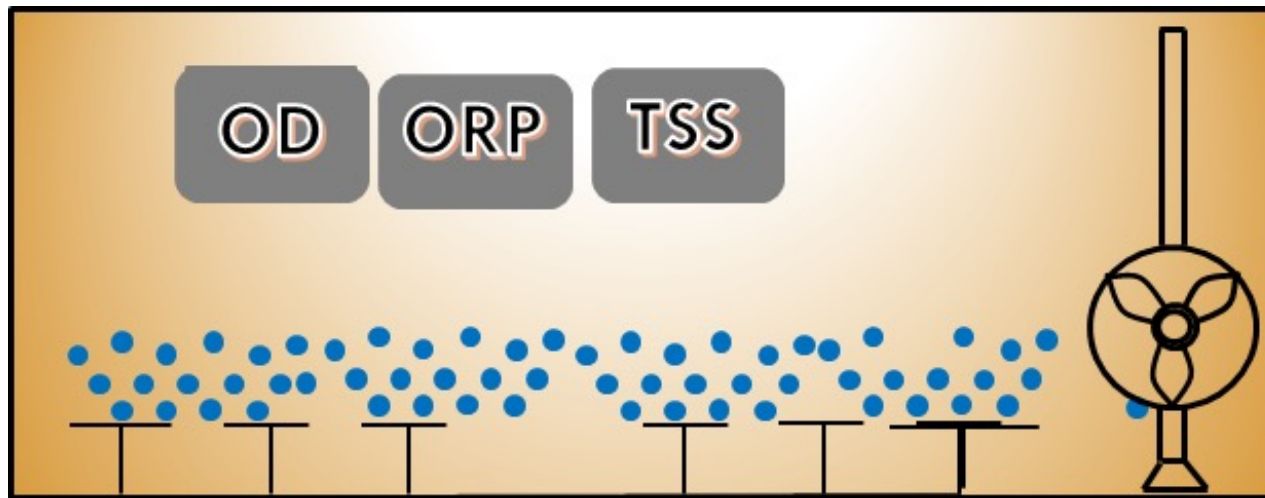
How to control the Process



What we need in the tank

- Air diffuser for oxic phases
- Mixer for anoxic phases
- DO and ORP probes for control
- TSS probe for monitoring

MBR PROCESS IS RECOMMENDED





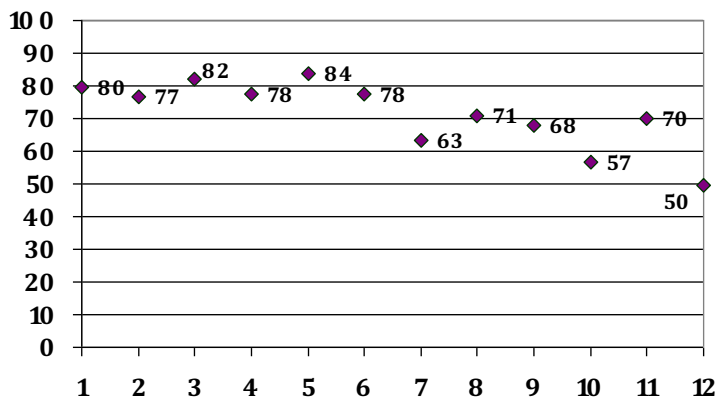
ALTERNATE CYCLES (AC)

BUSINESS CASES & RESULTS OBTAINED > INDUSTRIAL TREATMENT PLANT

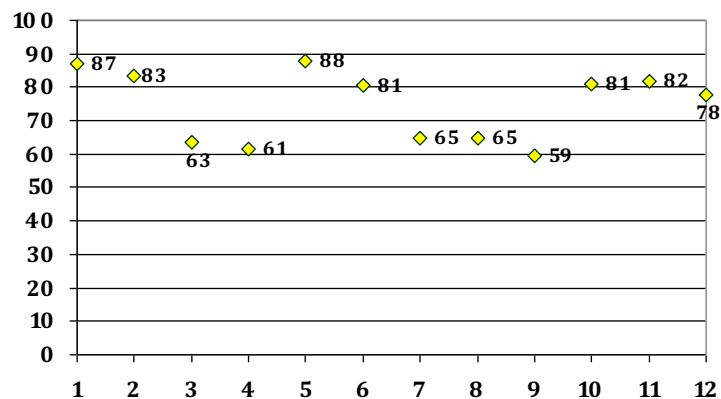


100.000 Ton/Yr > 500 KgN/d (Italy.1)

AVERAGE MONTHLY REDUCTION C O D (%)



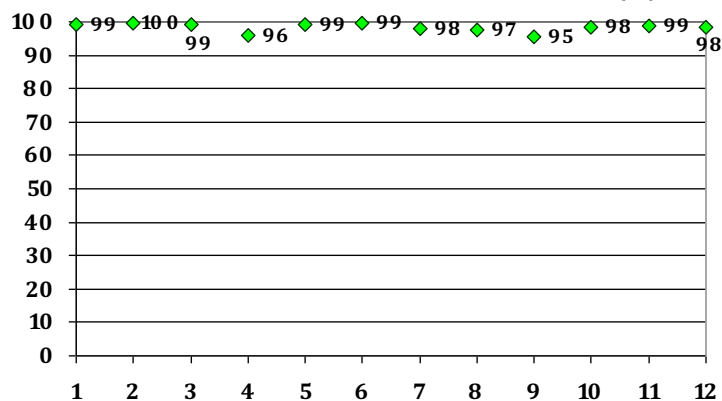
AVERAGE MONTHLY REDUCTION N tot(%)



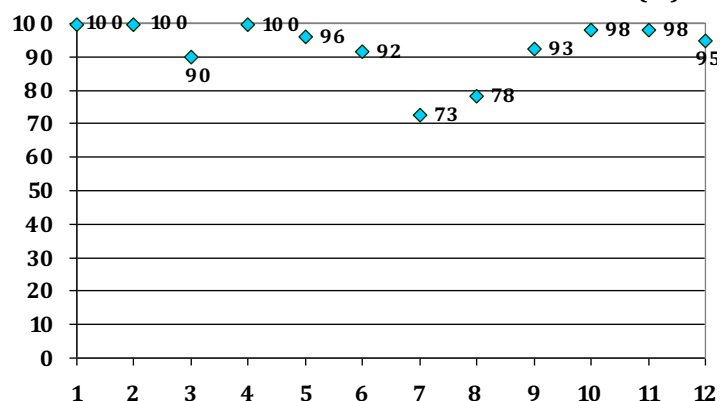
		Influent	Effluent	Removal [%]
COD	ppm	5000	1100	78%
N-NH4	ppm	1200	60	95%
N tot	ppm	1680	370	78%
TSS	ppm	2000	40	98%

LANDFILL LEACHATE

AVERAGE MONTHLY REDUCTION T S S (%)



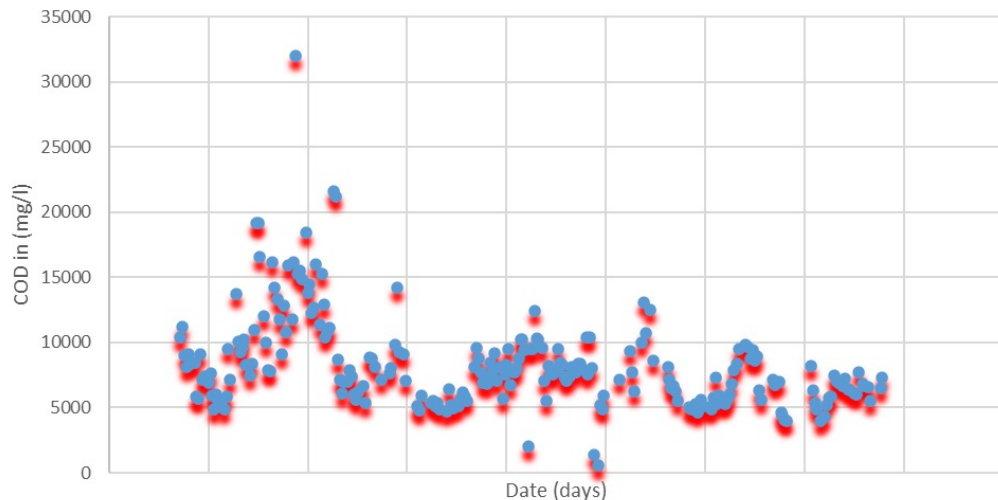
AVERAGE MONTHLY REDUCTION N - N H 4(%)



180.000 Ton/Yr > 1.200 KgN/d (Italy.2)

Influent

COD In (mg/l)



INDUSTRIAL LIQUID WASTE

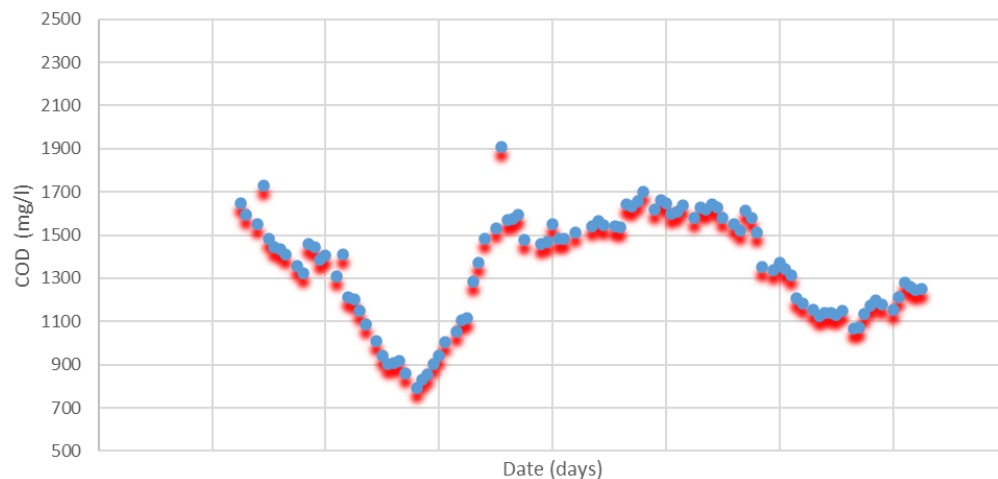
		Influent	Effluent
Flow	m ³ /h	600-700	
COD	ppm	6.000-12.000	900 – 1,500
Ntot	ppm	1.200-1.800	50 - 150
N-NH ₄	ppm	900 – 1.500	2 - 8
N-NO ₃ & N-NO ₂	ppm		20-40 & 10-30

**COD Removal
> more than 90%**

**(Only Non Biodegradable fraction
of soluble COD is not removed)**

COD Out (mg/l)

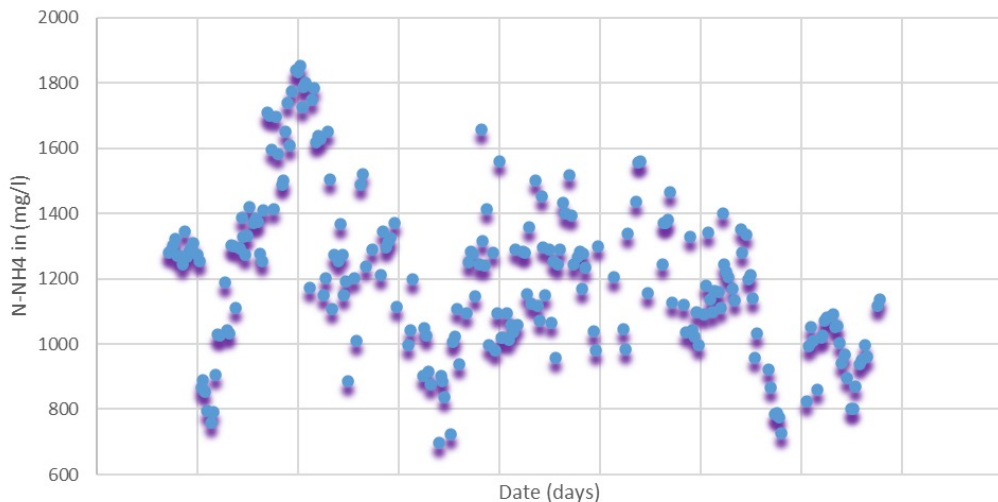
Effluent



180.000 Ton/Yr > 1.200 KgN/D (Italy.2)

Influent

N-NH₄ In (mg/l)



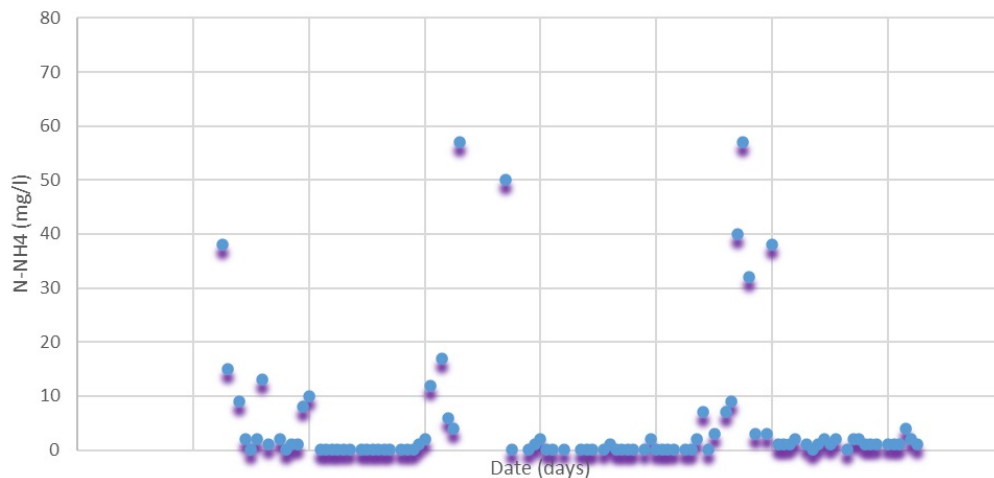
INDUSTRIAL LIQUID WASTE

		Influent	Effluent
Flow	m ³ /h	600-700	
COD	ppm	6.000-12.000	900 – 1,500
Ntot	ppm	1.200-1.800	50 - 150
N-NH₄	ppm	900 – 1.500	2 - 8
N-NO ₃ & N-NO ₂	ppm		20-40 & 10-30

**N-NH₄ Removal
> more than 95%**

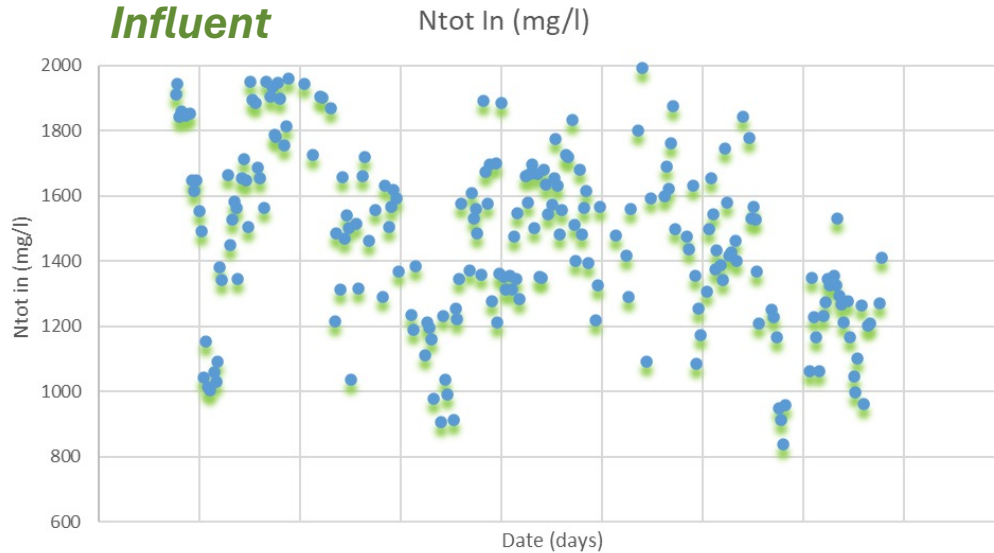
N-NH₄ Out (mg/l)

Effluent



180.000 Ton/Yr > 1.200 KgN/d (Italy.2)

Influent



INDUSTRIAL LIQUID WASTE

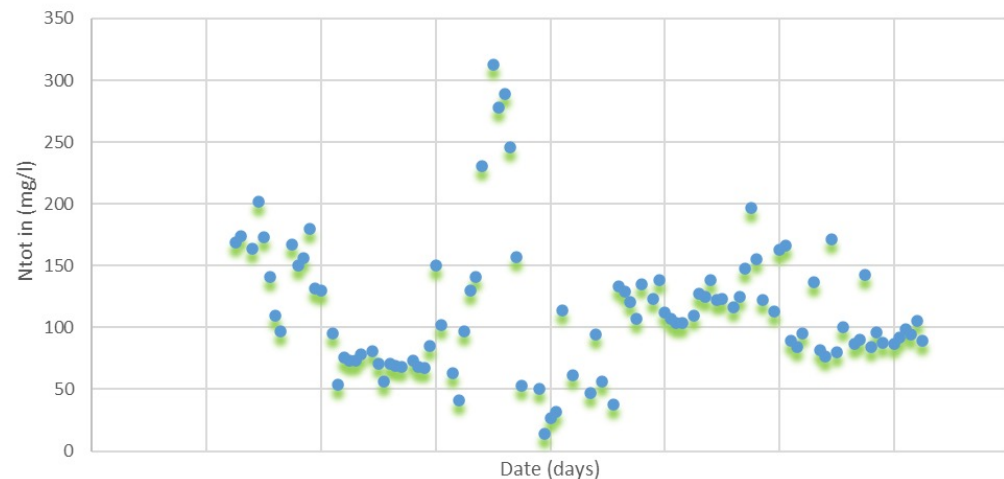
		Influent	Effluent
Flow	m ³ /h	600-700	
COD	ppm	6.000-12.000	900 – 1,500
Ntot	ppm	1.200-1.800	50 - 150
N-NH ₄	ppm	900 – 1.500	2 - 8
N-NO ₃ & N-NO ₂	ppm		20-40 & 10-30

**Total N Removal
> more than 85%**

*(Only the organic Nitrogen linked
with non biodegradable fraction of
soluble COD is not removed)*

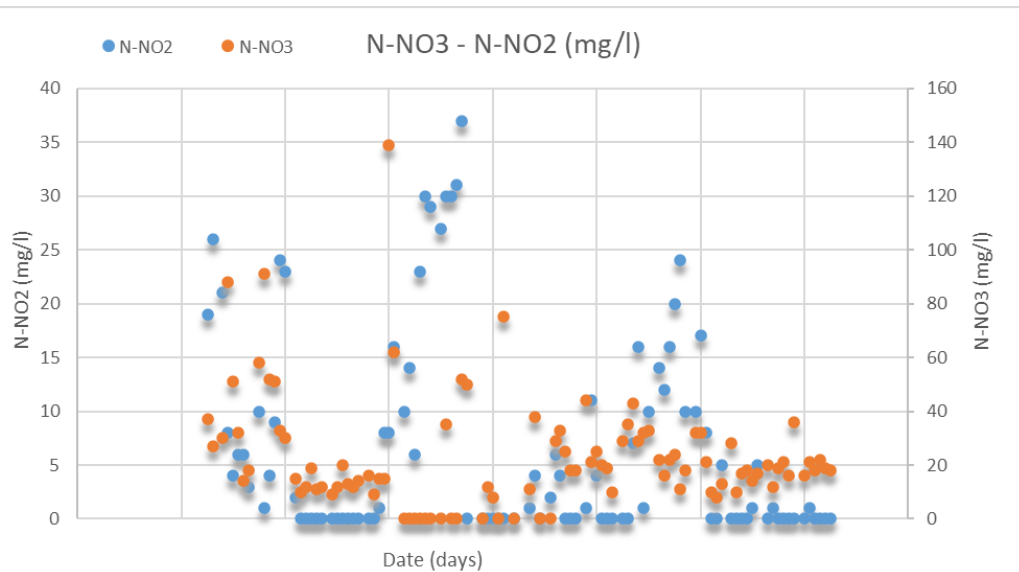
Ntot In (mg/l)

Effluent



180.000 Ton/Yr > 1.200 KgN/D (Italy.2)

...and what about Nitrates and Nitrites?

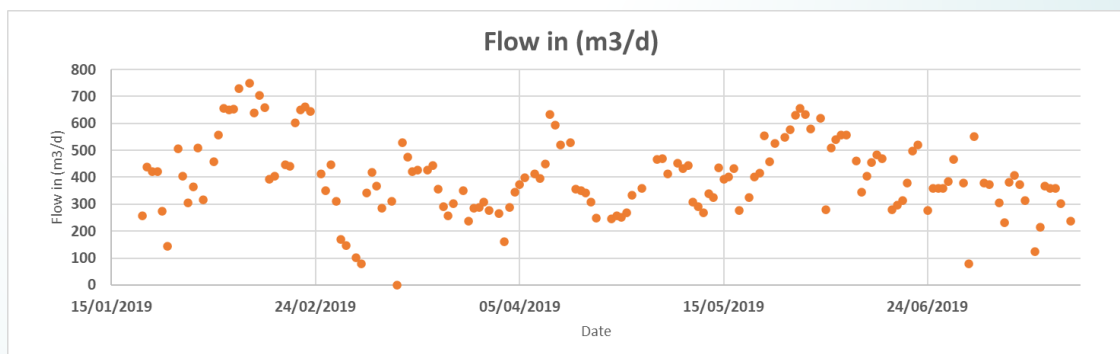


INDUSTRIAL LIQUID WASTE

		Influent	Effluent
Flow	m ³ /h	600-700	
COD	ppm	6.000-12.000	900 - 1,500
Ntot	ppm	1.200-1.800	50 - 150
N-NH ₄	ppm	900 - 1.500	2 - 8
N-NO₃ & N-NO₂	ppm		20-40 & 10-30

N-NO₃ (Nitrates) > up to 10-15ppm <---> N-NO₂ (Nitrites) > up to 30-35ppm

**...The flow treated
500-600m³/d**





ENRICO MARIA BATTISTONI

Chief Technology Officer

Master's degree in Civil Engineering and Environmental Engineering. Development of the technical solution and the design of the engineering, with particular reference to the preparation of drawings and calculations of hydraulic and reinforced concrete structure.

enricomaria.battistoni@ambienteingegneria.com

Mob: +39 335 6070 282 - Italy



ALESSANDRO AGUIARI

Business Development Manager

Master's degree in Political Sciences and studies in internationalization processes, chain supply management and business management. Since 1998 operates on international markets. 15 years Resident Manager: Hong Kong, India, Thailand.

alessandro.aguiari@ambienteingegneria.com

Mob: +66 (0)92 416 0057 - Thailand

Mob: +39 351 8974 081 - Italy

() **Ambiente Ingegneria Srl (AI)** is a spin-off of Ingegneria Ambiente Srl (IA), specifically established to “follow” the expansion on the markets overseas*

