



The European Commission

Community Research

Confirming the International
Role of Community Research



EOLI

Efficient Operation of Urban Wastewater Treatment Plants

Second annual meeting
Milano, Italy, 22-25 November 2004

Work Package 1

Uruguay





UU objectives in WP1

- Perform SBRs experiments at lab-scale for the development and the validation of the different algorithms to be developed within the framework of EOLI, in the particular case of carbon and nutrients removal for dairy wastewaters
- Perform the laboratory experiments needed to validate and integrate software sensors and optimal control laws in pilot aerobic bioreactors for the treatment for carbon and nutrient removal.
- ~~Perform field-scale pilot reactor experimentation and data collection, in order to test the controller in an industrial actual case.~~



UU Activities -1

- Complete the defined data set of experiences
- Evaluate the operation of both reactors
- Microbiological studies
- Kinetic parameters determination



UU Activities -1

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UU Activities -2

■ Data set for Reactor M

EXPERIENCE	DATE	CYCLE
M1	13-Abr	STD
M2	26-Mar	STD repl.
M3	28-Abr	STD repl.
M4	04-May	STD repl.
M5	14-Abr	C/X-50%
M6	10-Mar	C/X+25%
M7	23-Mar	C/X+50%
M8	27-Abr	C/X+50%repl.
M9	10-May	C/X+50%repl.
M10	17-Mar	C/X+75%
M11	11-Mar	C/N-50%
M12	15-Abr	C/N-35%
M13	31-May	C/N-35%repl.
M14	30-Mar	C/N-20%
M15	03-Jun	C/N+20%
M16	26-Abr	C/N+30%
M17	08-Jun	C/N+50%
M18	31-Mar	O/C-50%
M19	01-Abr	O/C+50%
M20	09-Jun	INH 20%ATU
M21	15-Jun	INH 40% ATU
M22	28-Jun	INH 20 % 4CP



UU Activities -3

■ Data set for Reactor F

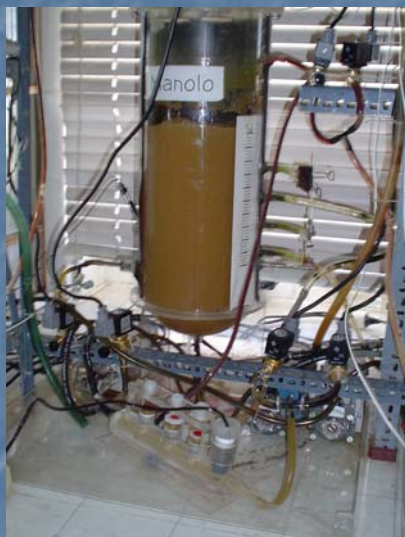
EXPERIENCE	DATE	CYCLE
F1	21-Abr	STD
F2	11-Mar	STD repl.
F3	30-Mar	STD repl.
F4	28-Abr	STD repl.
F5	19-May	STD repl.
F6	14-Abr	C/X-50%
F7	25-May	C/X-20%
F8	15-Mar	C/X+50%
F9	10-May	C/X+75%
F10	31-May	C/X+75%repl.
F11	10-Mar	C/X+75%repl.
F12	27-Abr	C/N-50%
F13	19-Abr	C/N-35%
F14	22-Abr	C/N-20%
F15	26-Abr	C/N+35%
F16	04-May	C/N+50%
F17	08-Jun	C/N+50%repl.
F18	12-Abr	C/N+50%repl.
F19	02-Jun	C/N+75%
F20	31-Mar	C/O-50%
F21	13-Abr	C/O+50%
F22	09-Jun	INH 20%ATU
F23	15-Jun	INH 40% ATU
F24	28-Jun	INH 20 % 4CP



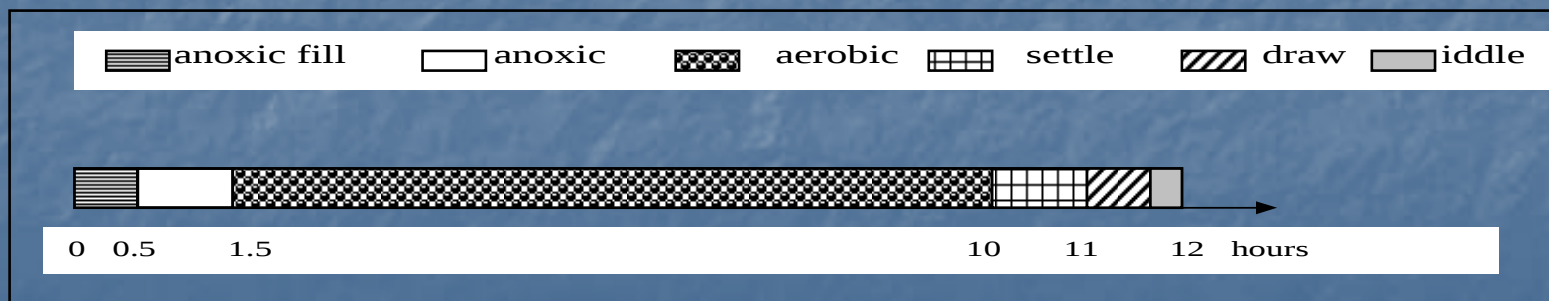
UU Activities -4

- Complete the defined data set of experiences
- Evaluate the operation of both reactors
- Microbiological studies
- Kinetic parameters determination

UU Activities -5



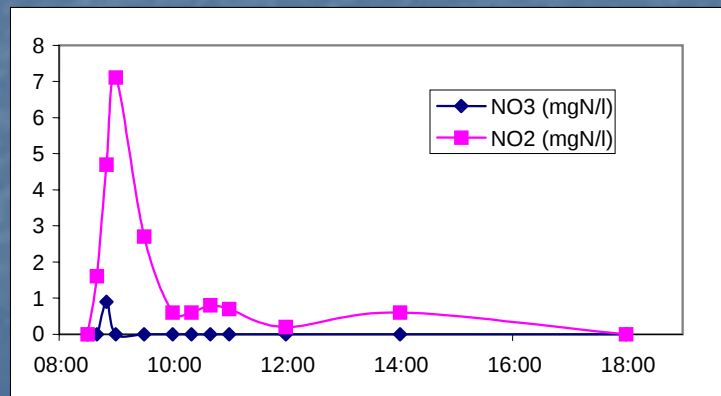
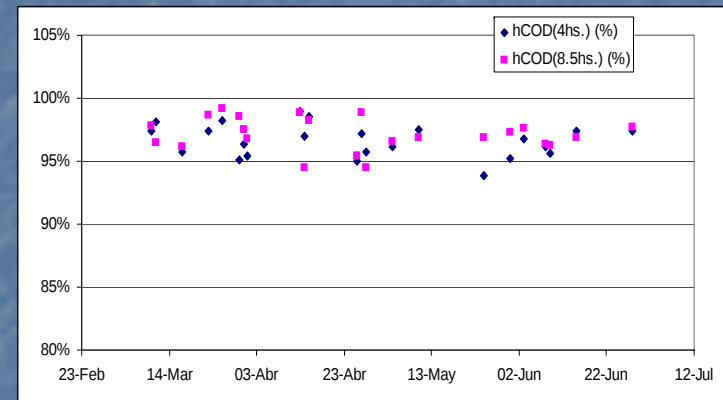
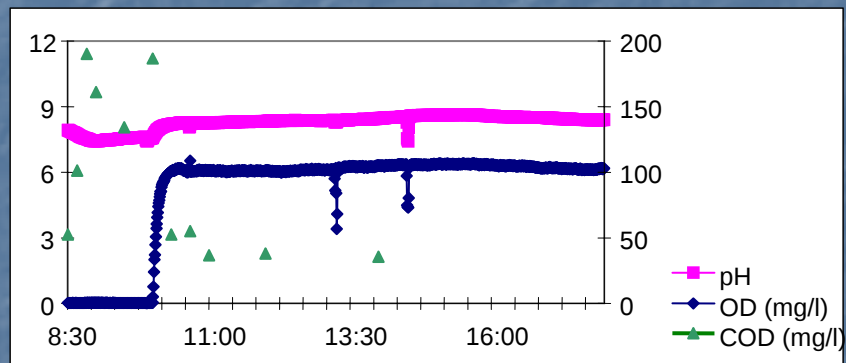
Influent:	Reactor M	Reactor
COD _t _inf (mg/l)	3350	900
TKN_inf (mgN/l)	60.0	100.0
NO ₃ (mgN/l)	93.0	3.0
Organic load (gCOD/l/d)	0.9	0.5
Θ	20d	20d





UU Activities -6

■ Reactor M operation



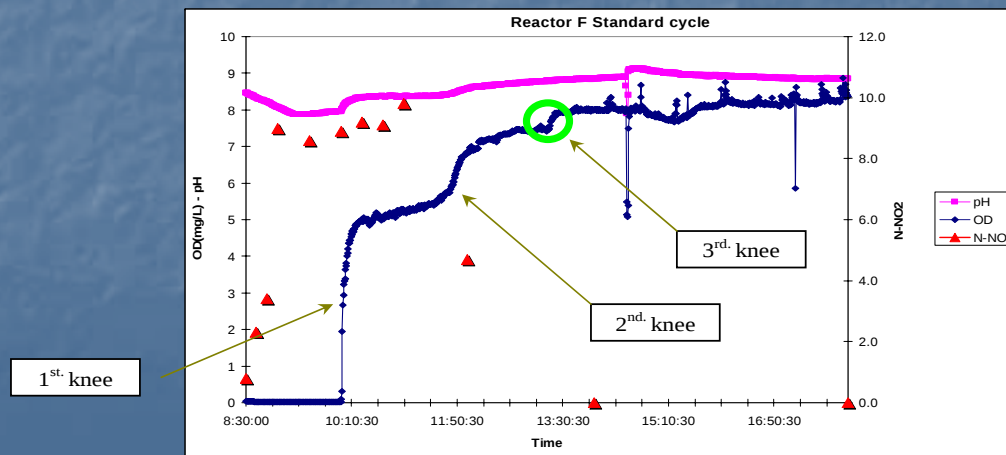
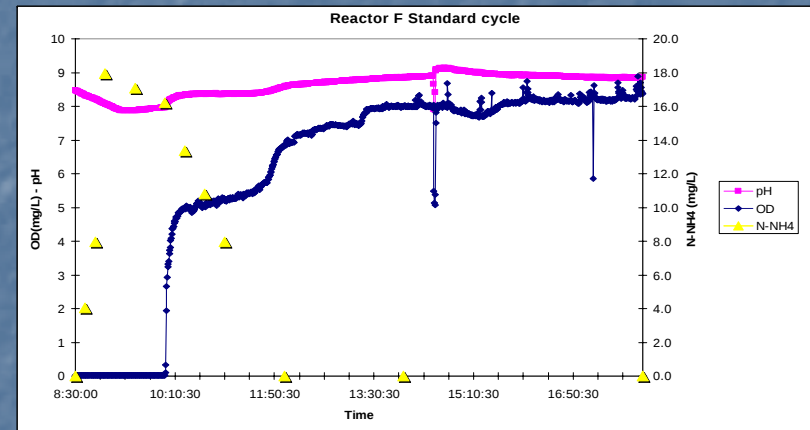
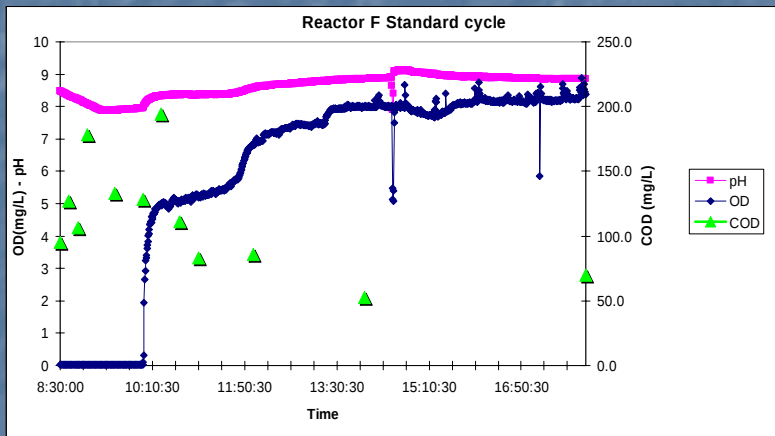


UU Activities -7

- Reactor M operation-2
- To increase organic load by increasing the volume fed each cycle (In process) and evaluating VSS, VSI and removal efficiency

UU Activities -8

■ Reactor F operation

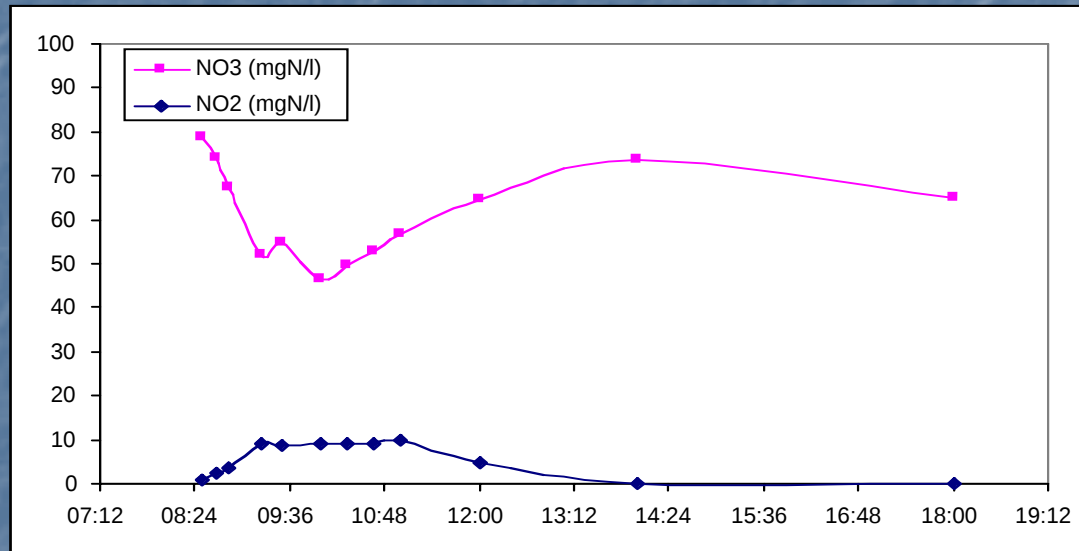


Reactor operation
needs to be improved



UU Activities -9

■ Reactor F operation-1



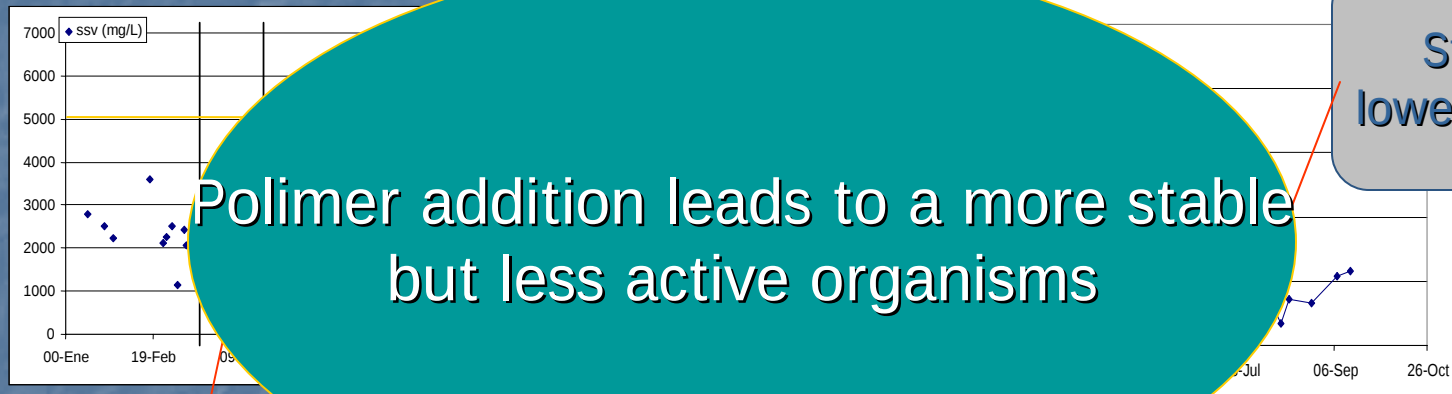
- Denitrification incomplete
- Changes in operating conditions (in progress):
Anoxic phase extended, mixing improved and BOD/COD evaluation

UU Activities -10

■ Reactor M

VSS evolution

Heterotrophic Activity



Stable
lower activity

Sludge washout

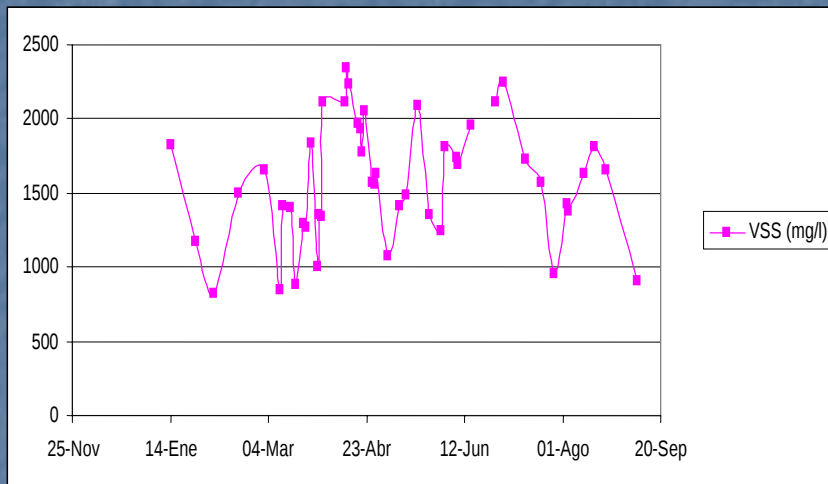
and po

variability and
high activity

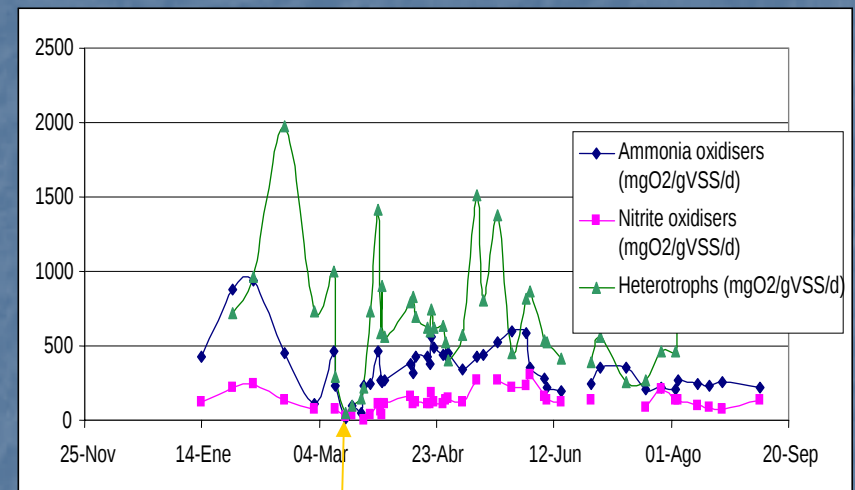
UU Activities -11

■ Reactor F

VSS evolution



Activity evolution



Reactor death



UU Activities -16

- Mean heterotrophic activity of acetate :

Reactor M: 500 (200)mgO₂/gVSS/d

Reactor F: 700 mgO₂/gVSS/d

- "Real" vs. Potential activity

Reactor M: comparable values

Reactor F: "Real" activity greater than potential activity (30–40%) (heterotrophic and nitrifying)

- Residual organic matter

Reactor M: Residual COD=85mg/l BOD/COD= 0.15

Reactor F: Residual COD=65mg/l, BOD/COD= 0.10



UU Activities

- Complete the defined data set of experiences
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- Microbiological studies
- Kinetic parameters determination



UU Activities -17

- FISH technique for enumeration and identification of bacteria in complex microbial communities

Probe Eub338 *bacteria*

Probe Arch915 *archaea*

Probe Nso1225 *most of ammonia oxidising beta-proteobacteria*

Probe Nit3 *nitrite oxidising bacteria of the genus Nitrobacter*

Probe Ntspa662 *nitrite oxidising bacteria of the genus Nitrospira*

Dapi stain *all microorganisms*

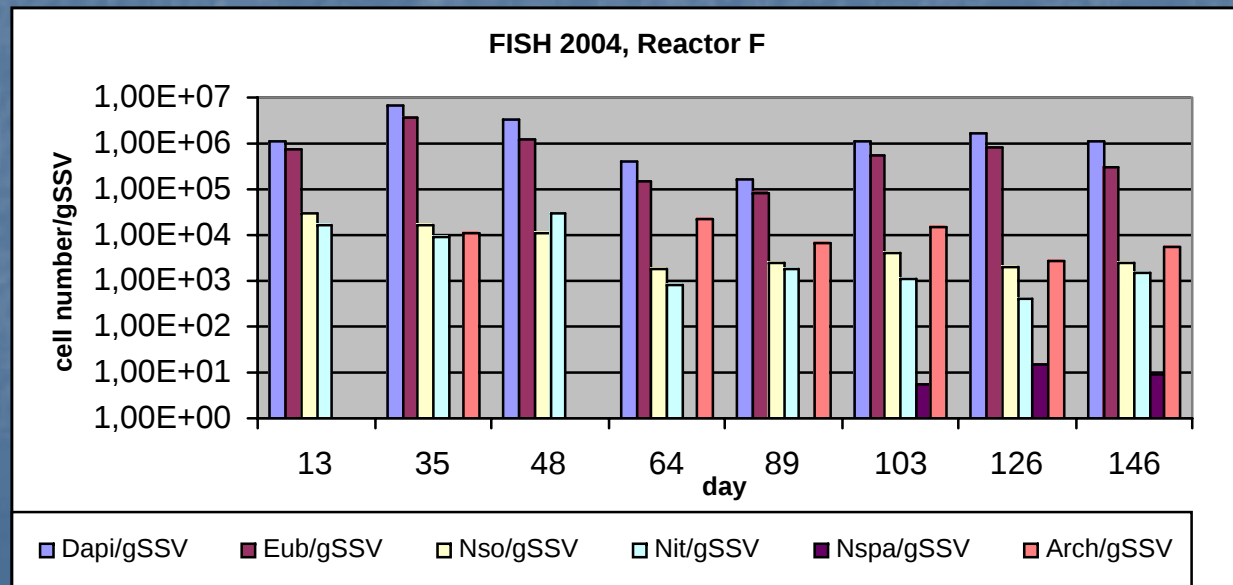


UU Activities -18

FISH results

Reactor M: no cells hybridising with the probes were detected

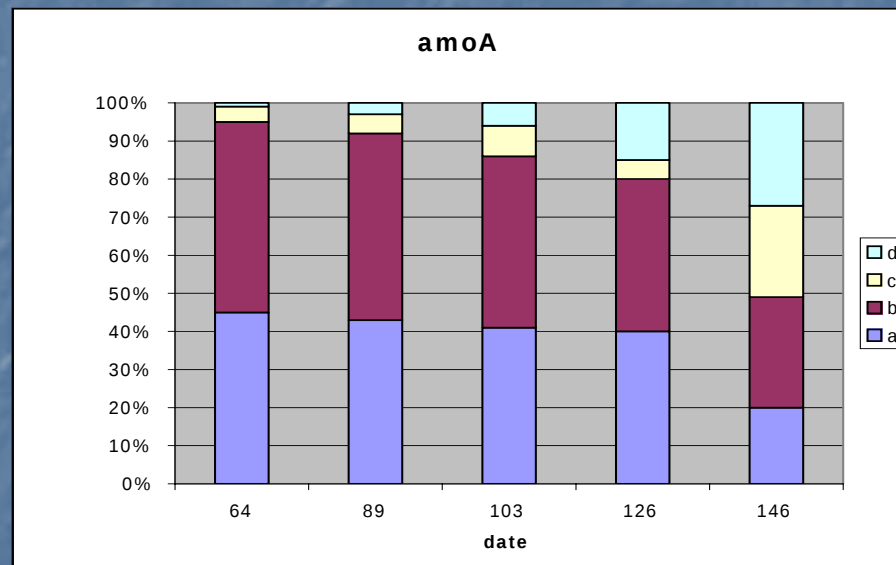
Reactor F: 8 samples were selected according with the reactor operating data





UU Activities -19

- T-RFLP : monitoring the microbial composition of the sludge (Reactor F)
- Ammonia oxidizers: 5 days were selected from february to may to evaluate this population.



More reserch needed to identify organisms and evaluate their nitrifiyng activity



UU Activities -20

■T-RFLP -2

- Denitrifiers; the same days from march to june were selected to search them with nirS nitrite reductase enzyme
- In this case, greather diversity is found , and high variability of composition is observed
- More research is needed to identify these organisms and to evaluate their denitrifying capacity.



UU Activities

- Complete the defined data set of experiences
- Evaluate the operation of both reactors
- Microbiological studies
- Kinetic parameters and adsorption evaluation



UU Activities -21

- Evaluation of maximum experimental denitrifying rate during cycles by mass balance estimation

Reactor M maximum denitrifying rate of $0.009 \text{ gN-NO}_3/\text{gVSS/h}$.

Dispersion of results

- Adsorption capacity evaluation

Mass balance estimation during 4 cycles allow to estimate average % adsorbed COD.

Reactor M: 64% (42-82%)

Reactor F: 56%



UU Activities -22

- Maximum heterotrophic specific growth rate for Reactor M

700 ml Batch test

Kappeler & Gujer procedure

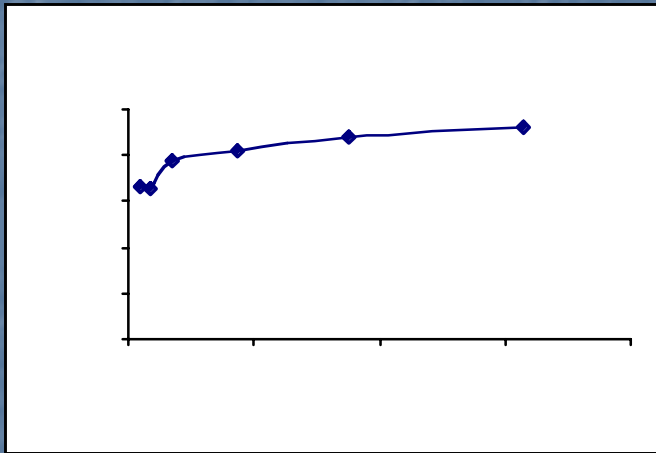
Repeated 3 times :

μ_{hmax} : 2-3.8d⁻¹

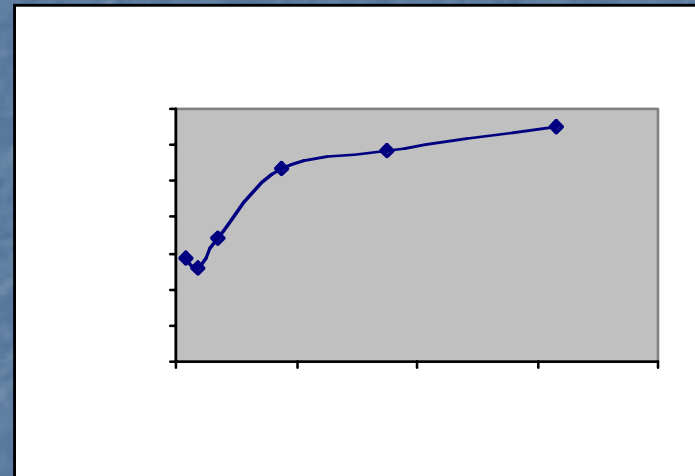


UU Activities -23

■ Saturation curves



Reactor M

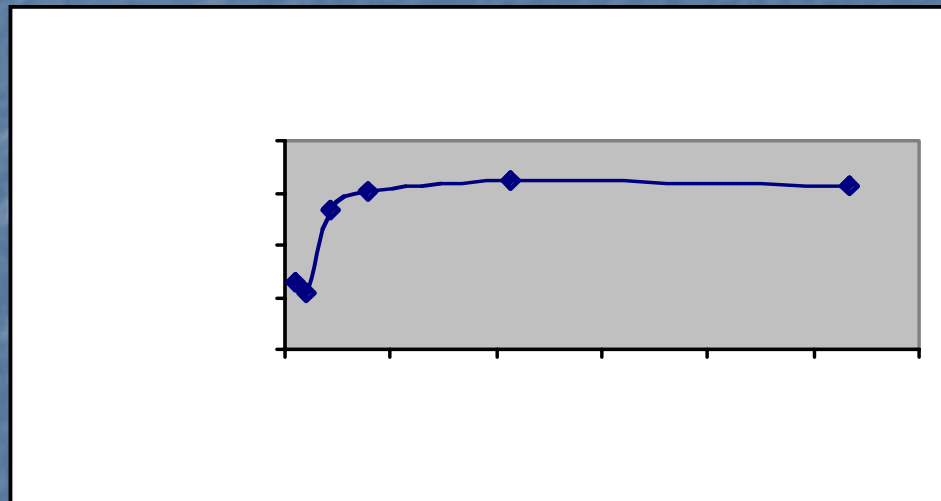


Reactor F



UU Activities -24

■ Saturation curves



Reactor F



UU Future activities -1

- Perform the laboratory experiments needed to validate and integrate software sensors and optimal control laws in pilot aerobic bioreactors for the treatment for carbon and nutrient removal.



UU Future activities -2

■ Reactor M

- Evaluation of maximum organic capacity
- Evaluation of sludge settleability and microbial selection in these conditions

■ Reactor F

- Evaluation of cycle modification
- Denitrifying activity test
- To isolate and identify microorganisms and their specific activity
- Maximum capacity: - increase organic load
- add a denitrifying phase at the end of the aerobic period



UU Future activities -3

- More experiences for μ_{hmax} K_{ch} and K_{nh} determination
- Anaerobic sludge toxicity: batch experiences (reactor F)
- Evaluation of BOD/COD profile during cycles