UNIVERSITEIT GENT

**BIOMATH**
Department of Applied Mathematics, Biometrics and Process Control

# Investigation of the influence of physico-chemical parameters on the activated sludge (de)flocculation dynamics

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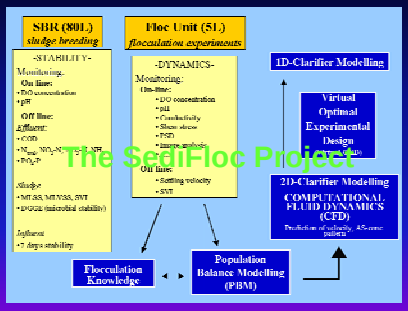
## The SediFloc Project




The SediFloc Project



## Outline

Introduction
- Motivation & Scope
- The Sequencing Batch Reactor
- The Floc Unit

Results and Discussions
- The experimental window & Time-Scale Evolution
- Calcium addition
- Shear Stress
- Dissolved Oxygen
- Temperature

Conclusions

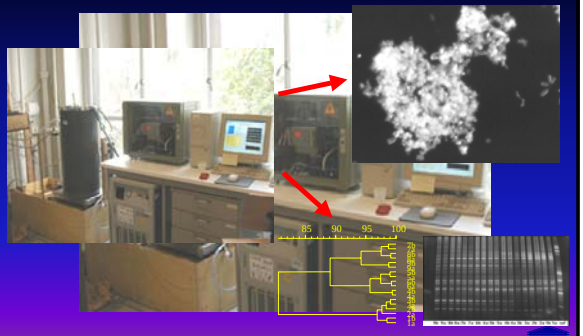


## Motivation & Scope

- Activated sludge flocculation:
  - Complex process with many interacting factors.
  - Modelling the activated sludge process - requires understanding of many physical properties of biological flocs as well as of the influence of process conditions.
  - Insufficient insight in the impact of these conditions makes that models frequently lump them together and ignore the effect of changing conditions on important phenomena such as settling, particle aggregation and breakage, sludge compaction, etc.
- Focus of the present research:
  - To quantify the effect of several physico-chemical parameters (e.g. sludge concentration, shear stress, dissolved oxygen, temperature and calcium) on the (de)flocculation process while keeping the biological properties as "stable" as possible.

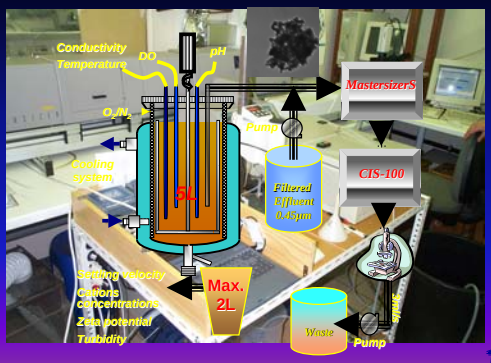


## The Sequencing Batch Reactor (SBR)






## The FlocUnit



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## Experimental Design- Factors

| Factor | Min | Max | Central | Min (Axial) | Max (Axial) |
|---|---|---|---|---|---|
| G (1/s) | 29 | 105 | 55 | 15 | 200 |
| DO (mg/l) | 1 | 3 | 2 | 0 | 4 |
| Temp. ( C) | 10 | 20 | 15 | 5 | 25 |
| Sludge conc. (g/l) | 0.25 | 1.59 | 0.63 | 0.1 | 4 |
| Cations-Ca (meq/l) | 6 | 18 | 12 | 0 | 24 |


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## Experiment - The Time-scale Evolution

Set the sludge concentration
*X (0.1-4 g/l)*

Set the preliminary conditions
*G = 55 s$^{-1}$*
*DO = 2mg/l*
*T=15ºC*
*Ca = 0meq/l*

Record the effect of initial conditions

Set the exp. conditions (no Ca addition)
*G (15-200 s$^{-1}$)*
*DO (0-4mg/l)*
*T (5-25ºC)*
*Ca = 0meq/l*

Not recorded — $t_0$ (var.) | Not recorded — $t_1$ (var.) | Recorded — $t_2$= 10min. | Not recorded — $t_3$ (var.) | *time*

Record the effect of the experimental conditions without Ca addition

Set the exp. conditions (Ca addition)
*G (15-200 s$^{-1}$)*
*DO (0-4mg/l)*
*T (5-25ºC)*
*Ca (6-24meq/l)*

Record the effect of the exp.conditions with Ca addition

Recorded — $t_4$ = 10min. | Recorded — $t_5$ ≈30sec. | Recorded — $t_6$ (var.) | *time*


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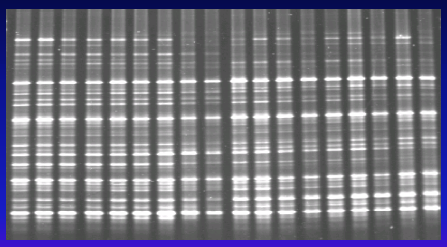
## Activated Sludge Microbial Community Evolution (DGGE)



***Relatively stable community during the experiment!***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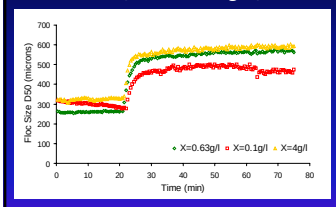
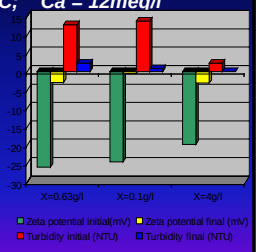
## Influence of the Sludge Concentration

**Operational Parameters:**

***G=55s$^{-1}$; DO= 2mg/l ; T= 15ºC; Ca = 12meq/l***




***Steady state occurs faster for highly concentrated activated sludge samples***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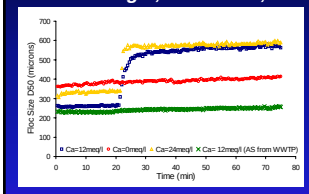
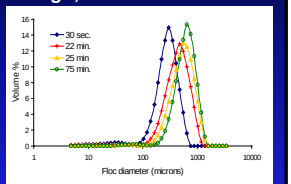
## The Impact of Calcium Addition

**Operational Parameters:**

***X= 0.63 g/l ; G = 55 s$^{-1}$; DO= 2mg/l; T= 15ºC***




- ***Calcium addition has a large effect on flocculation of the SBR activated sludge sample***
- ***No effect for the WWTP sludge sample***

| | Ca initial (meq/l) | Na initial (meq/l) |
|---|---|---|
| SBR | 0.15 ±0.05 | 9.31±0.095 |
| WWTP | 2.61 | 5.42 |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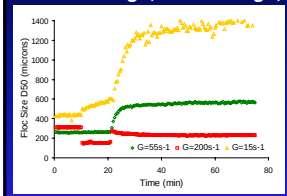
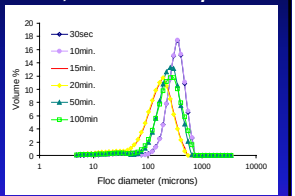
## Influence of the Shear Stress (G)

**Operational Parameters:**

***X= 0.63 g/l; DO= 2mg/l; T= 15ºC; Ca = 12meq/l***




- ***Shear (G) has a strong (de)flocculation effect***
- ***Fast flocs breakage is observed at high shear***
- ***Flocs breakage can be partly neutralized by the Ca addition***
- ***Low mixing together with Ca addition created very large flocs sizes***



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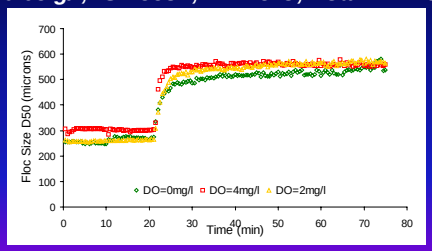
## Dissolved Oxygen (DO) Effect

- **Operational Parameters:**

***X= 0.63 g/l; G =55s$^{-1}$; T= 15ºC; Ca = 12meq/l***




***No significant DO effect***



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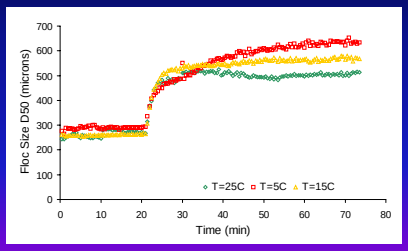
## Temperature effect

- **Operational Parameters:**

***X= 0.63 g/l; G =55s$^{-1}$; DO =2mg/l; Ca = 12meq/l***




***No significant temperature effect***



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## Outline





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## Conclusions

- Shear stress and calcium have the most important effects on floc size dynamics.
- Sludge concentration seems important to create homogenous flocculation
- The oxygen concentration and temperature have less significant effect

*These conclusions are only valid for this particular case since Ca addition did not have the same flocculation effect when sludge with different structural composition was analyzed.*



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