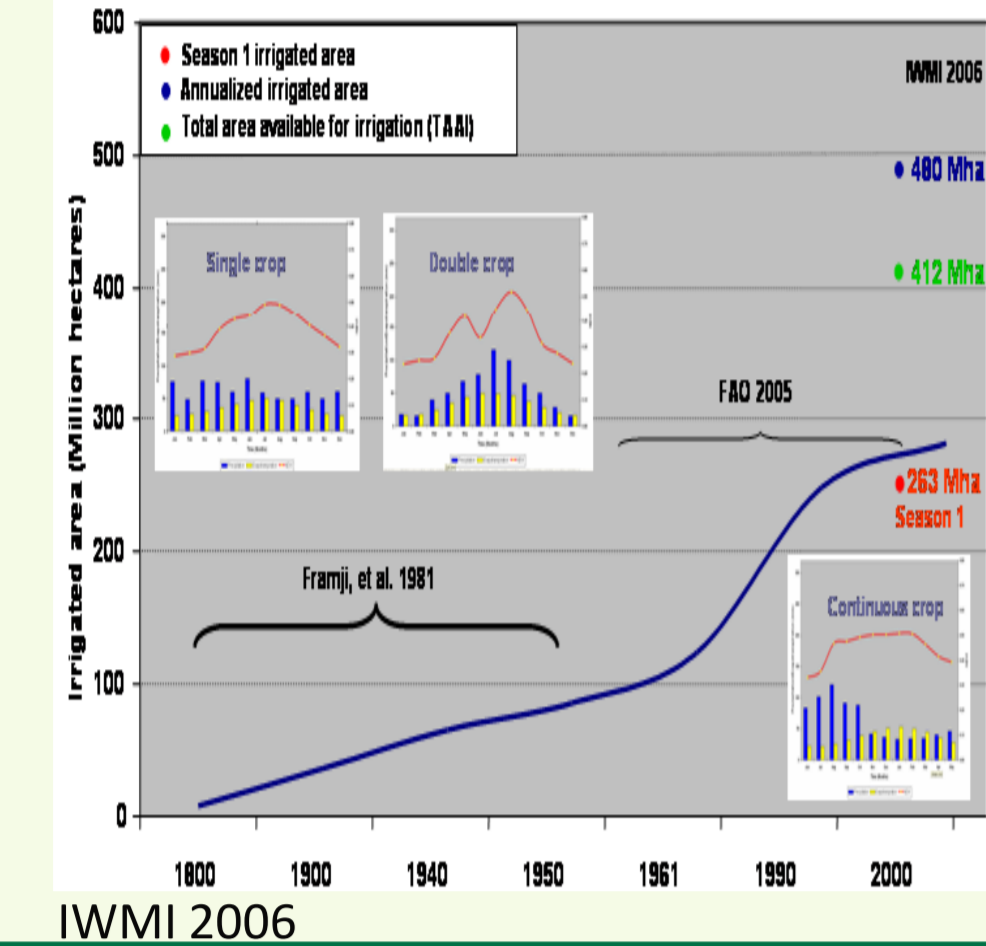


Context

In a context of water scarcity, especially with the increasing population and food needs, the use of treated wastewater to irrigate agricultural lands proves to be a relevant solution.



irrigate agricultural lands proves to be a relevant solution.

Micro-irrigation Advantages

- Reduction of water losses
- Risk of clogging

Aim of the phd

- 1) Analysis of the parameters inducing chemical precipitation and the elements formed in the micro-irrigation devices when using treated wastewater.
- 2) Study parameters inducing biofilm formation and their interactions with chemical precipitation.
- 3) Modeling biofilm development and chemical precipitation in micro-irrigation.



Chemical clogging

Experimental part

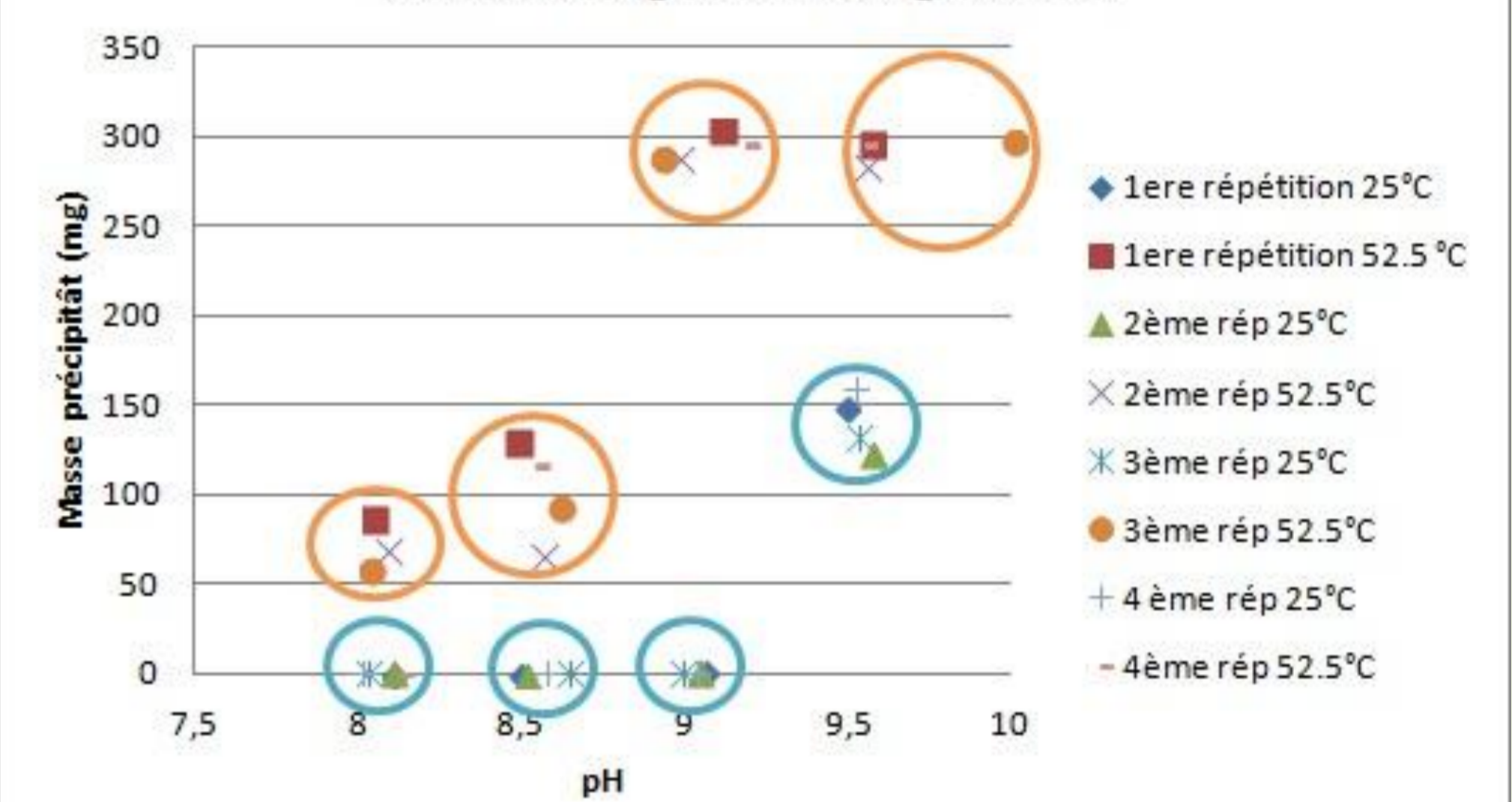
Type of water Treated wastewater from a sand filter outlet in Mauguio STP
Number of experiments 4
Volume 1L
T°C 22 and 55°C
pH 8, 8.5, 9 and 9.5
Chemical reaction time 12h



After 12h of reaction the water is filtered, the precipitate is dried then weighed.

Results

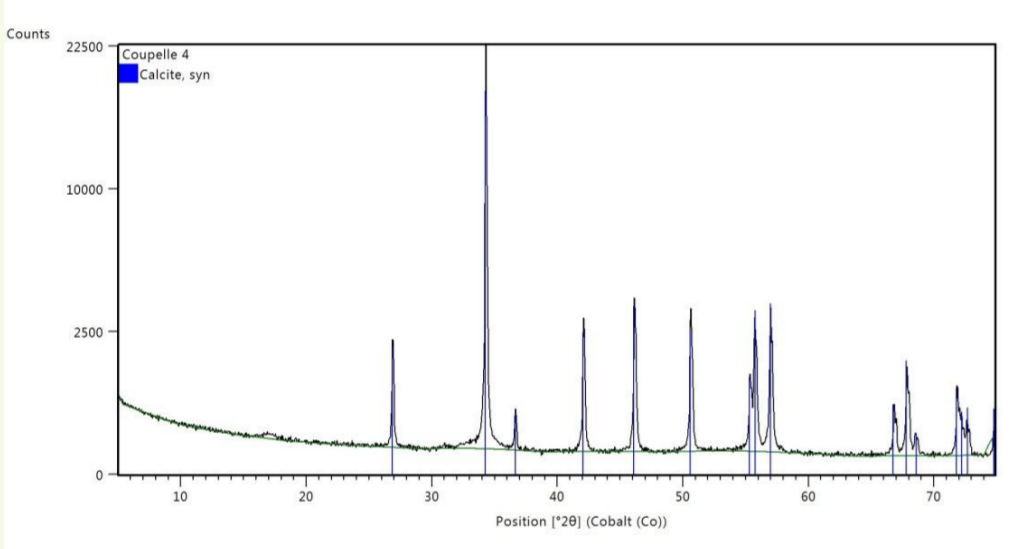
Evolution of the weight of précipitate in mg in function of pH and température



At 25°C we see a clear precipitation above pH 9 whereas at 52.5°C at pH 8 we have precipitation. The temperature has a greater effect than pH on the precipitation of calcium carbonate.

Identification of the precipitate using XRD

The authors thank Daniel BORSCHNEK (CEREGE) for his help in characterizing precipitate by XRD

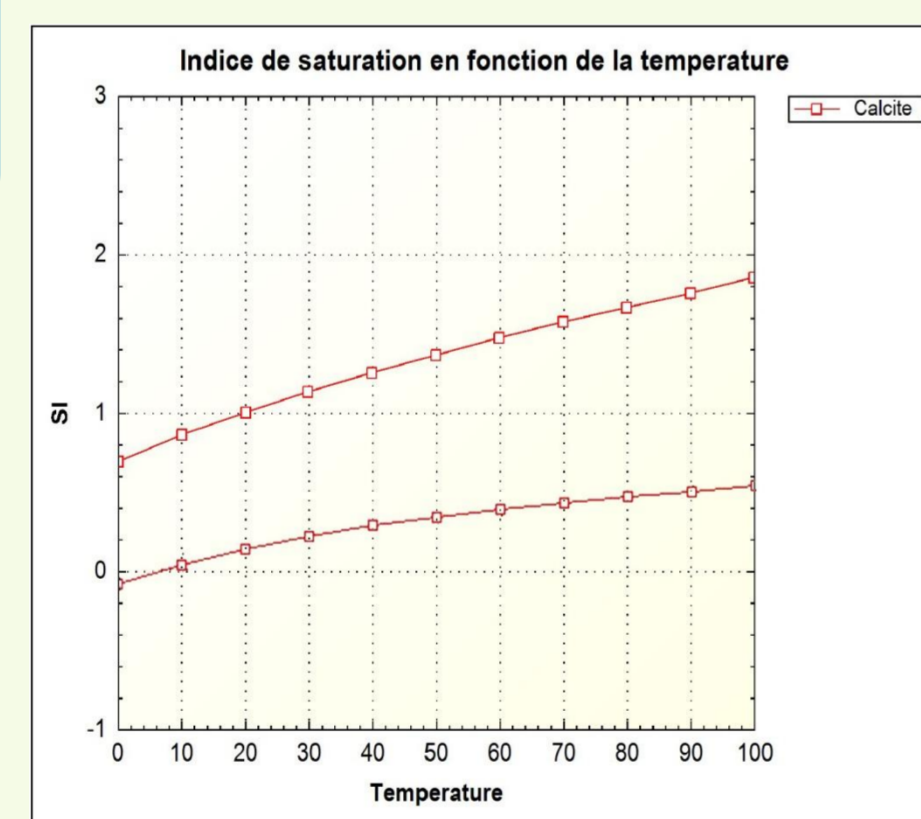


The drying samples were analyzed by XRD and the precipitate was found to be CaCO₃ in calcite form.

Measurement of the intensity as a function of the deflection angle 2θ

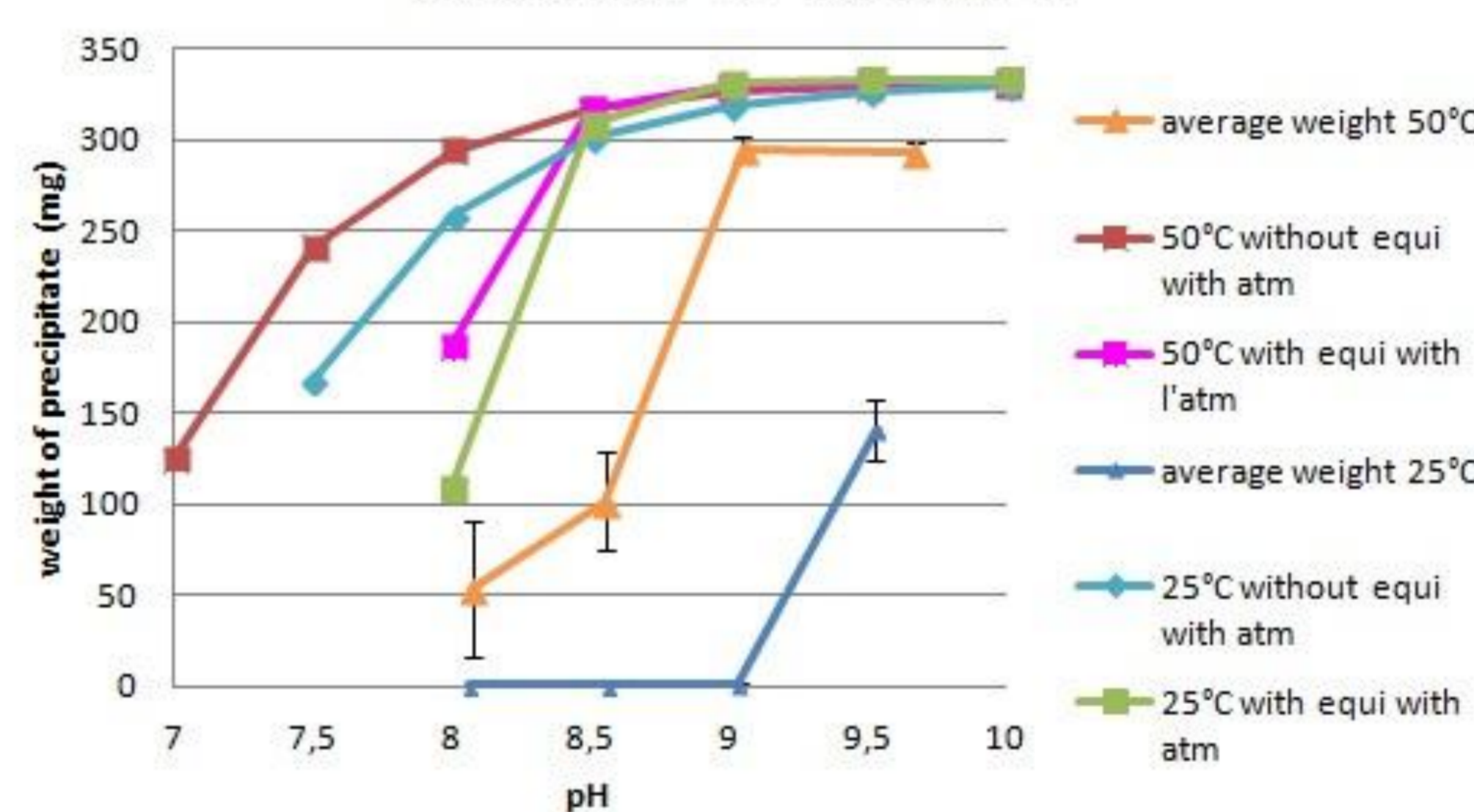
Numerical modelisation using Phreeqc

PHREEQC calculates:
- Saturation index (SI) of each element.
- The number of moles of the precipitated element.



a) without equilibrium with atm → same condition like emitters and pipes
b) with equilibrium with atm → same condition like beakers and exit drippers.

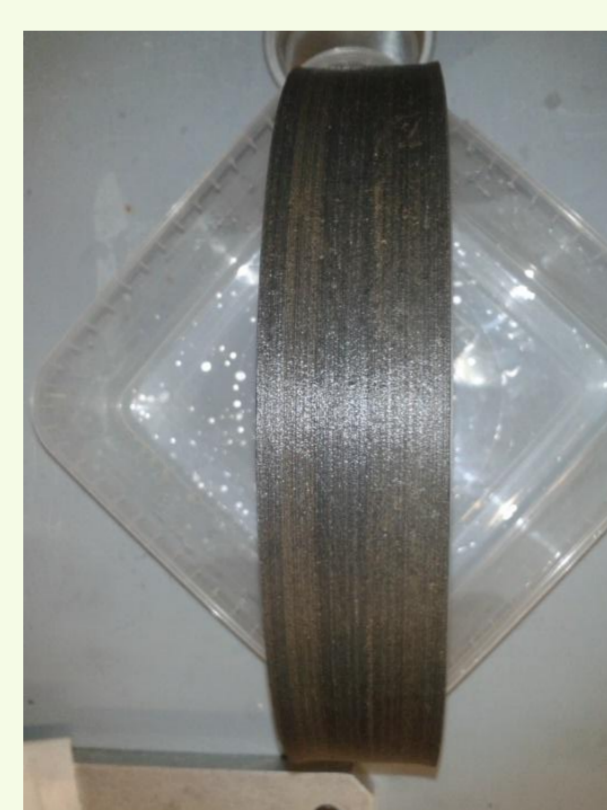
Comparison between experimental and modeling results at T=25 °C and 50°C



At low pH (<8.7) the calcocarbonic balance is not the same whereas at higher pH (>8.7) we have approximately the same values due to the almost total precipitation of calcite (about 330 mg).

At pH > 9 and T°C = 50°C all the calcite is precipitate but at 25°C we didn't reach these values even at pH > .

Biological clogging



Biofilms development on PE plates using Taylor-Couette reactor with treated wastewater .

The shear stress = 4.419 pa similar to drippers.



After 4 weeks of operation → biofilm formed on PE plates is collected → oven for 24 h at 105°C → weighed.

Quantification

Plate number	Weight of biofilm exp 1 (mg)	Weight of biofilm exp 2 (mg)
1	70.3	27
2	127.2	32
3	97.7	94
4	73.3	51
5	155	48
Tot weight mg/cm ²	0.43	0.21

Dried mass of 2 experiences after 4 weeks of operation the T°C was around 28°C and pH around 7.98

Conclusions and perspectives

- The precipitate mass increases with pH and temperature which may induce the chemical clogging of drippers.
- 98% of the precipitate mass was found to be CaCO₃ in calcite form.
- The development of biofilm varying on the different PE plates and from a experiment to another further experiments are needed to find out the cause.
- A biofilm growth model will be developed taking into account the kinetics of biofilm development and their interactions with chemical precipitation.
- A correlation will be made regarding Phreeqc and experimental chemical precipitation.