**PhD proposal**

**Plant-wide modelling of a wastewater treatment plant: implementation of sludge digestion**

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Deadline for application : 15th April 2020

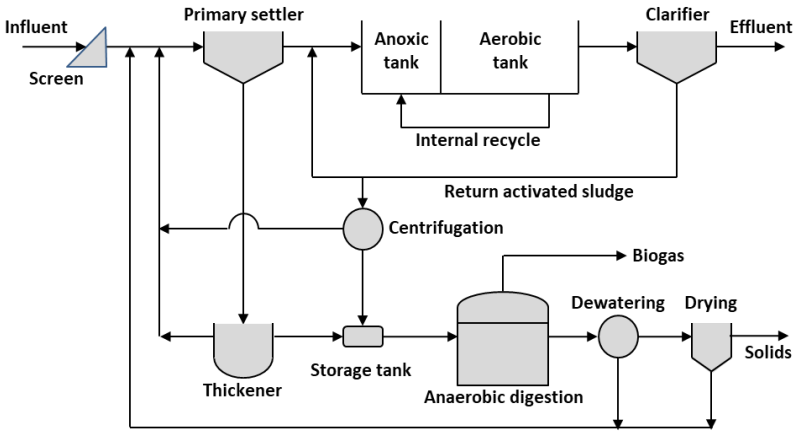
## Context and challenges

In the transition from wastewater treatment to the recovery of their resources, the optimization of wastewater treatment plants still largely depends on energy optimisation, i.e. reducing energy consumption and maximising energy production, especially via sewage sludge anaerobic digestion.

In this context, the plant located in Pierre-Bénite (Lyon, France) will encounter major modifications in the coming years, in order to implement a digestion step. Sludge from this conventional activated sludge plant, as well as external sludge produced on other plants, will be codigested on this site, challenging the future operation of the facility. Those modifications will induce important changes for example on the sidestreams coming from the sludge treatment line, or on the water line (implementation of a possibility to by-pass primary settling). The different mass flows (influent to the WWTP, internal sludge and external sludge, biogas) will require a dedicated management and monitoring that is not easy to foresee.

Furthermore, INRAE and INSA-DEEP, associated by the RESEED research group, have developed modelling tools that are *a priori* perfectly adapted to answer the questions raised by plant modifications. However, if modelling the water line of a wastewater treatment plant is rather well described in literature, sludge digestion and biogas production are still "overlooked". In particular, digestion models based on ADM1 (Batstone et al., 2002) lack full-scale implementation guidance and may not be useful for plant-wide modelling. Other models (e.g. Siegrist et al., 2002) may be better adapted. In addition, interfacing aerobic and anaerobic models is still challenging, as they do not include the same state variables (Seco et al., 2020).

The final objective of the proposed PhD thesis is to overcome the main bottlenecks encountered when developing plant-wide models using real data. Usual models will be adapted to mimic the operation of Pierre-Bénite WWTP, schematically represented in the following figure. The plant-wide model will be ultimately used to guide different operating strategies.




To develop the digital twin of the plant, two main scientific questions will been raised:

1/ Which models and associated data are required to simulate accurately primary settling and anaerobic digestion?

2/ Is an interface approach still feasible, or does the model complexity require a general approach (using a single set of state variables)?

## Description of the PhD thesis

The thesis will take place in four stages:

1/ Based on a thorough literature review: identification of candidate models to simulate primary settling and anaerobic digestion; to simulate the whole plant (interface model vs general model)

2/ Data collection and reconciliation for the existing plant.

This step may require to define and carry out specific measuring campaigns on the plant, in order for example to characterise wastewater and sludge biodegradability and assess the appropriate fractionation of the sludge in terms of state variables for the model. This characterization will complete the data routinely collected and a model representing the functioning of the water and sludge lines will be developed.

3 / Modification of the model to implement anaerobic digesters.

As no digester exists on the actual plant, data collected on a similar wastewater treatment plant including an anaerobic digestion step will be used to compare different models on real data.

4 / Development of the plant-wide model and simulation of different operating scenarios.

## Organisation

Doctoral school = ED 206 from Lyon (Chemistry, Process Engineering, Environment)

Host teams

DEEP Research Unit (INSA-Lyon). This unit conducts research on biological transformations of biosolids and anaerobic digestion.

Research Unit REVERSAAL of INRAE Lyon-Grenoble Auvergne Rhône Alpes. This unit conducts research on the processes of recovery and treatment of urban effluents (wastewater, wet weather effluents, sewage sludge).

A collaboration with the operators of the plant has been initiated in 2020 via a Master student supervision. The student will analyse and reconcile plant operating data.

Codirection of the thesis:

Pierre Buffière, Professor, INSA Lyon

Sylvie Gillot, PhD, Senior Scientist, INRAE Lyon-Grenoble

Start of the doctoral contract: October 2020

## Candidate profile

Competence in process engineering completed by a Master or an internship in (waste)water treatment and/or organic waste management. Modelling knowledge would be appreciated.

In addition, the candidate will have to master scientific English and will have to take over, with the support of the technical team, the design, the realisation and the analysis of the results for the measurement campaigns envisaged within the framework of its work.