

Smart identification of nitrogen compounds by ultraviolet spectroscopy and application to the control of an industrial denitrification process

The University of Compiègne is seeking a highly motivated graduate to undertake an exciting 3 years PhD project “ Smart identification of nitrogen compounds by ultraviolet spectroscopy and application to the control of an industrial denitrification process ”

Funding : French CIFRE grant (industrial research agreement)

Doctoral school : **ED 71 « Sciences pour l'Ingénieur » - UTC**

Scientific fields

- **Engineering**
- **Mathematics**

Place of work : **Université de Technologie de Compiègne**

Research laboratory : **Integrated Transformations of Renewable Resources**

Thesis supervisors : **Dr. Stéphane MOTTELET**, Prof. **André PAUSS**

Project description

The EU Water Framework Directive (december 2000) has imposed to members of the EU to restore the original ecological (biological and physicochemical) and chemical states (hazardous substances) of superficial water bodies within 15 years. This directive implies the tracking and the monitoring of various molecules such as nitrate and nitrite ions. These two compounds are usually measured in a combined way by UV spectrophotometry but this technique rarely allows discriminating them. We have tested and validated under real conditions with our partner SECOMAM, an online spectrophotometer allowing discriminating nitrates and nitrites concentrations. In order to estimate their concentrations from the UV spectra, the spectrophotometer software uses a multilinear regression model, which is calibrated under given conditions of the industrial process in a given time period.

This approach is not robust when the operating conditions of the process are subject to important changes, which require making a new calibration of the model. On the one hand, this lack of robustness undermines the industrial acceptability of this kind of measurement method. On the other hand, it prevents its use for the online control of the process, which is a strategic step for the optimization of the management of a Water Treatment Plant.

The first goal of the project is to propose new strategies of identification using the ultraviolet spectra, in order to estimate with improved precision and robustness the concentrations of chemical compounds causing the absorption. A preliminary study allowed to show that a « multi-model » approach, in contrast to classical methods, is very promising. In order to construct such models, modern data mining approaches will be considered.

The second goal is to study the control of the industrial process, by using the measurements of nitrates and nitrites at the input and the output. To this purpose, the differential equations system of the denitrifying process of the ASM model will be considered. On this basis a simplified model will be proposed, and using the experimental data accumulated by the Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne (SIAAP) will identify its parameters. Then different methods of control law synthesis will be studied and compared by numerical simulations.

Thus, the thesis will comprise several components, including among others experimental laboratory studies with the help of model solutions and on the real site (Water Treatment Plant) and *in silico* evaluation of identification and control methods.

The ideal candidate should have a process engineering degree and a strong interest for physics, statistics, automatic control and numerical analysis (MATLAB).

Keywords: spectrophotometry, wastewater treatment, mathematical modelling, data mining

National partnership: SECOMAM S.A., Alès

Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne (SIAAP)

International partnership: Ecole Polytechnique de Louvain, Université Catholique de Louvain, Louvain-la-Neuve, Belgium

Candidate profile

The candidate should have a Master's degree in one of the following disciplines: process engineering, computer engineering, applied mathematics, or chemical engineering

Application

Send a letter of motivation and a CV to :

Stéphane Mottelet, stephane.mottelet@utc.fr , tel +33 (0) 344 234 688

André Pauss, andre.pauss@utc.fr , tel +33 (0) 344 234 457