

## BioCo master thesis topics 2026-2027

Research in the 'Biosystems Control (BioCo)' group aims at sustainable process design and control, applied to biological wastewater treatment and other bioconversion processes. 'Sustainability' is interpreted as meeting the required product or effluent quality while minimizing the use of energy and resources, aiming at reuse and recovery, through compact installations, in an economically viable and socially acceptable way. We do process engineering via physical-based models (mass balances) combined with measurement campaigns at full scale and lab-scale experiments.

For 2026-2027, we offer the following master thesis topics:

- Modelling Hydrogen Sulphide Formation and Dynamics in Sewer Networks  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be)
- Methane Formation and Emissions in Sewer Systems  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be)
- Phosphorus Biomineralization Dynamics in Aerobic Granular Sludge  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be) & [Nouran.Bahgat@UGent.be](mailto:Nouran.Bahgat@UGent.be)
- Modelling Vivianite Formation and Phosphorus Recovery Potential in Wastewater Treatment Plants  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be) & [Nouran.Bahgat@UGent.be](mailto:Nouran.Bahgat@UGent.be)
- Optimization of biowaste (GFT) residual stream processing combined with anaerobic digestion  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be) & [Inge.DeBo@UGent.be](mailto:Inge.DeBo@UGent.be)
- Modelling and control of gaseous emissions from animal housing  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be) & [Christophe.Walgraeve@UGent.be](mailto:Christophe.Walgraeve@UGent.be)
- Something is in the air: pure oxygen for sustainable wastewater treatment  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be)
- Something is in the air: smart aeration for sustainable manure treatment  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be)
- Transition from linear to circular production systems for aquaculture, insect cultivation and hydroculture: monitoring and analysis of energy and mass balances  
[Eveline.Volcke@UGent.be](mailto:Eveline.Volcke@UGent.be)
- ... (feel free to propose your own topic matching our research scope)

More information on these topics is provided below. Do not hesitate to contact us if you are (potentially) interested.

# Modelling Hydrogen Sulphide Formation and Dynamics in Sewer Networks

## Description:

Hydrogen sulphide ( $H_2S$ ) formation in sewer systems poses significant challenges due to its toxicity, odour emissions, and role in biogenic corrosion. Sulphide production occurs mainly in anaerobic pressurized pipes due to microbial sulphate reduction and is controlled by hydraulic, chemical, and thermal conditions. When wastewater enters gravity sewers,  $H_2S$  release and sulphide oxidation can occur, often resulting in odour nuisance and concrete corrosion, and subsequent sewer deterioration.

This thesis centres on the modelling of  $H_2S$  dynamics in sewer networks, in collaboration with Aquafin, the Flemish wastewater treatment utility. You will analyse and apply existing predictive models, including the Aquafin Aqua $H_2S$  empirical model based on kinetics, hydraulic retention time, temperature, wastewater characteristics, pipe geometry, and flow conditions. Also, commercial sewerage-network-scale models may be evaluated and compared. Sensitivity analyses and examination of problematic real-life case studies will be performed, given that permits for industries may be supported by model outputs. Field pre-screening and  $H_2S$  sampling can complement the modelling work.

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## Keywords:

Hydrogen sulphide, sewer network, biogenic corrosion, modelling

## Confidential:

no

## Relevant for:

- MSc Bio-ingenieurswetenschappen: Milieutechnologie
- MSc Bio-ingenieurswetenschappen: Chemie en bioprocestechnologie
- MSc Environmental Science & Technology (IMESTE): major Urban Environmental Management
- Could also be taken up by incoming exchange students

## Methane Formation and Emissions in Sewer Systems

### Description:

Methane (CH<sub>4</sub>) is produced in sewer systems under anaerobic conditions through microbial methanogenesis. Both pressurized and gravity sewers can act as sources of dissolved and gaseous methane, with emissions influenced by hydraulic retention time, temperature, organic load, pipe geometry, and transitions between anaerobic and aerobic conditions. As methane is a potent greenhouse gas, sewer-related emissions are gaining attention, both in system-wide environmental assessments of the wastewater treatment sector, for example by Aquafin, the Flemish wastewater treatment utility, and in the context of climate mitigation.

This thesis aims to quantify and model methane emissions from sewer networks, in collaboration with Aquafin. Building on existing empirical and mechanistic equations for pressurized and gravity sewers, you will estimate CH<sub>4</sub> emissions under different scenarios (e.g., different conditions of the sewer). The work will compare models of varying complexity, from simplified to more detailed approaches, using measurement data provided by Aquafin and/or values reported in the literature. Sensitivity analyses will be used to identify key controlling parameters. Participation in field pre-screening campaigns for methane sampling is possible, linking your modelling outcomes to real-world observations.

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### Keywords:

Methane emissions, greenhouse gas emissions, sewer network, modelling, climate impact

### Confidential:

no

### Relevant for:

- MSc Bio-ingenieurswetenschappen: Milieutechnologie
- MSc Bio-ingenieurswetenschappen: Chemie en bioprocesstechnologie
- MSc Bio-ingenieurswetenschappen: Land, water en klimaat
- MSc Environmental Science & Technology (IMESTE): major Urban Environmental Management
- Could also be taken up by incoming exchange students

# Phosphorus Biomineralization Dynamics in Aerobic Granular Sludge

## Description:

Aerobic granular sludge (AGS) is revolutionizing wastewater treatment. Compact reactors, fast settling biomass, and efficient nutrient removal makes it one of the most promising technologies. Yet one key process inside these granules remains unresolved: **the competition between biological phosphorus uptake and chemical phosphate biomineralization**. This competition determines whether phosphorus is biologically stored as polyphosphate in PAOs or immobilized as minerals such as calcium phosphate, struvite, or vivianite.

Main objective: Develop and validate an integrated **bio-chemical-physical model** (in SUMO or Matlab/Simulink) that predicts the interplay between **biological polyphosphate accumulation** and **chemical phosphate biomineralization** within AGS. You will combine biological conversions, chemical equilibria, mineral precipitation kinetics, and 1D ion diffusion into a single simulation framework. The model will predict when and where phosphate minerals form inside granules.

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## Keywords:

phosphorus removal, environmental engineering, resource recovery, aerobic granular sludge, modelling, CAPTURE

## Confidential:

no

## Relevant for:

- Campus Kortrijk: Industr. wetenschappen - Circulaire bioprocestechnologie
- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Campus Coupure: Msc in Environmental Science and Technology - Major 2.2 Resource Recovery Technology
- Campus Coupure: Bio-ir – Milieutechnologie
- Could also be taken by incoming exchange students.

# Modelling Vivianite Formation and Phosphorus Recovery Potential in Wastewater Treatment Plants

## Description:

Phosphorus (P) is essential for global feed and food production, yet known reserves may be depleted in 50-100 years. Recovering phosphorus from waste streams therefore becomes increasingly important. Wastewater alone is estimated to supply 15-20% of the global P demand. A most promising pathway for P recovery is in the form of vivianite, particularly from sludge digestion and sidestreams. While vivianite is increasingly recognized as a key sink for phosphorus and a promising target for P recovery, its formation is rarely modelled explicitly.

This master thesis project aims to develop a **process-based model** that predicts when, where, and how much **vivianite** is formed in wastewater treatment plants, in the SUMO simulation environment. The model will quantify how operational conditions (e.g., Fe dosing, digestion conditions, Fe/S ratio) affect vivianite formation, estimate the **recoverable P fraction** in vivianite, and explore scenarios for **enhancing vivianite-based P recovery** (e.g. targeted Fe dosing or process configuration).

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## Keywords:

phosphorus recovery, environmental engineering, resource recovery, data analysis, modelling, CAPTURE

## Confidential:

no

## Relevant for:

- Campus Kortrijk: Industr. wetenschappen - Circulaire bioprocestechnologie
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- Campus Coupure: Msc in Environmental Science and Technology - Major 2.2 Resource Recovery Technology
- Campus Coupure: Bio-ir – Milieutechnologie
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## Optimization of biowaste (GFT) residual stream processing combined with anaerobic digestion

### Description:

Organic matter represents roughly half of global solid waste, historically landfilled with high land take, leachate risks, and significant greenhouse gas emissions. In the circular-economy transition, aerobic composting and anaerobic digestion (AD) have become cornerstone technologies to recover energy and nutrients from biowaste. AD converts biodegradable carbon into biogas (CHP) and leaves a digestate requiring post-treatment to meet stability, hygiene, and product quality criteria for safe agronomic use.

In regional GFT (source-separated kitchen and garden waste) systems, pre-treatment aims to minimize contaminants (metals, plastics, inerts) while preserving digestible organics. A typical line applies shredding, metal removal, and double screening (>60 mm and >200 mm). To minimize organics in the >60 mm residual, sites can operate drying tunnels: material is loaded in a tunnel, then dried with warm air (waste heat from CHP), and reprocessed through pre-treatment and optical (NIR) sorting to remove plastics and further reduce organic carryover in the residual stream.

This master's thesis addresses the design of a pilot-scale drying tunnel to simulate full-scale tunnel behavior and to optimize drying and aeration as part of an integrated DRANCO digestate post-treatment pathway. The work links thermo-hydraulics (airflow, heat, evaporation) with process function (reduced moisture, improved separability, lower organics in overflow), and regulatory compliance (e.g., VLACO sanitation and product quality). The pretreatment challenges will be studied by experimental work, modelling and simulation, and/or the analysis of data from lab/pilot/full-scale setups. Depending on the background and interest of the student, the focus can be put on one or another methodology. This research is done in close collaboration with DRANCO nv, a global leader in the construction of anaerobic digestion plants and in providing consultancy services in the field of organic waste management (office in Gent).

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### Key words:

biowaste, GFT, anaerobic digestion, AD, residual stream processing analysis, modelling and simulation, energy and mass balances, design pilot drying tunnel

### Confidential:

no

### Relevant for:

- Campus Kortrijk: industr. wetenschappen - Circulaire bioprocestechnologie
- Campus Coupure: Bio-ir - Milieutechnologie
- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Could also be taken by incoming exchange students.

## Modelling and control of gaseous emissions from animal housing

### Description:

Intensive livestock production is a significant source of both ammonia (NH<sub>3</sub>) and odorous emissions. Air scrubbers are a primary technology for mitigating these impacts by removing pollutants from the ventilated air streams from stables.

This master thesis aims to investigate the nitrogen removal efficiency and/or odour abatement in livestock air treatment systems. By combining experimental data analysis and dynamic modelling, the study will assess how operational parameters influence ammonia capture and/or odour reduction. Besides, the challenge of nitrogen recovery can be addressed in this study.

Through rigorous analysis of data and system behaviour, this research contributes to the overall control of integrated odour control and nitrogen management in livestock housing. The results will support improved system operation, reduce environmental impacts, and contribute to the practical understanding of nitrogen removal and odour emission reductions in real operational settings. The research challenges will be studied by modelling and simulation, and/or the analysis of data from lab/pilot/full-scale setups. Depending on the background and interest of the student, the focus can be put on one or another methodology.

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### Keywords:

ammonia emissions, odour emissions, environmental engineering, resource recovery, data analysis, modelling

### Confidential:

no

### Relevant for:

- Campus Kortrijk: industr. wetenschappen - Circulaire bioprocestechnologie
- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Campus Coupure: Msc in Environmental Science and Technology - Major 2.2 Resource Recovery Technology
- Campus Coupure: Msc in Environmental Science and Technology - Major 2.3 Urban Environmental Management
- Campus Coupure: Bio-ir – Milieutechnologie
- Campus Coupure: Bio-ir – Landbouwkunde
- Could also be taken by incoming exchange students.

## Something is in the air: pure oxygen for sustainable wastewater treatment

### Description:

Aeration is the most critical component of biological wastewater treatment. During aeration, air is supplied to the reactor to provide microorganisms with sufficient oxygen to degrade the pollutants present in the wastewater. However, oxygen transfer efficiency is typically low, meaning that a large fraction of the supplied oxygen leaves the reactor unused. This can (1) limit the treatment capacity of the installation, (2) reduce energy efficiency, and (3) contribute to significant emissions, including nitrous oxide (N<sub>2</sub>O), a potent greenhouse gas.

The use of pure oxygen instead of air offers potential advantages in addressing these challenges. Its nearly fivefold higher partial pressure significantly increases the achievable dissolved oxygen concentration. This may accelerate biokinetic processes, thereby enhancing treatment capacity and enabling more compact reactor designs. Moreover, the higher driving force for oxygen transfer can reduce the energy required to achieve a target dissolved oxygen level. Finally, lower gas flow rates decrease stripping effects, potentially reducing N<sub>2</sub>O emissions.

The aim of this master's thesis is to investigate the potential of pure oxygen supply in aerobic biological wastewater treatment. The research will involve carrying out experiments at VITO's Water Climate Hub in Ostend. These experiments will then be used to create a simple biokinetic model. Sludge will be collected from a full-scale wastewater treatment plant and used in batch experiments to compare biokinetic parameters under conventional aeration and pure oxygen conditions. The model simulation results will determine whether pure oxygen can enhance biological removal rates while simultaneously reducing N<sub>2</sub>O emissions.

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### Keywords:

biological wastewater treatment, pure oxygen, experimental work, simple model, VITO Ostend, CAPTURE

### Confidential:

no

### Relevant for:

- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Campus Coupure: Bio-ir – Milieutechnologie
- Campus Coupure: Msc in Environmental Science and Technology - Major 2.2 Resource Recovery Technology
- Could also be taken by incoming exchange students.

## Something is in the air: smart aeration for sustainable manure treatment

### Description:

Intensive pig and cattle production is an important economic activity in Flanders, at the same time the region has been labelled by the EU as a Nitrate Vulnerable Zone. Therefore, the Flemish Manure Decree obliges farmers to process manure surpluses. The most commonly applied manure treatment technique concerns mechanical separation followed by biological treatment of the liquid fraction.

Mathematical modelling and simulation are powerful tools for optimizing biological manure treatment processes. Within this biological treatment aeration is currently identified as the main limiting factor: (1) it restricts the treatment capacity of the installation, (2) it represents the highest energy cost, and (3) it may contribute to significant emissions, including nitrous oxide (N<sub>2</sub>O), a potent greenhouse gas. Accurate prediction of gas-liquid mass transfer of oxygen and N<sub>2</sub>O is therefore essential to make the process more compact, energy-efficient, and environmentally sustainable.

In this master's thesis project, an existing model (developed in MATLAB/Simulink) of a manure treatment plant will be calibrated and validated using data from the manure treatment facility of Voeders Seuryneck in Sint-Eloois-Winkel, West Flanders. The simulation results will be analyzed in detail, and potential optimization strategies will be proposed through scenario analysis.

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### Keywords:

Manure treatment, Biological nutrient removal, oxygen, Modelling, simulation, CAPTURE

### Confidential:

no

### Relevant for:

- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Campus Coupure: Bio-ir – Milieutechnologie
- Campus Coupure: Msc in Environmental Science and Technology - Major 2.2 Resource Recovery Technology
- Could also be taken by incoming exchange students.

# Transition from linear to circular production systems for aquaculture, insect cultivation and hydroculture: monitoring and analysis of energy and mass balances

## Description:

Primary production sectors such as aquaculture, insect farming, and horticulture face increasing pressures related to resource scarcity, environmental regulations, and economic constraints. At the same time, their regional presence offers a unique opportunity to transition from linear to circular production systems. By valorizing residual streams and connecting production cycles across sectors, circular systems can reduce waste, lower raw material demands, and increase both environmental and economic sustainability.

This master's thesis investigates the potential of the Aqua-Entomo-Ponics (AEP) system—an integrated model combining aquaculture, insect production, and plant cultivation—as an innovative circular approach to address the key bottlenecks identified in these sectors and to support more resilient, sustainable, and socially accepted production practices.

In this thesis, we will analyse the energy, water and nutrient balances of the recirculating aquaculture system (RAS) and cultivation of Black Soldier Fly (BSF), at Inagro, research centre for agriculture and horticulture in Beitem. A detailed monitoring of both systems by several sensors during a long term will result in an accurate dataset, taking seasonal fluctuations, process parameters and influencing factors into account. Modelling the correlations between components in the water can provide accurate estimates of small concentrations of nitrogen compounds, being toxic for fish. The AEP circularity challenges will be addressed through experimental work, modelling and simulation, and/or the analysis of data from lab/pilot/full-scale setups. Depending on the background and interest of the student, the focus can be put on one or another methodology. This research is part of the Flemish-Netherlands interreg-project AEP-Pulse, so embedded in an overall sustainability study.

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## Keywords:

aquaculture, RAS, insect cultivation, BSF, modelling, energy balance, mass balances, sensors, wastewater treatment

## Confidential:

no

## Relevant for:

- Campus Coupure: Bio-ir - Chemie en bioprocestechnologie
- Campus Coupure: Bio-ir - Landbouwkunde
- Campus Coupure: Bio-ir – Milieutechnologie
- Campus Kortrijk: Industr. wetenschappen - Circulaire bioprocestechnologie
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