 

MARMARA UNIVERSITY FACULTY OF ENGINEERING

ENVIRONMENTAL ENGINEERING DEPARTMENT

ENVE 4197/4198 ENGINEERING PROJECT PROPOSAL FORM (FALL 2025-2026)

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| **Instructor:** Prof. Bilge Alpaslan Kocamemi  **Project Title:** Centrate Treatment with Moving Bed Biofilm Reactor (MBBR): Start-up and Enrichment Stages  **Number of Students:** 2 | | | |
| **Scope of the Project:**  In recent decades, the paradigm of wastewater treatment has shifted from solely protecting receiving water bodies to developing sustainable, energy-neutral, and resource-oriented processes. High Rate Activated Sludge (HRAS, A-process) systems, when integrated with anaerobic digestion, redirect a substantial fraction of organic matter to digesters, thereby enhancing methane production and contributing to energy-positive wastewater treatment. While this configuration enhances methane generation, it produces nitrogen-rich digester supernatant that, when recycled, increases the nutrient load to the main treatment line. Conventional nitrification–denitrification is unsustainable due to its high energy and carbon demand, whereas deammonification—combining partial nitritation and Anammox—offers a promising, low-energy alternative.  Deammonification, a combined process of partial nitritation and anaerobic ammonium oxidation (Anammox), has emerged as a promising alternative due to its reduced oxygen demand, lower sludge yield, and negligible greenhouse gas emissions. Although extensively demonstrated in sidestream treatment in developed countries, the application of deammonification to HRAS digester supernatant remains insufficiently explored.  This research proposes evaluating HRAS digester supernatant treatment through a pilot-scale Moving Bed Biofilm Reactor (MBBR) deammonification system. Particular emphasis will be placed on the start-up and enrichment phases, which represent critical determinants of long-term process stability and efficiency. The start-up of deammonification systems is challenged by the inherently slow growth of Anammox bacteria, the need for appropriate biofilm development, and the sensitivity of microbial consortia to operational fluctuations, such as dissolved oxygen (DO) concentration and nitrite accumulation. Therefore, the proposed study will implement a systematic start-up strategy.  Overall, this project aims to establish a scientifically rigorous framework for the start-up and operation of lab-scale MBBR deammonification systems, thereby contributing to the sustainable evolution of wastewater treatment technologies. The pilot system will be systematically assessed in terms of nitrogen removal efficiency, operational stability, and microbial community dynamics.  The study will be conducted in a sequencing batch reactor system equipped with dissolved oxygen (DO), pH, and temperature monitoring probes. The reactor will be fed with ammonia, and process efficiency will be monitored through daily measurements of influent and effluent ammonium (NH₄⁺-N), nitrite (NO₂⁻-N), and nitrate (NO₃⁻-N). Enrichment will be evaluated using quantitative real-time polymerase chain reaction (qPCR) measurements. | | | |
| **Hardware/Software/Lab/Equipment Requirements:**   * **Plexiglass reactor ( 19 L )** * DO, pH probes, temperature transmitter (Hach Lange, Multi-parameter) * Peristaltic pumps (Prodoz PRS-7) * Pressure Transducer (Endress Hauser) * Mechanic stirrer (WiseStir, HS-50A) * Air pump (SEBO, SB-988) * Timers (Timer, Ledx) * Dual injection (cation and anion) ion chromatograph (Schimadzu SIL-10AP) * Thermoreactor | | | |
| **Development Plan:**  The thesis will be managed according to the work schedule below. At the end of this thesis, it is expected to have experience in literature searching, laboratory experiments, data analysis, time management, thesis writing, presentation, and teamwork.  **Work - Time Table** | | | |
|  | **Work** | **Time period (month)** |  |
|  | Literature search, Training for reactor operation | 2 |  |
|  | Daily measurements, Batch kinetic experiments, Data Analysis | 2-8 |  |
|  | Thesis writing | 8-12 |  |