

# Integrated Model for Simulation of Super-Large Scale Membrane Bioreactor Process and Energy Consumption

Kashif NADEEM<sup>a</sup>, Queralt PLANA<sup>b</sup>, Claire ALBASI<sup>a</sup>, Jean BERNIER<sup>b</sup>, Sam AZIMI<sup>b</sup>, Vincent ROCHER<sup>b</sup>, Marion ALLIET<sup>a</sup>

<sup>a</sup> Laboratory of Chemical Engineering, University of Toulouse, CNRS, INPT, UPS, Toulouse, France

<sup>b</sup> Parisian Sanitation Public Service (SIAAP), Direction Innovation, Colombes, France

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## Introduction

Activated sludge models (ASMs), filtration models, and integrated models considering the complex interactions among biology, filtration, and fouling have been developed and applied to MBRs plants, mostly ranging from bench scale to pilot scale and rarely for full-scale (<100,000m<sup>3</sup>/day). The applicability of these models for super-large scale MBRs (>100,000 m<sup>3</sup>/day) has not been studied yet. In this study, a super-large-scale MBR plant with 360,000 m<sup>3</sup>/day design capacity is dynamically modeled to simulate its de-pollution and filtration/fouling process along with energy consumption. The integrated model combines biochemical (EPS-ASM3-Bio-P & chemical precipitation) and resistance in the series (RIS) filtration model. The biological part also employed a sub-model to simulate the biological aeration. The biochemical part of the model considers the stoichio - kinetic activity of the biomass for carbon, nitrogen, and phosphorus removal. The filtration part of the model covers the fouling dynamics due to intermittent air scouring synchronized with filtration-backwashing cycles taking into account the influence of temperature, TMP, and biomass characteristics such as mixed liquor suspended solids (MLSS) and EPS concentrations. The calibrated model successfully simulated the biological, chemical, and physical processes for the super large-scale MBR. The model was validated against 92 days of operational data from the plant with/without FeCl<sub>3</sub> addition. The simulated effluent COD results fitted reasonably well with the experimental data with a root mean square error (RMSE) value of 0.32, and the model successfully simulates the minimum detection limit for COD measurement in the laboratory. Model accuracy for simulating NH<sub>4</sub>-H, NO<sub>x</sub>-N (nitrates & nitrites), TSS, and PO<sub>4</sub><sup>3-</sup> in terms of RMSE was found to be 0.80, 0.92, 1.10, and 0.85, respectively. Transmembrane pressure (TMP) has also been simulated reasonably well with a normalized RMSE of 19.65%. Furthermore, the model successfully simulated the energy consumed in biological aeration, mixing, and influent pumping, which accounted for 14%, 17%, and 9%, respectively. While the rest of the energy is being consumed by other processes such as recirculation, chemical dosing, foam breaking, permeate suction-backwashing, and sludge extraction. The calibrated model provided an excellent correspondence with the operational data and can be used as a valuable tool for optimizing and developing advanced control for large-scale MBR.

## References

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