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Ph.D. DISSERTATION DEFENSE

Candidate:	Jeanette Brown
Degree:	Doctor of Philosophy
School/Department:	Charles V. Schaefer, Jr., School of Engineering/ Civil, Environmental and Ocean Engineering
Date:	Thursday, December 7, 2023
Time/Location:	10:00am, Davidson Laboratory Room 235
Title:	Treatment of High Nitrate-Nitrogen Industrial Waste at a Municipal Wastewater Treatment Facility
Chairperson:	Dr. David A. Vaccari, Department of Civil, Environmental and Ocean Engineering
Committee Members:	Dr. Christos Christodoulatos, Department of Civil, Environmental and Ocean Engineering Dr. Tsan-Liang Su, Department of Civil, Environmental and Ocean Engineering Dr. Adeniyi Lawal, Department of Chemical Engineering and Material Science

ABSTRACT

The goal of this project was to determine if an industrial waste containing a high concentration of nitrate could be discharged to a municipal wastewater treatment facility for removal of the nitrate. The hypothesis was that this high-nitrate industrial waste could be denitrified in a municipal water resource recovery facility (WRRF) using the influent chemical oxygen demand (COD) as the carbon source, as well as endogenous carbon.

There were three distinct phases to the project. The first phase was a preliminary study using process simulation software to determine how much nitrate could be removed using typical wastewater characteristics. This phase also included the addition of a supplemental source of carbon, methanol. The results from this phase were a process flow using methanol which resulted in about 90% of the influent nitrate. The second phase of the research was to take the process developed in phase 1 and optimize the design using the Nelder-Mead Optimization algorithm. Overall daily cost (both capital and operating) were reduced by 54% by reducing the overall hydraulic retention time (HRT) and methanol and other operating costs. The goal of the next phase was to prove whether this process concept would work. To accomplish that, we designed a 5-L/hr pilot continuous flow pilot plant. The pilot plant was located at an operating WRRF which allowed the use of actual wastewater. Initially the pilot plant was operated as a modified Ludzack-Ettinger (MLE) process, but was converted to a Wurhmann process based on additional process simulations. The pilot was operated at three different solids retention times (SRT); 6.5-days, 10-days, and 15-days.

The results of these studies showed that about 78% of the total nitrogen could be removed without the addition of any external carbon source at SRTs greater than 10-days, only using the COD in the influent wastewater and endogenous carbon generated during the biological treatment process. The removal in the pilot plant was greater than predicted by numerical simulation. The mechanism for this high removal is not understood and could be the results of numerous factors that require further study.