

First Year Operation of a Dual Chamber Bioreactor for Nitrate Removal

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Introduction

This study was designed to investigate the nitrate-N removal characteristics across the length of two bioreactors connected in parallel. Additional aspects of interest include the hydraulic gradient along the length of the bioreactor, dissolved oxygen levels in the bioreactor, and *Escherichia coli* levels at the inlet and outlet of the bioreactor. This report has preliminary results for the first year of the bioreactor operation.

Materials and Methods

The study started in spring 2019 at the Iowa State University Uthe Farm. This site consists of two woodchip denitrifying bioreactors connected in parallel (referred to as a Dual Chamber Bioreactor), which were installed in the summer of 2018.

Tile drainage from uphill row crop fields enters the main inlet to the bioreactors where the flow is divided between the two bioreactors. Denitrifying bacteria within the bioreactors convert nitrate from the incoming tile drainage into nitrogen gas, leading to reduced nitrate loads to the downstream surface waters. The two bioreactors have been referred to as Chamber A and Chamber B. Chamber A is located to the west of Chamber B.

These two bioreactors each feature nine sampling wells randomly along the length of

the bioreactors for a total of 18 sampling wells. There also are five water control structures (one at the main inlet, two at the individual bioreactor inlets, and two at the individual bioreactor outlets).

Nutrient samples were collected weekly to biweekly at this site from the 18 sampling wells and the five water control structures. These nutrient samples were analyzed in the Water Quality Research Lab at Iowa State University for nitrate-N, *E. Coli*, total organic carbon, and orthophosphate. At the site, the temperature, dissolved oxygen, and water level in the bioreactor were measured and recorded.

Results and Discussion

Both of the Uthe bioreactors experienced extremely high nitrate removal throughout the 2019 drainage season. Samples were collected biweekly in April and May, then weekly from June through August 1, 2019, when the tiles stopped flowing. Chamber A had nitrate removal with values below the limit of detection at the outlet at every sampling date indicating 100 percent removal the entire season. Meanwhile, Chamber B had nitrate removal ranging from 72.6 to 100.0 percent. The removal in Chamber B dropped below 95 percent on two sampling dates in 2019 though, indicating the tile flow was not sufficient for the size of the bioreactors. Removal on a mass basis was not measured due to difficulties encountered with the flow measurement equipment. Changes have been made for improved monitoring during the 2020 drainage season.

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