# ABSTRACT

Sun, Zhe. M.S., Purdue University, May 2014. Attached-Growth System for Nitrification at Low Temperature. Major Professor: Ernest R. Blatchley III.

Lagoon systems are commonly used in small communities for domestic wastewater treatment. These systems are simple and economical to operate, and are often appropriate for use in areas where land costs are low. Lagoons have been found to be effective for removal of conventional pollutants under warm-weather conditions; however, biochemical nitrification has been observed to be hindered in suspended-growth lagoons during periods of extended cold weather. Attached-growth nitrification systems, as compared to suspended-growth systems, have been reported to yield improved biochemical nitrification under cold-weather conditions. Therefore a new type of biochemical nitrification reactor (BOBBER) that includes surfaces to promote development of attached-growth nitrifying communities has been applied to an aerobic lagoon system at Wingate, IN. Results of monitoring of this system have indicated improvements in oxidation of ammonia-N, especially during winter months.

To examine the behavior of this system in a more controlled setting, two laboratory-scale mini-BOBBER systems were installed in a temperature-controlled room. The systems were operated for 101 days with an ammonium chloride feed solution, and allowed to approach steady-state conditions at 20 ℃, 15 ℃, 10 ℃, and 5 ℃. In addition, a series of batch experiments were conducted at temperatures of 20 ℃ and 5 ℃ to investigate the relationship between nitrification rate and ammonia-N

concentration. Concentrations of nitrate, nitrite, pH and other process variables were measured daily during these experiments. These results were analyzed to quantify ammonia-N removal rates. Similar calculations were applied to the data from the full-scale lagoon system at Wingate.

Ammonia-N removal in the laboratory-scale lagoon system always exceeded 95%, even when the temperature was reduced to 4.6 ℃. However, the full-scale lagoon system was not as effective, with ammonia-N removal of approximately 74% at the same temperature. Possible explanations for these differences in behavior include: competition from heterotrophs, lack of ammonia-loading at Wingate, and a relatively small population of nitrifying bacteria at Wingate.

At 20 ℃, the results from batch experiments indicated ammonia-N removal rates of approximately 157 mg/$m^2$/hour, while the removal rate at 5 ℃ was roughly 37 mg/$m^2$/hour. Results from the batch experiments indicated that the ammonia-N removal rate was zero-order with respect to ammonia-N concentration and was highly temperature-dependent.

Collectively, these findings suggest that it is possible to maintain effective biochemical nitrification in attached-growth systems under cold-weather conditions. Satisfactory performance of these systems will depend on hydraulic design and loading rates of the systems. In general, it appears that effective nitrification may be possible in attached-growth systems when conditions are provided to maintain a healthy community of nitrifying bacteria.