MinnesotaCorn
RESEARCH & PROMOTION COUNCIL

INNOVATION GRANT PROGRESS REPORT

PROJECT TITLE: Novel algae bioreactor for nutrient removal from subsurface drainage water
REPORTING PERIOD: 4/1/17–7/31/17
FARMER INNOVATOR: N/A
COLLABORATING ORGANIZATION/PERSON: N/A
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1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD.

During the reporting period, we set up and operated an algae granular sludge bioreactor to achieve the Objective #1 (Develop algal granules in a laboratory-scale bioreactor). Algae granular sludge bioreactor has been operated with synthetic tile drain water that contains 50 mg NO_3-N/L, 1 mg NH_4-N/L, and 1 mg PO_4-P/L. These concentrations are typically observed in actual tile drain water. To automate the effluent discharge and influent refill, we connected a programmable relay controller (PLC) to the bioreactor. The PLC needs to be securely housed in a plastic box to prevent electric shock (as pointed out by a lab safety inspector at the University of Minnesota), and therefore, we asked the University machine shop for this.

After we establish the bioreactor operating conditions, we will enhance denitrification in the algae granules to increase the nitrate removal rate (Objective #2).

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.

- Granular biomass was formed in the bioreactor (**Fig. 1**). Granular-biomass sinks when aeration is turned off, leaving clean water in the upper part of the reactor.
- The pH values of the bioreactor increased from around 6.8 to 7.4-7.6 (**Fig. 2**), indicating that algae/cyanobacteria grow and fix CO_2 and/or denitrifiers reduce NO_3^-.
- We collected water samples, and tried to measure nitrate concentrations. However, due to equipment problems (we used flow injection analyzer in our lab), it was not successful so far. Once we fixed the instrument problem, we will measure nitrate concentrations again. All samples are kept frozen in the lab.

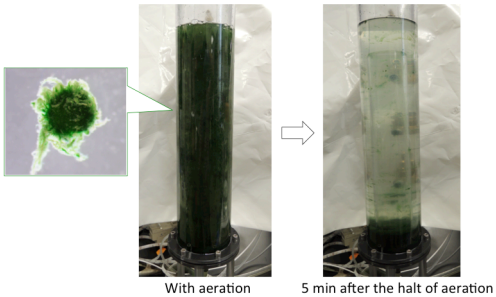

Fig. 1. Formation of algae granules in the bioreactors. Granular-biomass sinks when aeration is turned off, leaving clean water in the upper part of the reactor.

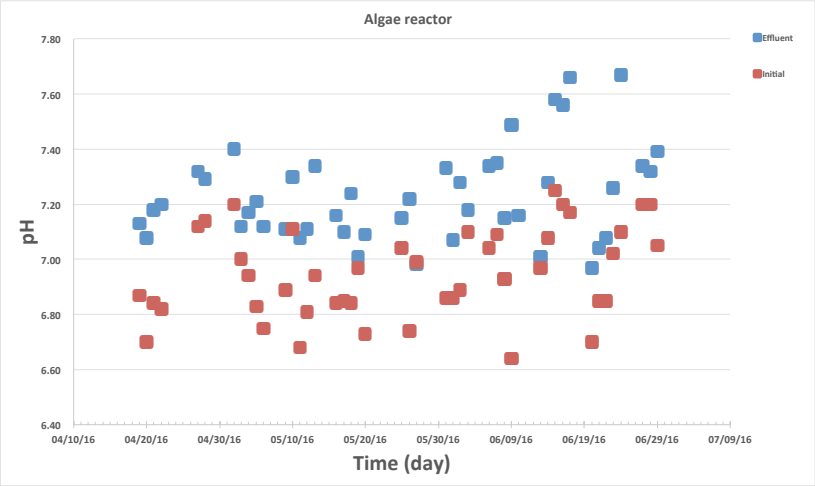

Fig. 2. The pH values of the influent (red) and effluent (blue) samples collected from the algae granular sludge bioreactor.

3.) CHALLENGES ENCOUNTERED.

- Undergraduate student who helped operate the bioreactors left the lab. I need to find another student to work with. I have identified one candidate.
- Biofilms formed on the surface of the bioreactor, which was unexpected. We may need to re-design bioreactors to prevent or minimize the formation of biofilms.

4.) EDUCATION AND OUTREACH ACTIVITES.

None so far.

5.) HOW CAN WE HELP?

The bioreactor is currently operated with synthetic tile drain water. Once we establish the bioreactor operating conditions, we want to feed actual tile drain water (e.g., from cornfields). At that time, we may ask your help find farmers who allow us to collect their tile drain waters.