Energy-Positive Wastewater Treatment and Reuse System for Agriculture Applications

Topic: 8.4 Air, Water and Soils
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The use of recycled water has never been more important than it is today, especially with parts of the Western United States experiencing the worst drought in 500 years. To address the severe and persistent shortage of water, food growers are increasingly looking to recycled water as a way to consistently meet their irrigation demands. In fact, states like California and Arizona have seen its cities recycle water and resell it to ratepayers at lower rates for use in certain sanitary applications. The main challenge for water reuse in agriculture, however, remains transitioning from a centralized recycling program to cost-effective, on-site wastewater treatment systems that can improve the quality of wastewater used in irrigation without imposing risks on health or the environment.

When considering affordable, yet effective wastewater treatment options for the agriculture industry, Cambrian Innovation's Research & Development (R&D) team found inspiration in the methane production central to the technology driving the EcoVolt® Reactor, our bioelectrically-enhanced anaerobic treatment systems. Methane is a double-edged sword: when released into the environment, methane is a potent greenhouse gas, but when combusted efficiently, it is one of the cleanest energy sources we have. The methane potential from animal manure in the United States is estimated at about 257 billion cubic feet or 142 trillion British thermal units, which is about 40% of total estimated energy potential from biogas sources in the U.S. This is enough energy to power more than 1.2 million U.S. homes for one year or to produce the equivalent of 1 billion gallons of gasoline for vehicles. In March 2014, the White House released the Climate Action Plan - Strategy to Reduce Methane Emissions in which the USDA, EPA, and DOE identified strategies to reduce methane emissions through the use of biogas systems and overcome barriers to growth for a robust biogas industry in the United States. It supports the U.S. dairy industry's voluntary 2008 goal to reduce its greenhouse gas emissions by 25% by 2020.

The challenge was clear: Cambrian's R&D team set out to develop an enhanced solution for improving agriculture water reuse while maximizing biogas energy recovery. The goal was to present the early stages of this solution—a packaged, distributed, energy-positive wastewater treatment and reuse system (WTRS) targeted for manure wastewater—to the above federal agencies for funding to help develop it further. The proposed system will enable more than 70% wastewater reuse by combining a novel anaerobic solids digester with an efficient aerobic membrane bioreactor (MBR). This system will be capable of addressing the major limitations associated with existing anaerobic digestor (AD) systems for manure waste treatment, while providing such additional benefits as: (i) 70% reuse of wastewater; (ii) net-energy-positive treatment; (iii) minimal waste generation; and (iv) modular design.

Cambrian's R&D team secured funding for the solution, winning a grant for research on behalf of the USDA. In Phase I of the research, R&D focused on validating the proof of concept of the

proposed integrated upflow anaerobic solids and liquid (UASL) digester, as our MBR is a mature technology. We are proud to announce that all of the Phase I project objectives were successfully accomplished. An effective yet simple method was identified for manure pretreatment: by reducing particle size and increasing contact surface area, R&D demonstrated higher methane yield in the biochemical methane potential (BMP) test. Max methane yield was achieved at 311 L CH_4/kg VS loaded in UASL reactors, which is 3.5% exceeding the project objective of 300 L CH_4/kg VS loaded, and 107% higher than the 150 L CH4/kg VS loaded found in conventional solids AD. DNA analysis demonstrated a significant difference of the community profile in various zones in the UASL reactor, indicating that the liquid digestion zone for the UASL reactor has the highest percentage of methanogenic organisms, 100% higher than the effluent zone in the same reactor. This finding was consistent with the max methane yield and clearly demonstrated that the unique UASL reactor design was able to select and enrich a higher percentage of methanogens in the liquid digestion zone and enable a higher methane yield.

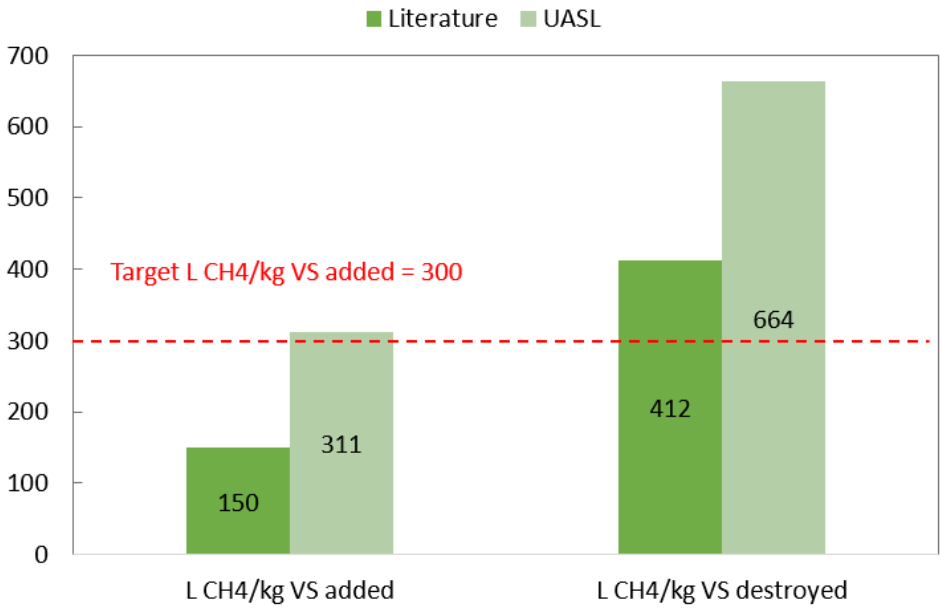

Figure 1: Amount of methane yielded compared to literature

Looking ahead to Phase II of the project, R&D must exhibit a UASL reactor design that can perform at scale. More specifically, the main goal will be to achieve the target methane yield at higher organic loading rates, while minimizing potential ammonia inhibition and validating the economics at scale. The successful development of this novel technology will have a substantial impact on agriculture by significantly mitigating water pollution and supplementing water supplies for agriculture applications while maximizing energy recovery via biogas production. For Cambrian Innovation, this project is yet another success for our R&D team, whose exciting approach to water and wastewater management for agriculture promises to be a dynamic and novel technology to add to the growing suite of EcoVolt solutions.