Energy From Waste Nitrogen – The CANDO Process July 4, 2014

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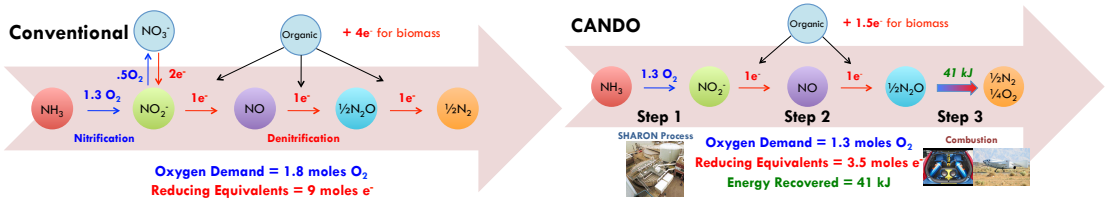
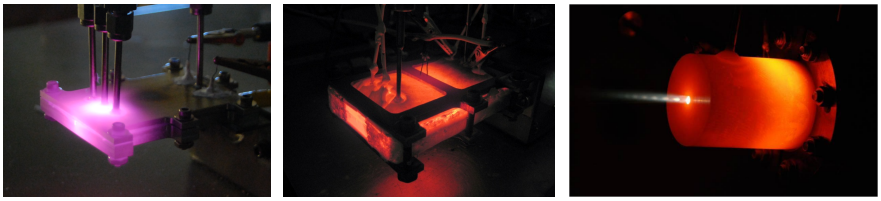
The Coupled Aerobic-anoxic Nitrous Decomposition Operation (CANDO) is a new wastewater treatment process that removes and recovers energy from nitrogen in wastewater. The process converts nitrogen in wastewater into nitrous oxide gas (N_2O), and then recovers energy from the N_2O gas through combustion.

The conventional method for nitrogen removal requires a large amount of energy for delivering oxygen to bacteria, produces large quantities of biosolids that are costly to dispose of, and does not derive value from the nitrogen waste. Historically, N_2O has been viewed as an undesired byproduct in wastewater treatment. For this reason, decades of research focused on minimizing its production and the renewable energy potential of N_2O from wastewater was overlooked.



CANDO seeks to maximize N_2O production. This approach eliminates several steps from conventional nitrogen removal with several benefits. Oxygen requirements are reduced and production of biosolids is reduced. Increased recovery of renewable energy is achieved through increased biogas production and N_2O combustion. No other process exists that recovers energy from nitrogen waste.

From 2007-2009, Professor Cantwell advised Yaniv Scherson and Kevin Lohner in developing small-scale rockets that used N_2O as the propellant. The team developed a suite of thrusters, pictured below, that extract energy by converting N_2O to N_2 and O_2 over a catalyst bed. This work motivated a search for a low cost source of N_2O that might be used to generate clean energy.



In 2009, Yaniv presented the idea of using bacteria to convert reactive forms of nitrogen in wastewater into N_2O gas to Professor Criddle. He recognized that this could lead to a new way of thinking about waste treatment and enthusiastically supported the idea. He also recognized the challenge: N_2O had never been intentionally produced in wastewater treatment. From 2009-2012 with support from the Stanford Woods Institute, the team conducted fundamental studies in the Stanford laboratories that resulted in two strategies that produced N_2O over long-time periods and with high conversion rates.

The success of CANDO sparked interest from local wastewater treatment utilities and industry. With support from the Stanford ERC ReNUWit in 2012, the team formed a partnership with the Delta Diablo Sanitation District (DDSD) in Antioch, CA. They operated a bench-top system for nearly a year in the DDSD lab that treated real wastewater. Following the successful lab study, the team installed a pilot-scale system also at the DDSD that is currently operating. The system will demonstrate CANDO with real wastewater and at a commercially relevant scale.