Contract No. R006-0014
"Renewable Electrolytic Ammonia Production from Water and Nitrogen"

Submitted by Energy and Environmental Research Center
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PARTICIPANTS

Sponsor	**Cost Share**
Department of Energy through the EERC JSRP	$200,000
ND Corn Utilization Council and Minnesota Corn Research & Promotion Council	$150,000
North Dakota Industrial Commission	$250,000
Total Project Cost	$600,000

Project Schedule – 18 months
Contract Date – January 11, 2010
Amendment Date – June 29, 2011
Start Date – July 1, 2011
Completion Date – December 31, 2012

Project Deliverables:
Quarterly Interim Report: October 31, 2011√
Quarterly Interim Report: January 31, 2012 √
Quarterly Interim Report: April 30, 2012
Quarterly Interim Report: July 31, 2012
Quarterly Interim Report: October 31, 2012
Final Report: December 31, 2012

OBJECTIVE/STATEMENT OF WORK:

This project is to develop and demonstrate a one-step electrolytic process for renewable ammonia production that utilizes inputs of water, air-separated nitrogen, and wind-generated electricity. If successful, this project could result in: low-cost nitrogen fertilizer, utilization of wind energy with minimal transmission capacity expansion requirements and improved rural economic health via development of regional fertilizer and transportation fuel production and distribution industries.

STATUS

Contract negotiated and in the process of being executed. Work has begun on this project.

Update July 19, 2010

The contract with the Industrial Commission has been executed. However, work on this project has been delayed pending on-going negotiations with the entity providing matching funds. It has been clarified that *work has not begun* on the project and the schedule for this project will be redone once the negotiations have been completed.

Update June 29, 2011

An amendment was requested and approved regarding modifications to the scope of work. All matching funds have been confirmed and agreements executed. Work will now begin on this project.

Update December 26, 2011

The quarterly report for the period July 1, 2011 through September 30, 2011 has been received. Major accomplishments during the July – September 30, 2011 quarter include:

- A project planning meeting organized by the project principal investigator, Dr. Kan Luo, and attended by EERC electrochemistry staff was held to formulate and evaluate strategies for augmenting and/or complementing Dr. Luo's ideas for developing a high-temperature electrolyte membrane.
- Necessary membrane-fabrication chemicals and reagents were procured, and the electrochemical fuel cell testing station was set up and calibrated.
- Fabrication and evaluation of candidate polymer membrane materials was initiated based on the key electrolytic membrane property requirements of high thermal stability, electrochemical performance, mechanical strength, and flexibility.

Membrane synthesis, modification and characterization work is expected to be ongoing for another quarter, and following that, the EERC's efforts will focus on how to most effectively utilize the best-performing membrane(s) by integration with the most appropriate gas diffusion electrode materials and membrane-electrode assembly (MEA). Plans are to prepare a super-thin layer of polymer composite and investigate its use in an MEA, with the objective of achieving reduced interfacial resistance due to proton phase transition.

Update March 29, 2012

The quarterly report for the period October 1, 2011 through December 31, 2011 has been received. Major accomplishments during the October – December 31, 2011 quarter include:

- Two test stands for evaluation of electrolytic membrane materials were designed, fabricated, and validated for performance.
- Two promising glass-based electrolytic membrane materials were synthesized, characterized, and evaluated. The two materials gave measured proton conductivity values of 10^{-4}—10^{-3} Siemens/centimeter (S/cm) over a temperature range of 200°-400°C.
- The viability of electrolytic ammonia production from water and nitrogen was demonstrated via a two-step approach comprising 1) water electrolysis to yield hydrogen followed by 2) electrolytic ammonia synthesis from hydrogen and nitrogen.

Optimization activities focused on the above-described membranes and additional membranes will be ongoing for at least one more quarter.

Although the viability of electrolytic ammonia production from water and nitrogen was demonstrated via a two-step approach, the overall objective of this project remains the development of a one-step water-to-ammonia process, which requires successful development of a high-temperature (300°-350°C) electrolytic membrane.

March 29, 2012