FY-02-XLV-113
"Anaerobic Treatment of Dakota Gasification Company Stripped Gas Liquor"

CONTRACTOR: **Energy & Environmental Research Center**

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PARTICIPANTS

Sponsor	Cost Share
Dakota Gasification Company	$ 50,000
Dakota Gasification Company (in-kind)	$ 80,000
DOE	$ 120,000
NDIC	$ 130,000
Total	**$ 380,000**

Project Schedule - 18 Months
Contract Date - 4/30/2002
Start Date -5/16/2002
Completion Date – 11/01/2003
Extended Completion Date – 11/30/04
Extended Completion Date – 9/30/05
Extended Completion Date – 11/30/05

Project Deliverables:
Proj. Mgmt. Plan – Jun 3, 2002√
Status Report – Aug 15, 2002 √
Status Report – Nov 15, 2002 √
Status Report – Feb 15, 2003 √
Qrt'ly Report – May 15, 2003 √
Qrt'ly Report – Aug 15, 2003 √
Status Report – Nov 15, 2003 √
Qrt'ly Report – Feb 15, 2004√
Status Report – Apr 30, 2004√
Qrt'ly Report – May 15, 2004√
Qrt'ly Report – Aug 15, 2004√
Final Report – Nov 30, 2005√

OBJECTIVE / STATEMENT OF WORK

The overall goal of this project is to establish the technical feasibility and economic viability of using an anaerobic process for the treatment of the Dakota Gasification Company (DGC) stripped gas liquor. DGC consumes 18,000 tons of lignite per day, produces 170 million cubic feet of synthetic natural gas (SNG) and results in a wastewater flow of 3,000 gallons per minutes. The plant is a zero liquid discharge facility and the only water leaving the boundaries is through evaporation, deepwell injection and disposal carried with coal ash to the coal pit. The wastewater contains concentrations of the organic impurities: phenols, catechols, acids and alcohols that stimulate microbial growth and fouling in the cooling tower and multiple-evaporator system. The proposed research will investigate anaerobic biological processing to degrade the organic impurities and thereby reduce air emissions associated with the cooling towers. The project consists of several interrelated tasks with the goal of establishing the technical feasibility and economic viability of

using an anaerobic microbiologically based process for the treatment of DGC stripped gas liquor. Anaerobic, oxygen-free, digestions are proposed at temperatures of 35° to 60° C (95° to 140° F) in batch and continuous test reactors to evaluate the efficacy of degradation of the organic impurities. It is expected that the project will demonstrate the potential to upgrade wastewater quality, increase gasifier throughput, enhance the operability of the gasifiers and downstream unit operations, reduce air emissions, and generate a methane gas product.

STATUS

Project Update: 7/31/02 A project kickoff meeting and a stripped gas liquor (SGL)-sampling event were held at the Great Plains Synfuels Plant on June 4, 2002. Personnel from Dakota Gasification Company (DGC) and the Energy & Environmental Research Center (EERC) established test conditions to be studied during batch testing to evaluate process operating conditions and limitations. Table 1 summarizes matrix test treatment conditions for total phenolics, ammonia, and pH. As-received values will be determined from sampling and analysis of stripped gas liquor collected at the time of sampling. Phenolics and ammonia will be added to the samples to obtain the high concentrations for total phenolics and ammonia of 500 and 4600 mg/L, respectively, as well as the midpoint concentrations. SGL pH will be adjusted from the as-received values of approximately 10 to levels of 8 and 6.

Constituent	Matrix Test Concentration (low, midpoint, high)
Total Phenolics, mg/L	As-received, midpoint, 500
Ammonia, mg/L	As-received, midpoint, 4600
PH, units	6, 8, as-received

Bulk samples of SGL (8 drums) were obtained for use in biomass adaptation and acclimation along with several smaller samples that were submitted to DGC laboratories for chemical characterization analyses. Several samples of biological material were collected from the DGC cooling water pump. The biological samples, along with a sample of recycle sludge from an anaerobic digester (source of methanogenic bacteria), were placed in a heated, mixed, glass reactor vessel for acclimation and biomass development. The reactor is being fed increasing amounts of SGL. Minimal analyses have been conducted on this reactor to date. However, a sample of gas collected from the reactor contained over 80% methane by volume when corrected for the presence of nitrogen and small amounts of oxygen.

January, 2003 A longer than anticipated acclimation period has resulted because of difficulty establishing a high-rate catechol-degrading culture. The acclimation reactor systems will continue operation along with routine analysis of effluent catechol. When good growth of *Desulfobacterium catecholicum* bacterium has been established in pure cultures, the acclimation bioreactors will be seeded.

Third Quarterly – May, 2003. Three bioreactors were operated to adapt biomass to biodegrading components of SGL, emphasis on catechol. The reactor using a synthetic SGL emphasizing catechol has seen very good removals (below detection limits).

Fourth Quarterly Report – August 18, 2003. The bioreactors operated with synthetic SGL specifically for catechol continued to show very good removals. The bioreactors using actual SGL continues to be inhibited and catechol degradation was negligible. It is believe that the catechol is undergoing a polymerization reaction instead of degrading and producing methane gas.

Oct – Dec ’03 Quarterly Report. The bioreactor system continues operation, decreasing the feed dilution until catechol degradation can be sustained without inhibition using full-strength SGL as influent.

Jan – Mar ’04 Quarterly Report. Using new SGL from DGC, tests were conducted at a reactor feed rate of 5.3 liters/day. Gas production ranged from 3 to 4 liters/day, consisting of 90 % methane and 10 % carbon dioxide.

April 1 – June 30, 2004. Recent tests indicate the catechol is being degraded such that gas production was greater than half the calculated theoretical production if all the catechol had been degraded, which is an encouraging result.

October, 2004. The PI requested that the contract be extended a second time to September, 2005.

April – June 2005. Catechol reduction continues to be problematic.

Final Report (January 2006). The project demonstrated that under the right operating conditions, catechol can be degraded under anaerobic conditions. It demonstrated that, with full-scale treatment to remove and recover additional ammonia from the stripped gas liquor, the process would have the potential to upgrade wastewater quality, enhance the operability of the gasifiers and downstream unit operations, reduce air emissions, and generate a methane gas product. An economic assessment compared annual amortized capital and operating and maintenance costs for a full-scale ammonia removal and anaerobic treatment system to annual revenue and avoided costs. At an assumed interest rate of 5%, with minimal net annual profit, the payback period would be just over six years.