Project Title	Primary Contractor	Project End Date	Fact Sheet Listing
Full-Scale Bioreactor Landfill	Yolo County	3/30/2005	PAN-3
Upgrading Methane Streams With Ultra-Fast Tsa	Velocys, Inc.	8/11/2008	PAN-5
Landfill Gas Sequestration In Kansas	Kansas Geological Survey	3/31/2007	PAN-7

* Factsheet Not Available

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PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

03/2006

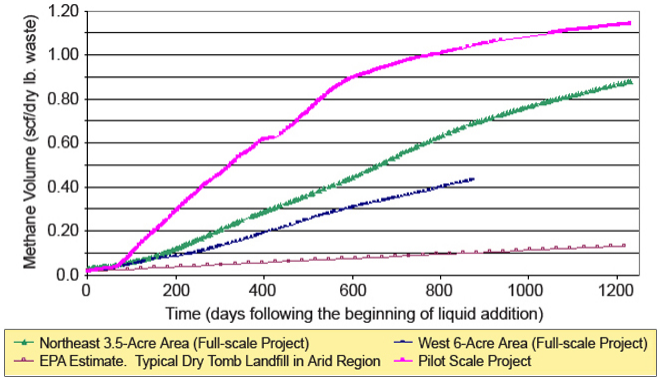
FULL-SCALE BIOREACTOR LANDFILL

Background

Sanitary landfilling is the dominant method of solid waste disposal in the United States, accounting for the disposal of about 217 million tons of waste annually (U.S. EPA, 1997). The annual production of municipal waste in the United States has more than doubled since 1960. In spite of increasing rates of reuse and recycling, population and economic growth will continue to render landfilling as an important and necessary component of solid waste management.

As a part of the Environmental Protection Agency's (EPA) Project XL program to develop innovative approaches while providing superior greenhouse gas (GHG) emissions protection, the Yolo County, CA Department of Planning and Public Works is constructing a full-scale bioreactor landfill. In a bioreactor landfill, controlled quantities of liquid (leachate, groundwater, grey-water, etc.) are added to increase the moisture content of the waste. The leachate is then recirculated as necessary to maintain the moisture of the waste at or near its moisture holding capacity. This process significantly increases the biodegradation rate of waste and thus decreases the waste stabilization and composting time to between 5 and 10 years compared to the time required within a conventional landfill (30 to 50 years or more). If the waste decomposes in the absence of oxygen (anaerobically), it produces landfill gas, primarily a mixture of CO_2 and methane, another greenhouse gas. Methane is 21 times more potent than CO_2 in its effects on the atmosphere. This by-product of anaerobic landfill waste composting can be a substantial renewable energy resource that can be recovered for electricity generation or other industrial uses.

In the initial phase of this project, a 12-acre module divided into several cells was constructed in the Yolo County Landfill. The cells contain a large array of instruments to monitor bioreactor performance. The final phase of this project pertaining to carbon sequestration involves the evaluation of full-scale performance and the potential of aerobic and anaerobic bioreactor landfill cells as tools for abating GHG emissions from organic wastes in landfills.



Yolo County Landfill Methane Production Compared to Other Landfills

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PARTNERS

Yolo County

Solid Waste Association of North America

Institute for Environmental Management

University of Delaware

COST

Total Project Value
$1,837,351

DOE/Non-DOE Share
$592,000 / $1,245,351

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Primary Project Goal

The goals of this project are to construct, then to evaluate full-scale performance and potential of aerobic and anaerobic bioreactor landfill cells as tools for abating GHG emissions from organic wastes in landfills. The GHG abatement is accomplished by routes including sequestration of photosynthetically derived carbon in wastes, CO_2 offsets from energy use of waste-derived gas, and mitigation of methane emission from the wastes.

Objectives

- Evaluate full-scale performance and potential of aerobic and anaerobic bioreactor landfill cells as tools for abating GHG emissions from organic wastes in landfills.
- Operate and measure the performance of anaerobic and bioreactor module to desired endpoint.
- Conduct analysis and interpretation of the data.

Accomplishments

In the initial phase of this project, the landfill cells have been constructed and filled with waste. Instrumentation, monitoring, and gas collection systems are in place and used to measure and to independently record data from each cell. The data from these sensors are automatically recorded and sent to the office of the Yolo County Department of Planning and Public Works. Partitioning tracer tests using injection and extraction wells are planned to aid in assessing landfill characteristics, including moisture content.

Benefits

This process will significantly increase the biodegradation rate of waste and thus reduce the waste stabilization and composting time by 67–80% and provide a substantially improved renewable energy resource that can be recovered for electricity generation or other industrial uses. This means that the energy market could increasingly depend on this type of renewable energy providing electric power. Another benefit of the bioreactor landfill is that it generally improves the gas generation rate, decreasing the time frame of landfill gas generation from several decades to between 5 to 10 years.

Waste Containment Base Liner System

Project199.pmd

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

02/2004

UPGRADING METHANE STREAMS WITH ULTRA-FAST TSA

CONTACT POINTS

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Background

Most natural gas streams are contaminated with other materials, such as hydrogen sulfide (H_2S), carbon dioxide (CO_2), and nitrogen. Effective processes for removal of H_2S and CO_2 exist, but because of its relative inertness, nitrogen removal is more difficult and expensive. This project will focus on the separation of nitrogen from methane, which is one of the most significant challenges in recovering low-purity methane streams. The approach is based on applying Velocys' modular microchannel process technology (MPT) to achieve ultra-fast thermal swing adsorption (TSA). MPT employs small process channels to greatly enhance heat and mass transfer. Enhanced heat transfer allows TSA cycle times of seconds compared to hours for conventional TSA systems and enables compact, economic systems for upgrading methane streams to pipeline quality.

Primary Project Goal

The primary goal of this project is to design and demonstrate a revolutionary approach to upgrading low-Btu methane streams from coal mines, landfills, and other sub-quality sources, based on applying Velocys' modular MPT to achieve ultra-fast TSA.

Objectives

This project is a two-phased effort. The objective of Phase I is to assess the technical and market feasibility of an microchannel process technology - based thermal swing adsorption (MPT-based TSA) approach for upgrading low-BTU methane streams. The three key tasks during Phase I are:

1. selecting an absorbent for use in a microchannel-based TSA unit
2. designing the MPT-based system and components
3. completing a process feasibility assessment

The objective of Phase II is to conduct bench-scale demonstration of Ultra-Fast TSA.

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PARTNERS

Velocys, Inc.
D'Amico Technologies

COST

Total Project Value:
$498,928

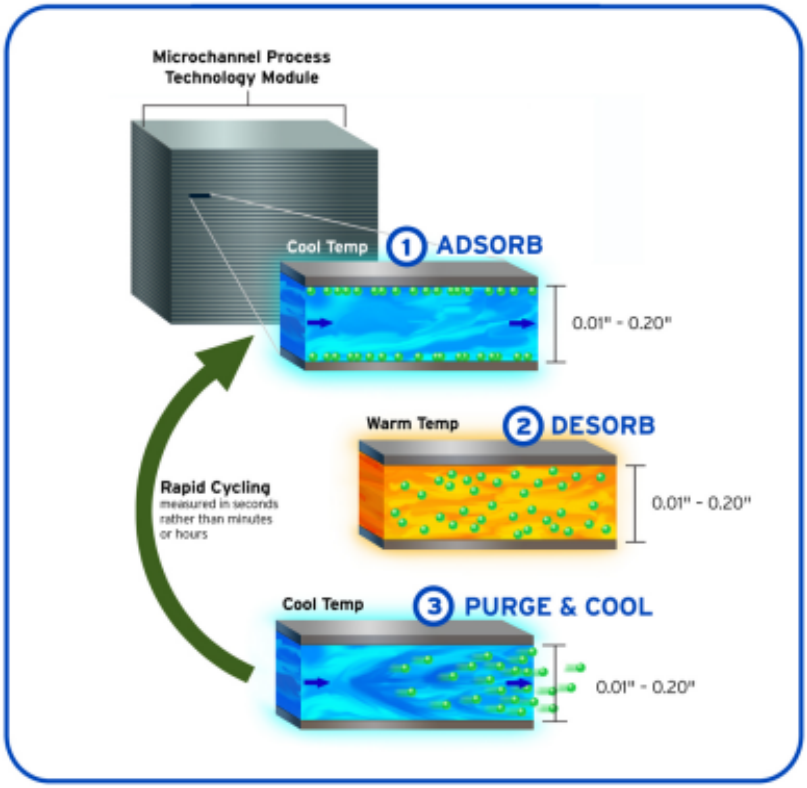
DOE/Non-DOE Share:
$398,928 / $100,000

Accomplishments

A one tier assessment of adsorbents, based on a literature search, has been completed and indicates that activated carbon looks promising. Preliminary tests have been initiated and include collecting methane and nitrogen capacity over several temperatures, compositions, and pressures. Planning for a conceptual system design has been initiated to guide the experimental test matrix.

Benefits

Successful completion of this project would enable recovery of methane from low-grade, previously uneconomic sources, such as coal mine ventilation gas and land fill gas. Because methane is a more powerful greenhouse gas than carbon dioxide, preventing methane emissions to the atmosphere is very important. Commercial deployment of this technology has the potential to reduce annual U.S. greenhouse gas emissions by 23.5 million tonnes of carbon dioxide equivalent while simultaneously recovering 3.5 trillion standard cubic feet of natural gas.



Conceptual scheme of the Ultra-Fast TSA process.

Proj253.pmd

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

4/2008

LANDFILL GAS SEQUESTRATION IN KANSAS

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Background

Municipal solid waste landfills are the largest source of anthropogenic methane emissions in the United States, accounting for about 34 percent of these emissions in 2004. Most methane (CH_4) generated in landfills and open dumps by anaerobic decomposition of the organic material in solid-waste-disposal landfills is either vented to the atmosphere or converted to carbon dioxide (CO_2) by flaring. The gas consists of about 50 percent methane (CH_4), the primary component of natural gas, about 50 percent carbon dioxide (CO_2), and a small amount of non-methane organic compounds. The amount of methane created in a landfill depends on the quantity and moisture content of the waste and the design and management practices at the site. Methane emissions from landfills represent a lost opportunity to capture and use a significant energy resource.

Methane emissions account for about 10 percent of the total U.S. greenhouse-gas emissions when weighted by methane's global warming potential factor. Gas-to-energy projects, including upgrading landfill gas (LFG) to pipelines natural gas, have been eligible for an "unconventional gas" tax credit. However, this tax credit has provided insufficient incentives for development of new LFG-to-energy projects. Unless methane recovery from landfills increases, the increasing tonnage of a landfill waste will result in higher levels of methane emissions from this source in the future.

Description

Production of raw landfill gas from the Johnson County (Kansas) Landfill comes from 150 wells with daily production of LFG at approximately 2.2 to 2.5 billion cubic feet (mmcf). The produced methane is separated from the LFG, cleaned, and sent to a local pipeline for regional distribution of the natural gas. Via this project the Kansas Geological Survey is addressing the gas-processing cost issue by investigating the potential of injecting LFG into subsurface coal seams, thus utilizing natural processes to produce larger quantities of high quality methane (natural gas) by stripping and sequestering the CO_2 component of the LFG along with non-methane volatile organic compounds. The surface, matrix, and

fracture systems of the coal seams allow for this novel concept to be tested at a laboratory-scale by analyzing cores from coal seams.

PARTNERS

Kansas Geological Survey

Kansas University Energy Research Center

Deffenbaugh Industries

Kansas City LFG, LLC

Oak Ridge National Laboratory

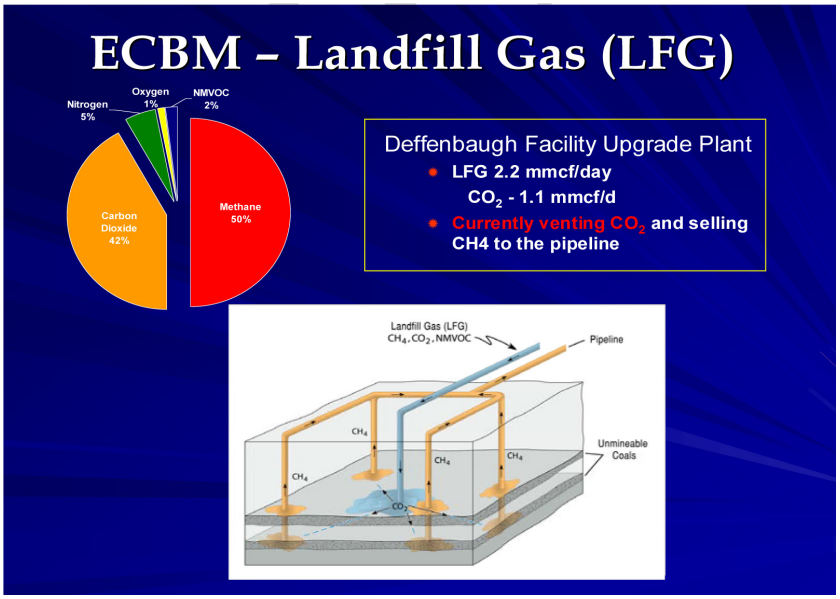
Primary Project Goal

The primary project goal has been to evaluate and assess the reservoir mechanisms and feasibility of subsurface processing of LFG using underlying coal seams while sequestering the CO_2 component from the landfill gas.

Objectives

Project objectives are the following:

- Drilling and coring of selected samples of underlying targeted coal seams of the Johnson County Landfill and subsequent laboratory testing of these coal-bearing cores.
- Specific laboratory testing of selected coal cores for reservoir properties of porosity, permeability, methane content, and CO_2 adsorption potential while displacing CH_4
- Determining the relationship and dynamics of methane, CO_2, and nitrogen on the internal surfaces of the coal samples.
- Evaluating the novel concept of subsurface processing of landfill gas (LFG) using the underlying coal seams of the Johnson County Landfill near Kansas City, Kansas.



Field Test for Validating ECBM-Landfill Gas (LFG)

Benefits

The landfill gas (LFG) project has evaluated the potential decrease of fugitive greenhouse gas emissions, both methane (CH_4) and carbon dioxide (CO_2), by sequestering CO_2 while providing increased methane (CH_4) for home heating, industry, and other commercial uses. Working closely with the EPA has allowed DOE to better assess the role that non-CO_2 greenhouse gas emissions abatement can play in a nationwide strategy for reducing greenhouse gas intensity.

Accomplishments

A final report of the project effort has been completed with detailed results highlighting the assessment of this novel approach for potentially processing landfill gas in underlying coal seams. Initial results of the effort show that there is potential for the carbon dioxide component of the LFG to be adsorbed by the coals and shales on a 2:1 ratio compared to the gas that was originally present.

The volume of in-place methane in the coals and shales underlying the Deffenbaugh Quarry was calculated by using the average of the gas contents of the coal and shale core samples and the average thickness of the gas-bearing coal or shale at each well. A unit was discounted as a viable source of gas if it had less that 10 standard cubic feet per ton (scf/ton) or if it was not at least one foot thick at either of the two core holes drilled at the landfill / quarry project site. The total gas-in-place was calculated to be 985.6 mcf/acre.

Proximate analysis of the coals indicate that they straddle the boundary between high-volatile B and high-volatile A bituminous rank coals. The coals and associated gas shales are under-saturated relative to their gas content with the degree of saturation decreasing with depth.

Assuming 1½ square miles of land (960 acres) at the Deffenbaugh Quarry/ Johnson County Landfill can be utilized for coalbed and shale gas recovery, the total amount of in-place gas calculates to 946,200 mcf, or 946.2 mmcf, or 0.95bcf (i.e., 985 mcf/acre X 960 acres).

PERFORMANCE PERIOD

9/30/2004 to 3/31/2007

COST

Total Project Value

$130,899

DOE/Non-DOE Share

$86,408 / $44,491

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Conclusions

Based on the modeling effort of the project:

- CO_2 sequestration in coalbeds is possible – coal is an efficient CO_2 sink
  - No CO_2 breakthrough in 10 years (160 acre spacing)
  - Limited loss in CH_4 production in 10 yrs (160 acres, 100% CO_2)
- Displacement of CH_4 by injection of CO_2 in coalbeds is a complex concept
  - CH_4 recovery process maximized when 100% CO_2 is injected
- Need to conduct follow-on Pilot Sequestration Project to validate simulation results obtained with this initial effort.

Project324.indd