Non-CO_2 GHG Mitigation Project Fact Sheet List

Project Title	Primary Contractor	Fact Sheet Listing
Capture and Use of Coal Mine Ventilation Air Methane	CONSOL Inc.	N-3
Intelligent Bioreactor Management Information System (IBM-IS) for Mitigation of Greenhouse Gas Emissions	University of Delaware	N-5
Strategies to Optimize Microbially-Mediated Mitigation of Greenhouse Gas Emissions from Landfill Cover Soils	University of Michigan	*
Bio-Tarp: Reducing Landfill Methane Emissions With Bioactive Alternative Daily Cover	University of North Carolina	*
Development of Nanofiller-Modulated Polymeric Oxygen Enrichment Membranes for Reduction of Nitrogen Oxides in Coal Combustion	North Carolina A&T State University	*

* Factsheet Under Development

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PROJECT facts

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

Carbon Sequestration

04/2008

CAPTURE AND USE OF COAL MINE VENTILATION - AIR METHANE

CONTACTS

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PARTNERS

U.S. Environmental Protection Agency (EPA)

CONSOL Energy

MEGTEC Systems

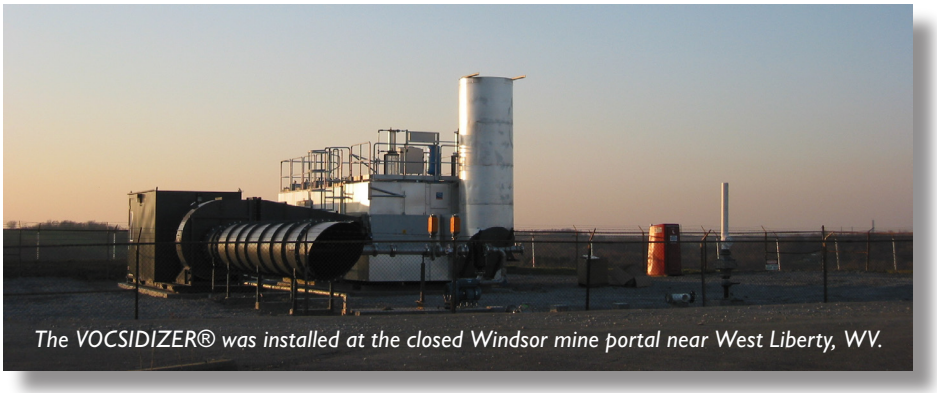
Background

Methane emissions from coal mines represent about 10 percent of the U.S. anthropogenic methane released to the atmosphere. Methane—the second most important non-water greenhouse gas—is 21 times as powerful as carbon dioxide (CO_2) in its global warming potential. Ventilation-air methane (VAM)—the exhaust air from underground coal mines—is the largest source of coal mine methane, accounting for about half of the methane emitted from coal mines in the United States. Unfortunately, because of the low methane concentration (0.3–1.5 percent) in ventilation air, its beneficial use is difficult. However, oxidizing the methane to CO_2 and water reduces its global warming potential by 87 percent. A thermal flow reversal reactor (TFRR) is one potential way to accomplish the oxidation of methane.

Description

The TFRR technology employs the principle of regenerative heat exchange between a gas and the solid bed of a heat exchange medium. VAM flows into and through the reactor in one direction, gaining temperature as heat is transferred from the medium until the methane is oxidized. The hot products of oxidation then lose heat to the heat exchange medium as they continue toward the far side of the bed. At a specified interval, the flow is automatically reversed, so that the part of the bed that was previously heated now heats the incoming gas. Through the use of in-bed heat exchange tubes, excess heat from the process may be transferred for local heating needs or for the production of electric power.

MEGTEC Systems manufactures such a reactor, which they call the VOCSIDIZER®. The VOCSIDIZER consists of a large bed of ceramic material in an airtight steel container. A process fan forces the ventilation air into the plenum chamber either above or below the bed. Valves typically reverse flow every two minutes. At startup, electrical heating elements heat the center of the bed to 1,832 ºF, and the reversal of the flow through the bed keeps the center hot.



The VOCSIDIZER® was installed at the closed Windsor mine portal near West Liberty, WV.

PERIOD OF PERFORMANCE

9/23/2002 to 9/30/2008

COST

Total Project Value
$2,102,428

DOE/Non-DOE Share
$2,102,428

TOTAL PROJECT VALUE

$2,102,428

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CONSOL Energy will demonstrate a commercial-scale (30,000 cfm of simulated ventilation air) VOCSIDIZER oxidation system at an inactive underground coal mine for one year. Site selection, permitting, detailed design of the oxidation system, procurement, start up, and commissioning of the system have been completed. This is being followed by eight to nine months of operation. The performance data generated will allow the feasibility and economics of energy recovery from the system to be determined. An engineering and economic analysis will be completed of a system designed to treat 180,000 cfm of VAM (which is the majority of flow from a large mine fan), including energy recovery.

Primary Project Goal

The primary goal is to evaluate the long-term technical and economic feasibility of applying a full-scale TFRR system for the safe and efficient oxidation of VAM from a large underground coal mine.

Objectives

- Design an effective interface between the TFRR and the mine ventilation system without compromising mine safety.
- Convert the low and variable concentration of methane in simulated coal mine ventilation air to CO_2 effectively and efficiently. The ventilation air stream will be simulated using diluted coal mine gob-gas methane.
- Determine the cost of applying the technology and the quantity of useful energy that can be economically produced from it.

Benefits

This technology holds the potential to significantly reduce the emissions of methane from underground coal mines while simultaneously permitting the recovery of useful energy. After successful demonstration, this technology could be implemented on a large scale and make a major contribution to reducing greenhouse gas emissions.

Accomplishments

- Completed the design for a single-bed TFRR system using simulated ventilation air.
- Completed site selection. Flow testing at the selected site, an inactive coal mine near West Liberty, WV, verified sufficient gob well capacity.
- Received a project exemption granted by the West Virginia Department of Environmental Protection from the requirement of a permit to construct and operate as a stationary source of air pollutants.
- The VOCSIDIZER was installed, commissioned, and began unattended operation in May 2007.
- Completed experimental (parametric) testing. The VOCSIDIZER effectively reduced methane emissions by more than 95 percent over a range of methane concentrations (0.3–0.9 percent) and flow rates (15,000–30,000 scfm) in the simulated VAM.
- Regarding criteria pollutant emissions, testing confirmed that the system generates no particulate matter and only exceptionally low emissions of NOx and CO.
- As of November 30, 2007, 1,300 hours of unattended operation were logged on the unit with 30,000 scfm of simulated VAM containing 0.6 percent methane.

Project248.indd

U.S. DEPARTMENT OF ENERGY
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INTELLIGENT BIOREACTOR MANAGEMENT INFORMATION SYSTEM (IBM-IS) FOR MITIGATION OF GREENHOUSE GAS EMISSIONS AND CARBON SEQUESTRATION

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Background

There is growing concern that the buildup of greenhouse gases (GHG) in the atmosphere is leading to global climate change with undetermined consequences. Most of the attention to date has focused on controlling emissions of carbon dioxide (CO_2), the most common GHG. However, interest in controlling other GHGs, particularly methane, is increasing. Methane is of concern because it is more than 20 times more effective in trapping heat in the atmosphere than CO_2. Landfills are the largest source of anthropogenic methane, accounting for approximately 30 percent of emissions. One promising approach for mitigating methane emissions is to operate landfills as "bioreactors" where water and gas flows are intelligently controlled to maintain optimal conditions related to waste degradation and control of methane releases.

Description

A bioreactor landfill is defined as any landfill or landfill cell in which liquid or air is injected in a controlled fashion into the waste mass to accelerate or enhance biostabilization of the waste. Operation of a bioreactor landfill involves controlling the conditions within the landfill so that the rate of reaction and conversion of waste is optimized. Bioreactor cells can be either anaerobic or aerobic. Anaerobic cells involve the addition of liquid to the waste in order to increase methane production, which can then be captured for use as an energy source. Aerobic cells are characterized by the injection of liquid and air to the waste, resulting in a reduction in methane generation. The rate of decomposition of waste observed in aerobic cells is faster than that in anaerobic cells.

PARTNERS

University of Delaware

Yolo County Department of Planning and Public Works

IEM Corporation

Hydro Geo Chem, Inc.

Figure 1 - Anaerobic Cell at the Yolo County facility

The University of Delaware will demonstrate a management program, the Intelligent Bioreactor Management Information System (IBM-IS), that manages a network of automated sensors and control points to manage and control bioreactor landfill gas extraction and liquid addition. This system will help control and optimize the biological conditions in the waste to allow for more rapid and complete decomposition of the waste and minimize the release of methane by controlled injections of air and liquids. The IBM-IS will mitigate methane emissions associated with barometric pressure fluctuations and potentially reduce fugitive methane emissions to below 10 percent, compared to the 15 to 30 percent typically released without such a system. Bioreactor landfilling will lead to an estimated reduction in GHGs equivalent to 55 to 110 million tons of CO_2 at a cost of $3 to $13/ton of carbon.

Primary Project Goal

The primary goal of this work is to develop and demonstrate an IBM-IS program to control landfill gas extraction, air injection, and liquid addition in bioreactor landfills with an accompanying reduction in releases of methane to the atmosphere.

Objectives

The objectives of this project are to:

- Couple new in situ measurement techniques with new and existing computer models of landfill processes in the demonstration of the IBM-IS
- Develop and test an IBM-IS for mitigating fugitive methane emissions from a new anaerobic landfill cell with a permeable earthen cover
- Develop and test an IBM-IS for controlled injection of air and liquids to maintain optimal conditions for suppression of methane generation in an aerobic landfill cell

Figure 2 - Aerobic Cell at the Yolo County facility

COST

Total Project Value
$814,798

DOE/Non-DOE Share
$599,373 / $215,425

Benefits

The major benefit of this project will be the advancement of controlled landfill technology with the concomitant reduction in methane emissions. Widespread application of controlled landfilling may reduce anthropogenic methane emissions by 10 to 20 percent. Because methane is such a powerful GHG, this could have a major effect in mitigating climate change effects.

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Accomplishments

- Construction of a new anaerobic bioreactor were completed in Fall 2005
- Laboratory testing of waste properties is taking place
- Numerical models of fluid flow in bioreactors are being developed

Figure 3 – Apparatus for measuring solid waste properties at the Yolo County facility