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

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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.