United States
Environmental Protection Agency

Air and Radiation
(6202-J)

EPA-430-N-99-004
June 1999

COALBED METHANE EXTRA

New Technologies Allow Productive Use of Methane in Mine Ventilation Air!

A recent investigation by the U.S. Environmental Protection Agency's (USEPA) Coalbed Methane Outreach Program (CMOP) has revealed that several viable options exist for productively using methane, a potent greenhouse gas, that is contained in underground mine ventilation air flows. These include its use as combustion air for internal combustion engines and as primary fuel in flow-reversal reactors that oxidize the methane and capture useable heat.

Responsible for approximately 73 percent of all coal mine methane emissions from U.S. coal mines, ventilation air releases to the atmosphere have long been viewed as an unavoidable consequence of mine safety procedures. Because it is characterized by very low methane concentrations in very large air flows (typically 3,529 to 8,823 ft^3/s; 100 to 250 m^3/s), productive use of ventilation air methane poses unique challenges.

Several viable options exist for productively using methane that is contained in underground mine ventilation air flows.

The upcoming CMOP report*, entitled "Technical Assessment Report: Mitigation of Methane Emissions from Coal Mine Ventilation Air", covers existing and emerging processes that are capable of oxidizing and recovering energy from methane in ventilation air. Both ancillary and principal uses for ventilation air are addressed in the report. Ancillary uses are those wherein the methane in ventilation air constitutes a supplemental process fuel; principal uses are those wherein the ventilation air methane is the primary fuel.

With methane concentrations at levels encountered in most domestic mines, the reactors produce excess heat that is recoverable in a useable form.

Ancillary Uses. One established and cost-effective use feeds ventilation air into a combustion facility such as a boiler, gas turbine, or internal combustion engine in lieu of ambient combustion air. This method, however, will usually consume just a fraction of the flow available from each ventilation shaft. The Appin project, owned by BHP Steel Collieries in Australia, is the leading example of such ancillary use. The project directs ventilation air to 54 one-megawatt, gob gas-fired, internal combustion engines for use as combustion air. This strategy increases the quantity of fuel available to the engines by about 10 percent, consumes up to 20 percent of ventilation air methane emissions, and contributes to the overall project's profits.

Principal Uses. CMOP evaluated the technical and economic feasibility of two emerging systems that may accept up to 100 percent of the flow from a ventilation shaft, oxidize the contained methane, and produce marketable energy.

- The VOCSIDIZER, offered by MEGTEC Systems, operates at 1000°C (the combustion temperature of methane). The system has been run on volatile organic compounds (VOC's) at more than 600 installations, and over 200 of these units use methane (in the form of very low concentrations of natural gas) to support combustion and maintain stability during periods when there is little or no VOC flow. The system does have successful, albeit limited, experience with ***coal mine methane.*** British Coal conducted tests on a VOCSIDIZER unit using ventilation

(continued on page 2)

Note: New CMOP Web Site Address!

As reported in last month's *Coalbed Methane Extra,* the Coalbed Methane Outreach Program's World Wide Web site has changed servers. If you use a bookmark to access our site, please be sure to delete our old bookmark and enter in the new address (http://www.epa.gov/coalbed).

New Technologies

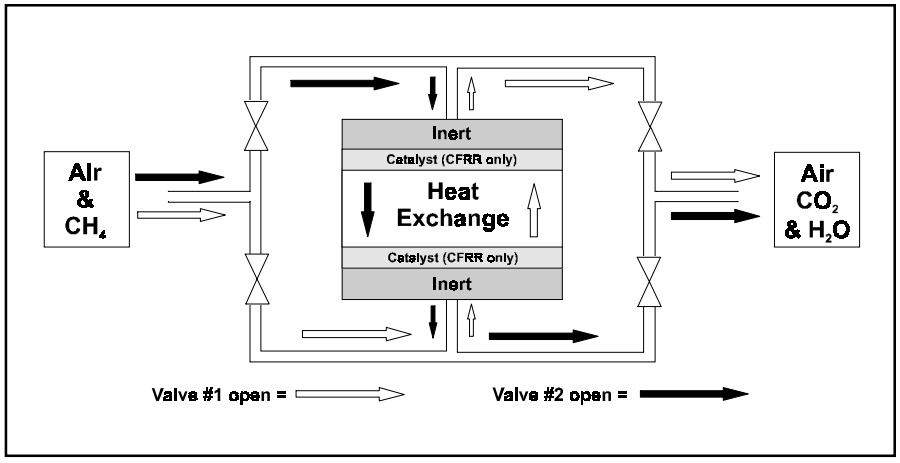
(continued from page 1)

air from one of its mines. Unfortunately, data from these tests are unavailable.

- The Catalytic Flow-Reversal Reactor, CFRR, offered by a consortium headed by CANMET, a Canadian national laboratory, uses a catalyst to reduce the combustion temperature by several hundred degrees. CANMET developed and verified this system at small scale on methane and will demonstrate a full-scale unit early in 2000.

Both systems use a regenerative flow-reversal reactor (see figure). This is a simple apparatus consisting of a large bed of silica gravel or ceramic heat exchange medium, a set of electric heating elements in the center, and airflow ducts, valves, and fans to bring ventilation air through the unit. The CFRR has two zones on either side of the reactor center that contain catalyst pellets. The electric heating elements preheat the middle of the bed to the temperature required to initiate combustion. Methane in ventilation air flowing in one direction enters the hot zone, combusts, and passes through the remainder of the bed, transferring its heat to the heat exchange medium. When the flow reverses, cool ventilation air passes over the heated medium, combusts, and the cycle repeats. Given certain minimum methane concentrations, the reactors can sustain the reaction without an external heat source, allowing the electric heaters to be turned off. With methane concentrations at levels encountered in most domestic mines, the reactors produce excess heat that is recoverable in a useable form.

Technical Evaluation. CMOP conducted a technical assessment of



the VOCSIDIZER and CFRR processes using computer simulation techniques. That assessment indicated that, for both oxidizers, operating on a steady supply of ventilation air at concentrations typically encountered in the field is technically feasible. A unit's ability to operate with low methane levels affects its ability to recover energy from the process. During modeling, the CFRR and the VOCSIDIZER remained stable at methane concentrations just above 0.1 and 0.35 percent respectively. However, MEGTEC has observed that many of its units maintain bed stability at methane concentrations at about 0.1 percent. MEGTEC supplied actual field data which showed a unit exhibiting stable operation with a 0.08 methane concentration. This result is consistent with MEGTEC's simulation modeling but contrary to the modeling performed for the U.S.EPA study. U.S. EPA acknowledges that computer simulations are no substitute for actual field observations."

Energy Recovery Option. Gas turbines offer a means of converting reactor heat to marketable energy. Ambient air enters a compressor mounted on the gas turbine's shaft, is compressed, enters an embedded high-temperature heat exchanger in the reactor, and leaves at about 700°C to 800°C. The hot compressed air returns to the gas turbine's expansion section where part of its energy converts to mechanical energy and then into electrical energy in the generator. Spent hot air then enters a waste heat boiler to produce cogenerated steam. The energy efficiency of the combined system would benefit if gob gas or other inexpensive fuel were available to inject into the flow-reversal reactor or the turbine.

Economic Evaluation. CMOP prepared an economic model of two illustrative projects:

- Gas turbine cogeneration - earns revenue from the sale of cogenerated electricity and steam, plus greenhouse gas credits.

- Steam - earns revenue from the sale of steam and greenhouse gas credits.

While system costs are preliminary and variable, models using conservative assumptions showed that many flow-reversal ventilation air projects should yield attractive returns on invested capital in the domestic U.S. marketplace.

(continued on page 6)

Early Greenhouse Gas Reduction Bill - Update

As expected, Senator John H. Chafee (R-RI) has reintroduced credit-for-early-action legislation to the 106th Congress. Now termed the "Credit for Voluntary Reductions Act" (S-547), the proposal again endeavors to provide incentives to industry that will foster implementation of emission reduction technology. When introducing the legislation, Senator Chafee stated that "… it is vital for Congress to provide companies with some certainty that their voluntary efforts to reduce greenhouse gas emissions do not go unnoticed nor unrewarded by the government." To that end, the bill proposes to allocate to companies that voluntarily reduce GHG emissions or increase GHG sequestration in the near term credits that would be useable under any future U.S. program that imposes limits on or taxes GHG emissions.

The bill has is sparking debate among interested parties and many details remain to be resolved. In addition, others in Congress are seeking to craft legislation that would pursue alternative means of providing proactive companies with rewards for early action. For example, Senator Frank H. Murkowski (R-AK) has introduced the Energy and Climate Act of 1999 (S. 882), which focuses on fostering greenhouse gas emissions reduction technology development and implementation. The Act proposes to create a new (Assistant Secretary level) Office of Global Climate Change in the Department of Energy, institute a technology research/development/demonstration program, and also offer incentives for greenhouse gas emission reductions achieved by industry.

Upcoming Events

Mine Ventilation Symposium
University of Missouri-Rolla
June 7-10, 1999

The University of Missouri-Rolla will host the 8th U.S. Mine Ventilation Symposium on its campus June 7-10, 1999. The symposium will address a host of topics, including theoretical, technical, and economic aspects of methane drainage. For more information, contact Dr. J. C. Tien via e-mail at tien@umr.edu, or visit the symposium Web site at http://www.umr.edu/~tien/symp.html.

The Future of Coalbed Methane in the Rocky Mountains
Denver, Colorado
June 22, 1999

The Rocky Mountain Association of Geologists (RMAG), Petroleum Technology Transfer Council (PTTC), and the Gas Research Institute (GRI) are sponsoring this one-day symposium. Technical, environmental, legal, and regulatory topics will be addressed within the context of coalbed methane development opportunities in Rocky Mountain coal fields. To register or to obtain additional information, visit RMAG's web site at http://www.rmag.org, or call Sandi Pellissier at (303) 573-8621.

World Mining Environment Congress
Moscow, The Russian Federation
September 7-11, 1999

The National Mining Research Center, Skochinsky Institute of Mining, is organizing this third in a series of Mining Environment Congresses. The first and second congresses were held in New Delhi, India in 1995 and in Katowice, Poland in 1997, respectively. The third congress is intended to provide a forum for discussing ecologically sound technologies for mineral extraction, state-of-the-art environmental monitoring systems for mining regions, and legal, social, and ecological problems associated with ecological disaster prevention. For more information, or to register, contact Mr. A. N. Novikov by phone at 011-7-095-5548155, by fax at 011-7-095 5545247, or by e- mail at igd@igd.ru.

EPA COALBED METHANE OUTREACH PROGRAM

Reminder:
CBM Companies/Experts List on the Web

The CMOP World Wide Web site (www.epa.gov/coalbed) includes a listing of companies and individuals with expertise in coal mine methane project development (see "CMM Companies/Experts List" link in our Web site menu). Any firm with appropriate expertise can be included. If you wish your firm to be listed (or to update your current listing), simply:

1. Send us the following information:

   Name: _____

   Title: _____

   Company Name: _____

   Address: _____

   Phone: _____

   Fax: _____

   e-mail: _____

   Web site address: _____

   Company Description: (<25 words on a separate page)

2. Indicate that the information is to be included in the CMM Companies/Experts List on our Web site (it automatically will be entered in our CMOP contact data base as well), and

3. Specify under which category(ies) of CBM/CMM development you should be listed (i.e., Project Development, Gas Production and Resource Assessment, and/or Gas Use).

Either mail the requested information to:

Roger Fernandez, 6202J
Coalbed Methane Outreach Program
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Or fax it to:
Roger Fernandez
(202) 565-2077

Or e-mail it to:
fernandez.roger@epa.gov

Recent Publications

White Paper: Opportunities for Coal Mine Gas Projects Created by Electric Industry Restructuring (3/99)

This white paper identifies and evaluates potential opportunities that electric industry restructuring offers for developing coal mine gas projects. The paper initially summarizes the history of the industry's restructuring, and then addresses electricity demand and market structure in today's electric power industry. Opportunities for the increased use of coal mine gas that derive from industry restructuring are then outlined. These opportunities result from a host of issues such as the delivered cost of fuel, the increased role of gas-fired electric generation technologies, and distributed power generation. Furthermore, additional opportunities for coal mine gas use that are being created by environmental regulations are addressed, including those relating to NO_x, SO_x, and greenhouse gas emission reduction and green energy marketing. Finally, the white paper suggests innovative strategies that project developers can adopt to take advantage of the restructured power market.

Guidebook on Coalbed Methane Drainage for Underground Coal Mines (4/99)

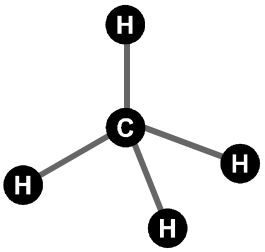
To assist coal mine operators in assessing the potential benefits of coalbed methane (CBM) produced as a byproduct of mining, this white paper surveys all aspects of the CBM handling problem. Developed under a grant to Pennsylvania State University, it summarizes available methane degasification technologies, and addresses the economic benefits of CBM drainage, including reduced downtime and development costs, ventilation power savings, increased reserve, and improved mine safety. Subsequently, strategies for and costs of drainage technology application are evaluated for both longwall and room-and-pillar mining. The paper then reviews potential uses for drained high-Btu, medium-Btu, and low-Btu gas. It concludes by considering various problems that may impede successful CBM drainage project implementation, and presenting a decision model that mining companies can employ when considering the many variables that affect the economics of potential CBM drainage projects.

Note:
Paper copies of these reports may be obtained free of charge by calling 1-888-STAR-YES. They also can be electronically accessed from the "Document Download" pages on our World Wide Web site at http://www.epa.gov/coalbed.

Reminder: Voluntary Reporting of Greenhouse Gases – 1999 Cycle

If you wish to participate in the Voluntary Reporting of Greenhouse Gases Program but were unable to submit your data for the next reporting cycle (data through 1998) to the Energy Information Administration (EIA) by June 1, 1999, contact the Communications Center at 1-800-803-5182 (or via e-mail at infoghg@eia.doe.gov). Also, copies of reporting forms can be downloaded directly from the Internet at ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom. (New users of the ftp site should first visit http://www.eia.doe.gov/oiaf/1605/ftphlp.html and review the "read1605.txt" file.) The new reporting forms are designed to expedite the reporting process by allowing simple updating of previous reports (see the "ghgfiles" folder on the FTP site) and automatic calculation of emissions reductions and sequestration levels (see "Recycling Worksheet" and "Sequestration Worksheet" on the Web site).

{Note: Copies of "Mitigating Greenhouse Gas Emissions: Voluntary Reporting 1997", tabulating voluntary reductions reported for the 1998 reporting cycle (1997 data), soon will be available from the Communications Center.}



Recent Conferences

North American Coalbed Methane Forum

The North American Coalbed Methane Forum held its Spring meeting in Washington Pennsylvania on April 22nd. The first half of the morning session focused on coalbed methane (CBM) production potential in the Appalachian basin. That was followed by a presentation by USEPA CMOP staff on opportunities for coal mine methane use, and a description of new technologies for productively using coal mine ventilation air. The afternoon session addressed CBM legal issues, produced-water treatment, CBM well completion and logging technology, and enhanced CBM recovery, and also provided CBM production updates. For more information, contact Kashy Aminian, Coordinator, by phone at (304) 293-7682.

International Coalbed Methane Symposium

An international gathering of scientists, engineers, mining experts, and government officials took place in Tuscaloosa, Alabama, at the University of Alabama in early May, 1999. Speakers from Eastern and Western Europe, Asia, Australia, and North America described their countries' resource potential, new modeling and recovery techniques, project opportunities, and actual field experiences. Industry representatives explained new technologies that use the energy contained in gob gas and ventilation air. The USEPA CMOP program conducted a half-day segment of the meeting which focused on international coal mine methane business opportunities including creative financing techniques. The University of Alabama's College of Continuing Studies organized the biannual event. For additional information, please write to (or call) Ms. Gwendolyn Hood at Box 870388, Tuscaloosa, AL 35487-0388 (telephone: (205) 348-7192)

New Technologies

(continued from page 2)

Conclusion. Using coal mine ventilation air as combustion air for boilers, gas turbines, or internal combustion engines, wherein methane contained in the ventilation air flow serves as ancillary fuel, has been well demonstrated in the field. Furthermore, CMOP's technical and economic assessments of the VOCSIDIZER and the CFRR coupled with their early operating history give confidence that regenerative flow-reversal technology using mine ventilation air methane as the primary fuel also will achieve success. Thus, mine operators can select from a number of viable options for profitably using the methane contained in underground mine ventilation air while avoiding its release to the atmosphere.

** The USEPA report will be finalized soon. Visit the CMOP World Wide Web site (www.epa.gov/coalbed) to download a copy of the final report when it is publicly available.*

REMINDER: CICLOPs Can Assist in Identifying Coal Mine Methane Project Opportunities!

The **C**ustomer **I**dentifier for **C**oalbed and **L**andfill Methane **O**utreach **P**rogram **s**ystem (CICLOPs) can help you to locate coal mine methane (CMM) sources and potential users! CICLOPs can be accessed over the Internet (at http://ciclops.dis.anl.gov), and provides easy access to nationwide information on gassy coal mines, landfills, potential users of methane, and natural gas pipelines. For full details on the system, as well as a detailed User's Guide, refer to the March '99 edition of the *Coalbed Methane Extra* (available for downloading from the USEPA CMOP Web site at *http://www.epa.gov/coalbed*).

CMOP Contact Information

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Please update us if your contact information (address, e-mail, or phone/fax number) changes.

Order CMOP reports by calling 1-888-STAR-YES, or electronically access documents from the "Document Download" pages on our World Wide Web site at http://www.epa.gov/coalbed.