

EPA Coalbed Methane Outreach Program Technical Options Series

ENERGY FROM VENTILATION AIR METHANE (VAM) USING OXIDATION TECHNOLOGIES



VOCSIDIZER Installation - Appin Colliery
(Photo courtesy of BHP Billiton)



CANMET CFRR Pilot Unit
(Photo courtesy of CANMET)

VAM OXIDIZERS PROVIDE KEY BENEFITS

- ◆ Operate continuously on high airflows typical of coal mine ventilation exhaust with methane concentrations ranging between 0.2 and 1.2%
- ◆ Use up to 80% of the heat energy in VAM for conversion to useable energy
- ◆ Produce thermal energy for use at nearby facilities such as boilers, furnaces, or district heating networks, or for cooling/refrigeration
- ◆ Use thermal energy to generate electric power
- ◆ Heat mine facilities as well as dry coal or slurry

WHY CONSIDER USING VENTILATION AIR METHANE IN OXIDIZERS?

Oxidation of coal mine ventilation air is a new application of a well-established technology

For safety reasons, most coal mines worldwide dilute and exhaust the methane liberated during coal mining operations to a concentration of less than 1%. At such low concentrations, it is difficult to convert this methane gas mixture to usable forms of energy with conventional technologies. Oxidation technologies have long been used to reduce volatile organic compound (VOC) emissions, and are now being investigated for use with coal mine methane. Oxidizers provide a way to simultaneously reduce methane emissions and use the energy contained in ventilation air methane, or VAM.

Two primary types of oxidation technologies have potential applications for utilizing VAM: **thermal and catalytic**. Both use a regenerative heat exchanger (direct contact heat exchange on inert material beds) in which the airflow reverses direction periodically. Each operates over a range of air flow rates and dilute methane concentrations. The systems produce excess thermal energy that mines could use for electricity generation, heating, cooling, and drying processes.

Regenerative oxidizers are self-sustaining at methane concentrations as low as 0.1%

The **Thermal Flow-Reversal Reactor (TFRR)** passes exhaust mine ventilation air through a very hot inert bed of high heat capacity material (e.g., silica gravel or ceramic material) to an oxidation zone. Due to its stability, methane requires ignition temperatures in excess of 1,832°F (1,000°C) to oxidize. Thermal energy produced from combustion heats the media on the exhaust side of the bed. The flow reverses periodically, allowing preheating of the incoming ventilation air. At concentrations above about 0.2% the oxidizer produces surplus heat, which can be recovered with a heat exchanger.

MEGTEC Systems, headquartered in Wisconsin, markets the VOCSIDIZER[®], a TFRR that operates using a variety of VOCs in over 700 locations worldwide. The company has demonstrated VOCSIDIZERS using VAM in the UK and Australia.

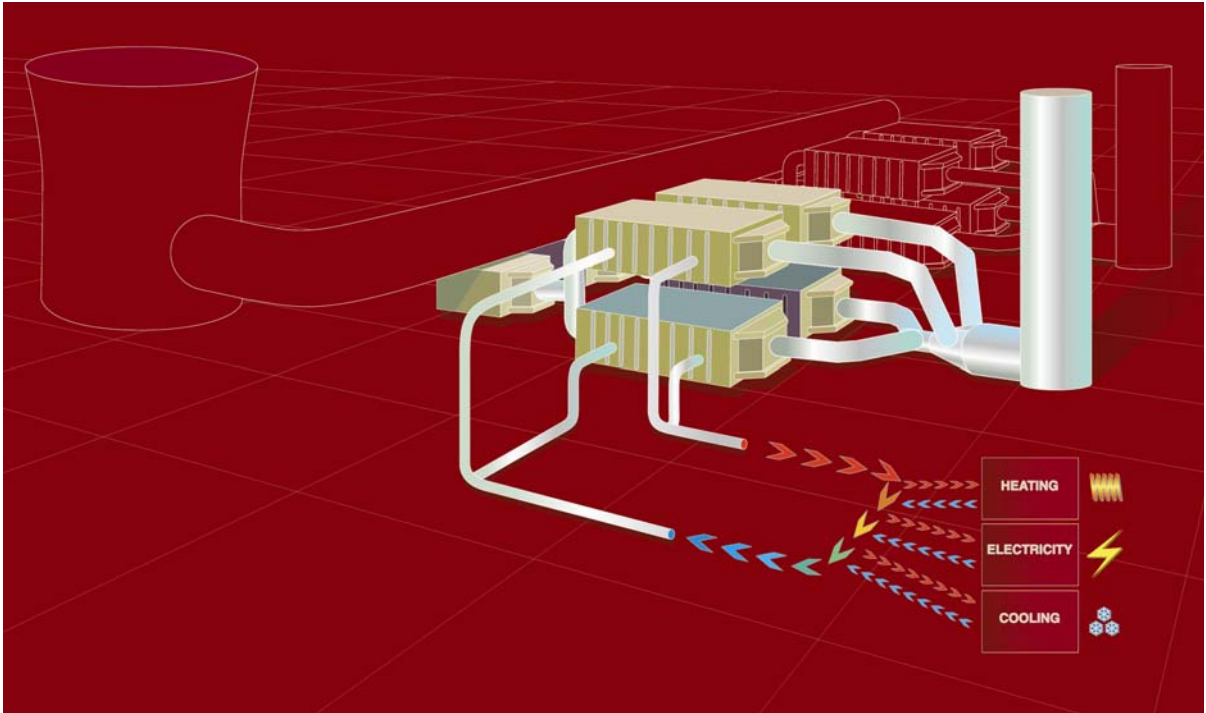
As much as 80% of VAM energy can be available for conversion to useful energy

The **Catalytic Flow-Reversal Reactor (CFRR)** uses the same basic design and operation as the TFRR except that the design includes a catalyst that allows the methane ignition to take place at much lower temperatures, from 662°F (350°C) to 1,472°F (800°C). After reaching ignition temperature, the system maintains a continuous reaction through the release of energy from methane oxidation. Excess heat can be removed with either air-to-air or air-to-water heat exchangers.

CFRR technology was developed exclusively for the treatment of methane in coal mine ventilation air. It has not yet been built or tested at a commercial scale.

Foresteel Industries Inc. (Lefebvre Frères Ltée.), the technology licensee, is currently cooperating with Natural Resources Canada (CANMET) in the implementation of this technology in China.

USING COAL MINE VENTILATION AIR WITH THERMAL OXIDIZERS



(Diagram courtesy of MEGTEC Systems)

TYPICAL PARAMETERS OF METHANE OXIDATION SYSTEMS

- ◆ Capable of operating at methane concentrations typical of coal mine ventilation air (0.2 - 1.2% by volume)
- ◆ Ability to recover the majority of VAM energy content
- ◆ Ability to produce a variety of forms of energy: electric power, steam, hot water, and hot air
- ◆ Capable of operating on high airflow rates – typical module capacities range from 40,000-60,000 standard cubic feet (scf) per minute (19–28 m³ per second); multiple modules together can accommodate even larger airflows
- ◆ Approximate installation costs range from \$US 800,000 -1,200,000 (depending on the size of the facility)
- ◆ Capable of producing significant quantities of energy (e.g., 10 to 20 MW electricity) per ventilation shaft
- ◆ Capable of producing ultra-low NO_x emissions as result of flameless oxidation process

For More Information...

Coal mine operators and energy producers have long sought a means of using the low concentration methane contained in ventilation air. Thermal and catalytic oxidizers provide coal mines with several options for converting ventilation air into usable energy while reducing greenhouse gas emissions.

To obtain more information about using oxidizers to convert coal mine ventilation air into energy, contact:

VOCSIDIZER[®] □

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