Ventilation Air Methane Oxidation

Climate Action Reserve Workshop
Coal Mine Methane Projects

Morgantown, WV | Nov. 9, 2010

Why Oxidize VAM?

- Source of profit (carbon offsets)
- Generate hot water
- Mitigate risk of upcoming GHG emission reduction requirement
- Positive corporate image
Why Now?

- Early action recognized under future GHG emission reduction scheme
- Lead industry in inevitable shift
- Does not interfere with mining

VAM Scope of Work

- Detailed scope & feasibility study
- Financing
- Permitting (MSHA, EPA, etc.)
- Carbon strategy & registration
- Select oxidizer vendor
- Detailed engineering (integrate oxidizer, evasé interface, instrumentation, etc.)
### VAM Scope of Work

- Construction & commissioning
- Operation & maintenance
- Periodic carbon verification
- Carbon offsets monetization
- **System relocation** *(short life shaft)*

### How to Oxidize VAM?

**Technology & Safety**
How? | Technology

- **1 proven technological approach**
  - Regenerative thermal oxidizers (RTOs)

- **2 companies with track record**
  - Biothermica (Vamox®)
  - Megtec (Vocsidizer™)

How? | General Arrangement

\[ CO_2 \quad H_2O \quad CO_2 \quad H_2O \]

VAMOX®

Mine Fan

Fresh Air (as required)

Propane (short- or long-term)

\[ \text{CO}_2 \quad \text{H}_2\text{O} \]
How? | Stop High CH$_4$ Ingress

- CH$_4$ analyzer
- Cut-Off Damper

How? | Operating Principle

- Burner
- Oxidation Chamber
- Fresh Air
- Mine Air
- Cut-Off Damper
- Inlet Duct
- Outlet Duct
- Stack
How to Oxidize VAM?

Putting a Project Together

How? | Possible Structures

- In-house effort
- Hand to independent developer
- Partnership with developer
How? | Possible Structures

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<th>In-house</th>
<th>External Developer</th>
<th>Partnership</th>
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<tr>
<td>Capex</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
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<tr>
<td>Req'd expertise</td>
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<tr>
<td>Req'd resources</td>
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How? | Financing Options

- Equity / Debt
- Upfront sale of carbon offsets (complex)
- Combination
**How? | Key Considerations**

- **CH\(_4\) level !!!**
- Will not capture all available VAM
- Limited shaft life?
- Drained CMM to increase CH\(_4\) level?
- System has large footprint
- Local need for heat?

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**Case Study**

Biothermica pioneered 1\(^{st}\) and only VAM project in America
1st U.S. VAM Project

- Partnership with Walter Energy
- Demonstration system
- Financed by Biothermica
- Destruction only (no heat recovery)
- Approved by MSHA
- Operating since March 2009

1st U.S. VAM Project

- Proprietary VAMOX® technology
- 30,000 ft³/min capacity
- Up to 98% CH₄ destruction
- 0.93% CH₄ average at fan
- Implementation in 8 months
- Carbon offsets listed with CAR
1st U.S. VAM Project

> 10,500 hrs operation hrs
> 42,000 tCO₂e avoided emissions
91.5% availability
25,931 bankable credits issued

As of the end of September 2010

Moving Forward

What’s next for Biothermica?
Recently Announced

Expanding partnership with

WALTER ENERGY

Scope of Agreement

- Mitigate VAM from *all* suitable shafts
- 3M tCO$_2$e/year pipeline
- Approx. 20 Vamox® systems
Upcoming Project

- ≈200,000 ft³/min total capacity
- Full scale Vamox® (≈100,000 ft³/min per unit)
- ≈330,000 tCO₂e/year
- Bleeder shaft 7-13 (≈0.9% CH₄)
- Operational in 2011

About Biothermica

Unique approach to VAM projects
Unlike Any Other

- Fully integrated carbon project developer
- Risk sharing partner (50/50 or 100%)
- Profit from carbon offsets, not technology
- Long term partnership, fair deals
- Mines can focus on principal activity
- No need for consultants
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