VENTILATION AIR METHANE
通风瓦斯

Options for use and mitigation of ventilation air methane emissions from coal mines

利用和减少煤矿通风瓦斯的方式

Presented by
Cliff Mallett Carbon Energy Limited
克里夫马里特 碳能源公司
Co-author Su Shi CSIRO Exploration and Mining
合作者 苏勃 卡西罗采矿公司

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What Can We Do with Ventilation Air Methane (VAM)? 我们如何利用通风瓦斯？

Mitigate Carbon Emissions (has a value)
减少碳排放（具备价值）

- burning 1kg of CH_4 produces 2.75kg of CO_2,
- 燃烧1公斤CH4,,产生2.75公斤CO2
- when 1kg of CH_4 is mitigated, 20.25kg of CO_2 emission is reduced in terms of the greenhouse gas impact. 减少1公斤CH_4, 减少20.25 公斤 作为温室气体的CO2排放

$$CH4 + 2O2 = CO2 + 2H2O$$

- **Combustion through thermal or catalytic oxidation**
  通过加热或氧化催化作用进行燃烧

Capture the energy in VAM - for example power
在通风瓦斯中获取能源-如 电力

- **Low energy in ventilation air requires either**
  由于通风瓦斯中低能源含量，因此需要
  - **enrich to higher concentration (1% CH4) to extract useful power**
    将浓度提升(1% CH4) 来提取有用能源 (can extract heat low % CH4)
  - **Use VAM for air supply providing supplementary energy in other combustion processes**
    用通风瓦斯作为供气手段为其它燃烧过程提供补充能源

VAM sites must be beside ventilation shafts and coordinated with mine development. 低成本的通风瓦斯获取、利用及减排需要一系列技术手段，并且需根据煤矿实地情况而定。

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Existing & Developing Technologies
现有和正在开发的技术

Ventilation Air as combustion air 通风气作为燃气

Technology 技术	Mechanism 机制	Principle 原则	Application status 应用情况
Combustion air for conventional p.f. power station 作为传统的p.f.电站的燃气	Thermal oxidation 加热氧化	Combustion in p.f. power station boiler furnace p.f.电站锅炉中燃烧	Mitigation & Utilisation – demonstrated in a pilot-scale unit, and being considered for a full-scale demonstration (ceased) 在试点单位进行减排和利用的示范，正考虑进行全面示范。（已停止）
Waste coal/methane combustion in a fluidised bed 废煤/废瓦斯在流化床燃烧	Thermal Oxidation 加热氧化	Combustion inside a fluidised bed and freeboard 流化床燃烧或悬浮燃烧	Mitigation Utilisation – investigated at a laboratory scale rig 减排及利用还在实验室阶段
Combustion air for gas turbine 作为汽轮机燃气	Thermal oxidation 加热氧化	Combustion in gas turbine combustor 在汽轮机燃烧室中燃烧	Mitigation Utilisation – studied 正在研究其减排及利用
Combustion air for gas engine 作为燃气发动机的燃气	Thermal oxidation 加热氧化	Combustion in gas engine combustor 在燃气发动机燃烧室中燃烧	Mitigation & utilisation – demonstrated (ceased at Appin economics?)有减排及利用示范(在Appin终止，经济原因？)

Existing & Developing Technologies (2)

Ventilation Air Methane as principal fuel

Technology	Mechanism	Principle	Application status
MEGTEC TFRR MEGTEC公司 TFRR技术	Thermal oxidation 加热氧化	Flow reverse reactor with regenerative bed 反向流动反应器和再生床	Mitigation – demonstrated in a small pilot-scale unit 就减排进行小范围进行试点示范 Utilisation – demonstrated at a mine site 在一家煤矿进行利用示范 (West Cliff, commissioned, MECTEC presentation to follow 西克里夫，受委托，结果未公布)
CANMET CFRR CANMET公司CFRR技术	Catalytic oxidation 氧化催化	Flow reverse reactor with regenerative bed反向流动反应器和再生床	Mitigation – demonstrated in a lab-scale unit 减排---在实验室进行示范 Utilisation – not demonstrated at a mine site 利用---未在煤矿示范
Biothermica TFRR? Biothermica公司 TFRR技术	Thermal oxidation 加热氧化	Flow reverse reactor with regenerative bed反向流动反应器和再生床	Mitigation – demonstrated in pilot-scale 减排---在试点进行示范
CSIRO CMR 卡西罗 CMR技术	Catalytic oxidation 氧化催化	Monolith reactor with a recuperator 整体反应器和换热器	Mitigation – demonstrated in a lab-scale rig 减排--在实验室进行示范 Utilisation – not demonstrated at a mine site 利用---未在煤矿示范
CSIRO Catalytic turbine (VAMCAT)通风瓦斯催化汽轮机	Catalytic oxidation 氧化催化	Gas turbine with a catalytic combustor and a recuperator 汽轮机和一个催化燃烧室及换热器	Mitigation – combustion demonstrated 减排—燃烧过程示范 Utilisation – being developed in a small pilot-scale unit 利用—在小范围试点进行开发
EDL Recuperative gas turbine EDL公司换热汽轮机技术	Thermal oxidation加热氧化	Gas turbine with a recuperative combustor and a recuperator 汽轮机和换热型燃烧室及换热器	Mitigation Utilisation – demonstrated in a pilot-scale unit?, but development ceased. 减排及利用在试验性机组，但开发停止了。

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Existing & Developing Technologies (3)

Ventilation Air Methane as principal fuel

Technology	Mechanism	Principle	Application status
Porous burner 多孔介质燃烧器	Thermal oxidation 加热氧化	Thermal oxidation inside porous ceramics 在多孔陶瓷内部加热氧化	Mitigation – lab scale study 减排—实验室研究 Utilisation – not demonstrated at a mine site 利用-未在煤矿进行示范
Biofilter 生物过滤器	Biological oxidation 生物氧化	Oxidation inside composts 在堆肥内部氧化	Mitigation – proposed concept, same as used for landfill gas, huge size? (1/h) 减排---作为概念提出，与作为填埋气使用一样，大规模?
Concentrator 浓缩器	Adsorption 吸附	Multi-stage fluidised/moving bed using adsorbent, and a desorber 利用吸附剂和解吸塔在流化床/移动床多阶段进行	Mitigation Utilisation – the development work stoped due to technical issue. 减排及利用—开发工作由于技术原因而停止
	Gas centrifuges 气体离心		Mitigation and utilisation – being proposed as a concept, feasibility? 减排及利用---作为概念提出，可行性? Chem Eng Sci, 60: 4397
	Adsorption 吸附	Carbon composite 碳复合	Under study 在研究中

Key Issues for Successful Technology Application 成功进行技术应用的关键问题

- Is the technology proven to cope with the VA characteristics?
  该技术是否能证明符合流通气的特质

  For example: 例如:

  Gas engine: Limits ≤1μm, ≤ 0.8mg/MJ for particles

  燃气发动机：微粒限定值 ≤1μm, ≤ 0.8mg/MJ

  Gas turbine: Limits ≤2ppmw, 0 for ≥10μm

  燃气汽轮机：限定值 ≤2ppmw, 0 for ≥10μm

- No impact on mine safety 对煤矿安全无影响

  compliance with all regulatory standards (e.g. gas engines used for drainage gas of 6-25% CH_4); 符合所有规范标准 （如：燃气发动机被用于6-25% CH_4瓦斯抽放）

- Profitable economics 经济效益

  Combining methane energy value and carbon reduction revenues;

  将瓦斯能源效益和碳排放缩减效益结合

  Capital, operational and maintenance costs

  资金、运营和维护费用

- Units have to be portable.

  设备需为可移动式

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CSIRO R & D　CSIRO 研发能力

- **For diluted methane, CSIRO can**:

对于稀释瓦斯，CSIRO 能够：

- Characterise mine methane emissions, including dust in methane emission streams;

  对煤矿瓦斯排放特点进行定位，包括瓦斯排放流中的灰分；

- Technical and economic assessment for your mine site, and identify the best option for the methane mitigation and utilisation;

  为煤矿提供技术及经济评估，并为其瓦斯减排和利用提供最佳解决方案；

- Conceptual plant design and optimisation of the technology for the mine site; 进行概念性工厂设计并对煤矿技术进行优化；

- Design and commission of small pilot-scale demonstration plants; 提供小型试验性示范工厂的设计服务和中介服务；

- Research and development of new technologies

  研发新技术

Current Status of CSIRO Technology Development 目前CSIRO 技术发展情况

CSIRO technologies for mine site demonstration

CSIRO 煤矿示范技术

- Generate Power - **VAMCAT**

  发电-通风瓦斯催化汽轮机

  lean burn catalytic combustion gas turbine 稀燃催化燃烧汽轮机
- Mitigate Carbon Emissions - **CMR mitigator**

  减少碳排放- CMR 减排器

  catalytic monolithic reactor 整装催化反应器

A range of technologies is needed for cost-effectively capturing, utilising and mitigating VAM depending on mine site specifications

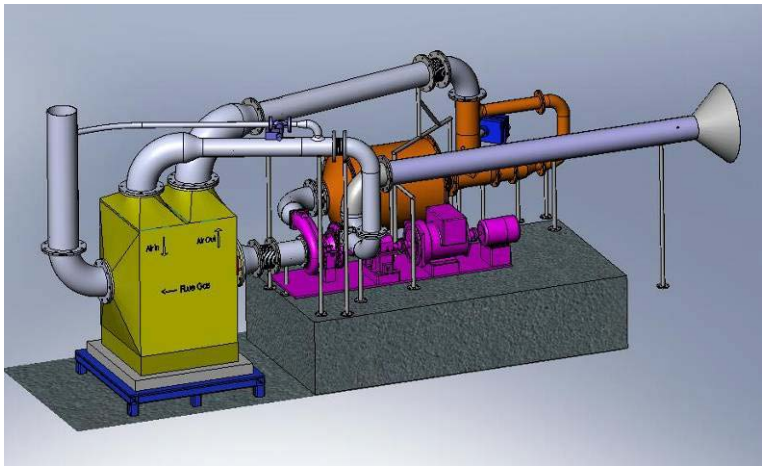
低成本的通风瓦斯获取、利用及减排需要一系列技术手段，并且需根据煤矿实地情况而定。

VAMCAT Technology
通风瓦斯催化汽轮机技术

- Ventilation air methane catalytic turbine – an innovative technology

通风瓦斯催化汽轮机—一项创新型技术

- To develop a lean burn turbine system, which can be powered with about 1% methane in air.
  稀燃汽轮机系统可以使用1%浓度的瓦斯做燃料
- 25KW$_e$ prototype demo unit – being commissioned
  25KW 样机 委托制造
- Mine site demonstration of the prototype unit will be at a mine site, expected in 2009. 样机预计将于2009年在煤矿进行示范



VAMCAT Advantages 通风瓦斯催化汽轮机的优势**:**
Simple process; no need for water, lower capital, operational and maintenance costs; high energy efficiency; good portability
工序简单；不需水；低资金投入，低运营和维护费用；高能源效率；方便移动

VAMCAT Technology (Continued)

通风瓦斯催化汽轮机技术 （接上）

Turbine block test
汽轮机台架试验

25kW demo unit
25kw
示范机组

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CSIRO CMR Mitigator CSIRO CMR 减排器

- **Objective 目标**
  - VAM Mitigation 实现通风瓦斯减排
  - Waste heat for: 余热可用作：
    - ✓ waste water desalination, and then the water for reuse in mines, 废水脱盐，经处理的煤矿可再利用
    - ✓ cooling process 冷却工序
    - ✓ Coal drying etc. 煤干燥等
- **Process 处理**
  - Operated at ≥0.3% methane 浓度大于等于0.3%的瓦斯

Summary 总结

- VAMCAT targets: poor drainage gas, Ventilation air (VA) from longwall bleeding fans, and VA with higher CH_4 concentration

  通风瓦斯催化汽轮机目标：通过长臂通风扇排放的低浓度抽排气，通风气以及含有较高CH4浓度的通风气。

  CMR targets: VA with CH_4 <0.5% for mitigation only

  CMR 目标: 通风气CH4浓度小于0.5%时，只可用于减排目的

- The economics is not viable when <0.3% CH_4.
- CH4浓度小于0.3% 时，项目无经济性。
- VAM can be upgraded to 1+% with low quality drainage mine methane thus adding the VAM to useable gas supply

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