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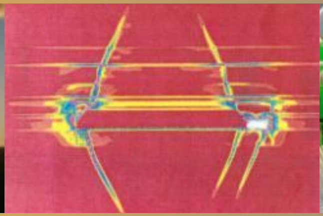
From coal face to grid
Coal Mine Methane as a resource

Delhi March 2010



Introduction – Methane Capture

Why drain methane gas?

Generally speaking, the rock strata disturbance caused by longwall mining causes the release of large amounts of gas into the working area.

Ventilation in many cases is insufficient to dilute the methane to safe levels, as a result the rate of mining must be reduced to maintain safe working conditions.

Methane drainage was implemented to capture a portion of the gas before it reaches the working area allowing the rate of mining to be safely increased without increasing coal face ventilation.

Methane drainage is undertaken to maintain safe working conditions whilst maximising coal production.

Types of methane drainage

Methane drainage must be tailored to the type of coal being mined and the geology surrounding to working seam.

Generally, this falls into two categories:

1. *High permeability coal* – Desorbed gas can migrate through the coal and drained from in-seam or surface boreholes. Coal seams can be pre-drained ahead of mining to reduce the gas emission during coal production.

2. *Low permeability coal* – Gas does not migrate through the densely packed coal, it is released once the coal is fractured and ground is disturbed by longwall mining. Boreholes must be drilled into the fractured strata to intercept gas migration paths that are created once the coal has been mined.

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High Permeability Coals

High permeability coals are present in many areas of the world, including North America, Australia and parts of Shanxi China.
A wealth of technologies are available to drill from the surface, or drill underground, in-seam.

Effective sealing of the boreholes and management of applied suction yields high concentration gas (>30% CH_4) which is suitable for safe utilisation.

The capture efficiency of in-seam drainage is dependent on the drainage time period given before mining, typically a coal panel is drained for 6 – 12 months before mining. This can yield capture efficiencies 50 – 70%.

When calculating ventilation requirements, consideration must be given to coal seams within 50m of the working seam, as the disturbance caused by longwall mining can cause gas desorbed in these seams to migrate to the working area.

Low Permeability Coals

Low permeability coals are common in UK, Europe, Russia, Kazakhstan and large areas of China, this type of coal generally can not be successfully pre-drained.

Instead, the strata disturbance caused by longwall mining is used to capture gas, the desorbed gas is captured by boreholes drilled into the fractured ground to target the migration paths.

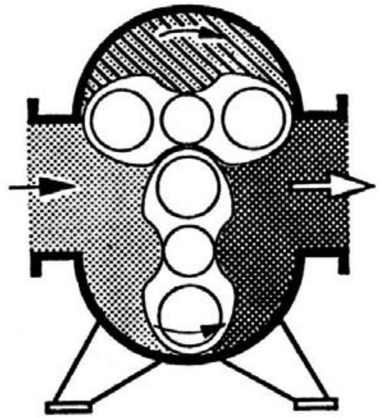
This technique is known as 'Cross Measures methane drainage.' It is **not** designed to extract gas from the seam being mined, rather capture gas from coal seams in close vicinity to the working seam (typically within 50m).

Air is unavoidably drawn into the boreholes which dilutes the gas concentration, this effect can be reduced through robust **borehole sealing** techniques and **regulation of applied suction**. Drained gas concentrations of between 30 – 50%CH_4 are achievable with cross measures.

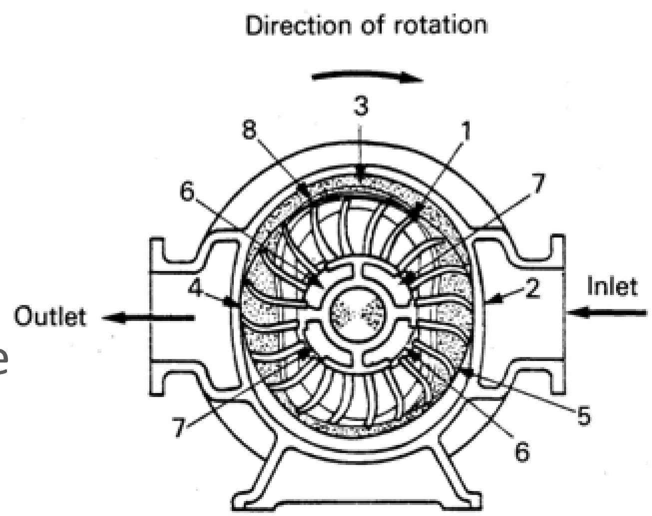
Extraction of drained CMM

Drained CMM is transported out of the mine through a pipe network under the influence of a vacuum created by the extraction plant.
Generally, two types of extraction pumps are utilised to create the vacuum:

1. The Positive Displacement (PD) blower is more suitable to draining high concentration CMM due to it's potential as an ignition source. Close tolerances between the rotating 'lobes' mean they can not handle dirty gas, a pre filter should be installed. They do not require water and are highly portable and the exhausted gas is dry and easy to utilise.



2. The Liquid Ring pump is more suitable for draining all concentrations of CMM due to its low potential as an ignition source. It is tolerant to dirt and has a long service interval, however it is not portable due to it's reliance on water supply which requires chemical treatment (Legionella) and the exhausted gas is very humid.



Utilisation of CMM – Importance of gas concentration

Methane is flammable when mixed with air in the concentration range 5 – 15% CH_4 by volume at standard atmosphere and pressure.

When a flammable mixture of CMM is utilised there is a risk that an uncontrolled ignition of this mixture (e.g. a gas engine backfire) would cause a flame to propogate down the drainage pipe and cause an explosion.

The primary defence against flame propagation and explosion is to drain CMM at high concentration above the Upper Flammability Limit (UFL) for methane. Generally, a CMM concentration >30%CH_4 is considered safe to utilise as it gives a large margin for safety above the UFL for methane (15%CH_4)

It should be noted that pressurising methane and air mixtures increases the UFL, this is applicable to utilisation of CMM in gas turbines and purification.

At a pressure of 10BarA, the UFL for methane is approx 35% CH_4.

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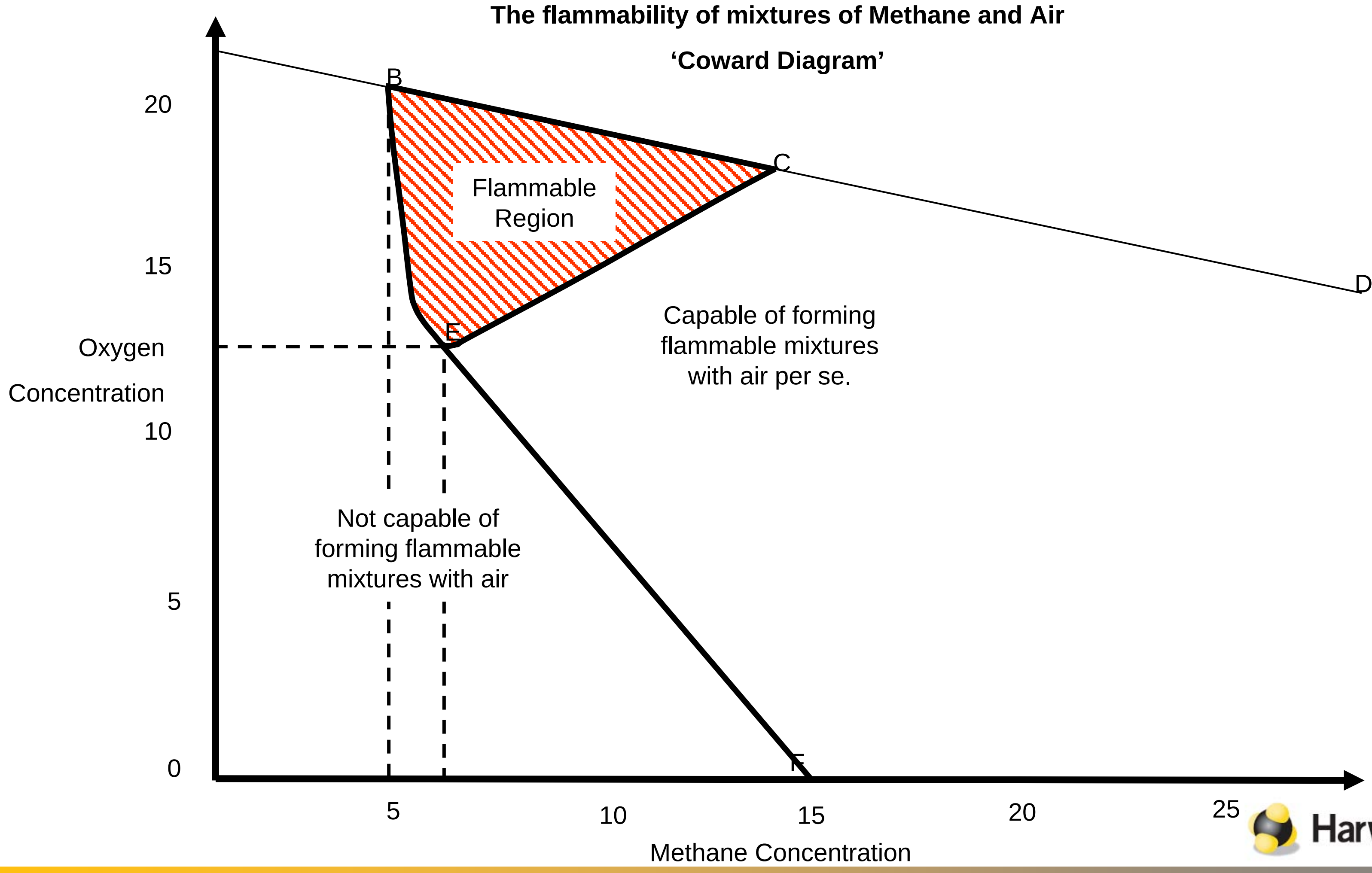
Utilisation of CMM – Importance of gas concentration

The diagram below shows the flammability of methane and air mixtures at atmospheric temperatures and pressures.



CMM Utilisation History – Power Generation

1980-1990 Large Medium speed gas engine's

- Requiring 40% + purity
- Issues with purity and flow fluctuations
- Low efficiency

1995-2000 Gas Turbine technology

- Minimum 40% purity requirements
- Oxygen in CMM required to be below 10% due to compression of gas
- Problems with flow and purity fluctuations
- Low efficiency even with waste heat recovery
- High maintenance costs

2000-2009 High speed gas engine introduction

- Installation of 14 x 1400KWe units on working mines
- Units capable of reacting to fast fluctuations in purity and flow
- High efficiency typically >40%
- UK legislation allowing gas use down to 27%

Methods of CMM utilisation – Power Generation

Gas generator sets:

Benefits:

A highly efficient method of generating useful energy from CMM.

A significant reduction in the overall electrical import of the mine can be realised.

Operation Requirements:

A commitment must be made to ensure the required service and maintenance is carried out on the generator sets. This, together with high purity CMM supply will ensure high availability.

A reciprocating gas generator rated at 1.4 MWe requires a methane pure flow of 100 litres/second

Suitable flame arrestor technology installed to prevent flame propagation into the mine.

Mine Suitability:

A disciplined drainage approach ensuring that methane is drained and utilised above 30%CH_4.

Examples of CMM Utilisation projects in the UK

1,415kWe Jenbacher 420 100L/s

Destruction of Ventilation Air Methane pilot project at Thoresby Colliery, Nottinghamshire in 1994.
The unit pictured is a Megtec Vocsidizer.

2000Nm^3/hour CMM Flare consumes 80L/s

80 kg/hour CMM Boiler consumes 80L/s

Thank you

Thomas Breheny
tbreheny@harworthenergy.com