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Coal Bed Methane

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Report Abstract
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INTRODUCTION

As a result of rising energy prices, the commitment to reduce greenhouse gas (GHG) emission through carbon credit incentives, and the growing safety concerns, increasing attention is being given to coal gas recovery and utilization.

The recovery of coal seam gas (CSG) is typically performed in one of three principal methods. Each method occurs at a different mining stage, requires different recovery and extraction technology, and results in the production of gas of different quality.

- **Coal Bed Methane (CBM)** – Gas that is extracted from virgin coal seams for which there are no immediate plans for mining. CBM recovery shares some similarities with unconventional natural gas operations as it involves well construction, hydraulic fracturing, and dewatering.
- **Coal Mine Methane (CMM)** – Gas that is recovered from active coal mines. CMM can be in the form of ventilated air and methane mixtures, coal gas recovered prior to mining or gas released from the seams adjacent to the mined strata.
- **Abandoned Mine Methane (AMM)** – Gas that is recovered from abandoned coal mines. In most cases, coal mines continue to emit methane for a period of time after abandonment.

While each of these methods will be more thoroughly described, this report will focus on coal bed methane extraction, which accounts for the largest volume of gas currently extracted from coal seams and will by far represent the largest volume of predicted future gas production from coal seams.

BACKGROUND ON COAL BED METHANE

Coal gas is a form of natural gas that is trapped within coal beds or coal seams. These gases are generated through the maturation of the coal and, as such, the rocks of coal themselves are ultimately the source of the gas. When generated, coal gas is typically known to have high methane content (>95 percent) and contain minimal foreign substances such as CO_2 and Nitrogen; hence the name Coal Bed Methane (CBM).

Coal bed methane is produced through two processes within the coal source rock:

- **Thermal maturation**: This process takes place during the coalification process as temperature and time progressively change the molecular structure of coal-forming materials. Usually formation temperatures of 100 °C to 150 °C are required. Coal at different thermal maturation stage and rank holds different gas generation capability; the bituminous range is typically the most prolific.
- **Bacterial action**: This process takes place when biological and anaerobic bacterial action is induced on mostly terrestrial organic matter deposited in prehistoric swamps, lake bottoms, and shallow marine environments. The generation of biogenic gas is

independent of coal rank and can be induced at any time in the coalification process if appropriate conditions are present.

The report discusses sources of gas in more detail, as well as:

- The adsorption capacity of a coal seam and gas content - the adsorption capacity of a coal seam is a good indicator of the volume of CBM that can be retained. It can be generalized that the adsorption capacity increases with rank and pressure and decreases with temperature.

- Desorptiopn and production - as can be inferred from sorption isotherms, coal seams will desorb gas as the formation pressure declines. This is the concept upon which CBM operations rely whereby coal bed pressure is reduced in order to release the CBM.

- Natural fractures and permeability - the natural fractures in coal seams are called cleats. The coal seams typically contain several cleat systems but the two most important are the face cleats and butt cleats. The face cleat is the primary fracture which is larger in diameter and longer in length than the butt cleat. The relative orientation of these cleat systems is almost perpendicular.

- Other properties, such as compressive strength, moisture content, macropores and micropores, density, and volatile matter.

- Suitable coal rank for CBM development - while coal is one of the world's most abundant energy sources, unfortunately not all coal deposits are suitable for CBM development. Coal ranks are often used to develop a geological profile of a coal deposit characterized by a unique set of chemical and physical qualities and provides a vital assessment in the consideration of CBM development.

- Differences between CBM and conventional gas - whereas the development of CBM shares a number of similarities to the exploitation of conventional natural gas, there are fundamental differences, which make CBM an unconventional gas resource.

- Exploration & development - similar to conventional oil and gas development projects, CBM development is a staged process and typically phased in three key stages: exploration, pilot testing, and development.

TECHNICAL CONSIDERATIONS

The development of CBM has been greatly influenced by the application of new technologies. Many of the innovations are the adaptation of technologies used in established oil and gas exploration and production and coal mining industries.

This section of the report reviews the technology employed for each of the principal activities associated with CBM development, which includes:

- Drilling technology
- Completion and stimulation technology

- Artificial lift technology
- Enhanced recovery technology

The future research and development needs for the CBM industry are also be explored.

ENVIRONMENTAL CONSIDERATIONS

As with conventional gas development operations, CBM production represents various concerns to the surrounding environments, some of which are typical issues of exploration and production (E&P) operations, others are unique to CBM. Some of the most critical issues are as listed below.

Environmental Considerations for CBM Operation

CBM Characters	Environmental Concerns
Conventional E&P operation	▪ Surface disturbances ▪ Noise pollution ▪ Air pollution ▪ Wildlife disturbances
Dewatering	▪ Water management and disposal ▪ Groundwater withdrawal
Shallow and fractured seams	▪ Groundwater contamination ▪ Methane venting
Large well requirement	▪ High well density ▪ Intensive surface disturbances

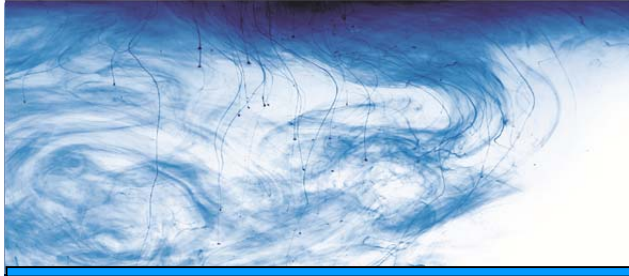
This section of the report discusses:

- Typical impacts from E&P operations
- Groundwater drainage
- Groundwater contamination
- Water management

COMMERCIAL CONSIDERATIONS

Commercial considerations are discussed, including:

- Global resources
- CBM pricing
- CBM development cost
- Regulatory challenges



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