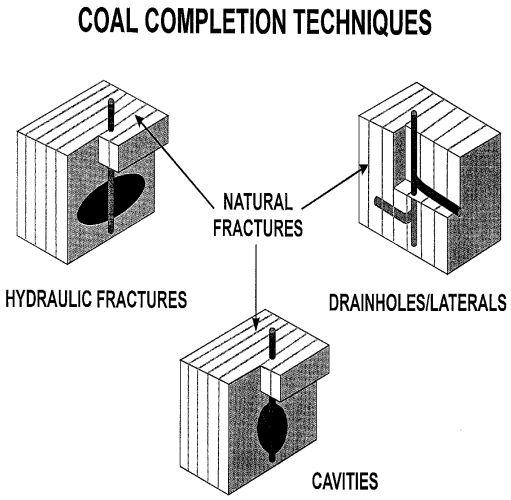
4.1.5 ADVANCES IN COAL MINE METHANE RECOVERY SYSTEMS

Technology Description

In-mine directional drilling.

Vertical drainage in advance of mining.



Coal mine methane (CMM) is liberated into underground coal mines – as coal seams are mined – and vented out of the mine to provide a safe working environment. Where ventilation air cannot adequately control these emissions, mine operators utilize a CMM drainage system. Drainage systems consist of boreholes drilled into the coal seams and adjacent strata, and equipment is used to extract and collect CMM. Dependent on geologic, reservoir characteristics, and mine layout, CMM can be recovered in advance of mining or after mining has occurred. State-of-the-art CMM drainage techniques are now available to mine operators. Advances in steerable motors and stimulation techniques have increased the ability to recover CMM far in advance of actual mining operations. This allows operators to recover a higher percentage of the total methane in coal seams. The most promising technologies either necessitate fewer wells to produce more gas or increase the recovery efficiency of surface wells or underground boreholes. This CMM, much of which is high quality, presents many alternatives for utilization and markets.

System Concepts

- Boreholes are drilled into the coal seams and adjacent gas-bearing strata vertically or horizontally from the surface or from within the mine, depending on geologic, reservoir, and mine design and conditions.
- Various drilling technologies are employed to promote the release of the CMM.
- Gathering systems are used to collect and vent the CMM or distribute the gas to a specific use such as a natural gas pipeline. CMM recovered through drainage systems would have otherwise been vented through mine ventilation systems.

Representative Technologies

- Directional drilling systems that enable fewer wells to contact the same quantity of coal.
- Advanced stimulation techniques that use injection of a second gas such as nitrogen to improve recovery.

Technology Status/Applications

- Directional drilling, applied in conjunction with flexible coiled tubing and high pressure water jets, has been downscaled and applied to coalbed methane reservoirs.
- Operators also have demonstrated and commercialized slant-hole directional drilling, which involves the drilling of a guided surface hole that intersects the targeted coal seam and continues drilling within the bounds of a coal seam.

- Recent innovative methods for enhancing the recovery of methane from coalbeds by injection of second gases such as nitrogen are being tested. Carbon dioxide, while potentially attractive for unmineable seams, is not appropriate for coalbed methane development associated with mining because CO_2 is a hazard in the underground mining environment. Further work regarding the use of nitrogen is required.
- Computer simulation has suggested various configurations of in-mine directionally drilled boreholes and surface vertical wells to optimize CMM drainage approach.

Current Research, Development, and Demonstration

RD&D Goals

- Refined directional drilling technologies to improve the application in friable coal seams, increase drilling depths, and reduce the cost of drilling.
- Application of in-mine hydraulic fracturing techniques.
- Additional data supporting nitrogen injection as a cost-effective alternative for improving recovery efficiencies.
- In-mine application of nitrogen-injection techniques.
- Use of other inert gases as a second gas for injection into mined coal seams.
- New drilling techniques that could improve recovery of coalbed methane.
- Further applications of surface oil and gas drilling, as well as completion technologies and their application for in-mine CMM recovery.

RD&D Challenges

- Must locate demonstration projects at coal mines to clearly establish greenhouse gas reductions, but the number of very gassy mines in the United States is limited to about 30-40 coal mines.
- Must develop products that the mining community considers a help rather than a hindrance.
- Must directly link gas recovered to methane emissions avoided. Total coal mine methane emissions (ventilation air methane and drained emissions) does not increase due to improved drainage technologies; rather, ventilation air emissions decrease when drained gas emissions increase. Must consider this when assessing total methane emissions at a specific project.

RD&D Activities

- Several U.S. companies have developed directional drilling techniques, both vertical and horizontal, which are currently being evaluated.
- Use of CO_2 and nitrogen have been laboratory tested and/or field tested by private industry and research institutes.
- U.S. government funding has focused on gas utilization techniques, rather than recovery enhancement.

Recent Progress

- Reports indicate that directional drilling and injection of a second gas have demonstrated drainage efficiencies of 50%-90%.
- Slant-hole drilling has been used successfully to date at the SASOL Secunda Operations in South Africa. SASOL Secunda has drilled in excess of 100,000 meters of the surface to in-seam wells, regularly reaching target depths of up to 2 km. Dallas-based CDX Gas has successfully commercialized a surface directional drilling technique called the "Pinnate" multilateral drainage networks, and a dual-well drilling and production system.
- Nitrogen tests appear to be successful, but results are confidential.
- If the national, industry-wide drainage efficiency at underground mines increased from the current average of 34%-50%, then the United States could realize an additional 8 $MtCO_2e$ emissions reductions.

Commercialization and Deployment Activities
• Projects in the United States are currently employing directional drilling on a limited basis. • Carbon dioxide injection has been used for enhanced oil production for quite some time, and is being evaluated by the Alberta Research Council and an international consortium of Canadian and U.S. organizations. The results are confidential at this point. CO_2 injection does not appear appropriate for coal mine applications, however. • Nitrogen injection to enhance methane recovery from mineable coal seams needs demonstration. **Market Context** • Gassy coal mines in the United States, where improved gas recovery efficiencies will yield greater coal mine productivity and natural gas for use or resale are potential markets for this technology. • Additional gas recovered likely will interest gas users such as gas marketers, power generators, etc. • Markets for these technologies exist worldwide in countries with gassy coal seams and coal-mining industries such as Australia, Canada, China, India, Ukraine, Russia, and Poland. • Beyond carbon reductions, market for these products will be found in the exploration and production sector of the natural gas industry.