

Underground Coal-Gasification: Water-Quality Hazards and Risk Mitigation Strategies

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Project Description and Objectives

Underground Coal Gasification (UCG) converts solid coal *in situ* into an energy-rich gaseous product known as synthesis gas (syngas). UCG periodically attracts commercial interest as a potentially cost-effective way to recover energy from deep coal seams. Pilot and demonstration operations have been completed or are underway internationally, and have been in various stages of planning and proposal in the United States.

While UCG has several environmental and health-and-safety advantages relative to standard mining and surface combustion, significant UCG-specific hazards exist. In particular, the process produces concentrations of organic compounds and other contaminants that may migrate into nearby aquifers if they are not properly destroyed or contained by careful operation. The mechanisms and management of these hazards are not widely understood.

The objective of this project was to develop a best practices manual specifically focused on water-quality hazards and mitigation strategies for UCG. The manual provides an in-depth review of the underground coal gasification process, a detailed discussion of different contaminants and transport pathways, and recommendations for prudent monitoring and management practices. The recommendations are supported by a wealth of data collected at field tests conducted in the United States and abroad in recent decades.

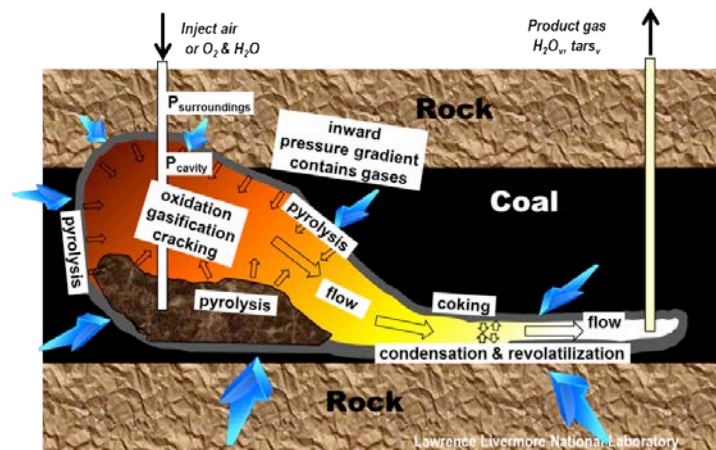


Figure 1: Schematic of an underground gasification module using two wells.

Applicability to Mining and Reclamation

The project was designed to meet the Applied Science Program goal of “improved science and technologies for achieving applicable water quality standards at sites either mined or reclaimed under the authority of SMCRA programs.”

The best practices manual developed here can have a significant, near-term impact on two audiences. First, it can provide technical guidance for regulators to support well-balanced regulations, permitting decisions, and enforcement programs. Second, the proposed work can help operators entering the UCG arena develop science-based best practices for pilot and commercial operations.

Methodology

Each chapter of the best practices manual focuses on a key topic of interest:

- Chapter 1: Introduction to UCG
- Chapter 2: Site selection and characterization
- Chapter 3: Contaminant behavior during proper operation
- Chapter 4: Abnormal transport of contaminants
- Chapter 5: Risk mitigation recommendations
- Chapter 6: Compositions and monitoring analytes
- Chapter 7: Fate, transport, and remediation of residual contaminants
- Chapter 8: Hazard screening checklist

The discussion is supported by water-quality data from many field and laboratory studies. An extensive bibliography is also provided for readers interested in digging further into the source material.

Highlights

Research conducted during this project has been featured in a number of news articles, including: *National Geographic Online* Apr. 2014, *NPR/Wyoming Public Radio* Dec. 2013 and June 2014, *Platts Coal Outlook* Jan 2013, and *Alaska Business Monthly* Aug. 2013. Recently, OSMRE pulled together a working group of Federal, State, and Tribal regulators to address UCG. The goal of this working group was to develop a technical consensus around key issues that should be addressed during the permitting process. To support this effort, LLNL held several in person and online education workshops discussing UCG technology and associated hazards. In turn, the working group provided feedback and critical review of the best-practices manual as it developed.

Results/Findings:

Historical experience has shown that water-contamination hazards are very real and must be addressed seriously. A sound understanding of contamination mechanisms, careful site selection, and conservative operations are needed to assure that UCG operates in an environmentally acceptable manner. The guidance manual developed here can serve as a valuable education document to help future operations avoid unwanted consequences.