MICROBIAL ENHANCED COALBED SYSTEMS

INTRODUCTION

Microbial Enhanced Coalbed Systems (MEC Systems) describes a bioconversion process in which microbial communities native to a coalbed convert coal to methane. MEC Systems research conducted by the U.S. DOE NETL aims to develop an efficient and cost-effective fuel source for advanced distributed power generation from fossil energy sources by optimizing biological conversion for multiple coal seams.

NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

BACKGROUND

Methane, the primary component of natural gas, is increasingly becoming a dominant form of global energy. A portion of natural methane deposits are trapped below the surface in unmineable coalbeds. While retrieving the coal itself is cost-prohibitive, the methane contained within the coal can be more economically extracted and may provide a significant global energy source. A need exists to optimize coalbed methane production, which will benefit future energy availability.

Living organisms[1] produced much of the methane already present in coalbeds. Adjusting coalbed conditions, such as nutrient availability or coal surface area, may stimulate the natural biogasification process. A thorough characterization of the microbial processes important to coal-to-methane conversion, followed by experimental analysis of optimal coalbed conditions, will result in a strategy to promote increased methane production.

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[1] Bates, B.L., McIntosh, J.C., Lohse, K.A., and Brooks, P.D. (2011). Influence of groundwater flowpaths, residence times and nutrients on the extent of microbial methanogenesis in coal beds: Powder River Basin, USA. Chemical Geology 284, 45-61.

Thielemann, T., Cramer, B., and Schippers, A. (2004). Coalbed methane in the Ruhr Basin, Germany: a renewable energy resource? Org Geochem 35, 1537-1549.

RESEARCH CAPABILITIES

NETL has a unique expertise in industrial coal processes and geomicrobiology. The following outcomes may be achieved by combining and refining these tools:

- Key microbial species in the coal-to-methane conversion process will be identified.
- Synergistic and competing microbial processes naturally occurring in coalbeds will be characterized.
- Optimal coalbed conditions for coal-to-methane conversion will be defined.
- Methods for increasing the quantity/quality of coalbed methane production will be developed.

Once these techniques are refined, NETL may establish a global strategy of increasing the microbially driven methane output from unmineable coalbeds.

BENEFITS

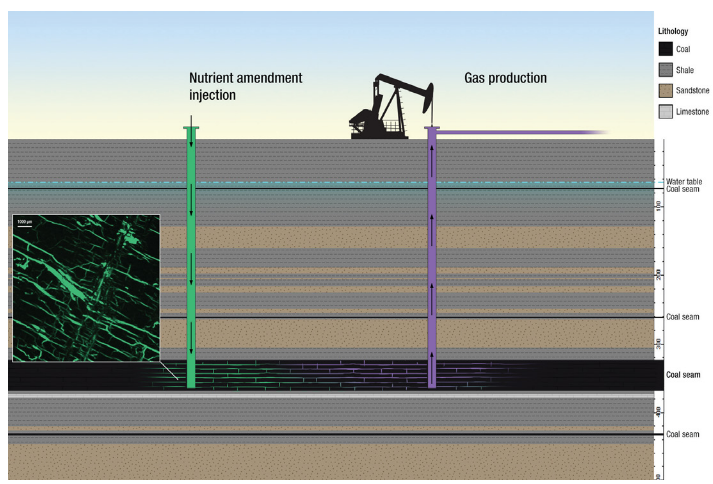
Coal converted by biological processes under anaerobic conditions (without oxygen) is expected to result in methane-rich biogas, which has immediate uses as a clean fuel or chemical feedstock. Unlike thermal gasification, this biological-based coal conversion could occur at near-ambient conditions, thereby avoiding the high temperatures and often high pressures of thermal gasification. These extreme conditions require expensive gasifier vessels and equipment, resulting in reliability and availability issues. MEC Systems avoids these inherent problems of thermal gasification by simply augmenting a naturally occurring process within its original environment.

As opposed to thermal underground coal gasification (UCG), which involves partial in situ combustion of coal to provide high temperatures for gasification, MEC Systems uses natural microorganisms and introduced nutrients to enhance microbial growth to break down in situ coal into simpler compounds, methane and other gases, which can then be extracted via wells. One advantage of biological underground coal conversion over thermal UCG is that groundwater contamination is not a risk because toxic species, such as benzene, are not formed in the biological conversion process, which occurs at ambient underground temperatures.

GOALS

Over the next few years, the primary goal of this research is to provide information that supports site selection and operations of potential MEC Systems sites. This research will also support assessments of MEC Systems' potential contribution to the U.S. fossil fuel energy supply.

This research will evaluate the potential to increase coal-to-methane production of unmineable coal basins using the naturally occurring microbial consortia. Researchers will analyze methane output and the genetic material (metagenomic) recovered from environmental samples from coal basins to determine optimal field sites for future deployment. Pressure vessels and sensors will be developed to simulate coal basin conditions while measuring key parameters such as permeability and methane output. Additional metagenomic analysis of nutrient amended microbial consortia will optimize methods for future nutrient injection during field deployment.



Depiction of nutrient amendment injected into the coal seam resulting in increased methane production. Coal stimulated by biological processes under anaerobic conditions would be expected to result in methane-rich biogas, which has immediate uses as a clean fuel or chemical feedstock.

Research Partners

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