

CO₂ Sequestration Potential Of Texas Low-Rank Coals

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By:

**Duane A. McVay
Walter B. Ayers, Jr.
Jerry L. Jensen**

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**Texas Engineering Experiment Station
3000 TAMU
332 Wisenbaker Engineering Research Center
College Station, Texas 77843-3000**

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ABSTRACT

The objectives of this project are to evaluate the feasibility of carbon dioxide (CO₂) sequestration in Texas low-rank coals and to determine the potential for enhanced coalbed methane (CBM) recovery as an added benefit of sequestration. The primary objectives for this reporting period were to construct a coal geological model for reservoir analysis and to continue acquisition of data pertinent to coal characterization that would help in determining the feasibility of carbon dioxide sequestration.

Structural analysis and detailed correlation of coal zones are important for reservoir analysis and modeling. Evaluation of existing well logs indicates local structural complexity that complicates interpretations of continuity of the Wilcox Group coal zones. Therefore, we have begun searching for published structural maps for the areas of potential injection CO₂, near the coal-fired power plants.

Preliminary evaluations of data received from Anadarko Petroleum Corporation suggest that coal properties and gas content and chemical composition vary greatly among coal seams. We are assessing the stratigraphic and geographic distributions and the weight of coal samples that Anadarko has provided to select samples for further laboratory analysis. Our goal is to perform additional isotherm analyses with various pure and/or mixed gases to enhance our characterization model. Additionally, we are evaluating opportunities for field determination of permeability with Anadarko, utilizing one of their wells.

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INTRODUCTION

The objectives of this project are to determine the feasibility of CO₂ sequestration in Texas low-rank coals and the potential for enhanced coalbed methane (CBM) recovery as an added benefit of sequestration. The main objectives for this reporting period were to (1) assess Wilcox Group structure near potential injection sites, (2) gather more coal samples from various depths to aid in characterizing these coals through laboratory studies, (3) identify potential wells owned by Anadarko in which well tests could be conducted to gather more information about permeability in coalbeds, and (4) determine the best well test design that would provide accurate permeability values.

All of these objectives will add value to our reservoir modeling study since this study is the first of its kind in Texas low-rank coals and would provide decision makers with more accurate information about carbon dioxide sequestration and enhanced methane recovery.

EXPERIMENTAL

None.

RESULTS AND DISCUSSION

Anadarko Data

Following the data exchange agreement between Anadarko and Texas A&M University, we obtained adsorption, desorption and gas and water analysis reports for three wells that penetrated deep coals in the vicinity of our identified Sites 1 and 2 (Table 1). Also, we obtained additional well log data from Anadarko, which is aiding our structural evaluation of the Wilcox Group coals in the areas of interest. We are correlating the various coal zones in these wells, and we are searching for published regional structure maps for this area to complement our local structural analysis.

Obtaining Coal Samples

Determination of the number of coal beds, cumulative and individual coalbed thickness, and lateral extent of coal beds or coal-bearing zones is critical to reservoir characterization and evaluation of the potential for CO₂ sequestration and enhanced coalbed methane production. It is also necessary to characterize individual coal seams by obtaining values for gas content, multi-component adsorption isotherm values and in situ gas composition to provide estimates of the quantity of carbon dioxide that may be sequestered and the amount of methane that will be produced.

As part of our data exchange agreement with Anadarko, we obtained coal samples from various wells and varying depths from the areas of interest. We are reviewing the stratigraphic and geographic locations of the samples to select those which will provide the most critically needed data. These samples have been in storage for a few years, so we expect minor oxidation to have occurred, which may affect isotherm results. However, discussion with Anadarko staff indicates that these samples should provide representative values for the coals. Also, we are discussing with Anadarko the possibility of obtaining fresh core samples from wells that are currently being drilled. These fresher core samples would be preferable for characterization of these coal seams. Our aim is to obtain whole core samples and not just cuttings or sidewall core samples so that we may conduct flow studies on these samples and enhance our understanding of the East Texas low-rank coals.

Once final samples are selected, we plan to conduct multi-component adsorption studies with varying compositions of nitrogen, methane and carbon dioxide to aid in quantifying the amount of CO₂ or flue gas that may be sequestered and the amount of methane that may be recovered. We are also interested in the behavior of these gases under supercritical conditions during injection and flow through the coalbed system. To this end, we are identifying testing laboratories with the capabilities of performing the adsorption and flow tests under supercritical conditions, since we anticipate that, at the depths of interest, reservoir conditions would be beyond the critical pressures and temperatures for CO₂.

Potential Sites for Well Tests

Since permeability estimates are necessary to accurately model a coalbed reservoir, we need to perform well tests and to analyze the results of these tests. Our initial plan was to drill a few wells in key areas and perform pressure transient tests on these wells to obtain permeability values for various coal seams. However, following our data exchange agreement with Anadarko, we are in the process of identifying a possible well(s) where we may perform this test(s). Prerequisite for these wells is having a vertical section through the Hooper, Simsboro and Calvert Bluff coals of the Wilcox Group. Discussions are underway with Anadarko to assess possible target wells and the pre-test requirements, including cleaning up the wellbore and identifying service companies experienced in testing coalbed methane reservoirs.

Well Test Design

Since the mechanism of coal gas production is different from that of production from conventional gas wells due to the gas being adsorbed on the surface of the coal matrix, well test analysis in the presence of two-phase flow and the combined mechanisms of diffusion and gas flow in porous media becomes difficult. At the beginning, the fractures are saturated with water, but upon pressure decline, adsorbed gas is released from the coal matrix, becomes mobile and flows to the wellbore together with the water, resulting in two-phase flows which are difficult to analyze.

With this in mind, it would be more prudent to inject water into the coal formation and analyze the pressure falloff as opposed to withdrawing fluids from the formation, which may result in methane desorption and may complicate the analysis. Although there are many models for analyzing two-phase flow data from coalbeds, these models are not as satisfactory as pressure falloff tests or slug testing (injection) for determining permeability values.

Conducting test under two-phase flow conditions has other disadvantages. In particular, coal properties such as relative permeabilities and sorption isotherm properties must be known to analyze a test and this information may not always be available.

Slug testing does not have the multiphase flow disadvantages associated with pressure buildup testing in coalbeds. However, there are some drawbacks to this method of testing. The biggest disadvantage is the radius of investigation, which has been estimated to be about 100 times the wellbore radius, a distance that would not be effective in providing reasonably accurate values of permeability considering near-wellbore damage during drilling.

Overwhelmingly, the literature supports the use of pressure falloff tests to characterize coalbed permeability. Since we anticipate low values of permeability for the East Texas coals at the depths of interest, pressure falloff tests would require lesser time for testing as opposed to slug tests. However, it will be necessary to ensure that the maximum test pressure does not exceed around 60% of the fracture gradient to minimize the effects of pressure on the permeability results.

Presentations

We presented our findings at two meetings this quarter. In Baltimore, MD, we gave a presentation for the Third International Forum on Geologic Sequestration of CO₂ in Deep, Unmineable Coalseams on March 25-26, 2004. The presentation is on the web and available at www.coal-seq.com. Our findings also were featured in a poster session at the AAPG annual meeting in Dallas, April 18-21, 2004. The reference for that presentation (Ayers *et al.*, 2004) is included in the references at the end of this report.

CONCLUSIONS

1. Discussions are ongoing with Anadarko to obtain fresh, whole-core samples from the coals of interest to aid in better coal characterization.
2. Pure gas and multi-component adsorption isotherm analyses at supercritical conditions are planned for selected coal samples to simulate reservoir conditions with either CO₂ or flue gas injection.
3. We are in the process of identifying Anadarko wells that may be available for conducting pressure transient tests to determine permeability for the different coal seams.
4. An analysis of literature suggests that pressure falloff testing is the best technique to obtain reliable estimates of permeability.

REFERENCES

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Table 1: Data exchange following the agreement between Anadarko and Texas A&M University.

Data collected	Number of Reports
Adsorption data	Data from 7 wells
Desorption reports	Data from 4 wells
Gas composition analysis	Data from 1 well
Vitrinite reflectance data	Data from 1 well
Water sample analysis	Data from 1 well
Proximate Analysis	Data from 1 well