A Self-Teaching Expert System (SETES) for the Analysis, Design and Prediction of Gas Production From Unconventional Gas Resources

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Objectives

Using a multi-disciplinary approach, to develop a self-teaching expert system (SETES) that:

- Incorporates data (geological, geophysical, drilling, well completion, core, GIS, fracturing/well stimulation, reservoir and production [evolving]) from a continuously expanding database of installed wells in unconventional tight gas reservoirs (i.e., tight sands, shale or coal beds).
- Continuously updates the SETES database and refines the underlining decision-making metrics and process (baseline mode).
- Can make recommendations about formation fracturing/stimulation, well location, orientation, design, operation and management using the updated metrics and processes (predictive mode)
- Predicts the performance of proposed wells; estimates the corresponding uncertainties (predictive mode).
- Permits the analysis of data from installed wells for parameter estimation (optimization mode) and continuous data base expansion.

Deliverables

A self-teaching expert system, available as a Web application/computer program, that:

- Is centrally located on LBNL servers, and distributed over the web
- Can use both "public" (but protected) and "private" databases
- Protects the confidentiality of data in the "public" database
- Is used as a web application when only "public" databases are used
- Can be easily installed at the user's facilities, and executed as a computer program, when used with "private" databases
- Continuously updates the databases and refines the underlying decision-making metrics and process (baseline mode)
- In prediction mode, it enables the design of appropriate production systems, the operation and management of unconventional (tight) gas resources (UGR), and estimates uncertainties
- In optimization mode, it allows history matching and parameter identification from UGR data

Scientific publications, presentations, reports, etc.

Tasks

Task 1: Project Management Plan

Task 2: Technology Status Assessment

Task 3: Technology Transfer

Task 4: Development of Data Abstraction, Reduction and/or Compression (DARC) technologies

- Necessary to render the potentially massive data inputs manageable as inputs to the SETES for analysis and utilization
- Need to yield quantitative metrics that describe the dominant system characteristics and capture its attributes and behavior
- Differentiation of DARC technologies according to data types
  - Numerical models and Analytical/approximate flow models
  - Uncertainty analysis
  - Geology, geophysics, well logging, coupled
  - Geomechanics
  - Well stimulation

Task 5: Define functional capabilities and requirements of SETES

- Designing the concept of SETES
- What can (and cannot) accomplish?
- Type and form of outputs
- Starting point: developing the lowest order of component models

Task 6: Review and Analysis of the "Kernel" complete data set

- Complete data sets are provided by industrial partners
- Verification of "fuzzy" information (e.g.: Why was a particular operation performed? What are the dominant variables in a data stream?)
- Special attention to the element of retained human knowledge

Analysis of data by the various specialist teams

Only a portion of the data set will be used as a "kernel"

Current consensus: add a synthetic data set as the "zero kernel"

Task 7: Develop preliminary decision-making and soft-computing methodology of SETES

- Delineation of time scales and associated decision-making tasks
- Implementation of available info of any type at each scale
- Broad outline of info flow within each scale and between scales
- Identification of sources and nature of uncertainty and risk
- Decision-making paradigms suitable for each level (e.g., database look-up, feedback control)

Task 8: Partial validation of approach; Identification of Additional data and refinement requirements

- Use the remaining portion of the original data sets (not included in the "kernel") to validate the approach by testing predictions
- Identify needs for additional data requirements and further development/refinement
- Evaluation by each of the component teams

Task 9: Refinement of the DARC technologies

Task 10: Refine decision-making and soft-computing methodology

Task 11: Development and testing of operational framework and pre-prototype; release of alpha-version of SETES

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Overall Approach

The focus is on the integration of state-of-the-art knowledge from diverse fields and scientific disciplines, NOT on the development of new fundamental knowledge.

Potential Impact

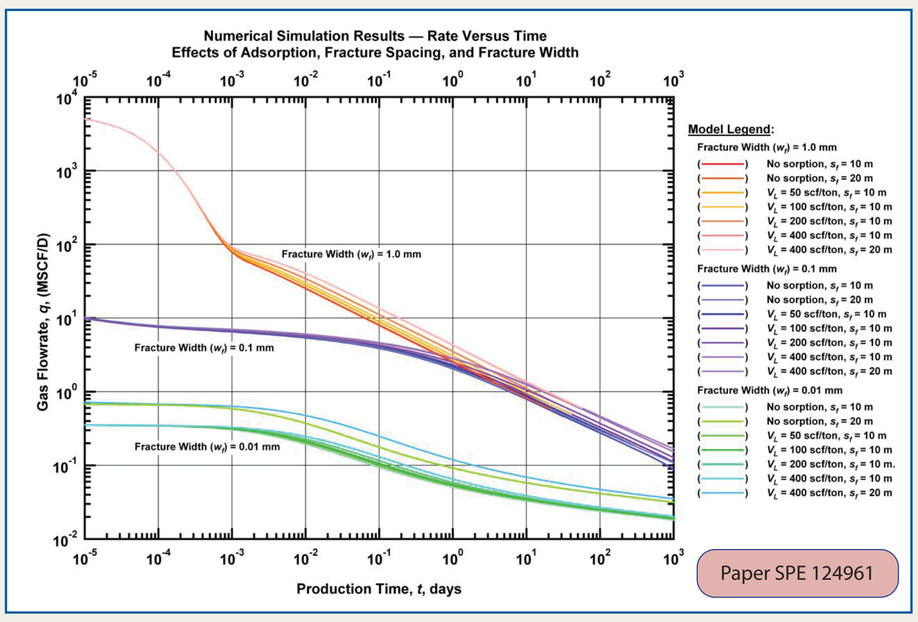
Successful development of the proposed SETES for the analysis, design, prediction and management of gas production from UGR is expected to result in a decision-making tool that can:

- Significantly reduce the considerable risks and uncertainties associated with production from UGR
- Allow the design of effective production systems, strategies and operations in undeveloped UGR
- Bring previously inaccessible energy resource to production
- Improve the performance and productivity of UGR already under production
- Increase reserves

Task 4

Flow Analysis

- Determination of similarities in gas flow in various UGR types: same processes, different characteristics and parameter values.
- Unified analysis, but distinctly different behavior and performance markers.
- Developed a methodology to analyze gas production from UGR.
- Used numerical simulation of production from fractured UGR systems that are described by very large 3D grids to develop simplified production curves that can be easily represented by parametric analysis: DARC technology for flow analysis and numerical simulation.



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Tasks 4 and 7

Estimation & Simulation of Reservoir Properties Using Well Logs, Geological Data, and Geophysical Attributes

- Establishes the basis for statistical analysis and parameter estimation in the description of the property distributions of inherently risky UGR systems
- Uses several hybrid approaches and tools:
  - Geostatistical techniques and machine learning approaches to guide estimation and simulation of reservoir properties
  - Pattern simulation techniques based on seismic attributes to produce plausible geological training images
  - Combined use of geological training images, conditions probabilities inferred from well logs, and rock physics models
  - Mathematical transforms to assess the spatial variability of properties and the propagation of uncertainty