EORI Screening & Scoping tools for Wyoming Oil Fields

Glen Murrell
EORI

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Contributors:

Vladimir Alvarado
Benjamin Cook
Carolyn Coolidge
Patrick Gardner
Andrew Kauppila
Diem Pham
Owen Phillips
Brian Reyes

Samiha El-Sayed
Savanna Sharp
Geoff Thyne
Klaas van ‘t Veld
Schaochang Wo
Peigui Yin
Xiufen Yu

http://eori.uwyo.edu
Today’s Agenda:

- Decision making
- EORI Database
- Screening
- Scoping
The EORI database, Screening and Scoping programs are components in a system of information management.

Database: 350 Mb data, multiple tables, in excess of 2000 Field Reservoir Combinations (FRC’s).

Accurately subdividing database into groups suitable for particular EORI applications is impossible to do with high degree of certainty (would require a simulation model of each reservoir).

Screening and scoping reduces uncertainty and dataset size.
Decision Making Under Uncertainty

- Cannot define outcome probability with any certainty because database is limited.
- Level of uncertainty (or risk) depends on number of potential “false positives” in dataset.
- Screening removes as many of these potential “false positives” as possible, thus reducing the uncertainty.
- More parameters are introduced (e.g. economics), adding uncertainty and then Scoping reduces this by again removing potential false positives.
Expected Monetary Value (EMV)

Implement EOR Project

Successful Project ($P_{SP}$)
\[ PO_{SP} \cdot P_{SP} \]

Unsuccessful Project ($P_{UP}$)
\[ PO_{UP} \cdot P_{UP} \]

Do Nothing
\[ X \]
Risk (Potential for reality to be something other than what is expected)

Precision (Reduction of predictive uncertainty)

Screen  Scope  Reservoir Characterization  Reservoir Simulation  Project Model
An MS Access database containing petrophysical and other data for all the field-reservoir combinations in Wyoming

Parameters included:

- Production related: Cumulative Prod., OOIP, decline rates, water cut
- Petrophysical: Poroperm, Field size, Net pay, Lithology, Depth, Temp., Fracture Pressure.
- Crude Chemistry: API, Viscosity, mwC5+, MMP, Sulfur content.
- Produced Water Chemistry: TDS, pH, Calcium, Chloride, Magnesium.
- Field information: locations, shape files, well counts.

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Components – EORI Database

- **Data sources**
  - Internal data acquisition – decline curve analysis, lab studies.
Data Processing
- Nomenclature standardization
- Data-cleaning
  - Sorting, relational queries, random checking
- Data Mining
  - Correlations, multi-component statistics.
- Data-infilling
  - Using correlations (e.g. Depth-Temp, API-Viscosity)
Data Infilling example (Viscosity vs. API)

Viscosity (cp) vs. API Correlation

\[ y = 46.283x^{-0.1878} \]

\[ R^2 = 0.9479 \]

Figure courtesy of Samiha El-Sayed.
Data from DOE/NETL Crude Oil Database

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Future Work

- Further Data Mining and Infilling
- Public release
Benchmark example: Taber et. al. 1997 Parts I & II
- SPE 35385 & 39234

Assess technical feasibility.

Multiple Criteria, dependant on EOR Method.

Varying levels of complexity.
- “Go/no-go” criteria
- “Fuzzy” criteria
- Neural networks

Represent application of global knowledge base.

May need to be tuned on a regional basis.
Criteria Selection

- Generally experience based and acquired from laboratory experiments and/or field case studies.
- Can contain bias arising from regional practices.

Figure courtesy of Samiha El-Sayed.
Data from Oil and Gas Journal 2008 EOR survey
Simple ‘go/no-go’ example: CO2Mac

- Single value criteria (Means, Medians)
Components – Screening

- Fuzzy logic Screening
  - Range based criteria (Max and Min)
  - Qualitative criteria
  - Commercial Example: SWORD

Image from SWORD, Pre simulation/screening tool for rapid IOR and reservoir evaluation Version 2.1.0.6. Copyright 2000-07 IRIS
www.iris.no
Components – Screening

- Wyoming work
  - Chemical Flooding Screening Strategy development
Components – Screening

- GIS Screening
  - Enables spatial analysis (e.g. resource proximity)

Figure courtesy of Brian Reyes
TOTAL DISSOLVED SOLIDS FOR CLASTIC RESERVOIRS IN THE NORTHERN POWDER RIVER BASIN, WYOMING

Legend
- Minnelusa Res. > 20,000 PPM TDS
- Reservoirs < 2,500 PPM TDS
- Streams
- Lakes
- Basins
- Yellowstone
- Counties

Reservoir Buffer Zone
Distance (km)
- 1
- 2
- 5
- 10

Cartographer: Brian Reyes
Company: Enhanced Oil Recovery Institute
Date: July 7, 2008
Date Source: http://www.netl.doe.gov/technologies/oil/gas/database.html
Projected Coordinate System:
NA Lambert Conformal Conic
Projection: Lambert Conformal Conic
Future Work

- Tuning the criteria for Wyoming.
- Criteria weighting system
- Identification of EOR potential groups
  - E.g. all those reservoirs amendable to CO2 flooding.
- Greater GIS utilization
Components – Scoping

- Economic Screening
- Introduces new variables
  - Cost and revenue based
- Single criteria (ROR)
- Require some method of estimating production
  - Production analogues, Compositional model
Production Analogue

- Classic example: Kinder Morgan model.
- Wyoming Analogue: Lost Soldier-Tensleep.
- Pro: Dimensionless curve integrates reservoir characteristics (Poro., Perm., etc).
- Con: Limited by availability.
Components – Scoping

- **Wyoming Scoping**
  - Identify profitable enhanced oil recovery (EOR) projects in the major Wyoming basins.
  - Estimate the profitability of a project.
  - Estimate demand for CO2 and incremental oil production in an EOR project.
  - Estimate cumulative demand for CO2 in a basin and for the State of Wyoming.
  - Incorporates two technical screening criteria (>5 MMBO Cum. Prod and MMP<Frac. Pres.)
Components – Scoping

\[ NPV = \sum_{t=1}^{T} \frac{PQ_t(1-x^R)(1-x^{SP}) - pq_t^p - c_t^r q_t^r - c_t^o}{(1+r)^t} - K \]

- \( P \): Price of Oil
- \( Q_t \): the projected incremental amount of oil recovered in period \( t \)
- \( x^R \): Royalties
- \( x^{SP} \): severance and property taxes
- \( pq_t^p \): cost of purchasing CO2
- \( c_t^r q_t^r \): cost of recycling and re-injecting CO2
- \( c_t^o \): other incremental operating costs
- \( K \): upfront investment costs

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Oil: $70 bbl
CO₂: $2.50 Mcf
ROR: 20%
Spac.: 80 A/W
Analog: LSTP
GIS Scoping
- Again, enables spatial variables to be incorporated
- Network modeling
  - Monte Carlo Simulation and/or Constrained Random Search
  - Sink and Source Clustering
  - Optimal transportation pathways
- Currently working with Wyoming Pipeline Authority on potential CO$_2$ Pipeline pathways.
Future Work

- Synthetic Dimensionless Curves
- Greater GIS utilization
Screening and Scoping Models are tools for **identifying prospects**. They should not be used to assess **categorically** the viability of **individual reservoirs**.
Summary

- The EORI database, Screening and Scoping programs are components in a system of information management designed to reduce risk.

- Database: 350 Mb data, multiple tables, in excess of 2000 Field Reservoir Combinations (FRC’s).

- Screening removes as many of potential “false positives” as possible, thus reducing the uncertainty.
  - Assess technical feasibility.
  - Multiple Criteria, dependant on EOR Method.
  - Represent application of global knowledge base.

- Scoping introduces parameters for economic screening.
  - Cost and revenue based
  - Single criteria (ROR)
  - Require some method of estimating production

http://eori.uwyo.edu
Lon Whitman
307 760 0577
LWhitma3@uwyo.edu

Glen Murrell
307 766 2843
gmurrell@uwyo.edu

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