An Intelligent Portfolio Management Approach to Gas Storage Field Deliverability Maintenance and Enhancement; Part One Database Development & Model Building

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Outline

- Introduction
- Objective
- Methodology & Software
- Results
- Conclusions
Introduction

Energy consumption by fuel

Source: Energy Information Administration (EIA)
Typical gas storage fields usually contain large number of wells.

Storage wells deliverability usually declines with time.

The decline may be attributed to many factors among which are:
- Gas supplies
- Well damage with time
Introduction

- Each year a limited budget is dedicated to remedial operations such as workovers, re-completions, restimulation, … to combat decline due to well damage.

- Not every well in the field responds to remedial operations in the same way.

- This is an optimization problem. Gaining the highest return with minimum risk.
Objective

To modify and apply the state-of-the-art intelligent, optimum portfolio management to the gas storage field using skin damage in order to optimize the return on investment associated with well remedial operations
Study Area

Our research partner in this research was Columbia Gas Transmission Corp.
Methodology

Wells Information → IGST → Neural Network → Well Test Analysis → Genetic Optimization
Software

Modify/Add Wells Information

Query wells for Information

Identification of Optimum Candidates for Remedial Operations
Software - Database

Gas Storage Field Database

Well-bore data
- API Number
- Field Name
- Well Number
- Latitude
- Longitude
- Section
- Township
- County
- State
- Operator
- Total Vertical Depth
- Formations

Completion data
- API Number
- Description of Casing
- Date Casing run
- OD
- Top
- Bottom
- Weight
- Grade

Stimulation data
- API Number
- Formation
- Stimulation Type
- Contractor
- Trade Name
- Top
- Bottom
- Pore Pressure
- Break down Pressure
- Avg. Treatment Pressure
- BH Rate
- Fluid Volume
- Proppant Type
- Proppant (lbs)
- Nitrogen
- ISIP

Perforation data
- API Number
- Completion Type
- Completion Date
- Perforation Top
- Perforation Bottom
- Shot Type
- Shot / ft

Well Test Data
- API Number
- Test Date
- Test Type
- Time 1
- Field Pr 1
- Flowing Pr 1
- Rate 1
- Time Extended
- Field Pr Extend
- Flowing Pr Extend
- Rate Extend
- n Value
- C Value
- kh
- Skin
- True Skin
- Non Darcy Co-efficient
- Delta P squared
- Peak Day Rate
- Absolute Open Flow
Software - Import a New Dataset

Fill the Excel Sheets
Software - Edit Add/Modify Existing Dataset

- Surf through wells in the database
- Option for modifying/adding new information
- Surf through selected category for each well (Wellbore, Completion, Perforation, Stimulation, Well Test, Reservoir Characteristics)
Software- Edit Add/Modify Existing Dataset
Software- Edit Add/Modify Existing Dataset
Software- Edit Add/Modify Existing Dataset
Software - Edit Add/Modify Existing Dataset

![Software Interface](image)

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<td>Stim To (ft)</td>
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Software - Edit Add/Modify Existing Dataset
Software - Edit Add/Modify Existing Dataset

![Image of software interface]

- Well Radius (ft): 1.5
- Porosity (%): 0.14
- Temperature (F): 75
- Specific Gravity of Gas: 0.585
- Reservoir Thickness (ft): 10
Software- Well Test Analysis
Software- Well Test Analysis

\[ AOF = C(p^2 - o^2)^n \]

\[ 10^8 \frac{kh}{1.632 \times 10^7 T} - \log \left( \frac{kt}{\phi \mu \kappa} \right) + 3.23 \]

\[ TDRate = (C \times 250,000)^n \]
Software - View Well Data

**Selected Well Data**

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Export to Excel
Software- Neural Network Results

Training Set

RSquare: 0.95334
Co.Coeff: 0.9767
Software - Neural Network Results

Calibration Set

RSquare: 0.69545
Co.Coeff: 0.94843
Software- Neural Network Results

Verification Set

- \( R^2 = 0.97884 \)
- \( \text{Co.Coeff} = 0.9976 \)
Software

Genetic Algorithm for optimization of Skin & cost

Working of Genetic Algorithm
Software- Candidate Selection
## Results

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</table>
Results

AVERAGE SKIN COMPARISON

Skin 100 - cost 0: -3.803
Skin 50 - cost 50: -5.059
Skin: -4.870

AVERAGE COST COMPARISON

Actual Cost:
- Skin 100 - cost 0: $386,841
- Skin 50 - cost 50: $22,132
- Skin 100 - cost 0: $796,086
- Skin 50 - cost 50: $22,132
Conclusions

- This is the first successful attempt to combine Data editing, Gas well-test analysis and Artificial Intelligence Tools in one software package.

- The Artificial Intelligence Tool can predict Skin with high confidence.

- The Portfolio Management for re-stimulation candidate well selection with the help of Intelligent Gas Storage Toolbox (IGST) can be very cost effective.