Flowing Bottomhole Pressure during Gas Lift in Unconventional Oil Wells

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INTRODUCTION

- Gas lift is an energy-efficient technology widely applied in oil wells to improve oil production.
- Flowing bottomhole pressure (FBHP) is one of the key parameters determining the operation’s success.
- The FBHP is commonly calculated using empirical correlations or mechanistic model, which are either oversimplified or computational consuming.
- Machine learning methods are successfully implemented for FBHP prediction.

OBJECTIVE

- This research aims to predict FBHP of unconventional oil wells under gas-lift operations using machine learning techniques.
  - Physics-Based ANN Model: based on fluid properties, well parameters, and production data. Data is generated from representative PVT and flow models.
  - Data-Based ANN Model: based on well depth and production data only. Data is derived from unconventional oil wells.

METHODS

- **FBHP Prediction Workflow**
  - Well consideration
  - PVT & flow model selection
  - ANN model development
  - Field dataset verification

- **ANN Model Development**
  - Physics-Based Model Inputs: gas/oil/water gravity, tubing diameter/roughness, well depth, wellhead temperature/pressure, temperature gradient, liquid flow rate, gas-liquid ratio, water-oil ratio.
  - Data-Based Model Inputs: well depth, liquid flow rate, gas-liquid ratio, water-oil ratio.

- **Physics-Based Model**
  - Representative PVT models: Lee, Gonzalez, and Eakin model ($\mu_g$) and Standing model (FVFoil and Rs).
  - Representative flow model: Hagedorn & Brown model with 11.8% normalized mean absolute error (NMAE).

- **Data-Based Model**

- **Physics- and Data-Based Model Comparison**
  - At early times, data-based model performs better in predicting FBHP of a new well with only 5.7% NMAE.
  - At later times, physics-based and data-based models provide similar predictions of FBHP.

RESULTS

- For entire gas lift period, both physics- and data-based model have strong performance with 10% NMAE.
  - For early time, data-based model performs better with 10.2% NMAE; for late time, physics-based model performs better with 8.0% NMAE.

CONCLUSIONS

- We developed ML models for predicting FBHP of unconventional wells under gas lift.
  - Physics-Based ANN Model
    - Inputs: fluid properties, well parameters, and production data
  - PVT Model: Lee, Gonzalez, and Eakin model and Standing model
  - Pipe Flow Model: Hagedorn and Brown model
  - Data-Based ANN Model
    - Inputs: well depth and production data
  - Field Data Validation
    - For entire gas lift period, both physics- and data-based model have strong performance with 10% NMAE.
  - For early time, data-based model performs better with 10.2% NMAE; for late time, physics-based model performs better with 8.0% NMAE.

REFERENCE


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