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Prediction of Dew Point Pressure of Gas Condensates Using Machine Learning Methods

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1. ABSTRACT

Accurate and timely prediction of dew point pressure (p-dew) in gas condensate reservoirs is crucial for fluid characterization, reservoir performance calculations, development planning, and optimization of production systems. This study investigates various intelligent modeling methods for predicting p-dew using a comprehensive dataset of 721 samples. The analysis shows that the Random Forest model outperformed others, achieving a mean absolute percentage error (MAPE) of 3.26% and an R^2 value of 0.84. These findings highlight the potential of machine learning techniques in enhancing prediction accuracy for gas condensate properties.

Keywords: Gas condensates, data mining, dew point pressure, artificial intelligence models

2. INTRODUCTION

The accurate characterization of reservoir fluids, particularly pressure-volume-temperature (PVT) data, is essential for engineering calculations such as reserve estimation and enhanced oil recovery planning. Gas condensate reservoirs exhibit two dew point pressures; the upper dew point, known as retrograde dew point, is critical for reservoir management. This study focuses on predicting the upper dew point pressure [1,2].

3. MATERIALS AND METHODS

3.1. Modeling theory

Artificial Various modeling approaches were employed, including:

- Linear Regression: Models linear relationships but can struggle with outliers.
- Lasso Regression: A regularized linear model that performs feature selection.
- Ridge Regression: Another regularized approach that prevents overfitting.
- Elastic Net: Combines Lasso and Ridge penalties.
- Artificial Neural Networks (ANN): Mimics human brain structures for complex relationships.
- Decision Trees: Non-linear models that partition data based on features.
- Random Forest: An ensemble of decision trees that enhances accuracy and reduces overfitting.

3.3. Data Collection

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A comprehensive review yielded 721 dew point pressure samples from 22 studies spanning several decades. Data cleaning resulted in 701 usable samples.

3.4 Model Construction

Eight machine learning algorithms were systematically applied to predict dew point pressure. Models were trained and validated using an 80-20 split of the data.

3.5 Model Evaluation

Performance metrics included:

- R^2 (Coefficient of Determination): Indicates how well the model explains the variability of the data.
- Mean Absolute Percentage Error (MAPE): Measures prediction accuracy.
- Mean Squared Error (MSE): Emphasizes larger errors.

4. RESULTS AND DISCUSSION

The results of the various models are summarized in Table 1. Random Forest and Decision Tree models showed superior performance, with Random Forest achieving the lowest MAPE of 3.3%.

Table 1. The statistical evaluation of the proposed models

MSE	R^2	MAPE (%)	Model
664319	0.75	12.5	**Linear Regression**
662896	0.75	12.5	**Lasso Regression**
662896	0.75	12.5	**Ridge Regression**
793398	0.75	12.4	**Elastic Net**
490222	0.82	11.4	**ANN**
532585	0.8	6.8	**K-Nearest Neighbors**
792494	0.7	3.5	**Decision Tree**
419511	0.84	3.26	**Random Forest**

5. CONCLUSION

The Random Forest model demonstrated the best predictive performance for dew point pressure in gas condensate reservoirs, highlighting its robustness in handling complex data relationships. Future studies should consider integrating more diverse datasets and exploring advanced ensemble methods.

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