



Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

journal homepage: www.elsevier.com/locate/pce

Forecasting the bottom hole closed pressure using time series analysis paradigms. A case study of the Mishrif reservoir at West Qurna oilfield, southern Iraq

Mustafa A. Abdulhasan, Amna M. Handhal, Alaa M. Al-Abadi^{*}

Department of Geology, College of Science, University of Basrah, Basrah, Iraq

ARTICLE INFO

Keywords:

ARIMA
Machine learning
Time series
Mishrif formation
Iraq

ABSTRACT

This study seeks to establish a reliable forecasting framework for Bottom-Hole Close Pressure (BHCP) in the Mishrif Formation of the West Qurna-1 oilfield, southern Iraq, through a comparative analysis of six time-series and machine learning models evaluated under realistic operational conditions. Monthly BHCP, production, and injection data spanning a 12-year period were analyzed using a combination of classical time-series models—including Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), and Seasonal ARIMA with Exogenous Variables (SARIMAX)—alongside advanced machine learning techniques, specifically Long Short-Term Memory (LSTM) neural networks and Extreme Gradient Boosting (XGBoost). Model performance was assessed using root mean square error (RMSE) and mean absolute error (MAE). The LSTM achieved the best predictive performance, followed closely by Holt–Winters and SARIMA. Although SARIMAX produced slightly higher errors, it offered superior interpretability by explicitly modeling BHCP as a function of injection and production rates. In contrast, XGBoost overfitted severely, producing excellent training accuracy but poor generalization. Using the best-performing models (LSTM and SARIMAX), BHCP forecasts were generated under three different operational conditions. Scenario forecasting from 2022 to 2030 showed that increasing production by 40–80 % leads to a progressive pressure decline, whereas increasing injection by 40–80 % results in measurable pressure recovery. Under constant operational conditions, SARIMAX predicts a stable BHCP trajectory fluctuating around 2700–2800 psi. These findings demonstrate that reservoir pressure in the Mishrif Formation is highly sensitive to the production–injection balance and underscore the effectiveness of SARIMAX as a robust forecasting tool for reservoir-management decision-making.

1. Introduction

Bottom hole closed pressure (BHCP), also known as shut-in bottom-hole pressure (SIBHP), is a fundamental parameter in reservoir engineering that plays a critical role in reservoir performance, fluid dynamics, and recovery efficiency (Alasiri et al., 2023). BHCP is measured when a well is shut in long enough for the pressure at the bottom of the well to stabilize, thereby reflecting the reservoir's static pressure at that point. This measurement serves as a primary indicator of reservoir energy and is vital for understanding the pressure distribution within the reservoir. By monitoring BHCP over time, geologists and engineers can evaluate reservoir depletion rates, identify pressure maintenance needs, and optimize production strategies to maximize recovery (Ahmed,

2018). A declining BHCP may signal reservoir pressure depletion, necessitating secondary or enhanced recovery methods, such as water or gas injection, to sustain production (Dake and Ershaghi, 1995). Thus, BHCP serves as a fundamental metric for reservoir health and long-term productivity.

Moreover, BHCP plays a vital role in well testing and reservoir characterization. Pressure transient analysis (PTA) relies on BHCP data to estimate reservoir properties, including permeability, skin factor, and boundary effects, which are crucial for reservoir simulation and forecasting (Earlougher, 1977, 2003). Accurate BHCP measurements enable the calibration of reservoir models, improving predictions of future performance and optimizing field development plans. Furthermore, BHCP is critical for establishing the bubble point pressure in oil

^{*} Corresponding author.

E-mail addresses: mustafa.almaliky@hotmail.com (M.A. Abdulhasan), amna.handhal@uobasrah.edu.iq (A.M. Handhal), alaa.atiaa@uobasrah.edu.iq (A.M. Al-Abadi).

<https://doi.org/10.1016/j.pce.2026.104283>

Received 20 August 2025; Received in revised form 6 December 2025; Accepted 8 January 2026

Available online 9 January 2026

1474-7065/© 2026 Elsevier Ltd. All rights are reserved, including those for text and data mining, AI training, and similar technologies.