

Extended Abstract

Prediction of Sand Production-Prone Zones and Determination of Critical Drawdown Pressure Using a One-Dimensional Geomechanical Model in the Asmari Formation

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Keywords

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Abstract

Sand production is a core challenge in oil and gas, occurring when sand accompanies oil and water production, damaging equipment and reducing well productivity. To mitigate sand production, building a geomechanical model of the formation is essential. This study evaluates sand production potential in the Asmari Formation using a 1D geomechanical model. To accurately determine rock geomechanical parameters, Techlog, along with well logs and core data, was used. After finalizing the geomechanical model and validating it with laboratory results, the proelastic method predicted effective zones, calculated the critical drawdown pressure (CDDP), and forecasted the onset time for sand production. The impact of different completion types on the CDDP was also examined. Results indicate that a perforated completion best mitigates sand production and can serve as a control strategy to reduce its potential. Findings show a high likelihood of sand production at 2357 meters depth, since CDDP is negative, signaling a strong rock-failure potential at this depth. A sensitivity analysis considered ranges of UCS, sand grain size, wellbore diameter, azimuth angle, well deviation, and perforation angle and diameter. These parameters are critical for real-time decisions on control techniques. The study focused on geomechanical sensitivity; hydromechanical fluid parameters were not included in the modeling, and the software used cannot define fluid behavior. By centering on the Asmari Formation and using a calibrated one-dimensional geomechanical model with actual lab data, the work offers a new perspective for more accurate sand production predictions in similar reservoirs. Precisely identifying critical sand-production zones at 2357 meters, based on the overlap of geomechanical data and predicted CDDP helps delineate high-risk regions for optimal completion design. Additionally, sand production behavior in vertical, deviated, and horizontal wells was analyzed and compared for perforated versus open-hole cases, to assess how well type influences formation stability and overall sand-risk.

1. Introduction

Sand production is a major challenge in weakly consolidated sandstone reservoirs, causing wellbore instability, equipment erosion, and production losses [1]. Geomechanical modeling is widely used to estimate rock failure and Critical Drawdown Pressure (CDDP) for identifying sand-prone intervals. Previous studies developed one-dimensional geomechanical models to evaluate

in-situ stresses demonstrated the effectiveness of CDDP for predicting sand production [2], and showed that perforated completion provides greater wellbore stability than open-hole completion in the Asmari Formation [3]. Therefore, this study develops a calibrated one-dimensional geomechanical model to predict sand production and optimize well completion design.

2. Methodology

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A one-dimensional geomechanical model of the Asmari Formation was developed using well log data, laboratory core measurements, and reservoir information in Techlog software. Dynamic elastic properties obtained from density and sonic logs were converted into static rock mechanical parameters through calibrated empirical correlations. The model was validated using laboratory measurements of Young's modulus, Poisson's ratio, and Unconfined Compressive Strength (UCS). The Critical Drawdown Pressure (CDDP) was calculated using the poroelastic model combined with the Mohr–Coulomb failure criterion:

$$CDDP = \frac{1}{1-a} [2P_R - (3\sigma_{\max} - \sigma_{\min} - U)] \quad (1)$$

where CDDP is the critical drawdown pressure, P_R is the reservoir pressure, a is Biot's coefficient, $\sigma_{\max}$ and $\sigma_{\min}$ are the maximum and minimum principal stresses, and U is the rock strength parameter.

After calibration, pore pressure, overburden stress, and horizontal stresses were estimated to construct the geomechanical model. The calculated CDDP was used to identify sand-prone intervals. Finally, sensitivity analysis was performed by varying key parameters, including UCS, wellbore diameter, well inclination, well azimuth, sand grain size, and perforation geometry, to evaluate their effects on sand production under perforated and open-hole completion scenarios.

3. Results and Conclusions

The results indicate that the perforated interval at 2357 m has the highest sand production potential, where negative CDDP values indicate rock failure. As shown in Fig. 2, a reservoir pressure of 3100 psi with bottom-hole flowing pressures of 3100, 2500, and 850 psi demonstrates that BHFP is a key factor controlling sand production, with 850 psi representing the critical condition for the onset of sanding. Compared with the open-hole configuration, the perforated completion provides significantly greater wellbore stability and reduces the risk of sand production. Therefore, optimizing well completion and maintaining BHFP above the critical limit are essential for minimizing sand production and improving production performance. Therefore, optimizing well completion and maintaining the bottom-hole flowing pressure above the critical limit are essential for minimizing sand production and

improving production performance.

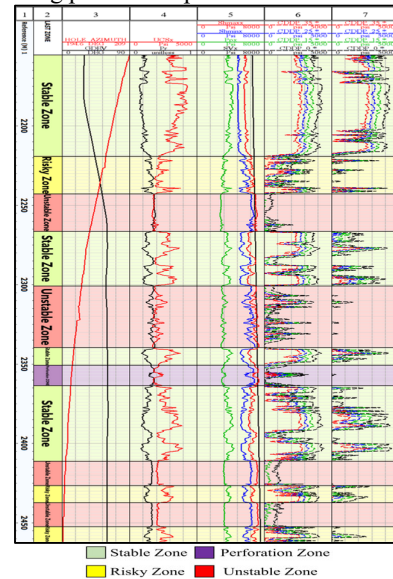


Fig.1. Effect of reservoir pressure depletion on the CDDP along the wellbore for depletion levels of 0%, 15%, 25%, and 35%.

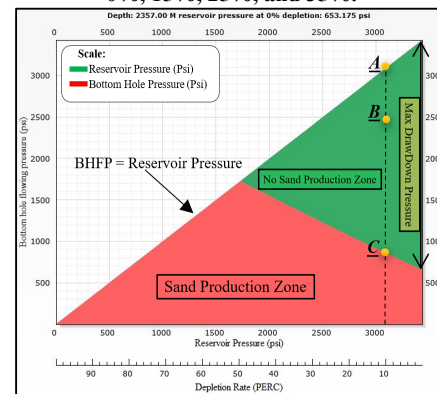


Fig.2. CDDP profile for the perforated well at a depth of 2357 m.

5. References

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