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Optimization of Gas Lift Operation Method and Production Enhancement Using a Reservoir–Well Model

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ABSTRACT

The primary objective of oil and gas operators is to minimize both capital and operating expenditures while maximizing cumulative oil production from the field in a safe and cost-effective manner. Achieving this objective requires a holistic and systematic approach to production optimization, encompassing the entire production system from reservoir and wellbore conditions to surface facilities. In many mature or energy-depleted reservoirs, natural reservoir drive is insufficient to sustain economic production rates, necessitating the implementation of artificial lift systems to enhance performance. Among the available artificial lift techniques, gas lift is widely applied due to its operational flexibility and suitability for a broad range of well conditions. However, effective utilization of gas lift requires careful optimization, as improper gas injection rates can lead to suboptimal performance. Beyond a certain threshold, increasing the injected gas rate may result in diminished liquid production due to flow instability, increased gas interference or reduced drawdown efficiency. This study aims to identify the optimal gas injection rate for gas-lifted wells by analysing the relationship between injected gas volume and oil production performance. The results of this work provide insights into gas lift optimization and support improved production efficiency, reduced operating costs and enhanced field-wide recovery.

Keywords: Oil and gas operators; Injected gas rate; Economic production rates

Introduction

Energy is required to lift reservoir fluids from the formation to the surface facilities. During the initial stages of field development, many oil wells can produce under natural flow conditions and are therefore classified as flowing or naturally flowing wells. In such wells, sufficient energy is available within the reservoir system to enable produced fluids to reach the surface without external assistance. This energy is primarily provided by reservoir pressure and solution gas drive[1,2].

As production progresses, reservoir pressure gradually declines and the available energy may become insufficient to sustain natural flow or to achieve the desired production targets. In addition, operational or economic objectives may require production rates that exceed the natural deliverability of the well. Under these conditions, the application of artificial lift systems becomes necessary to maintain or enhance production performance and to meet target production rates[3,4].

Gas lift is one of the most widely used artificial lift methods and operates by injecting external gas into the production system, typically through the annulus surrounding the tubing string. The primary objective of gas lift is to increase liquid production by assisting the upward flow of reservoir fluids. Compressed gas is injected into the well annulus and enters the tubing through multiple entry points known as gas lift valves, which are installed at predetermined depths along the tubing string[5-7].

As injected gas enters the tubing at various depths, it forms gas bubbles that mix with the produced fluids, thereby reducing the average density of the fluid column. This reduction in fluid density decreases the hydrostatic pressure gradient and lowers the bottomhole flowing pressure. As a result, the driving force for flow from the reservoir to the wellbore is increased, leading to higher flow velocities and improved production rates **(Figure 1)**.

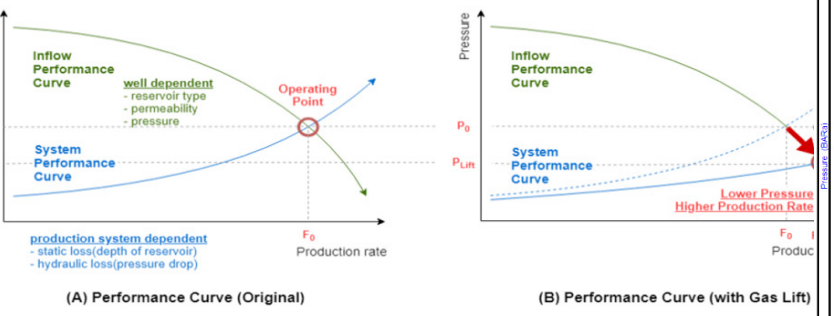

Figure 1: Production performance curve without gas lift and with gas lift.

This figure illustrates how gas lift gas injections increase the production rate based on nodal analysis.

Experimental Section

This paper describes the effect of hydraulic fracturing on well productivity using a real well example. The study was conducted using the Prosper simulation model. The well model was based on well Gun_287, which is located in the Shallow Water Gunashli field. The project evaluates the performance of oil and gas production under base conditions with a constant gas lift injection rate. In addition, the impact of different gas lift injection rates on determining the optimal production rate of the well was analyzed.

The well is slightly deviated. The main objective was to perform a sensitivity analysis based on a reservoir–well model in order to determine the optimal continuous gas lift injection rate for a given well. This sensitivity analysis was carried out using nodal analysis. To build the reservoir–well model, the following PVT and reservoir data were required **(Figures 2-4)**.

The PVT parameters of the well are presented below:

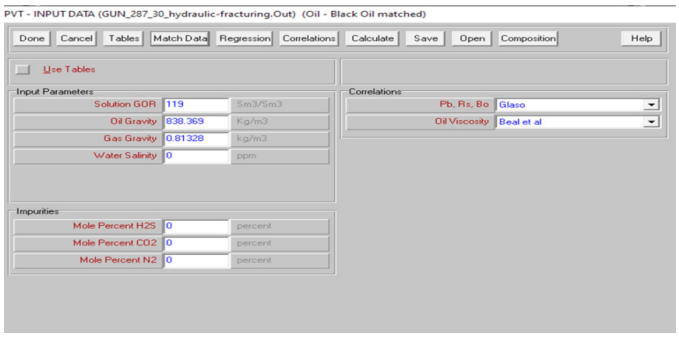

Figure 2: PVT parameters for the well model.

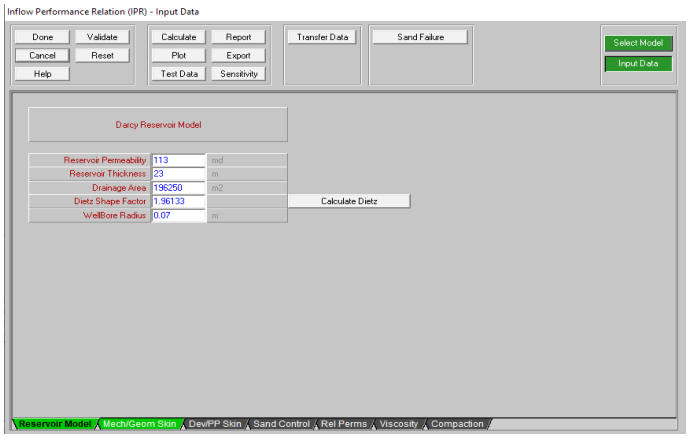

Figure 3: Reservoir parameters.

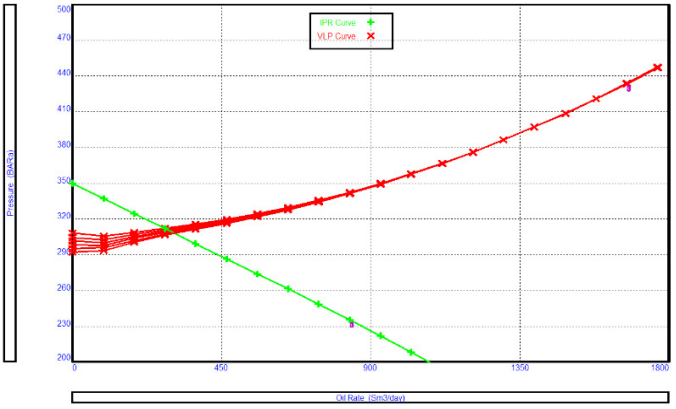

Figure 4: Nodal analysis at different gas lift injection rates.

The current daily oil production rate of well Gun_287 is approximately 230 m³/day under existing operating conditions. In this study, the impact of varying gas lift injection rates on oil production performance was systematically evaluated. The results indicate a clear positive correlation between injected gas volume and oil production within the operating range analysed.

At a gas lift injection rate of 5,000 m³/day, the oil production rate increases to approximately 265 m³/day, representing a notable improvement over the base-case scenario. Further increasing the gas lift injection rate to 12,000 m³/day results in an oil production rate of approximately 310 m³/day, demonstrating the effectiveness of gas lift in enhancing well productivity.

These findings confirm that under conditions of declining reservoir energy, gas lift serves as an efficient and economically viable artificial lift method for well Gun_287. As reservoir pressure continues to decrease, reliance on gas lift is expected to increase, making it the preferred solution to sustain and optimize production from this well.

Conclusion

The gas lift method is applied to reduce the hydrostatic pressure gradient of the fluid column within the well by injecting gas from an external source, thereby increasing drawdown and enhancing fluid inflow from the reservoir. To maximize oil production and achieve optimum economic performance, the efficient and optimal allocation of lift gas is of critical importance.

The analysis presented above clearly demonstrates that the application of gas lift results in a significant increase in oil production compared to the base-case scenario. In cases where the natural energy of the reservoir is depleted, gas lift represents an effective and technically viable artificial lift solution for improving production performance in well Gun_287. Simulation results indicate that injecting lift gas at a rate of 12,000 m^3/day increases daily oil production from approximately 230 m^3/day to 310 m^3/day.

Nevertheless, prior to implementing the gas lift system, a comprehensive economic evaluation should be conducted. This assessment should account for gas availability, compression and operating costs, incremental oil production and overall project economics to ensure that the proposed gas lift operation is both technically justified and economically feasible.

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