

# OPTIMIZING HORIZONTAL WELL PUMPING AND BHA DESIGN TO REDUCE BOTTOMHOLE FLOWING PRESSURE

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## INTRODUCTION

Artificial lift optimization in horizontal wells presents unique challenges due to gas interference, stratified multiphase flow, and mechanical limitations associated with rod lift systems in deviated wellbores. As reservoir pressure declines below bubble point, free gas evolves in the lateral section, creating stratified flow regimes where liquid occupies the lower portion of the wellbore and gas segregates above.

Rod lift systems in the vertical sections are effective at reducing bottomhole pressure (BHP) when operating under single-phase or low gas fraction conditions. However, performance degrades significantly when free gas reaches the pump intake, leading to reduced pump fillage, lower volumetric efficiency, and in severe cases, gas locking. Because rod pumps are typically set in the vertical or tangent section due to mechanical constraints, intake placement becomes a critical factor influencing system performance. This paper presents a field case study demonstrating the impact of insert pump placement on production performance, followed by the development of a conceptual bottomhole assembly (BHA) designed to improve gas separation, mitigate liquid fallback, and enable deeper drawdown in horizontal wells.

## FIELD BACKGROUND

The subject well is a marginal horizontal well located in Cochran County, Texas, operated by A.C.T. Operating Company. The well includes approximately 200 ft of tangent section above the lateral.

The well was originally completed with an electric submersible pump (ESP) and later converted to rod lift to reduce operating costs. A conservative design approach was used during conversion, placing the insert pump in the vertical section to minimize rod wear and tubing damage.

Under this configuration, the well produced:

- ~358 BFPD
- ~2% oil cut

While mechanically stable, this configuration limited drawdown and allowed significant gas interference at the pump intake, constraining production performance.

## FIELD OPTIMIZATION AND RESULTS

A targeted optimization was implemented by repositioning the insert pump deeper into the tangent section. Additional modifications included:

- Installation of a gas separator at the intake (set in the tangent)

- Addition of rod guides to reduce rod-on-tubing wear
- Landing tubing just above the lateral

Following these changes:

- Fluid production increased from ~358 to ~560 BFPD
- Oil cut nearly doubled

These results demonstrate that intake placement within the deviated section significantly impacts production performance. Positioning the intake closer to the liquid source and improving gas handling increased drawdown and improved pump efficiency.

### GAS SEPARATION IN HORIZONTAL WELLS

Gas-liquid separation in horizontal wells is strongly dependent on flow regime. As reservoir pressure declines below bubble point, stratified flow becomes dominant in horizontal and near-horizontal sections. Under these conditions, effective separation occurs when the intake remains fully submerged in the liquid phase.

Previous experimental studies of lateral gas separation tools have demonstrated that gas separation efficiencies of 90-100% are achievable under stratified flow conditions<sup>12</sup>. Performance is maximized in horizontal or toe-up geometries, and a critical superficial gas velocity exists above which separation efficiency declines<sup>1</sup>. Wave disruption and tortuous flow paths have also been shown to enhance phase separation efficiency<sup>2</sup>. These findings support the placement of gas separation devices within the lateral section, where stratification is most pronounced and separation efficiency can be maximized.

### PROPOSED BHA DESIGN

The proposed bottomhole assembly is shown in Figure 1.

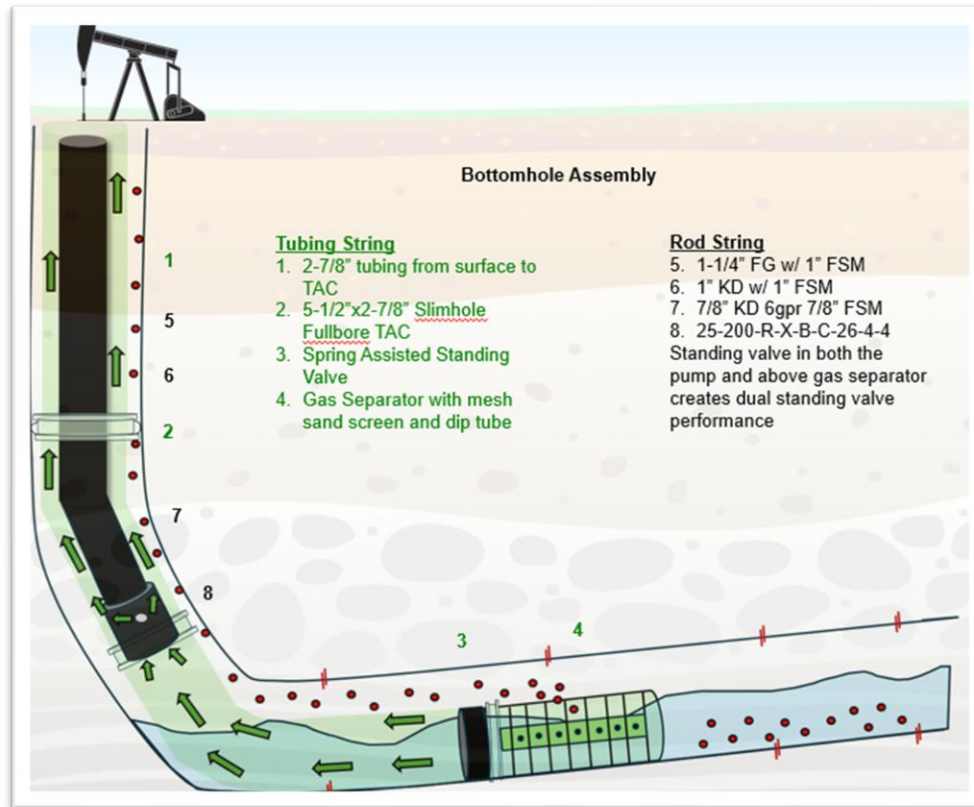


Figure 1 - Bottomhole Assembly with Lateral Gas Separator and Dual Standing Valve Configuration

To build on field results, a modified bottomhole assembly is proposed that extends intake functionality into the horizontal lateral. The proposed configuration includes:

- Insert pump set in the deepest feasible vertical or tangent section
- Tailpipe extending into the lateral
- Lateral gas separator positioned in the horizontal section
- Spring-assisted standing valve located above the separator
- Internal dip tube with intake holes distributed over approximately 120° along the bottom of the pipe
- A blank section below the dip tube intake to promote a quiescent separation zone

The separator design promotes gas-liquid segregation through flow deceleration, wave breakage, and a tortuous flow path. The downward-oriented dip tube intake ensures preferential entry of liquid from the lower portion of the wellbore, minimizing gas ingestion.

### LIQUID FALLBACK AND FLOW STABILITY

A key limitation of conventional gas separation systems is liquid fallback during pump cycles. When upward velocity decreases during the downstroke, gravity can cause separated liquid to reverse direction and fall back into the separator, reducing pump fillage and overall efficiency.

To address this, a spring-assisted standing valve is positioned above the separator to prevent reverse flow. This configuration:

- Maintains a continuous liquid column above the separator
- Prevents loss of fluid momentum during transient conditions
- Stabilizes pump intake conditions

Additionally, the reduced diameter of the dip tube increases fluid velocity relative to the surrounding annulus, helping sustain upward transport and further reducing fallback potential.

### PRODUCTION POTENTIAL AND INFLOW PERFORMANCE

The inflow performance relationship is shown in Figure 2.

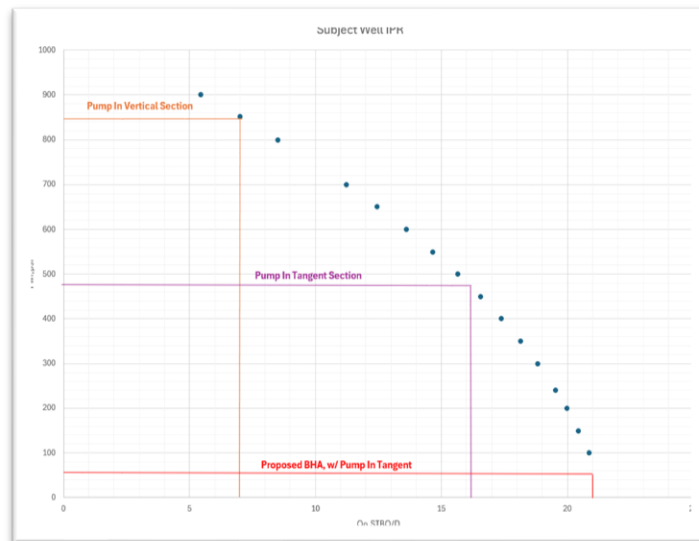


Figure 2 - IPR A.C.T. Operating Horizontal Well

An inflow performance relationship (IPR) was developed using established correlations for solution-gas drive reservoirs<sup>34</sup>.

Analysis indicates:

- Maximum oil rate ~21-22 BOPD
- At ~50 psi BHP equals 20 BOPD

This represents an incremental production gain of approximately +6 BOPD compared to current conditions, demonstrating the potential benefit of improved drawdown through enhanced gas separation and flow stability.

### CONCLUSIONS

1. Insert pump placement in horizontal wells is a critical production variable.
2. Deeper intake placement significantly improved production performance.
3. Lateral gas separation is effective under stratified flow conditions<sup>12</sup>.
4. Liquid fallback is a key limitation in conventional systems.
5. A dual standing valve configuration is proposed to mitigate fallback and stabilize flow.
6. Modeling indicates potential incremental production gains of approximately 6 BOPD.

7. Further validation through laboratory and field testing is recommended.

#### REFERENCES

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2. Karmon, I. 2019. *Quantifying Horizontal Well Gas Anchor Performance*
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