

# **SURFACTANT-ASSISTED FRAC-HIT PRODUCTION RECOVERY IN GAS-LIFT WELLS**

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## **ABSTRACT**

Frac hits in unconventional developments often cause persistent liquid loading, increased flowing pressures, and reduced lift efficiency in offset gas-lift wells. These effects are largely driven by trapped frac fluids, elevated water saturation, and unstable multiphase flow, all of which delay production recovery. This paper evaluates the use of targeted surfactant treatments to accelerate post-frac-hit cleanup and restore gas-lift performance.

Laboratory screening—including foam height, foam break test, and emulsion tendency test on fluid samples collected from candidate wells. The results confirmed the efficacy of the surfactant and showed no adverse effects on oil emulsion or water quality. The surfactant was then tested for compatibility with the combination corrosion/scale inhibitor to verify no adverse effects. Field applications in impacted gas-lift wells showed improved unloading, lower flowing bottomhole pressures, and faster stabilization compared to conventional lift optimization alone. Several wells achieved earlier return to pre-hit production trends and incremental oil uplift.

Results demonstrate that surfactant-assisted recovery provides a low-cost, low-intervention method to mitigate frac-hit impacts and enhance gas-lift effectiveness in tightly spaced unconventional developments.

## **1 INTRODUCTION**

Fracture-driven communication, commonly referred to as frac hits, has become increasingly prevalent in infill shale developments and often results in sustained degradation of gas-lift performance in offset producers (1). These events introduce frac fluids and water into producing wells, increasing liquid holdup, elevating hydrostatic head, and shifting multiphase flow toward intermittent behavior. The resulting pressure increase and instability reduce gas-lift efficiency and lead to persistent oil-rate losses that are not always recoverable through conventional lift optimization.

## **2 BACKGROUND AND PRIOR WORK**

Continuous gas lift improves well productivity by reducing the effective density of the produced fluid column through injection of gas into the tubing, thereby lowering flowing

pressure and increasing drawdown (2). The effectiveness of gas lift is strongly influenced by multiphase flow behavior in the tubing, particularly under high liquid-rate conditions. Increases in liquid holdup and liquid fallback can shift the prevailing flow regime toward slug or churn flow, resulting in elevated hydrostatic head, increased pressure losses, and reduced lift efficiency (3).

Pressure diagnostics are commonly used to evaluate gas lift performance and system response. When available, bottomhole pressure measurements provide a direct indication of drawdown and changes in tubing hydrostatic head. In the absence of downhole gauges, casing pressure is frequently used as a surface-based diagnostic to assess gas injection requirements, valve operating conditions, and overall gas lift system efficiency (2).

Surfactants and other chemical aids have been investigated as tools to influence multiphase flow behavior by reducing surface tension, modifying liquid holdup, and improving flow stability in liquid-loaded wells. Laboratory and field studies have demonstrated that surfactants can alter flow regime transitions, reduce liquid loading tendencies, and improve gas transport efficiency under high water-cut conditions (4). More recent work on Surfactant Assisted Gas Lift (SAGL) has shown that surfactants injected in conjunction with lift gas can directly impact tubing-side multiphase flow behavior by reducing liquid holdup and slip, resulting in improved gas lift efficiency and stabilized flow in high-liquid-rate systems (5). While SAGL has been studied previously, published field data specifically addressing frac-hit remediation in continuous gas lift wells remain limited.

### 3 FIELD AND WELL DESCRIPTION

The field trial was conducted on three horizontal producing wells located in the Permian Basin, within the Midland Basin shale development. All wells were producing under continuous gas lift at the time of the study, with lift gas injected through the casing–tubing annulus to operating gas lift valves.

The wells were similarly configured from an artificial lift standpoint, and no changes were made to lift gas rates, choke settings, or surface facilities during the evaluation period. Instrumentation differed across the wells: one well was equipped with a bottomhole pressure gauge, while the other two wells were monitored using surface casing pressure. This configuration reflects typical field conditions and enabled evaluation of surfactant performance using both downhole and surface-based pressure indicators.

Table 1: Summary of Trial Wells

Well	Lift Type	Pressure Evaluation	Injection Gas	Surface Facilities
A	Continuous	BHP	Unchanged	Unchanged
B	Continuous	CP	Unchanged	Unchanged
C	Continuous	CP	Unchanged	Unchanged

#### 4 FRAC-HIT EVENTS AND PRODUCTION DEGRADATION

The trial wells experienced frac-hit events during nearby hydraulic fracturing operations on offset wells. In each case, the frac-hit resulted in an immediate degradation of gas-lift performance and oil production. Following the frac hits, oil rates declined sharply, gas rates decreased or became erratic, and water production increased or became unstable. These responses indicate significant degradation of continuous gas lift performance rather than short-lived transient effects. During the post-frac, pre-treatment period, limited natural recovery was observed. Oil production remained well below pre-frac levels and gas lift was unable to unload accumulated liquids. Figures 1A-1C show the pre-treatment oil, gas, and water production histories for the three trial wells.

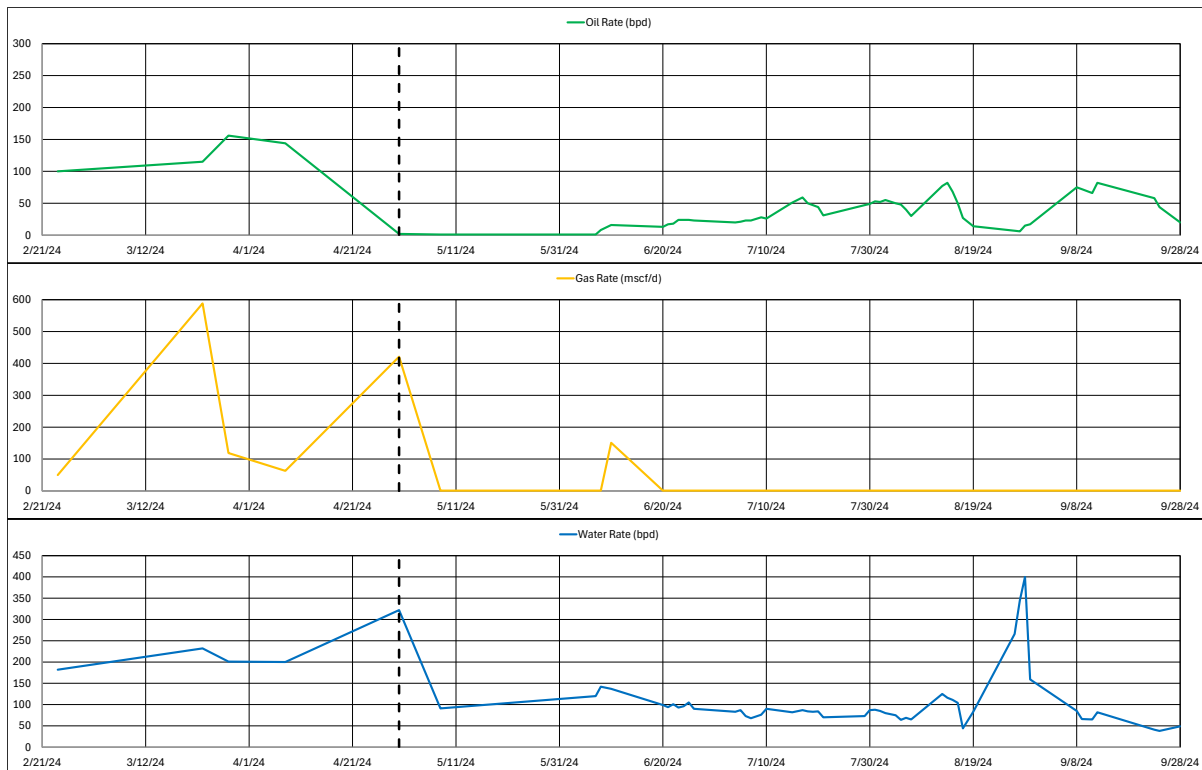
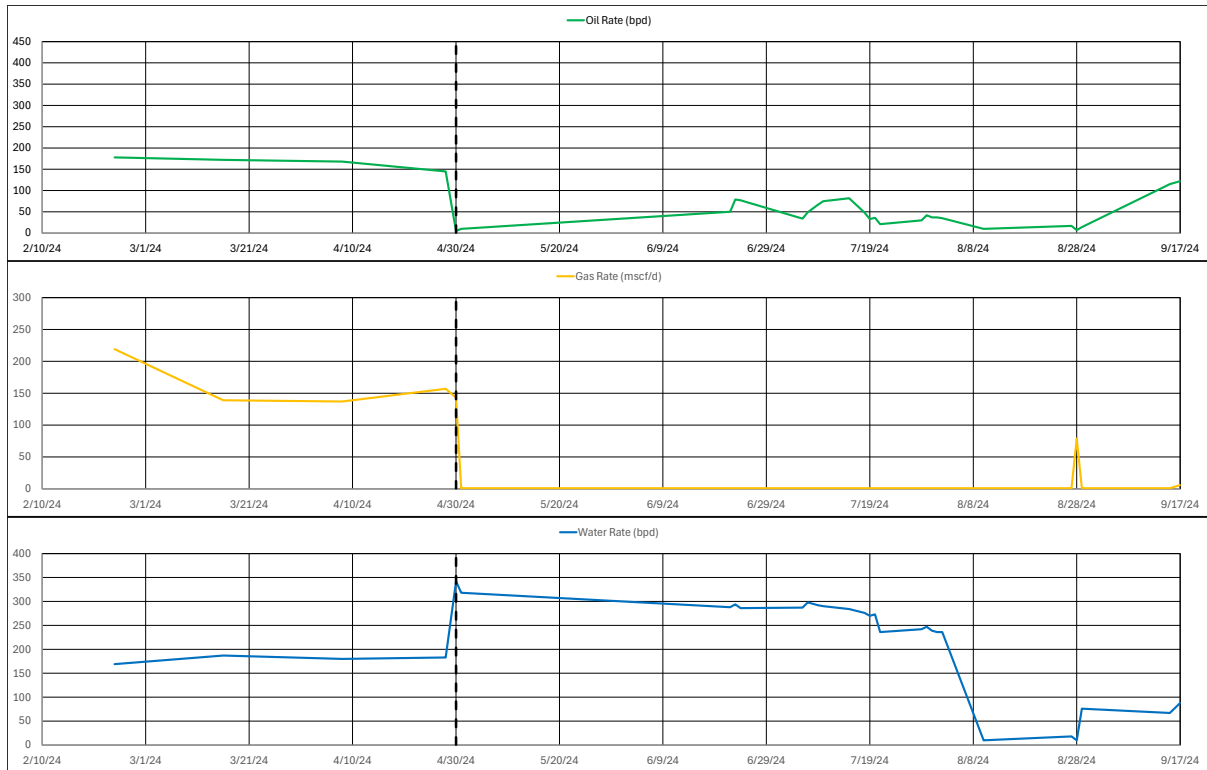


Figure 1A: Well A - Oil, gas, and water production rates versus time prior to surfactant application with the vertical dashed-line indicating the frac-hit event.



*Figure 1B: Well B - Oil, gas, and water production rates versus time prior to surfactant application with the vertical dashed-line indicating the frac-hit event.*



Figure 1C: Well C - Oil, gas, and water production rates versus time prior to surfactant application with the vertical dashed-line indicating the frac-hit event.

## 5 SURFACTANT APPLICATION AND EVALUATION METHODOLOGY

### 5.1 Field Application Method

Surfactant in conjunction with a combination corrosion and scale inhibitor was continuously injected with the lift gas into the casing–tubing annulus of each well. Lift gas injection rates were maintained at pre-application levels, and no changes were made to surface facilities or operating conditions during the trial.

### 5.2 Laboratory Screening and Fluid Compatibility Evaluation

Laboratory screening was conducted to confirm that surfactant application would not introduce operational issues prior to field deployment. Foam tendency, oil–water separation, and compatibility with the existing corrosion and scale inhibitor program were evaluated using representative produced fluids. Testing showed low foam persistence, clean oil–water separation, and no adverse chemical interactions, supporting field application and aligning with subsequent surface performance.

#### 5.2.1 Fluid Samples and Test Conditions

Produced fluid samples (oil and water) were collected from the subject wells following frac-hit events and prior to surfactant application. Tests were performed on representative oil–water systems reflecting elevated water cut conditions observed post-hit. All laboratory evaluations were conducted at ambient conditions using standardized

qualitative and semi-quantitative screening procedures commonly applied for production chemical assessment.

#### 5.2.2 Foam Height and Foam Break Testing

Foam tendency was evaluated utilizing a blender foam test with fluid samples containing the surfactant at representative treatment concentrations. Initial foam height was visually recorded immediately following agitation. Foam stability was assessed by measuring the time required for foam collapse (foam break), with observations categorized qualitatively as rapid-breaking or persistent foam.

These tests were intended to assess the likelihood of stable foam formation that could adversely impact gas lift performance or surface separation, rather than to quantify absolute foaming behavior under downhole conditions.

#### 5.2.3 Emulsion Tendency Testing

Emulsion tendency was evaluated using bottle tests performed on oil–water mixtures containing the surfactant. Samples were agitated and allowed to separate without further agitation, with visual observations recorded for phase separation behavior, interface clarity, and emulsion persistence over time. Emulsion tendency was qualitatively classified based on separation rate and stability of the oil–water interface.

#### 5.2.4 Chemical Compatibility Testing

Compatibility testing was conducted to evaluate interactions between the surfactant and the existing combination corrosion and scale inhibitor program used in the field. Chemical blends were prepared at representative treatment concentrations and observed for signs of incompatibility, including precipitation, haze formation, phase separation, or viscosity changes. Compatibility screening was intended to confirm that the surfactant could be applied without adversely affecting the integrity or performance of the existing chemical treatment program.

#### 5.2.5 Role of Laboratory Screening

The laboratory screening program was designed to identify potential operational risks associated with surfactant application, including stable foam formation, emulsion stabilization, or chemical incompatibility. Results from these tests were used to inform field deployment and to support interpretation of observed field behavior, particularly with respect to separator performance and pressure response, rather than to establish a direct correlation between laboratory results and production outcomes. Laboratory screening and fluid compatibility results are summarized in Table 2.

*Table 2: Summary of laboratory screening results, including foam behavior, emulsion tendency, and compatibility with the existing corrosion and scale inhibitor program.*

<b>Test</b>	<b>Observation</b>	<b>Operational Interpretation</b>
Foam height	Moderate	Foam formation possible
Foam break	Rapid collapse	Low persistent foam risk
Emulsion tendency	Clean separation	Low emulsion risk
CI/SI compatibility	No precipitation	Compatible

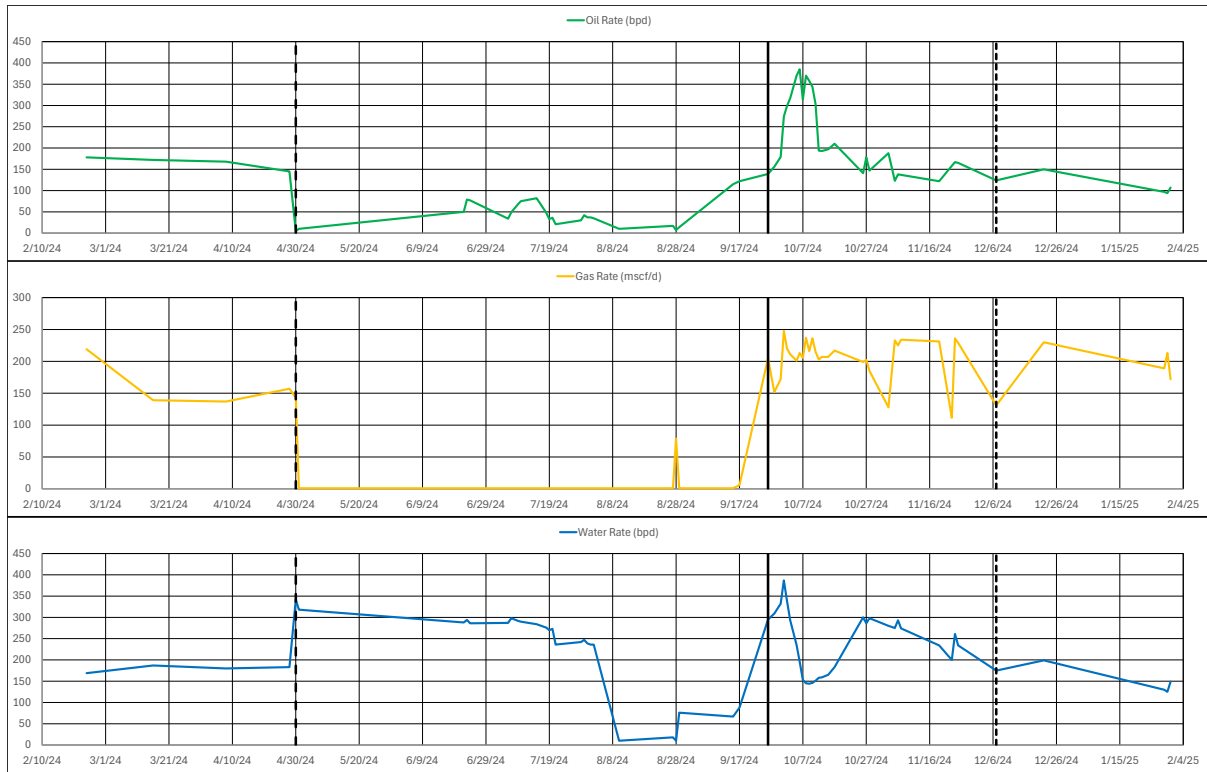
## 6 RESULTS

### 6.1 Oil, Water, and Gas Production Response

All wells exhibited an immediate and material production response following the initiation of the surfactant application. Oil rates increased rapidly following treatment and recovered from post-frac lows to sustained rates exceeding pre-treatment performance. Gas rates increased or stabilized, and gas-lift behavior became more consistent. All wells exhibited a transient increase in produced water at treatment onset, followed by a sustained decline during the treatment period. After surfactant injection was terminated, oil production remained materially higher than pre-treatment levels. Gas-lift performance remained stable, and water production continued to decline. No reversion to pre-treatment liquid-loaded behavior was observed (Figures 2A-2C). Dashed, solid, and dotted vertical lines indicate the frac-hit event, surfactant initiation, and surfactant termination, respectively.



**Figure 2A: Well A - Oil, gas, and water production rates versus time before and after surfactant application.**



**Figure 2B: Well B - Oil, gas, and water production rates versus time before and after surfactant application.**

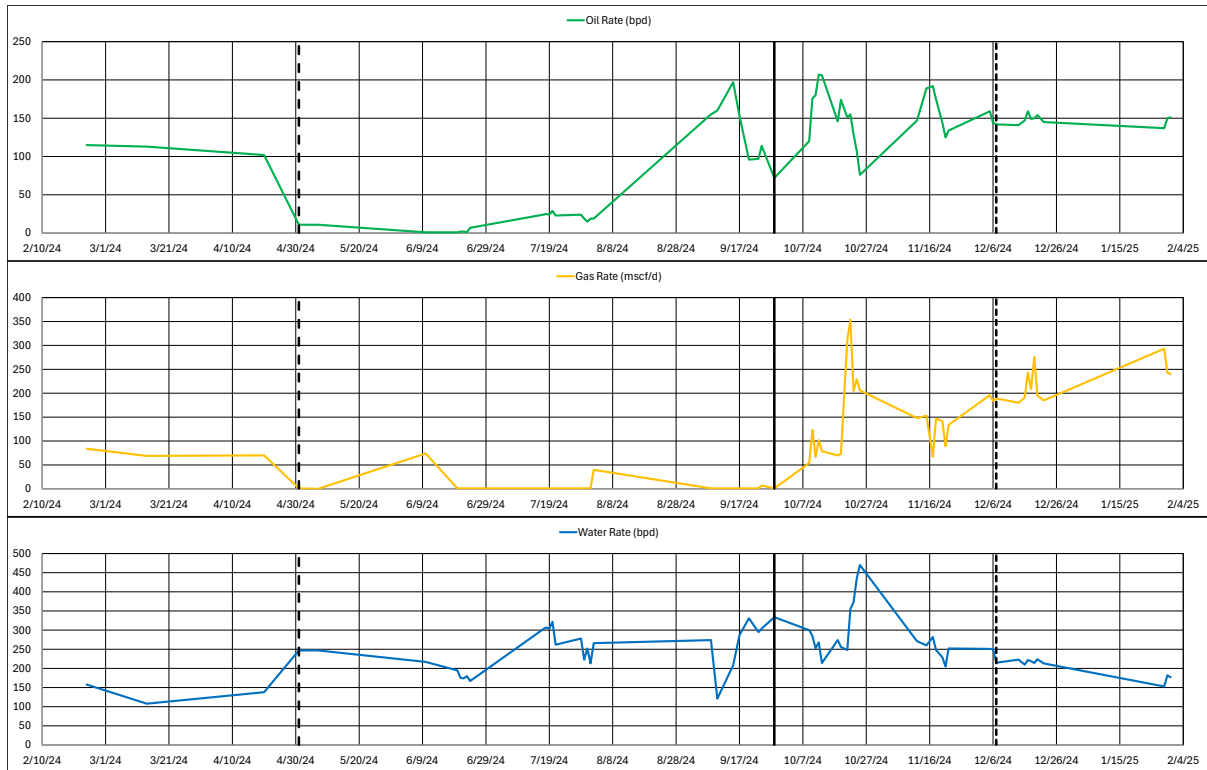


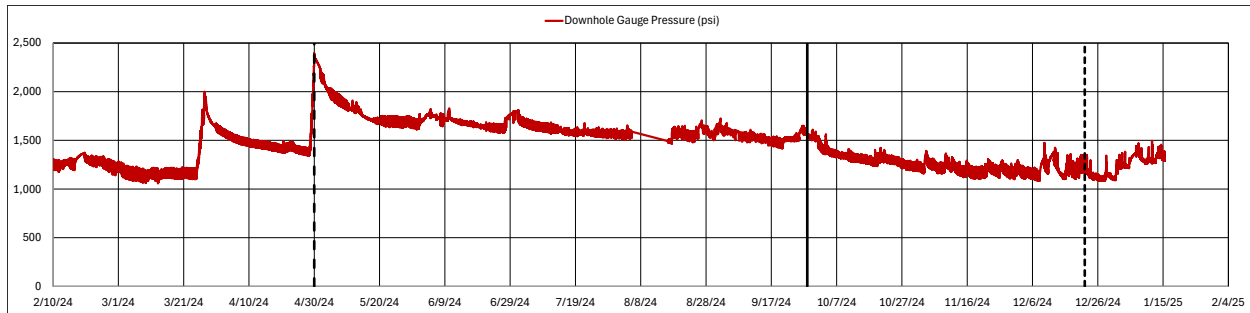
Figure 2C: Well C - Oil, gas, and water production rates versus time before and after surfactant application.

## 6.2 Pressure Response

A pressure response was observed across all three wells following surfactant application, despite differences in available measurement instrumentation.

### 6.2.1 Well A Bottomhole Pressure Response

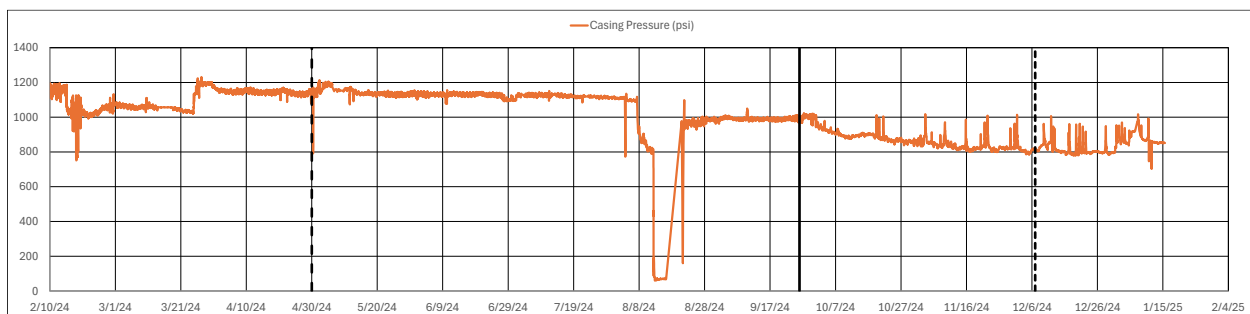
Prior to the frac hit, bottomhole pressure was relatively stable with normal operational variability. Following the frac-hit event, bottomhole pressure increased, indicating increased liquid holdup. After initiation of surfactant injection, bottomhole pressure declined and stabilized at a lower level, coinciding with improved oil production. This stabilized pressure behavior persisted after treatment termination, indicating improved gas-lift efficiency and a sustained reduction in liquid holdup. (Fig. 3A).



**Figure 3A:** Flowing bottomhole pressure versus time for Well A before and after surfactant application. Dashed, solid, and dotted vertical lines indicate the frac-hit event, surfactant initiation, and surfactant termination, respectively.

### 6.2.2 Well B Casing Pressure Response

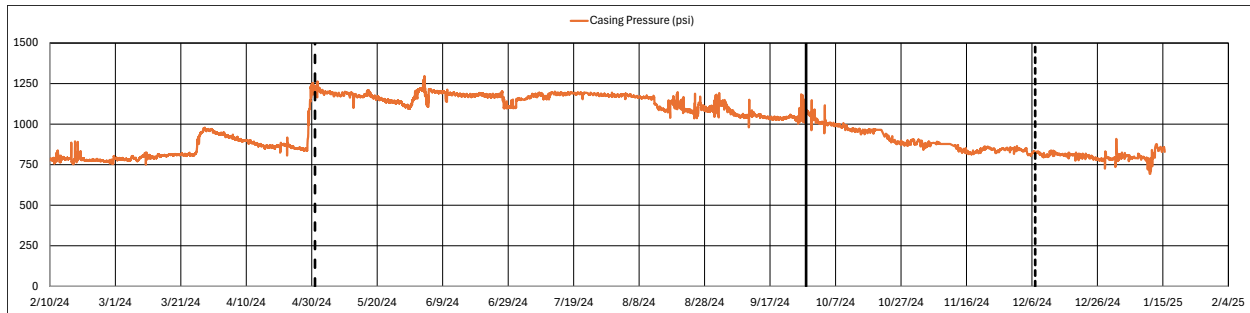
Prior to the frac hit, casing pressure was relatively stable with normal operational variability. Following the frac-hit event, casing pressure became degraded and unstable, indicating reduced gas-lift efficiency. After initiation of surfactant-assisted gas lift, casing pressure stabilized at a lower level, coinciding with improved oil production. This stabilized pressure behavior persisted after treatment termination, indicating improved gas-lift efficiency and a sustained reduction in liquid interference (Fig. 3B).



**Figure 3B:** Casing pressure versus time for Wells B following surfactant application. Dashed, solid, and dotted vertical lines indicate the frac-hit event, surfactant initiation, and surfactant termination, respectively.

### 6.2.3 Well C Casing Pressure Response

Prior to the frac hit, casing pressure was relatively stable with normal operational variability. Following the frac-hit event, casing pressure increased and stabilized at a higher level, indicating reduced gas-lift efficiency. After initiation of surfactant injection, casing pressure declined and stabilized at a lower level, coinciding with improved oil production. This stabilized pressure behavior persisted after treatment termination, indicating improved gas-lift efficiency and a sustained reduction in liquid interference (Fig. 3C).



**Figure 3C:** Casing pressure versus time for Wells C following surfactant application. Dashed, solid, and dotted vertical lines indicate the frac-hit event, surfactant initiation, and surfactant termination, respectively.

### 6.3 Transient and Steady-State Behavior

An initial uplift in production and pressure response was observed following surfactant across all three wells. This early response was followed by a partial decline and subsequent stabilization as the wells transitioned to a new steady-state operating condition. Table 3 summarizes production and pressure behavior for each well during post-frac baseline conditions, treatment steady-state operation, and post-treatment steady state.

**Table 3:** Summary of production and pressure behavior for each well during post-frac baseline conditions, treatment steady-state operations, and post-treatment steady state.

Well	Operating State	Oil Rate (bpd)	Gas Rate (Mscf/d)	Water Rate (bpd)	Pressure Metric	Flow Behavior
A	Post-frac, pre-treatment	Low, unstable	Erratic	Variable	Elevated BHP	Liquid-loaded
	Treatment steady state	Increased, stable	Stabilized	Declining	Reduced BHP	Continuous
	Post-treatment steady state	Sustained	Stable	Lower	Stable BHP	Continuous
B	Post-frac, pre-treatment	Suppressed	Unstable	Elevated	Unstable CP	Intermittent
	Treatment steady state	Significantly increased	Stable	Declining	Reduced CP	Stable lift
	Post-treatment steady state	Sustained	Stable	Lower	Stable CP	Stable lift
C	Post-frac, pre-treatment	Near-zero	Ineffective	Elevated	Elevated CP	Liquid-loaded
	Treatment steady state	Recovered	Improved	Declining	Reduced CP	Continuous
	Post-treatment steady state	Sustained	Stable	Lower	Stable CP	Continuous

## 7 DISCUSSION

### 7.1 Frac-Hit Impact on Wellbore Hydraulics

Frac-hit events produced immediate and sustained changes in both production and pressure behavior across the trial wells. In wells equipped with pressure instrumentation, frac hits resulted in increases in bottomhole or casing pressure and increased pressure instability. These pressure responses coincided with sharp declines in oil production and reduced gas-lift effectiveness. The coupled pressure increase and production degradation indicate that frac hits primarily impaired wellbore hydraulics through increased liquid holdup and hydrostatic head rather than causing short-term transient disturbances.

## 7.2 Coupled Pressure and Production Response to Surfactant-Assisted Gas Lift

Initiation of surfactant-assisted gas lift produced simultaneous improvements in pressure and production behavior. In all instrumented wells, reductions in bottomhole or casing pressure coincided with rapid increases in oil production and improved production stability, followed by stabilization of pressure and production behavior. Pressure declines indicate reduced hydrostatic head and improved liquid removal, while stabilized pressure behavior suggests a transition from intermittent or slug flow to a more continuous flow regime. The alignment of pressure reduction and oil-rate recovery provides strong evidence that improved gas–liquid coupling and liquid unloading were the primary drivers of the observed production response.

## 7.3 Mechanism and Durability of Treatment Response

Concurrent pressure reduction and oil-rate recovery indicate reduced liquid holdup as the dominant recovery mechanism. Transient increases in produced water at treatment onset are consistent with removal of previously trapped liquids, followed by establishment of a new steady-state flow condition. Improvements in both pressure and production persisted after surfactant injection was discontinued, demonstrating that continuous chemical treatment was not required once stable operation was restored.

## 7.4 Role of Laboratory Screening

Laboratory screening supported interpretation of the field response. Foam testing indicated low foam stability, consistent with the absence of separator foaming during the trial. Emulsion tendency testing showed clean oil–water separation, aligning with stable surface performance. Compatibility testing with the existing corrosion and scale inhibitor program identified no adverse interactions, supporting operational robustness during surfactant application.

## 7.5 Alternative Explanations Considered

Changes in lift gas injection, surface facilities, or backpressure were ruled out, as operating conditions were held constant throughout the trial. Measurement artifacts were considered; however, consistent trends across wells with different instrumentation support the validity of the observed responses.

## 8 OPERATIONAL IMPLICATIONS

Surfactant-assisted gas lift is an effective operational response to frac-hit-induced production degradation in gas-lifted wells. Frac hits were associated with increased liquid holdup, degraded pressure behavior, and reduced oil production. Concurrent improvements in pressure and production following treatment indicate restoration of gas-lift efficiency through improved liquid handling.

A short transient response should be expected after treatment initiation, including temporary increases in produced water, pressure variability, and production fluctuations as accumulated liquids are removed. Performance should be evaluated using stabilized pressure behavior and sustained production trends rather than initial rate changes.

Pressure response provides the most reliable diagnostic of treatment effectiveness. Sustained reductions and stabilization of bottomhole or casing pressure that coincide with oil-rate recovery indicate successful liquid unloading. Wells exhibiting post-frac pressure elevation, sustained production loss, and evidence of liquid loading represent strong candidates for treatment.

Improved pressure and production behavior persisted after treatment termination, indicating that continuous surfactant injection is not required once stable operation is achieved. Surfactant-assisted gas lift can therefore be applied as a targeted post-frac recovery rather than a permanent chemical program. Wells exhibiting frac hits followed by elevated or unstable pressures, sustained production losses, and evidence of liquid loading represent strong candidates for treatment. The effectiveness of surfactant treatment is influenced by the persistence of elevated water production, and under sustained water influx conditions, benefits may be diminished.

## 9 CONCLUSIONS

Frac-hit events degraded gas-lift performance through increased liquid holdup, elevated flowing pressures, and sustained oil loss.

In all three wells, surfactant-assisted gas lift restored lift efficiency by reducing liquid holdup, resulting in concurrent pressure reduction and oil-rate recovery.

Laboratory screening and chemical compatibility testing supported field deployment and aligned with observed surface performance, with no adverse foaming, emulsion stabilization, or chemical interactions.

Pressure and production improvements persisted after surfactant injection was terminated, demonstrating a durable hydraulic response without the need for continuous chemical treatment.

## 10 NOMENCLATURE

- BHP – Bottomhole Pressure
- CP – Casing Pressure
- SAGL – Surfactant Assisted Gas Lift

## 11 REFERENCES

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