ADDRESSING GAS LIFT CHALLENGES WITH INNOVATIVE SURFACE-CONTROLLED TECHNOLOGY

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INDUSTRY BACKGROUND

Gas lift remains one of the most widely deployed artificial lift methods globally, particularly in wells characterized by moderate-to-high gasoil ratios, deviated wellbores, and offshore or subsea completions where reliability and simplicity are paramount. In recent years, industry trends have shifted toward maximizing recovery from mature assets, extending field life, and developing increasingly complex reservoirs with variable inflow performance and changing pressure regimes. As reservoirs deplete and operating margins tighten, operators are demanding greater efficiency, lower intervention frequency, and enhanced production optimization capabilities from gas lift systems. In parallel, digital monitoring and real time production surveillance have become more prevalent, highlighting the limitations of traditional pressure balanced or injection pressure dependent valve designs that lack adjustability once deployed. These evolving operational and economic drivers are accelerating the need for gas lift technologies capable of dynamic performance optimization, improved reliability, and reduced total cost of ownership across diverse well conditions.

PRODUCT AND APPLICATIONS BACKGROUND

The surface-controlled gas lift system builds upon established industry practices, maintaining a deliberate “one degree of separation” from conventional gas lift architecture to ensure familiarity, reliability, and ease of adoption. The technology utilizes standard gas lift mandrels, injection pressure valve parts and pieces, internal biasing force, integrating them with a capillary string and a surface mounted hydraulic pump and control skid. This configuration enables active, surface-controlled actuation of downhole valves within a closed-loop system.

Through hydraulic signaling transmitted via the capillary string, operators can selectively open and close valves in either ascending or descending sequence. This capability allows for maximum use of surface injection pressure and precise control of the active injection point, enabling operators to accurately determine where lifting occurs within the wellbore.

Operational deployments have demonstrated functionality across mid pressure and low-pressure injection environments. Injection pressure ranges enable broader applicability without requiring significant infrastructure changes. The system supports seamless transitions between casing flow and tubing flow configurations, providing operational flexibility across varying well conditions. In addition to continuous flow applications, the technology enables controlled intermittent lift directly at the point of injection. This level of surface directed timing control enhances production optimization while minimizing unnecessary gas injection. In addition to intermittent gas injection, intermittent gas injection with plunger cycles to improve plunger travel efficiency and reduce total gas consumption.

To further enhance operational learning and signal interpretation behavior during kick-off events, pressure transitions, and unstable flow regimes. By incorporating casing pressure as a primary real-time control signal, the system enables more accurate identification of optimal injection rate effectiveness. Monitoring casing pressure trends in conjunction with tubing response allows operators to distinguish between true fluid movement improving decision-making during start up and optimization phases.

Ongoing evaluation continues to identify additional applications where surface-controlled valve actuation can enhance production performance. These efforts support the integration of the technology into broader gas lift optimization strategies and emerging artificial lift system architectures.

GAS LIFT KICKOFF EXAMPLES

Traditionally, gas lift kickoffs are conducted using established API-recommended procedures or operator specific pressure ramp up programs. These conventional approaches typically rely on incremental casing pressure increases to sequentially activate injection pressure operated (IPO) valves until the desired injection point is achieved. While widely adopted, these methods can be time intensive, highly dependent on stable reservoir conditions, and often require a conservative pressure approach to avoid valve instability, excessive gas injection, or surface equipment constraints.

Field applications of the surface-controlled gas lift system have demonstrated alternative pressure transition strategies that enhance kickoff efficiency and control. In several deployments, wells were successfully initiated from low pressure to high pressure operating conditions by actively managing valve sequencing through surface controlled hydraulic actuation. (Figure 1) Conversely, operators can implement a surface-controlled kickoff methodology by first closing all downhole valves, then pressuring either the tubing or casing to a predetermined level before selectively opening valves in a bottom-up sequence. Valves are incrementally actuated until a distinct casing pressure response (“casing signature”) confirms active injection at the desired depth. In conventional pressure-driven kickoffs, large differentials between tubing and casing pressures can develop during startup, increasing the risk of improper valve activation, seat damage, or mechanical stress on the valve assembly. By initiating lift from the deepest injection point and progressing upward only as required, the bottom-up sequencing approach minimizes excessive pressure differentials, thereby reducing valve-related risk and improving kickoff stability and repeatability. (Figure 2)

Collectively, these pressure transition examples illustrate how surface-controlled valve actuation fundamentally alters traditional kickoff methodology, offering operators a faster, safer, and more precise means of returning wells to production across varying pressure environments.

GAS PASSAGE CAPACITY AND FLOW PERFORMANCE

Injection Pressure Operated gas lift valves are inherently limited in the volume of injection gas they can pass due to fixed port geometry, restricted stem travel, and differential between tubing and casing. Similar constraints apply to reverse flow and standard wireline-retrievable valve designs, where flow area is governed by port configuration and mechanical travel limits. As injection rate requirements increase, in larger geometry flow area applications these limitations can restrict operational flexibility and production optimization.

The surface-controlled gas lift valve architecture addresses these constraints by incorporating extended stem travel, effectively increasing the available flow area during actuation. This enhanced mechanical stroke allows greater gas throughput compared to traditional IPO configurations operating under similar port specifications. In field applications, a 16/64th port surface-controlled valve configuration has demonstrated the capability to pass approximately 2 MMscf/d of injection gas. By similar surface differential comparison, a conventional 16/64th port IPO valve typically cannot reliably achieve these flow rates without approaching mechanical or stability limits. (Figure 3).

GAS INJECTION OPTIMIZATION

The surface-controlled system operates as a controlled, gasless actuation platform, meaning valve positioning is not dependent on injection pressure dome charging or conventional IPO balancing mechanisms. Instead, the effective differential at the point of injection is defined by the relationship between tubing and casing pressures at the injection depth. The observed casing pressure response (“casing signature”) is directly influenced by tubing pressure at that same depth, enabling a clearer interpretation of true injection behavior.

Because tubing and casing pressures are dynamically linked at the injection point, casing pressure trends can be used as a reliable surface diagnostic to infer downhole injection performance. When critical velocity or critical rate is calculated through transient flow equations, Turner’s based correlations, or alternative modeling methodologies, the system allows operators to observe, in real time, the direct impact of incremental gas injection on casing pressure behavior. This provides immediate feedback on whether sufficient gas volume is being delivered to sustain stable flow and prevent liquid fallback.

In contrast, traditional IPO based systems often mask inefficiencies. Injection pressure operated valves may reopen, leak, or “crack” intermittently under fluctuating pressure conditions, creating ambiguous pressure signatures at surface. These behaviors can obscure true injection depth, distort casing pressure interpretation, and conceal performance degradation within the system. By eliminating passive pressure driven actuation and replacing it with deterministic surface control, the surface-controlled methodology provides clearer pressure diagnostics, improved injection point certainty, and greater transparency into system performance. (Figure 4)

FLOW REGIME TRANSITION – ANNULAR TO CONVENTIONAL OR CONVENTIONAL TO ANNULAR

Transitioning from annular flow to alternate flow configurations such as conventional injection, Plunger Assisted Gas Lift (PAGL) or intermittent modes traditionally requires mechanical intervention when using IPO based systems. While hybrid designs and wireline retrievable equipment have been deployed to provide greater operational flexibility and visibility, these approaches can introduce mechanical complexity and operational risk. Although such transitions are technically achievable, they are often challenging, condition dependent, and not always consistently successful, particularly in wells with dynamic pressure environments or evolving reservoir conditions.

The surface-controlled gas lift system addresses these limitations by enabling flow path transitions without the need for a workover rig. Because valve actuation is hydraulically controlled from surface and is independent of injection pressure directionality, operators can selectively reposition injection points and transition between tubing and casing injection configurations without mechanically altering downhole hardware. The system does not rely on reversing the direction of injection gas to shift operating modes; instead, valve states are deliberately controlled through surface command, allowing predictable and repeatable changes in flow regime. (Figure 5)

LATE-LIFE WELL OPTIMIZATION AND GAS EFFICIENCY

In the later life of a well, operators increasingly seek to minimize gas injection volumes while maximizing liquid production efficiency. As reservoir pressures decline and margins tighten, optimizing the gas-to-liquid production ratio becomes a critical operational priority.

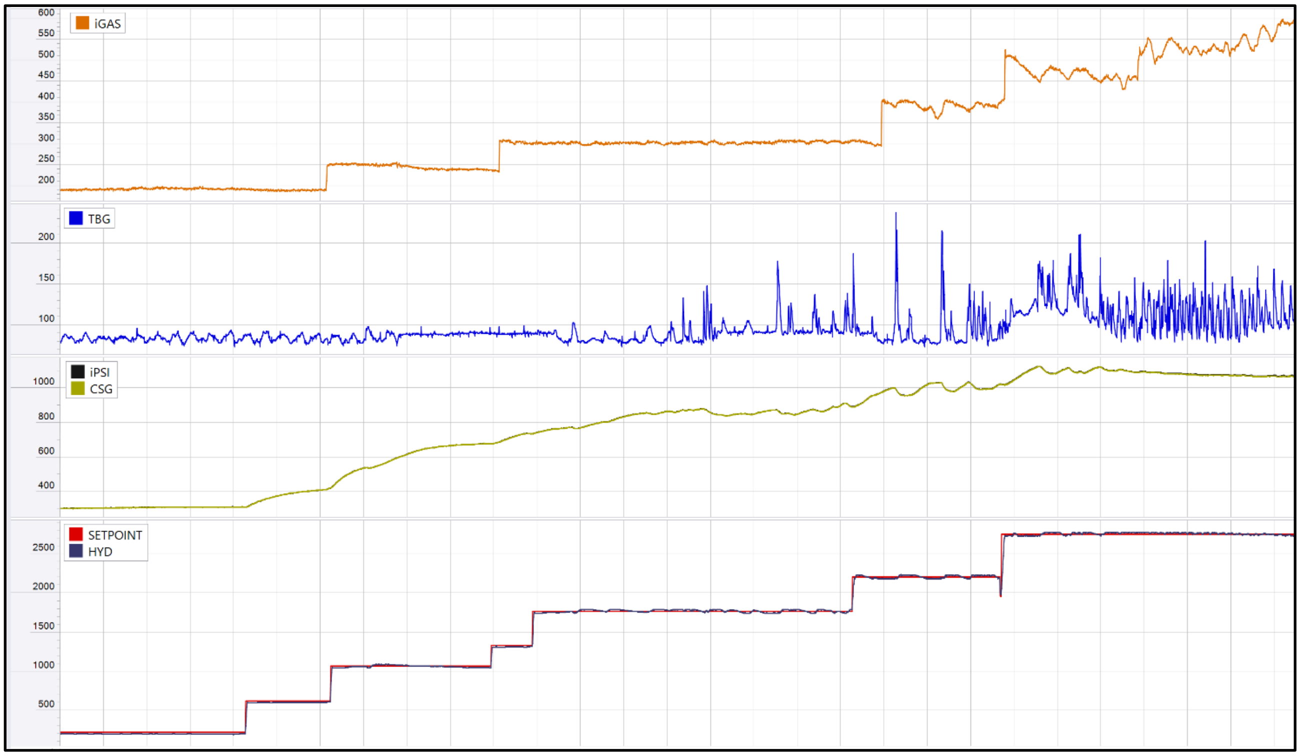
Current industry approaches for managing late-life gas lift performance typically include the use of pilot operated valves, large port IPO valves, or surface-controlled strategies that rely on fixed or unrestricted injection. While these methods can be effective under certain conditions, they do not provide precise control over the volume of gas delivered at the specific point of injection. Instead, injection rates are largely governed by surface pressure and valve mechanics, limiting the operator's ability to dynamically fine-tune gas volumes in response to changing well conditions.

The surface-controlled gas lift system addresses this gap by enabling direct, surface-commanded regulation of injection timing and duration at the active valve depth. This allows operators to intentionally reduce injected gas volumes while maintaining sufficient lift performance to maximize fluid recovery and sustain stable production.

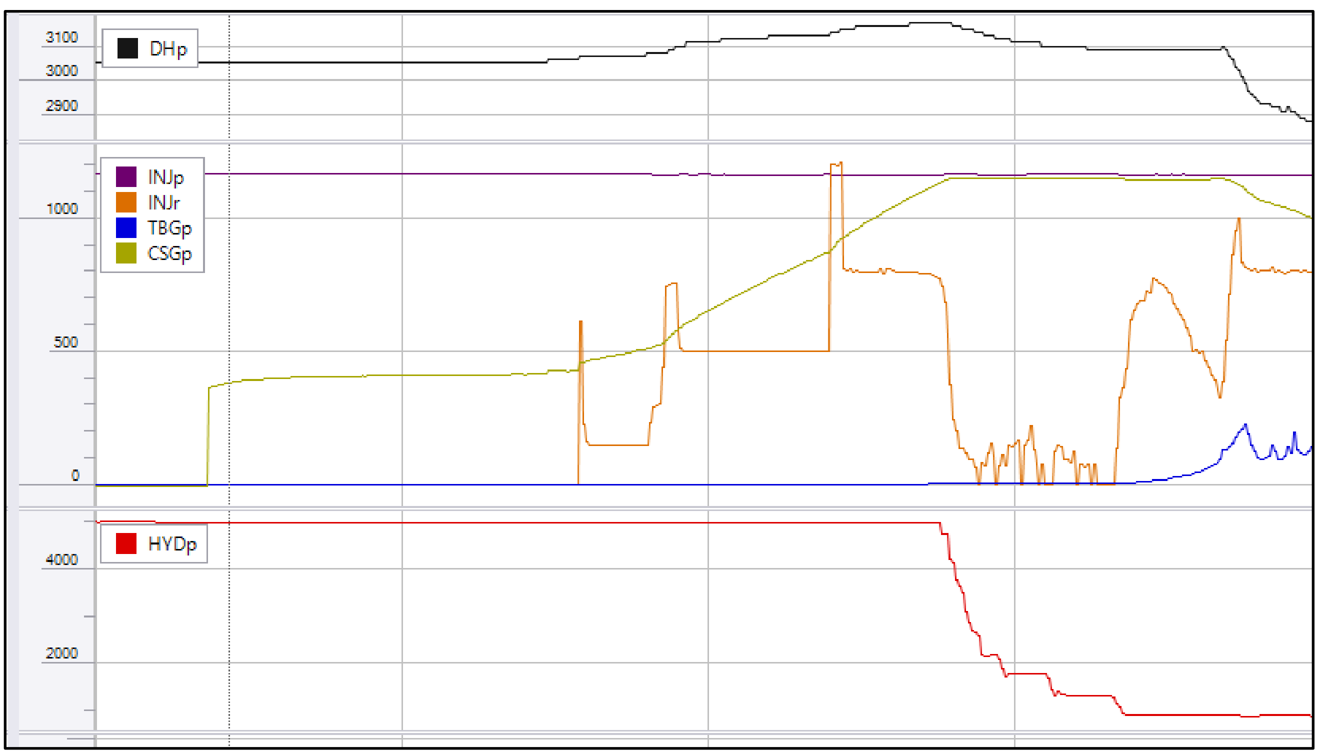
Figure 6 shows an example of an intermittent lift application utilizing a surface-controlled gas lift system.

The surface-controlled gas lift system can be integrated with plunger lift operations to further optimize intermittent lift performance and reduce gas consumption. In these applications, operators can synchronize valve actuation with the plunger cycle to precisely control gas injection. When the plunger reaches the bottom of the bumper spring, the operator initiates valve opening, allowing gas to lift the plunger to surface. Upon surface arrival, the gas injection is terminated, permitting the plunger to fall freely. This cycle is repeated in a controlled manner, with valve actuation coordinated to the plunger's position, ensuring efficient unloading and minimizing gas usage.

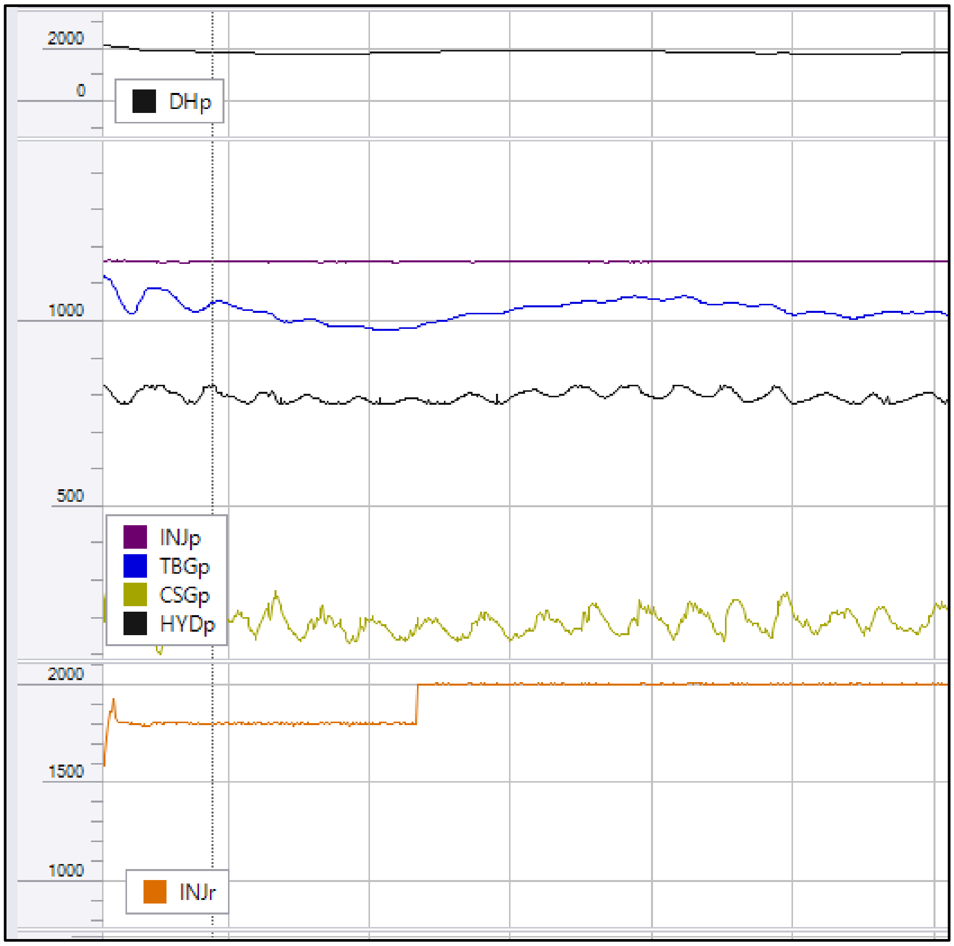
Figure 7 shows an example of an intermittent lift with a plunger application utilizing a surface-controlled gas lift system.



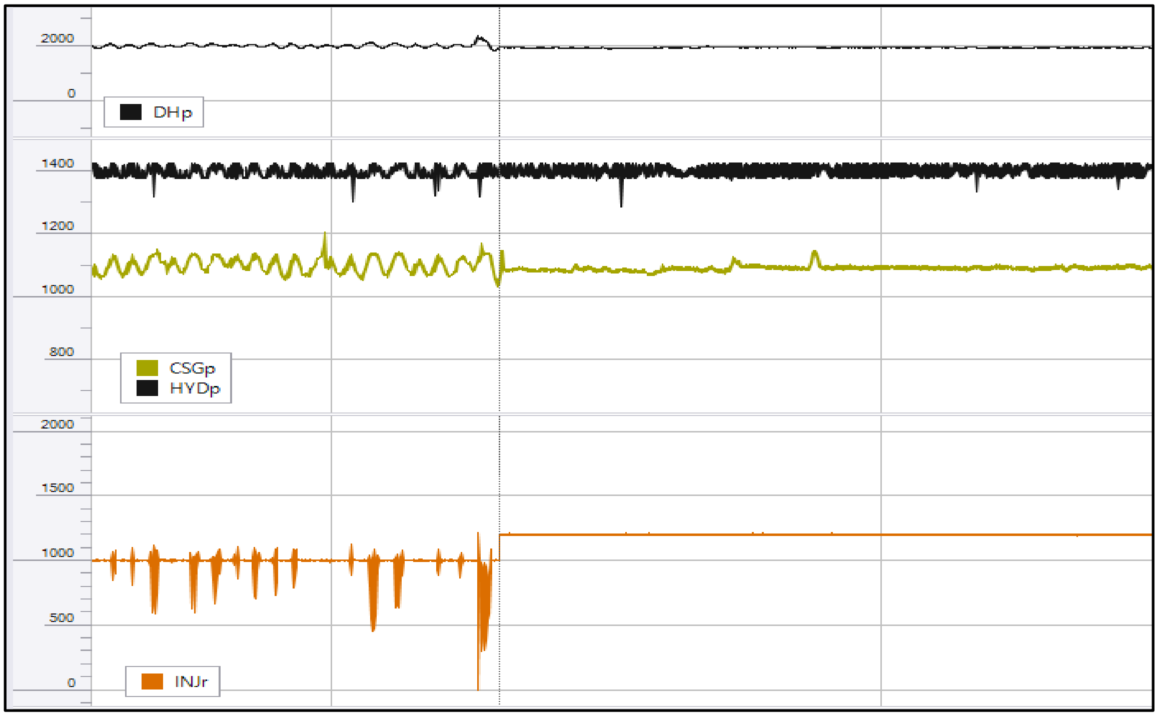
(Figure 1 - Lower Pressure to High Pressure Kick Off)



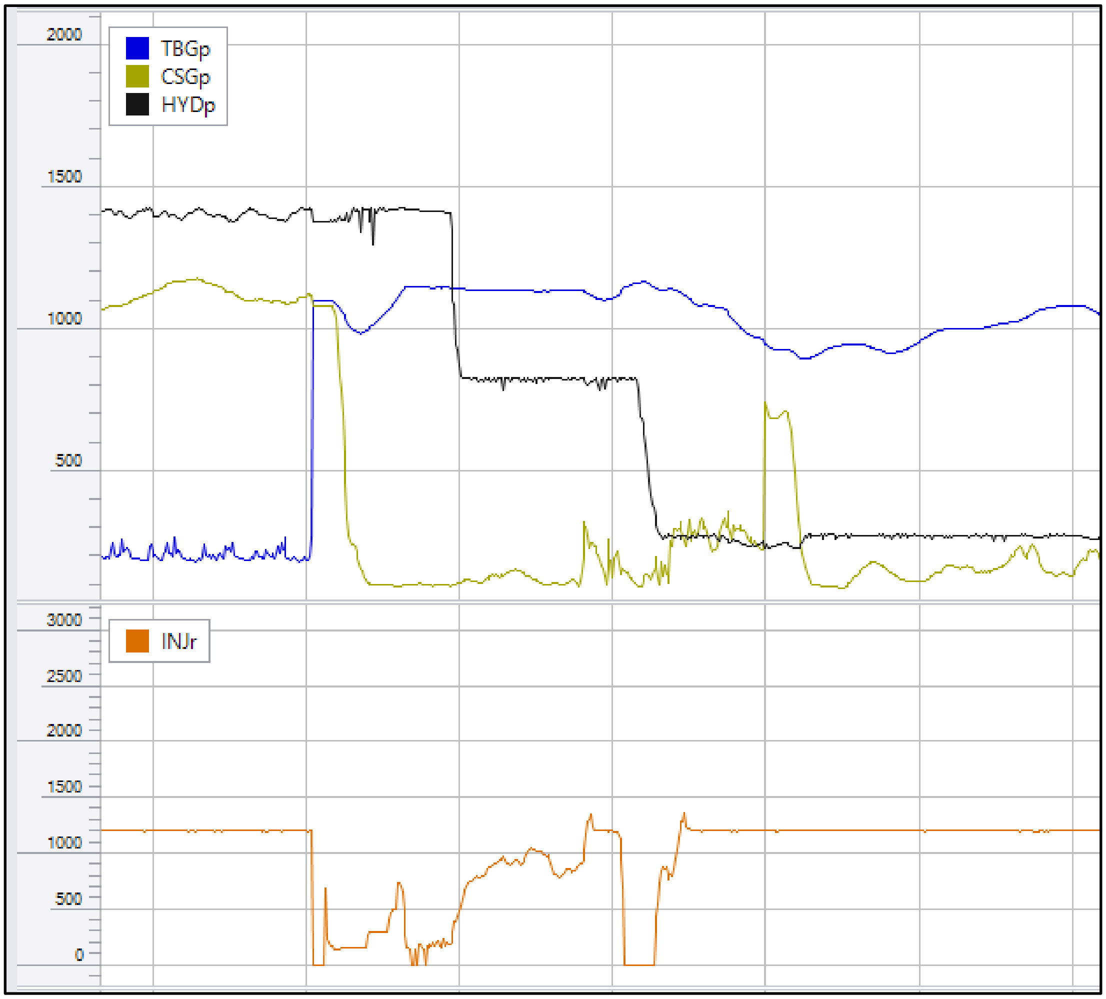
(Figure 2 - High Pressure to Lower Pressure Kick Off)



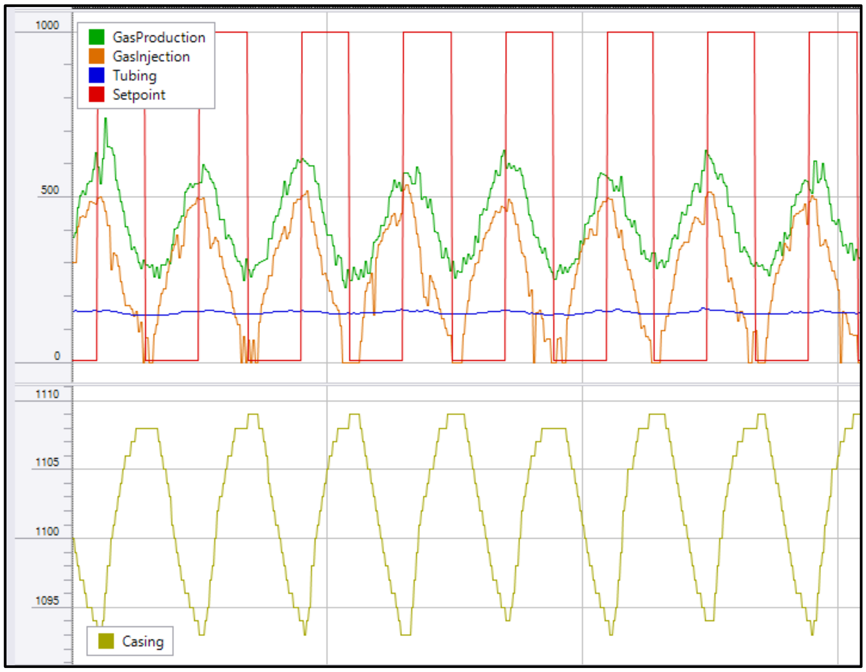
(Figure 3 - Gas Passage Through a 16-Port Hydraulic Valve)



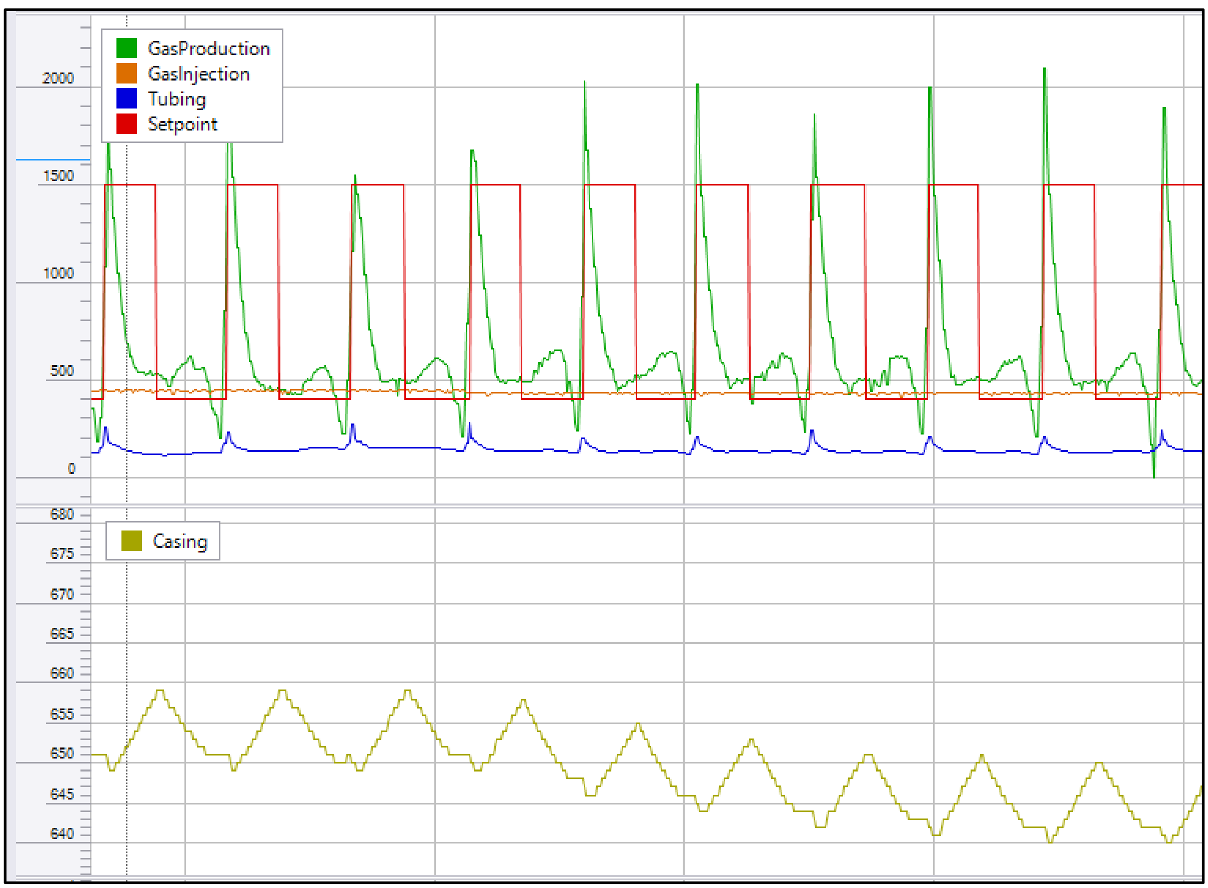
(Figure 4 - Adjusting Injection Rate for Better Casing Response)



(Figure 5 - Conventional Flow to Annular Flow Example)



(Figure 6 - Intermittent Lift Application)



(Figure 7 - Intermittent Lift w/ Plunger Application)