# BENEATH THE SURFACE: Q2-TRAK ILLUMINATES WELL PERFORMANCE WITH DATA-DRIVEN ANALYSIS

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Q2 Artificial Lift Services

## INTRODUCTION: A FRAGMENTED VIEW OF PERFORMANCE

Rod lift is the most widely applied artificial lift method in unconventional resource development. Ensuring long-term performance and reliability requires continuous monitoring and timely optimization decisions. Production data plays a critical role in this optimization effort by guiding intervention timing, supporting equipment selection, and influencing cost management strategies. The challenge is that the value of this data depends on the ability to interpret it alongside run-life results, interventions, and cost impacts. Yet most existing systems still treat these datasets independently, leaving important performance connections unexplored.

This paper examines how integrated visibility can reduce uncertainty and strengthen decision-making in rod pump operations. It introduces a platform designed to combine production outcomes, equipment performance history, and financial records into a single environment, allowing operators to evaluate artificial lift effectiveness with greater clarity. To demonstrate the importance of this capability, the paper reviews the limitations of existing systems, outlines a unified approach to performance evaluation, and presents a field-based case study showing how access to linked data supports optimization across wells.

## PROBLEM DEFINITION: DISCONNECTED DATA LIMITS PERFORMANCE EVALUATION

Rod pump operations generate significant volumes of production, equipment, and intervention data, from rate trends and fluid levels to run-life history and failure comments. Yet, this information is commonly distributed across multiple systems and departments: production data with operations, equipment history with engineering, and cost records with accounting. When these critical datasets remain disconnected, the result is delayed, reactive, and assumption-based decision-making. The challenge becomes even more pronounced when operators attempt to evaluate the true impact of specialty components. Without a direct, integrated view linking production behavior to equipment performance and financial outcomes, operators must rely on indirect indicators such as gradual production changes, pump pulls, or maintenance reviews long after the fact. These traditional methods keep essential insight in the dark, leaving uncertainty around whether the right equipment was selected or whether performance improvements are being achieved.

The industry needs a way to illuminate well performance as it evolves, capturing how production, run-life, and spending move together so that optimization decisions can be made with confidence. Operators require access to data that not only shows what is happening to their wells, but why. However, despite advancements in digital monitoring, most systems still leave critical aspects of well performance in the dark, limiting evaluation of artificial lift performance.

## STILL IN THE DARK: VISIBILITY GAPS IN EXISITNG SYSTEMS

Efficient production data analysis plays a critical role in optimizing artificial lift performance, improving intervention timing, and ensuring that equipment investments deliver measurable value. However, most existing systems focus on diagnosing isolated issues without providing a complete view of well behavior or connecting technical performance to operational and financial outcomes.

Moises et al. (2010) introduces a failure diagnostic system that relies on teardown inspections, expert evaluation, and structured classification methods to determine why rod pump components fail. While this approach improves how failures are recorded and understood, the insights only emerge after the pump has already been pulled, meaning operators still lack visibility into specialty component behavior while the well is producing. This reactive workflow leaves a critical performance gap: operators cannot evaluate whether the equipment they install is improving production or run-life in real time.

Hidayat et al. (2023) demonstrate that real-time IoT monitoring can increase well uptime and reduce field interventions through automated control. Although this system improves awareness of operational status, it does not provide specialty-component insight or link rod-pump equipment selection to production outcomes over time. Key performance interpretation remains separated from the equipment responsible for delivering that performance.

Sindi et al. (2023) apply nodal analysis, ESP modeling, and machine learning to predict equipment degradation before failure occurs. This enhances proactive diagnostics for ESP lift, but evaluation remains focused on pump health rather than its impact on production efficiency or cost performance. Additionally, the solution targets ESP systems, leaving a gap in rod-lift operations where most artificial lift wells reside.

Across these studies, three critical limitations persist:

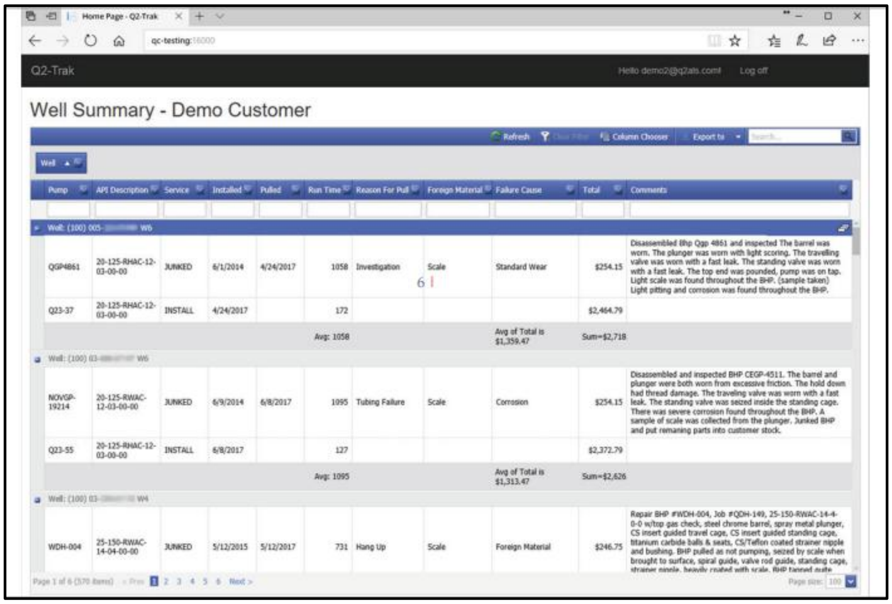
- **Fragmented data** — Production, run-life, and cost information remain separated across systems, preventing a unified performance view.
- **Limited ability to validate specialty component performance while producing** — Insights often emerge only after failure or pump pulls, leaving uncertainty during active operation.

- **Narrow technology scope** — Many digital solutions focus on ESP systems or high-level monitoring and do not connect equipment selection to production or financial outcomes in rod-lift operations.

These limitations make clear that a new level of visibility is needed. One that unifies production, equipment, and financial context so operators are no longer working in the dark. Integrated insight enables confident, real-time decisions that enhance artificial lift performance across the well lifecycle.

## INTO THE LIGHT: Q2-TRAK'S INTEGRATED SOLUTION

Q2-Trak introduces a paradigm shift in the artificial lift industry. By providing operators with a unified view of production, equipment history, and financial data (Figure 1), scattered operational information is transformed into actionable performance insight. Instead of relying on disconnected systems or delayed field observations, users are able to evaluate rod pump performance using data already captured across the lifecycle of each well. The platform is built to support the realities of modern artificial lift operations, where decisions must be made quickly, budgets are closely managed, and equipment changes must be justified with evidence.



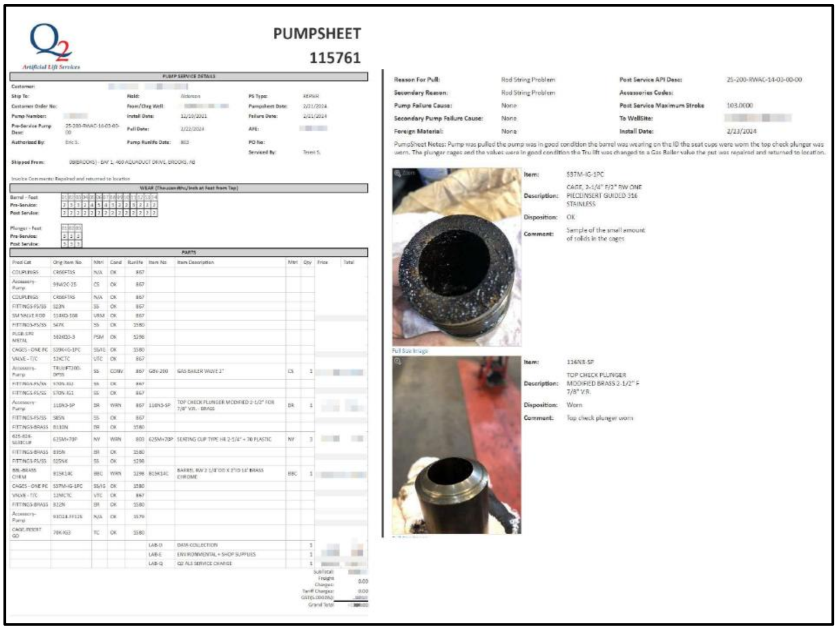
Well Summary - Demo Customer

| Pump | API Description | Service | Installed | Pulled | Run Time | Reason For Pull | Foreign Material | Failure Cause | Total | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| Well: (100) 005-[redacted] W6 | | | | | | | | | | |
| QGP4861 | 20-125-RHAC-12-03-00-00 | JUNKED | 6/1/2014 | 4/24/2017 | 1058 | Investigation | Scale | Standard Wear | $254.15 | Disassembled Bhp Qgp 4861 and inspected The barrel was worn. The plunger was worn with light scoring. The travelling valve was worn with a fast leak. The standing valve was worn with a fast leak. The top end was pounded, pump was on tap. Light scale was found throughout the BHP. (sample taken) Light pitting and corrosion was found throughout the BHP. |
| Q23-37 | 20-125-RHAC-12-03-00-00 | INSTALL | 4/24/2017 | | 172 | | | | $2,464.79 | |
| | | | | | Avg: 1058 | | | Avg of Total is $1,359.47 | Sum=$2,718 | |
| Well: (100) 03-[redacted] W6 | | | | | | | | | | |
| NOVGP-19214 | 20-125-RWAC-12-03-00-00 | JUNKED | 6/9/2014 | 6/8/2017 | 1095 | Tubing Failure | Scale | Corrosion | $254.15 | Disassembled and inspected BHP CEGP-4511. The barrel and plunger were both worn from excessive friction. The hold down had thread damage. The traveling valve was worn with a fast leak. The standing valve was seized inside the standing cage. There was severe corrosion found throughout the BHP. A sample of scale was collected from the plunger. Junked BHP and put remaning parts into customer stock. |
| Q23-55 | 20-125-RHAC-12-03-00-00 | INSTALL | 6/8/2017 | | 127 | | | | $2,372.79 | |
| | | | | | Avg: 1095 | | | Avg of Total is $1,313.47 | Sum=$2,626 | |
| Well: (100) 03-[redacted] W4 | | | | | | | | | | |
| WDH-004 | 25-150-RWAC-14-04-00-00 | JUNKED | 5/12/2015 | 5/12/2017 | 731 | Hang Up | Scale | Foreign Material | $246.75 | Repair BHP #WDH-004, Job #QDH-149, 25-150-RWAC-14-4-0-0 w/top gas check, steel chrome barrel, spray metal plunger, CS insert guided travel cage, CS insert guided standing cage, titanium carbide balls & seats, CS/Teflon coated strainer nipple and bushing. BHP pulled as not pumping, seized by scale when brought to surface, spiral guide, valve rod guide, standing cage, strainer nipple, heavily coated with scale. |

Figure 1: Q2-Trak Well Summary view (demo), showing integrated pump installation details, reason-for-pull information, and failure comments for field evaluation.

### Integrated Data Engine

Q2-Trak consolidates publicly available production rates with internal records, including pump installations, run-life outcomes, and documented failure mechanisms. This unified context enables operators to directly connect production behavior to the equipment installed in the wellbore and the conditions in which it is operating (Figure 2).



PUMPSHEET

115761

PUMP SERVICE DETAILS

Customer: [redacted]
Ship To:
Customer Order No:
Pump Number: [redacted]
Pre-Service Pump Desc: 25-200-RWAC-14-03-00-00
Authorized By: Eric S.
Field: Alderson
From/Chng Well: [redacted]
Install Date: 12/10/2021
Pull Date: 2/22/2024
Pump Runlife Date: 803
PS Type: REPAIR
Pumpsheet Date: 2/21/2024
Failure Date: 2/21/2024
AFE: [redacted]
PO No:
Serviced By: Teren S.
Shipped From: 08(BROOKS) - BAY 1, 460 AQUADUCT DRIVE, BROOKS, AB

Invoice Comments: Repaired and returned to location

WEAR (Thousandths/Inch at Feet from Top)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barrel - Feet | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
| Pre-Service: | 2 | 3 | 3 | 2 | 4 | 5 | 4 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| Post Service: | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | |
|---|---|---|---|
| Plunger - Feet | 01 | 02 | 03 |
| Pre-Service: | 3 | 3 | 3 |
| Post Service: | 3 | 3 | 3 |

PARTS

| Prod Cat | Orig Item No | Mtrl | Cond | Runlife | Item No | Item Description | Mtrl | Qty | Price | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| COUPLINGS | CR86FTAS | N/A | OK | 867 | | | | | | |
| Accessory-Pump | 99W2C-25 | CS | OK | 867 | | | | | | |
| COUPLINGS | CR86FTAS | N/A | OK | 867 | | | | | | |
| FITTINGS-FS/SS | 523N | SS | OK | 867 | | | | | | |
| SM VALVE ROD | 518KD-168 | VRM | OK | 867 | | | | | | |
| FITTINGS-FS/SS | 547K | SS | OK | 1580 | | | | | | |
| PLGR SPR METAL | 502KD3-3 | PSM | OK | 1298 | | | | | | |
| CAGES - ONE PC | 539K-IG-1PC | SS/IG | OK | 1580 | | | | | | |
| VALVE - T/C | 12KCTC | UTC | OK | 867 | | | | | | |
| Accessory-Pump | TRULIFT200-DPSS | SS | CONV | 867 | GBV-200 | GAS BAILER VALVE 2" | CS | 1 | [redacted] | [redacted] |
| FITTINGS-FS/SS | 570N-IG1 | SS | OK | 867 | | | | | | |
| FITTINGS-FS/SS | 570N-IG1 | SS | OK | 867 | | | | | | |
| Accessory-Pump | 116N3-SP | BR | WRN | 867 | 116N3-SP | TOP CHECK PLUNGER MODIFIED 2-1/2" FOR 7/8" V.R. - BRASS | BR | 1 | [redacted] | [redacted] |
| FITTINGS-FS/SS | 585N | SS | OK | 867 | | | | | | |
| FITTINGS-BRASS | 8110N | BR | OK | 1580 | | | | | | |
| 625-626-SEATCUP | 625M+70P | NY | WRN | 803 | 625M+70P | SEATING CUP TYPE HR 2-5/4" + 70 PLASTIC | NY | 3 | [redacted] | [redacted] |
| FITTINGS-BRASS | 835N | BR | OK | 1580 | | | | | | |
| FITTINGS-FS/SS | 525NK | SS | OK | 1298 | | | | | | |
| BBL-BRASS CHRM | 815K14C | BBC | WRN | 1298 | 815K14C | BARREL RW 2 1/4" OD X 2"ID 14' BRASS CHROME | BBC | 1 | [redacted] | [redacted] |
| CAGES - ONE PC | 537M-IG-1PC | SS/IG | OK | 1580 | | | | | | |
| VALVE - T/C | 12MCTC | VTC | OK | 867 | | | | | | |
| FITTINGS-BRASS | 822N | BR | OK | 1580 | | | | | | |
| Accessory-Pump | 93D2LL-FF126 | N/A | OK | 1579 | | | | | | |
| CAGE INSERT GD | 70K-IG3 | TC | OK | 1580 | | | | | | |
| | | | | | LAB-D | DATA COLLECTION | | 1 | [redacted] | [redacted] |
| | | | | | LAB-E | ENVIRONMENTAL + SHOP SUPPLIES | | 1 | [redacted] | [redacted] |
| | | | | | LAB-Q | Q2 ALS SERVICE CHARGE | | 1 | [redacted] | [redacted] |

| | |
|---|---|
| SubTotal: | [redacted] |
| Freight Charges: | 0.00 |
| Tariff Charges: | 0.00 |
| GST(5.0000%): | [redacted] |
| Grand Total: | [redacted] |

Reason For Pull: Rod String Problem
Secondary Reason: Rod String Problem
Pump Failure Cause: None
Secondary Pump Failure Cause: None
Foreign Material: None
Post Service API Desc: 25-200-RWAC-14-03-00-00
Accessories Codes:
Post Service Maximum Stroke: 103.0000
To WellSite: [redacted]
Install Date: 2/23/2024

PumpSheet Notes: Pump was pulled the pump was in good condition the barrel was wearing on the ID the seat cups were worn the top check plunger was worn. The plunger cages and the valves were in good condition the Tru lift was changed to a Gas Bailer valve the put was repaired and returned to location.

Item: 537M-IG-1PC
Description: CAGE, 2-1/4" F/2" RW ONE PIECEINSERT GUIDED 316 STAINLESS
Disposition: OK
Comment: Sample of the small amount of solids in the cages

Item: 116N3-SP
Description: TOP CHECK PLUNGER MODIFIED BRASS 2-1/2" F 7/8" V.R.
Disposition: Worn
Comment: Top check plunger worn

Figure 2: Example pump sheet from Q2-Trak, linking installed components and failure observations, including visual evidence, to support equipment-performance evaluation.

### Performance Tracking

The platform presents over a terabyte of production data in consistent and comparable formats, enabling pre- and post-installation trend evaluation for specialty components (e.g., Q2 Flow, HVS Valve, WhaleShark and SharkTAC). Users can confirm run-life improvements, validate production gains, and assess equipment selection choices using actual field data rather than assumptions or delayed physical inspections. This enables real-time evaluation of artificial lift performance throughout the run life of a component, as illustrated in the production trend dashboard shown in Figure 3.

Figure 3: Pump Metrics Dashboard in Q2-Trak showing time-aligned oil, water, and gas production with pump history overlays for a single well.

### Real-Time Invoicing and Cost Visibility

As soon as a pump is entered into the system, cost records and well dashboards update automatically. Figure 4 illustrates how this real-time connection between equipment performance and financial impact allows operators to evaluate whether investments are delivering value and informs future equipment selection.

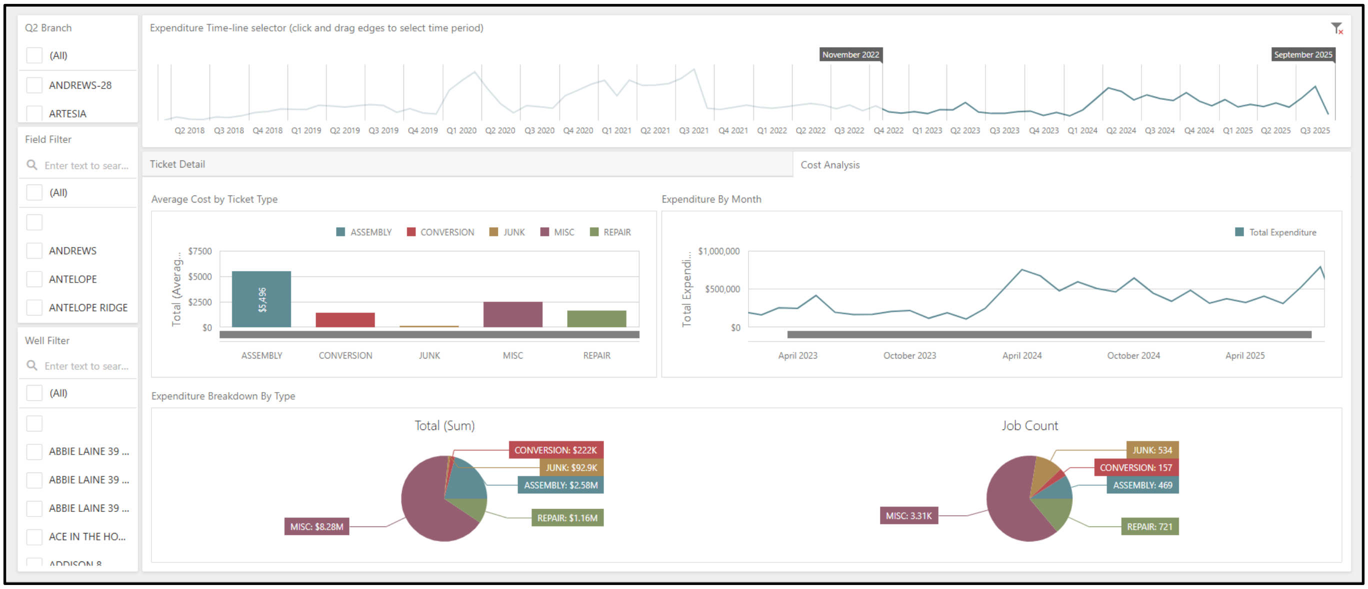


Figure 4: One of Q2-Trak's financial dashboards displaying expenditure trends, average cost by ticket type, and job count distribution, supporting real-time visibility into operational costs.

### Cross-Functional Collaboration

Q2-Trak provides common visibility to customers and internal Q2 ALS teams, including engineering, operations, sales, IT, and accounting, ensuring decisions are based on shared, up-to-date information. This transparency fosters clearer communication, faster issue resolution, and more reliable decision-making across the artificial lift workflow.

Together, these capabilities transform fragmented information into meaningful operational understanding. Replacing uncertainty with visibility and bringing clarity to areas of well performance that have long remained unseen.

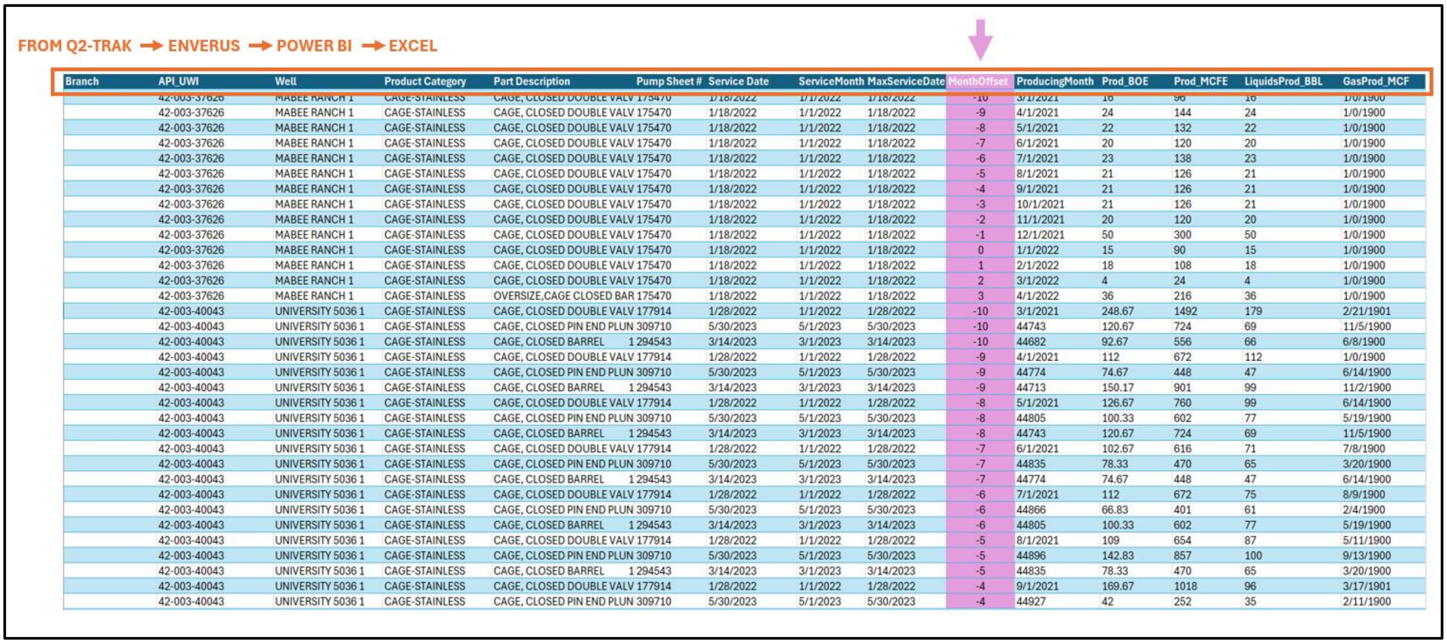
### Limitations & Considerations

Public production data includes a three-month reporting delay, meaning recent well activity may not immediately appear in Q2-Trak. While the platform provides structured access to production and equipment information, engineering judgment remains essential when evaluating performance outcomes. Artificial lift performance is influenced by reservoir factors, wellbore condition, and surface constraints beyond component selection, and these must be considered in assessment. As Q2-Trak continues to expand its data capabilities, system-supported performance evaluation will only evolve.

## BUILDING THE VIEW: STUDY METHODOLOGY

A retrospective performance analysis was conducted for Company X to evaluate the impact of various traveling and standing cage designs installed in rod-lift wells. The objective of the study was to quantify production behavior and reliability trends before and after specialty component installation using existing operational data.

Q2-Trak was first used to extract historical records for pumps installed within the study region. The exported dataset included installation dates, invoice details, product descriptions, failure mechanism comments, and well identifiers such as API or UWI numbers. These identifiers were then provided to Enverus, who matched the equipment history to publicly available production data for the same wells. The merged dataset was delivered through Power BI and exported to Microsoft Excel for analysis, as outlined in Figure 5.

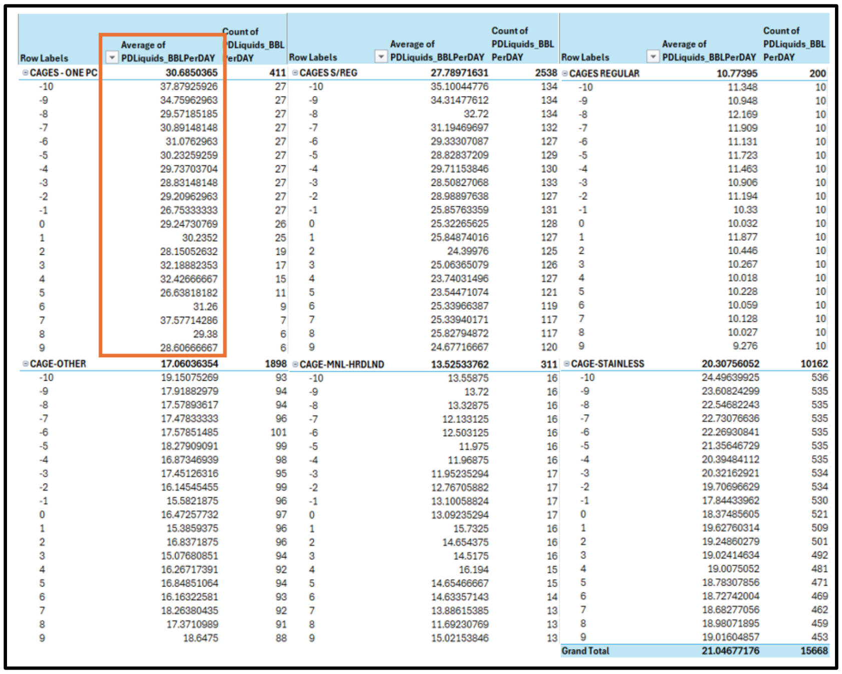


| Branch | API_UWI | Well | Product Category | Part Description | Pump Sheet # | Service Date | ServiceMonth | MaxServiceDate | MonthOffset | ProducingMonth | Prod_BOE | Prod_MCFE | LiquidsProd_BBL | GasProd_MCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -10 | 3/1/2021 | 16 | 96 | 16 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -9 | 4/1/2021 | 24 | 144 | 24 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -8 | 5/1/2021 | 22 | 132 | 22 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -7 | 6/1/2021 | 20 | 120 | 20 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -6 | 7/1/2021 | 23 | 138 | 23 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -5 | 8/1/2021 | 21 | 126 | 21 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -4 | 9/1/2021 | 21 | 126 | 21 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -3 | 10/1/2021 | 21 | 126 | 21 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -2 | 11/1/2021 | 20 | 120 | 20 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | -1 | 12/1/2021 | 50 | 300 | 50 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | 0 | 1/1/2022 | 15 | 90 | 15 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | 1 | 2/1/2022 | 18 | 108 | 18 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | 2 | 3/1/2022 | 4 | 24 | 4 | 1/0/1900 |
| | 42-003-37626 | MABEE RANCH 1 | CAGE-STAINLESS | OVERSIZE,CAGE CLOSED BAR | 175470 | 1/18/2022 | 1/1/2022 | 1/18/2022 | 3 | 4/1/2022 | 36 | 216 | 36 | 1/0/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -10 | 3/1/2021 | 248.67 | 1492 | 179 | 2/21/1901 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -10 | 44743 | 120.67 | 724 | 69 | 11/5/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -10 | 44682 | 92.67 | 556 | 66 | 6/8/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -9 | 4/1/2021 | 112 | 672 | 112 | 1/0/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -9 | 44774 | 74.67 | 448 | 47 | 6/14/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -9 | 44713 | 150.17 | 901 | 99 | 11/2/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -8 | 5/1/2021 | 126.67 | 760 | 99 | 6/14/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -8 | 44805 | 100.33 | 602 | 77 | 5/19/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -8 | 44743 | 120.67 | 724 | 69 | 11/5/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -7 | 6/1/2021 | 102.67 | 616 | 71 | 7/8/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -7 | 44835 | 78.33 | 470 | 65 | 3/20/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -7 | 44774 | 74.67 | 448 | 47 | 6/14/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -6 | 7/1/2021 | 112 | 672 | 75 | 8/9/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -6 | 44866 | 66.83 | 401 | 61 | 2/4/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -6 | 44805 | 100.33 | 602 | 77 | 5/19/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -5 | 8/1/2021 | 109 | 654 | 87 | 5/11/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -5 | 44896 | 142.83 | 857 | 100 | 9/13/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED BARREL 1 | 294543 | 3/14/2023 | 3/1/2023 | 3/14/2023 | -5 | 44835 | 78.33 | 470 | 65 | 3/20/1900 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED DOUBLE VALV | 177914 | 1/28/2022 | 1/1/2022 | 1/28/2022 | -4 | 9/1/2021 | 169.67 | 1018 | 96 | 3/17/1901 |
| | 42-003-40043 | UNIVERSITY 5036 1 | CAGE-STAINLESS | CAGE, CLOSED PIN END PLUN | 309710 | 5/30/2023 | 5/1/2023 | 5/30/2023 | -4 | 44927 | 42 | 252 | 35 | 2/11/1900 |

Figure 5: Data workflow used in this study: records were extracted from Q2-Trak, production data was aligned in Enverus and Power BI, and the merged dataset was exported to Excel for analysis. The standardized Month Offset index (highlighted) enables aligned pre- and post-installation performance comparison across wells.

The combined dataset contained time-aligned production metrics including total liquid rate, oil and gas volumes, water cut, and flowing behavior indicators. Each well record also included a standardized Month Offset value, where zero represents the installation month of that specific cage. Negative values correspond to well production before installation, and positive values reflect production while the new cage was in operation. Most wells contained at least nine months of data before and after installation, providing a meaningful period for evaluation.

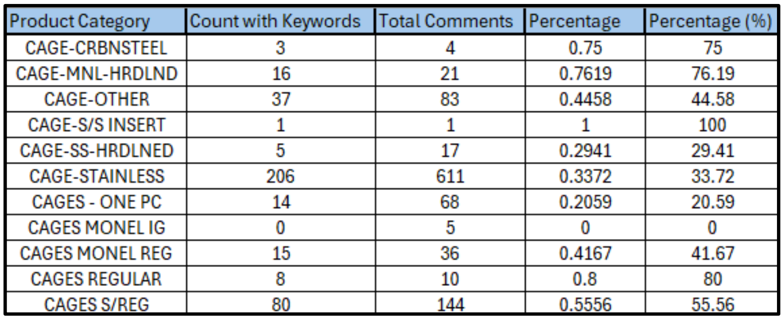
Production trends were evaluated in Excel using pivot tables (Figure 6). Liquid production in barrels per day was plotted for each cage type and normalized to account for differences in sample size and reservoir variability. Trendlines were applied to observe shifts in well performance following component installation. To assess product prevalence and ensure appropriate weighting in interpretation, cage count distributions were also generated using pivot tables. Pie charts (Seen in Figure 10) illustrated the proportional use of each cage design within each operating district, helping contextualize performance results relative to deployment frequency.



| Row Labels | Average of PDLiquids_BBLPerDAY | Count of PDLiquids_BBL PerDAY | Row Labels | Average of PDLiquids_BBLPerDAY | Count of PDLiquids_BBL PerDAY | Row Labels | Average of PDLiquids_BBLPerDAY | Count of PDLiquids_BBL PerDAY |
|---|---|---|---|---|---|---|---|---|
| **⊟CAGES - ONE PC** | **30.6850365** | **411** | **⊟CAGES S/REG** | **27.78971631** | **2538** | **⊟CAGES REGULAR** | **10.77395** | **200** |
| -10 | 37.87925926 | 27 | -10 | 35.10044776 | 134 | -10 | 11.348 | 10 |
| -9 | 34.75962963 | 27 | -9 | 34.31477612 | 134 | -9 | 10.948 | 10 |
| -8 | 29.57185185 | 27 | -8 | 32.72 | 134 | -8 | 12.169 | 10 |
| -7 | 30.89148148 | 27 | -7 | 31.19469697 | 132 | -7 | 11.909 | 10 |
| -6 | 31.0762963 | 27 | -6 | 29.33307087 | 127 | -6 | 11.131 | 10 |
| -5 | 30.23259259 | 27 | -5 | 28.82837209 | 129 | -5 | 11.723 | 10 |
| -4 | 29.73703704 | 27 | -4 | 29.71153846 | 130 | -4 | 11.463 | 10 |
| -3 | 28.83148148 | 27 | -3 | 28.50827068 | 133 | -3 | 10.906 | 10 |
| -2 | 29.20962963 | 27 | -2 | 28.98897638 | 127 | -2 | 11.194 | 10 |
| -1 | 26.75333333 | 27 | -1 | 25.85763359 | 131 | -1 | 10.33 | 10 |
| 0 | 29.24730769 | 26 | 0 | 25.32265625 | 128 | 0 | 10.032 | 10 |
| 1 | 30.2352 | 25 | 1 | 25.84874016 | 127 | 1 | 11.877 | 10 |
| 2 | 28.15052632 | 19 | 2 | 24.39976 | 125 | 2 | 10.446 | 10 |
| 3 | 32.18882353 | 17 | 3 | 25.06365079 | 126 | 3 | 10.267 | 10 |
| 4 | 32.42666667 | 15 | 4 | 23.74031496 | 127 | 4 | 10.018 | 10 |
| 5 | 26.63818182 | 11 | 5 | 23.54471074 | 121 | 5 | 10.228 | 10 |
| 6 | 31.26 | 9 | 6 | 25.33966387 | 119 | 6 | 10.059 | 10 |
| 7 | 37.57714286 | 7 | 7 | 25.33940171 | 117 | 7 | 10.128 | 10 |
| 8 | 29.38 | 6 | 8 | 25.82794872 | 117 | 8 | 10.027 | 10 |
| 9 | 28.60666667 | 6 | 9 | 24.67716667 | 120 | 9 | 9.276 | 10 |
| **⊟CAGE-OTHER** | **17.06036354** | **1898** | **⊟CAGE-MNL-HRDLND** | **13.52533762** | **311** | **⊟CAGE-STAINLESS** | **20.30756052** | **10162** |
| -10 | 19.15075269 | 93 | -10 | 13.55875 | 16 | -10 | 24.49639925 | 536 |
| -9 | 17.91882979 | 94 | -9 | 13.72 | 16 | -9 | 23.60824299 | 535 |
| -8 | 17.57893617 | 94 | -8 | 13.32875 | 16 | -8 | 22.54682243 | 535 |
| -7 | 17.47833333 | 96 | -7 | 12.133125 | 16 | -7 | 22.73076636 | 535 |
| -6 | 17.57851485 | 101 | -6 | 12.503125 | 16 | -6 | 22.26930841 | 535 |
| -5 | 18.27909091 | 99 | -5 | 11.975 | 16 | -5 | 21.35646729 | 535 |
| -4 | 16.87346939 | 98 | -4 | 11.96875 | 16 | -4 | 20.39484112 | 535 |
| -3 | 17.45126316 | 95 | -3 | 11.95235294 | 17 | -3 | 20.32162921 | 534 |
| -2 | 16.14545455 | 99 | -2 | 12.76705882 | 17 | -2 | 19.70696629 | 534 |
| -1 | 15.5821875 | 96 | -1 | 13.10058824 | 17 | -1 | 17.84433962 | 530 |
| 0 | 16.47257732 | 97 | 0 | 13.09235294 | 17 | 0 | 18.37485605 | 521 |
| 1 | 15.3859375 | 96 | 1 | 15.7325 | 16 | 1 | 19.62760314 | 509 |
| 2 | 16.8371875 | 96 | 2 | 14.654375 | 16 | 2 | 19.24860279 | 501 |
| 3 | 15.07680851 | 94 | 3 | 14.5175 | 16 | 3 | 19.02414634 | 492 |
| 4 | 16.26717391 | 92 | 4 | 16.194 | 15 | 4 | 19.0075052 | 481 |
| 5 | 16.84851064 | 94 | 5 | 14.65466667 | 15 | 5 | 18.78307856 | 471 |
| 6 | 16.16322581 | 93 | 6 | 14.63357143 | 14 | 6 | 18.72742004 | 469 |
| 7 | 18.26380435 | 92 | 7 | 13.88615385 | 13 | 7 | 18.68277056 | 462 |
| 8 | 17.3710989 | 91 | 8 | 11.69230769 | 13 | 8 | 18.98071895 | 459 |
| 9 | 18.6475 | 88 | 9 | 15.02153846 | 13 | 9 | 19.01604857 | 453 |
|  |  |  |  |  |  | **Grand Total** | **21.04677176** | **15668** |

Figure 6: Pivot-table summary of average liquid production (BBL/day) by Month Offset and cage type, used to normalize production behavior across wells.

A complementary evaluation was performed on field-recorded failure comments to identify recurring issues by cage design. These comments, which include descriptions such as *"beat-out," "leaked," "ball worn," "cage worn,"* and *"valve worn,"* were extracted from pump pull documentation and processed using Copilot to automatically categorize and quantify occurrences of these keywords. The results were then normalized as a percentage of total recorded comments for each cage type to support unbiased comparison of reliability across designs, as summarized in Figure 7.



| Product Category | Count with Keywords | Total Comments | Percentage | Percentage (%) |
|---|---|---|---|---|
| CAGE-CRBNSTEEL | 3 | 4 | 0.75 | 75 |
| CAGE-MNL-HRDLND | 16 | 21 | 0.7619 | 76.19 |
| CAGE-OTHER | 37 | 83 | 0.4458 | 44.58 |
| CAGE-S/S INSERT | 1 | 1 | 1 | 100 |
| CAGE-SS-HRDLNED | 5 | 17 | 0.2941 | 29.41 |
| CAGE-STAINLESS | 206 | 611 | 0.3372 | 33.72 |
| CAGES - ONE PC | 14 | 68 | 0.2059 | 20.59 |
| CAGES MONEL IG | 0 | 5 | 0 | 0 |
| CAGES MONEL REG | 15 | 36 | 0.4167 | 41.67 |
| CAGES REGULAR | 8 | 10 | 0.8 | 80 |
| CAGES S/REG | 80 | 144 | 0.5556 | 55.56 |

Figure 7: Summary table showing the percentage of failure-related comments associated with each cage type, reflecting relative reliability differences across configurations.

Together, these steps created a consistent framework for evaluating whether specialty cage designs influence production trajectory and component durability under real-world operating conditions. The next section presents the results of this analysis, including production performance outcomes and observed differences in failure-related comment frequency between cage types.

## REVEALING PRODUCTION AND RELIABILITY TRENDS: RESULTS & INSIGHTS

The objective of this analysis was to compare Q2 ALS's one-piece Q2 Flow cage with several traditional cage designs in Company X's Permian Basin operations, using aligned production and reliability data (Figure 8).

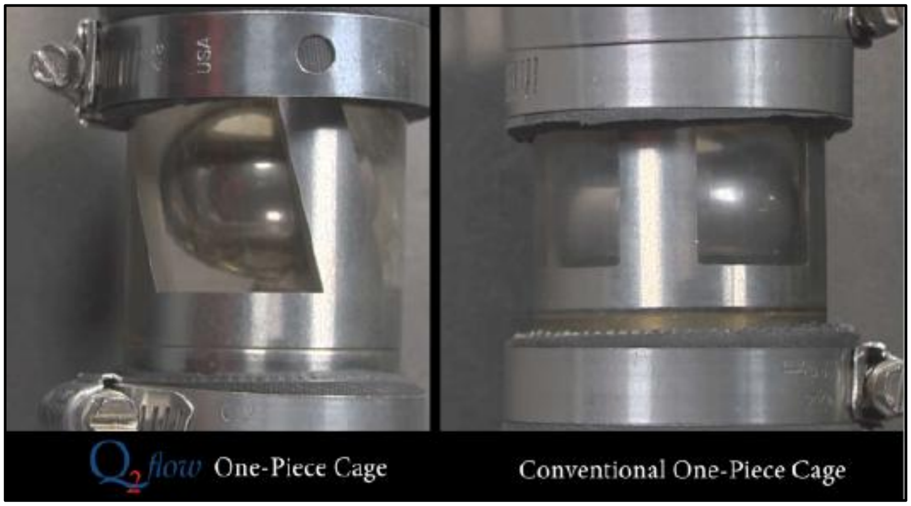


Figure 8: Q2 Flow one-piece cage (left) versus a conventional one-piece cage (right), showing differences in internal flow geometry.

## Production Analysis

Across 1,811 cage installations reviewed in Company X's study area, roughly 22% utilized standard double-valve cage designs, which are known to increase pressure drop by up to 70% when paired with API standard balls. As reflected in the normalized production curves, wells operating with these traditional cage types generally showed a continued decline in liquid production after installation, indicating increasing flow restriction through the pump over time (Figure 9).

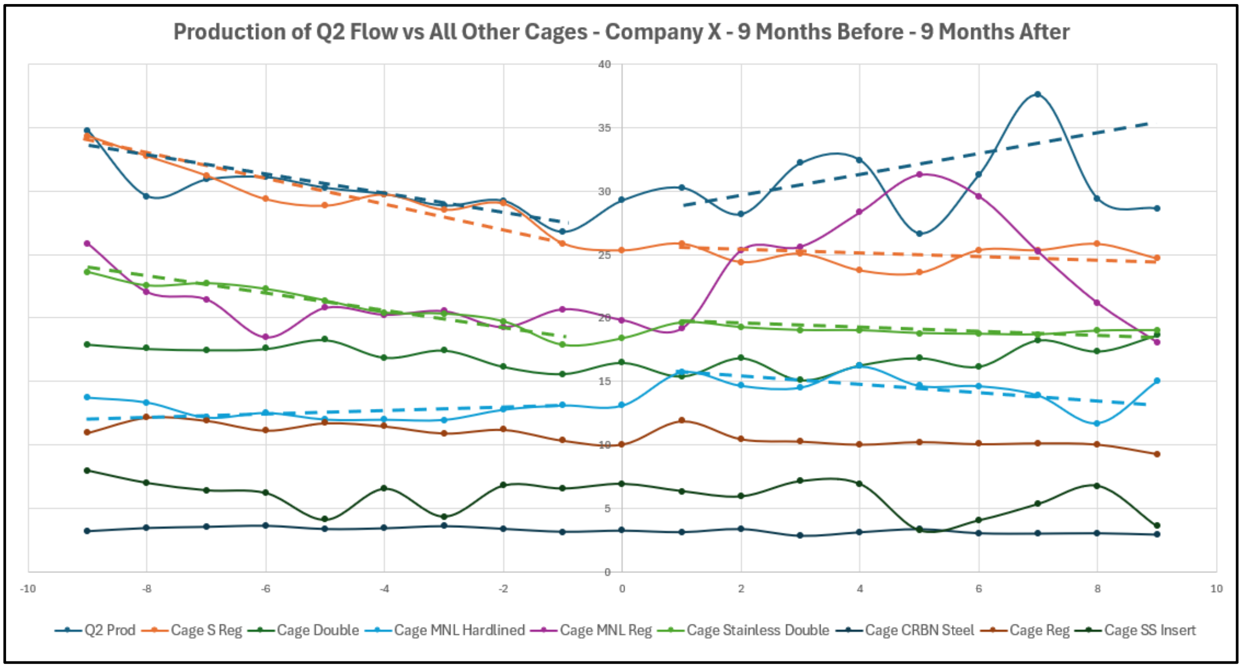


Figure 9: Normalized production trends for Q2 Flow (Dark Blue) and conventional cage designs across Company X wells.

In contrast, wells equipped with the Q2 Flow one-piece cage demonstrated a distinct positive shift in production trajectory following installation. Although fewer of these cages were deployed in this district (26 installations, Figure 10), the month-offset results showed a clear improvement in slope direction relative to baseline performance. Where other cage types continued gradual decline, the Q2 Flow curve recovered and increased after installation, indicating more stable deliverability under similar reservoir and operating conditions.

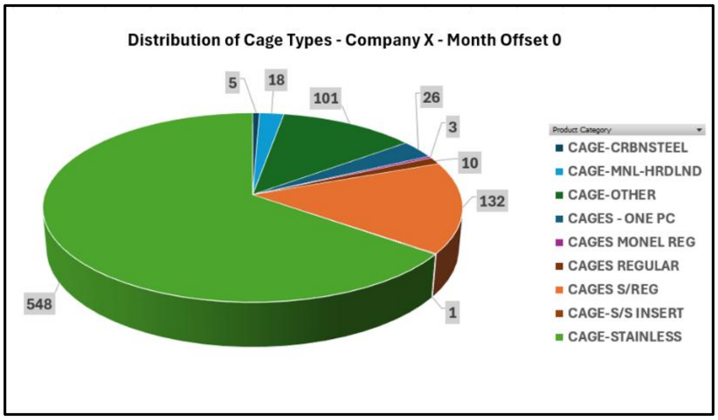


Figure 10: Distribution of cage types at Company X at installation month, including 26 Q2 Flow one-piece cages.

This measurable divergence in production behavior suggests that reduced pressure drop and improved flow efficiency associated with the Q2 Flow one-piece cage are reflected in real-world well performance. Even with a smaller deployment count, the strength and consistency of the upward trajectory position Q2 Flow as a notably higher-performing option compared to the standard configurations included in this evaluation.

## Failure Analysis

Across all cage types evaluated, the Q2 Flow one-piece cage demonstrated the lowest incidence of reported cage- or valve-related issues, with only 21% of comments referencing these concerns. In comparison, several conventional configurations exhibited substantially higher failure-related percentages, including stainless-steel cages at 34%, and Monel regular cages at 42%, indicating more frequent wear- and seal-related challenges. Additional reliability outcomes for all cage designs are summarized in Figure 11.

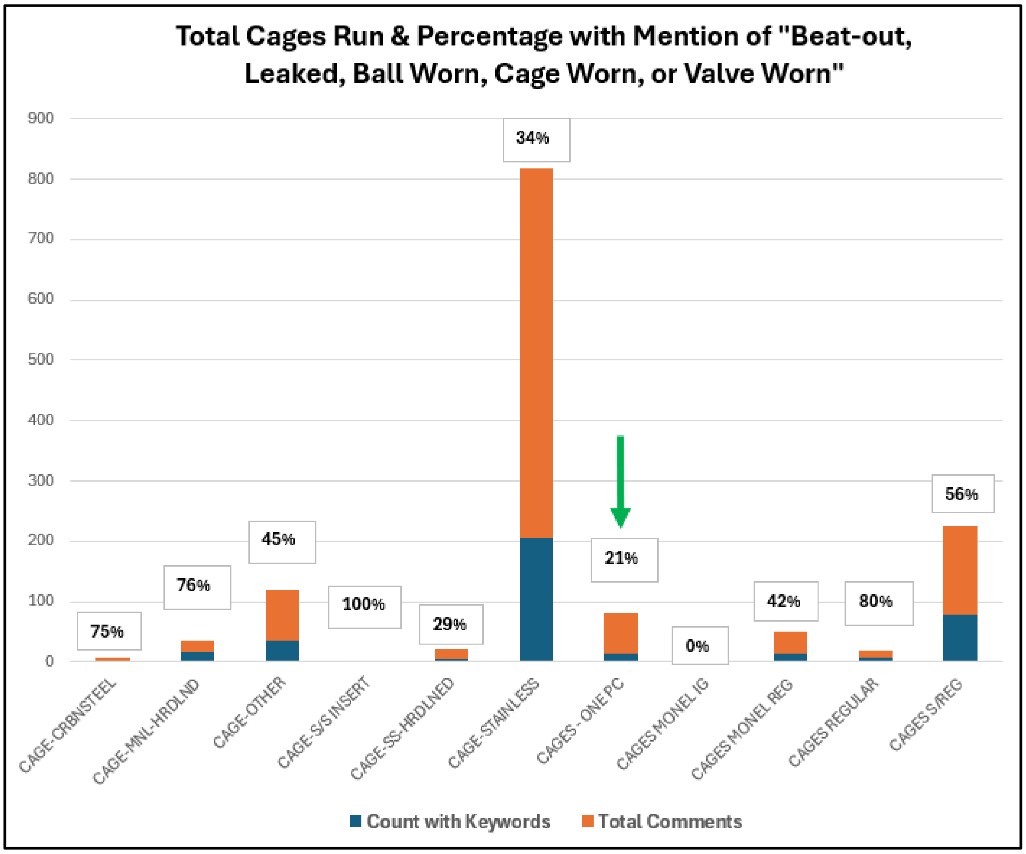


Figure 11: Percentage of failure-related comments by cage type, showing the Q2 Flow one-piece cage with the lowest incidence at 21%, compared to significantly higher rates in other configurations.

Despite its smaller deployment count within the dataset, Q2 Flow maintained both lower failure comment frequency and reduced severity of leakage and wear indicators relative to traditional designs. These findings reflect a meaningful reliability advantage, with fewer reported mechanical degradation issues during service life.

### Interpretation

The alignment between improved production trajectory and reduced failure incidence suggests that the Q2 Flow cage supports both sustained deliverability and enhanced component durability under comparable operating conditions.

These insights were enabled through Q2-Trak's ability to align production history with equipment configuration and run-life documentation across Company X's asset base. By bringing these datasets into a single comparable structure, operators were able to verify value from specialty components using actual field performance rather than assumptions or delayed well interventions.

## CLARITY BENEATH THE SURFACE: CONCLUSIONS

This case study demonstrated how integrated access to production behavior, equipment configuration, and run-life documentation can support clearer performance evaluation in rod-lift operations. By aligning existing operational data within Q2-Trak, Q2 ALS engineers were able to compare field performance across multiple cage designs for Company X, revealing measurable differences in both production trajectory and reliability outcomes.

These findings reinforce the importance of visibility when evaluating specialty artificial-lift components. Without unified access to production behavior during run life, operators are left uncertain whether equipment changes are truly improving outcomes. Q2-Trak addresses this gap by enabling decisions to be supported with field-based evidence rather than delayed diagnostics or assumptions. When performance clarity replaces operational uncertainty, operators gain confidence that their investments are working below the surface, even when they cannot see into the well directly.

The implications for the industry extend beyond this study. As datasets expand and platform adoption increases, artificial-lift decisions can become faster, more proactive, and more financially accountable. Continued development has the potential to incorporate greater automation and AI-assisted analytics, further enhancing performance benchmarking and supporting operational decision-making. These opportunities represent a path toward increasingly efficient optimization across wells.

By illuminating the connection between equipment selection and production outcomes, Q2-Trak brings long-obscured well behavior into view and provides operators a clearer path toward sustained artificial-lift performance.

## Acknowledgements

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