



Enhanced Operational Efficiency Combining Gas Lift with Flow Improver

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Synergistic Solution

- Hybrid lift approach using chemical flow improvers in conjunction with conventional gas lift
- Used in pre-identified and selected wells/scenarios
- **Ultimate goal = improve flowing conditions to optimize existing gas lift**
- ROI based on bridging the gap between theoretical VLP vs actual
 - Typical outcomes are an uplift of 20% gross fluid production

GAS LIFT + FLOW IMPROVER = ↑ SALES & ↓ OPEX

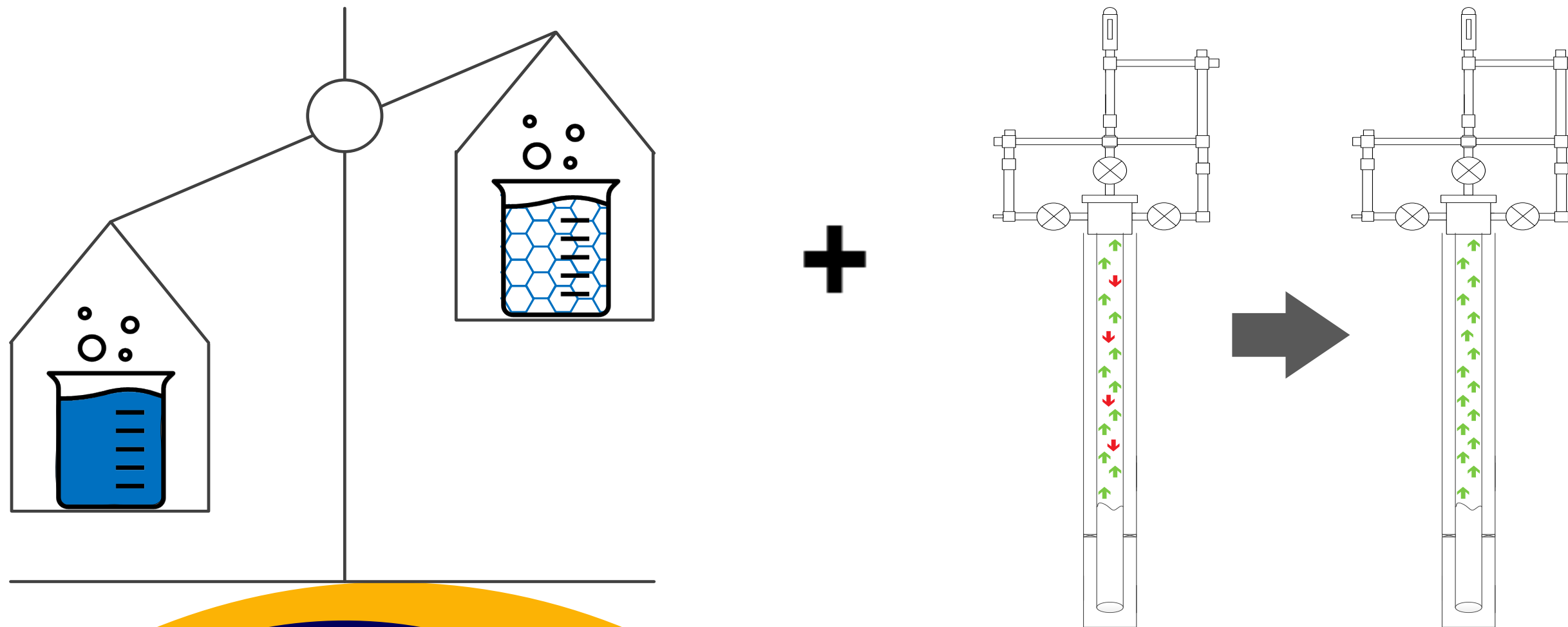
What is Foam?

- Object formed by trapping pockets of gas within a liquid/solid.
- Many types we interact with daily

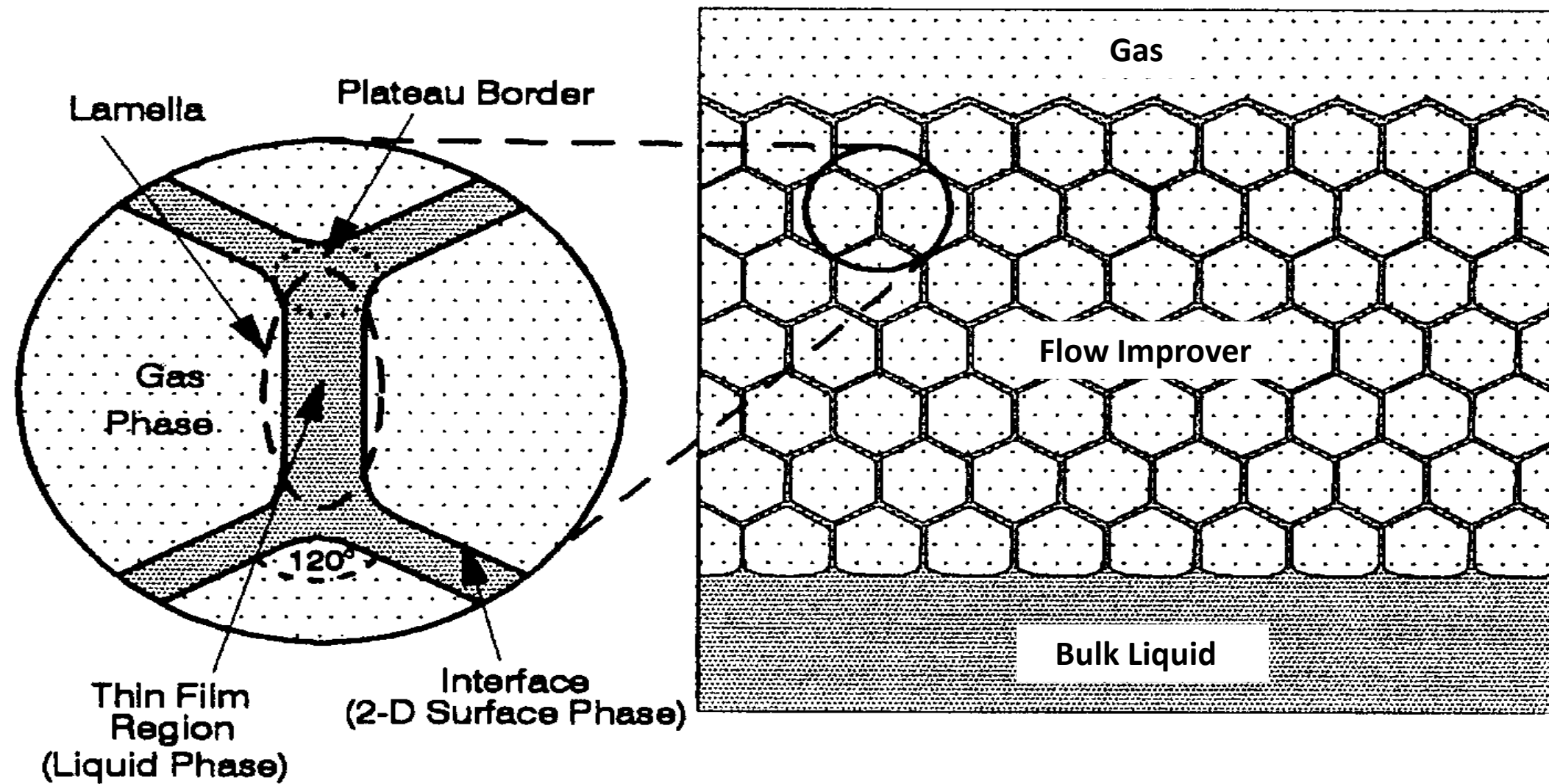


Gas Lift Flow Improver

- A GLFI reduces the velocity required to lift fluids out of a wellbore
 - Reduces fluid column density and slippage (“lightens” fluid load)



GLFI Assists Gas in Lifting Fluids to Surface



Gas is colloiddally dispersed into a continuous liquid phase

Candidate Selection/Field Trial

- Picking the right well
- Selecting the correct chemistry/concentration
- Determining application
- Setting the right trial and monitoring plan
- Interpreting the results
- Extrapolating results to the rest of the field

Candidate Well Selection

- Modeled to be below critical rate
- Departure from expected VLP curves
- Gas lift system bottlenecks
- Irregular production/flow patterns

Selecting the Right Chemistry/Concentration

Which
product
and how
much?

Will my
injection
equipment
be able to
handle it?

- **Benchtop Qualification Testing**

- Bottle Test
- Waring Blender
- Sparge/Small Column
- Large Column
- Surface Tension

- **Material Compatibilities**

- Metallics
- Non-metals

- **Fluid Compatibilities**

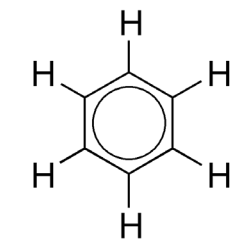
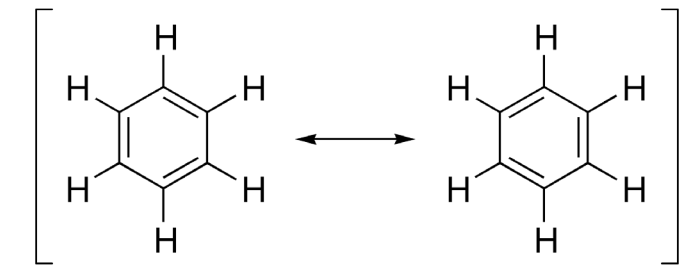
- Water-in-oil emulsion tendency
- Oil-in-water emulsion tendency

- **Physical Properties**

- Pour Point (winterization)
- Flash Point/Gunking Tendency (application specific)
- Viscosity (chemical pump requirements)

Performance Influencers

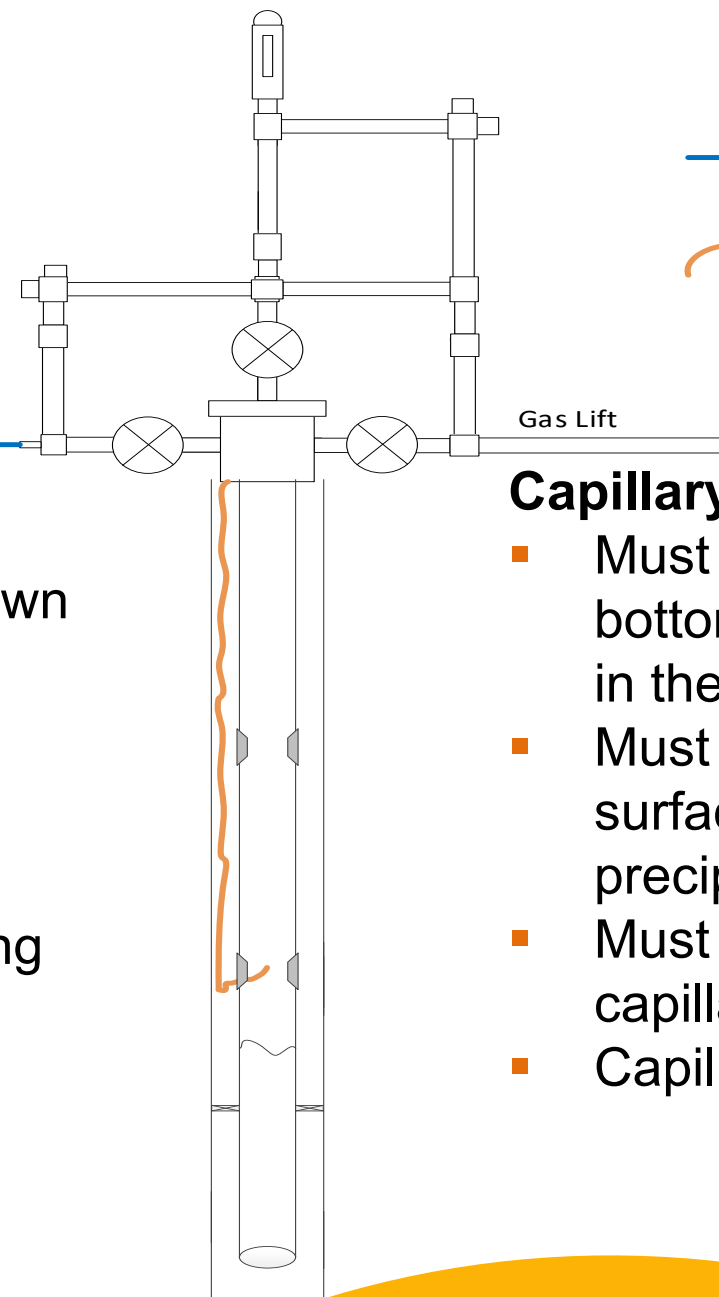
- Percent Hydrocarbons
 - More hydrocarbons = higher flow improver concentrations needed
- Hydrocarbon Composition
 - Aromatic content has greatest (negative) impact
- Brine Chemistry
 - TDS and TSS increase the weight of the fluid to lift and impact lamella
- Velocities
 - Excessive shear can impact foam stability both ways



Picking Application (Continuous)

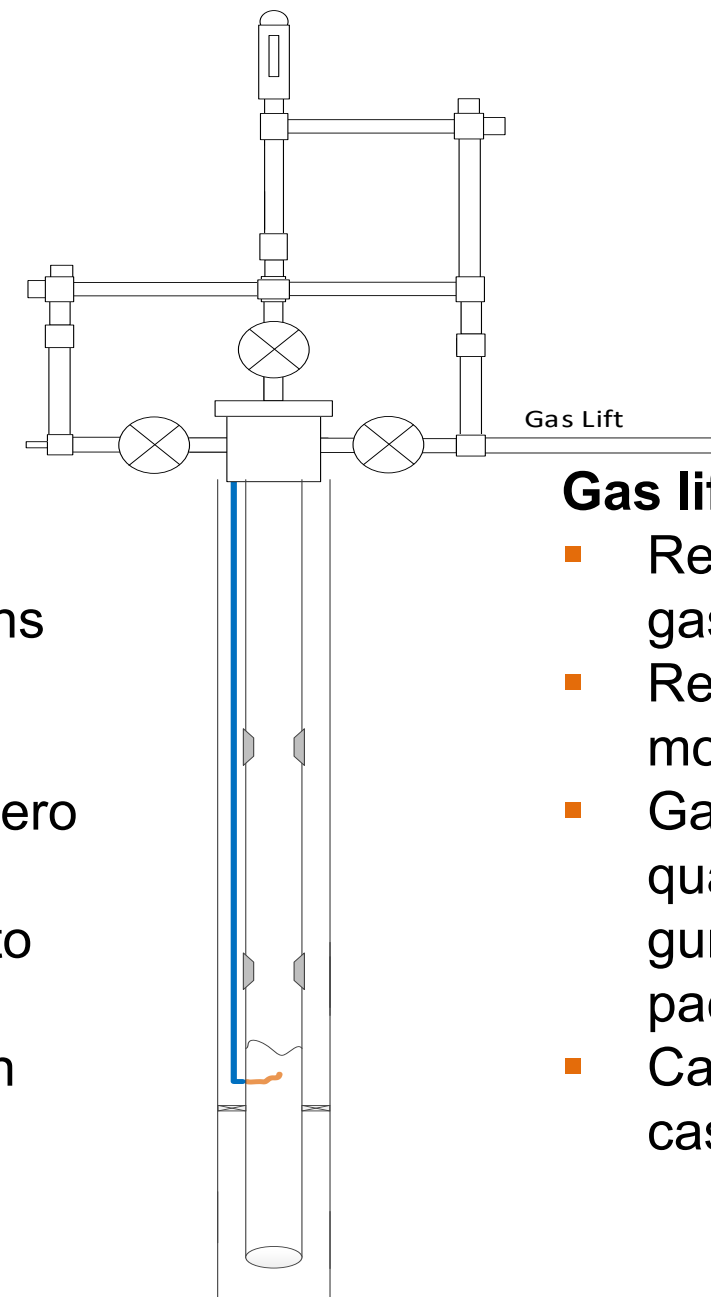
Annular (Backside) Injection

- Required to travel down the casing
- Can be “lost” to the casing
- Formulation must be compatible with casing metallurgy
- Annular qualification



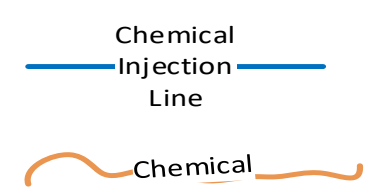
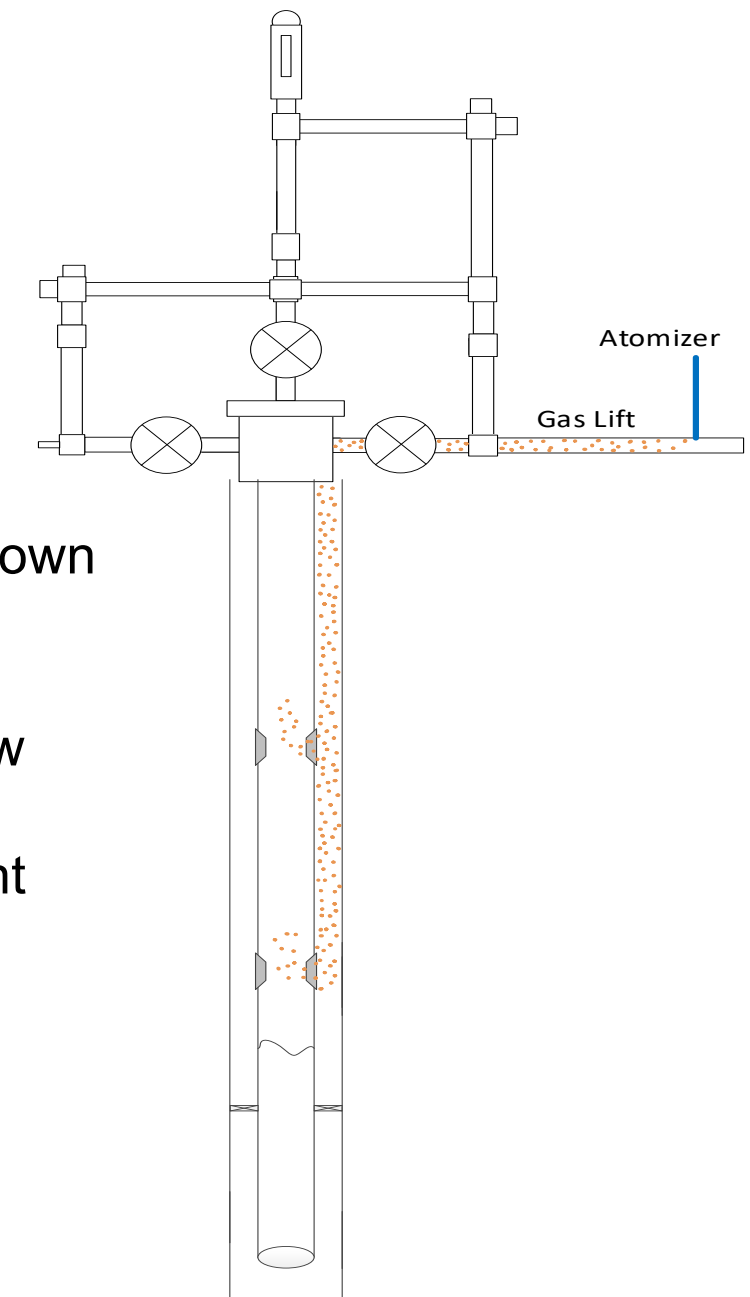
Capillary injection

- Must be stable at bottom hole conditions in the cap string
- Must be stable at surface conditions (zero precipitation)
- Must be compatible to capillary metallurgy
- Capillary qualification



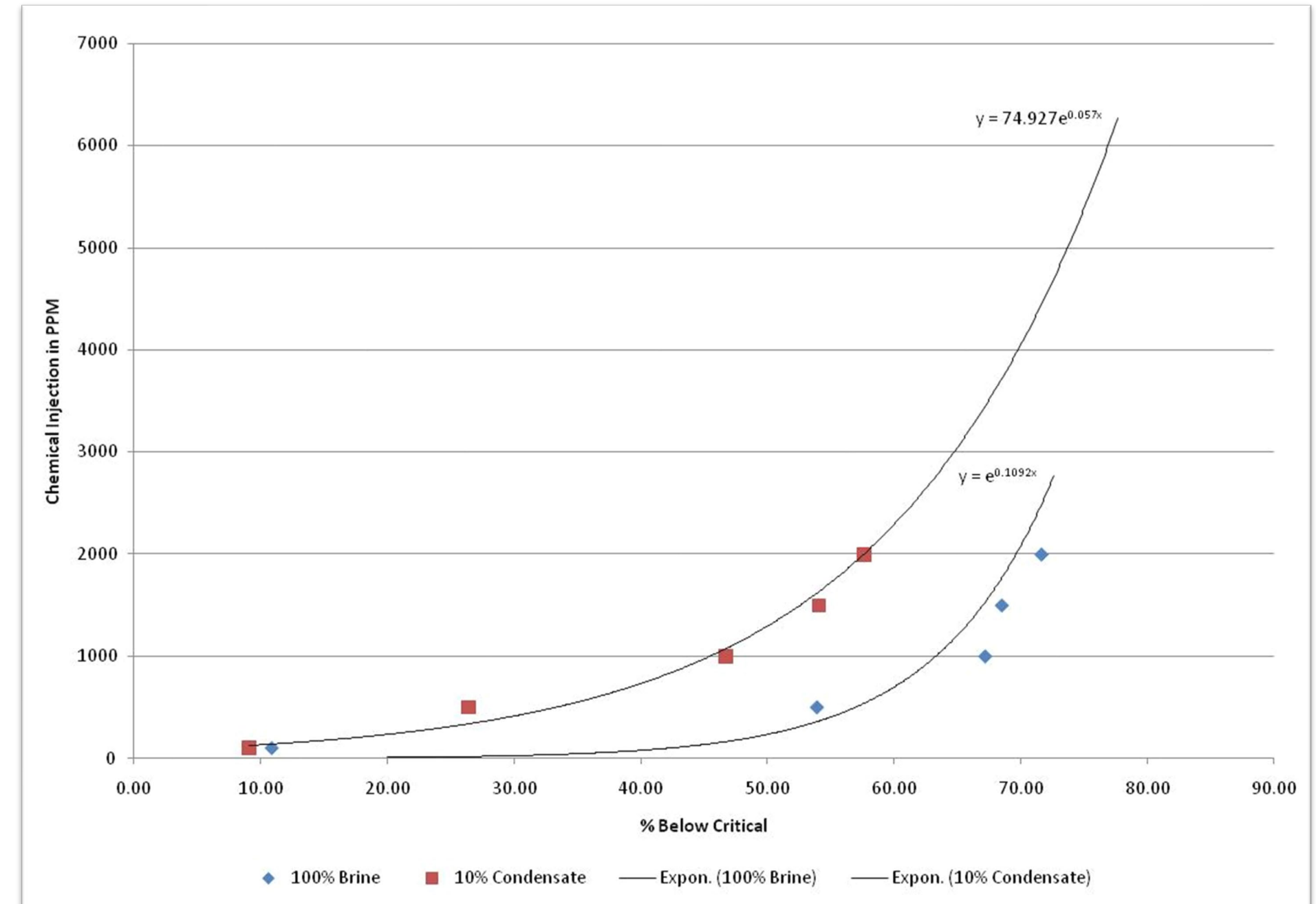
Gas lift injection

- Required to travel down gas lift line
- Required to remain mobile in gas lift flow
- Gas lift injection qualification (prevent gunking/solvent package stripping)
- Can be “lost” to the casing



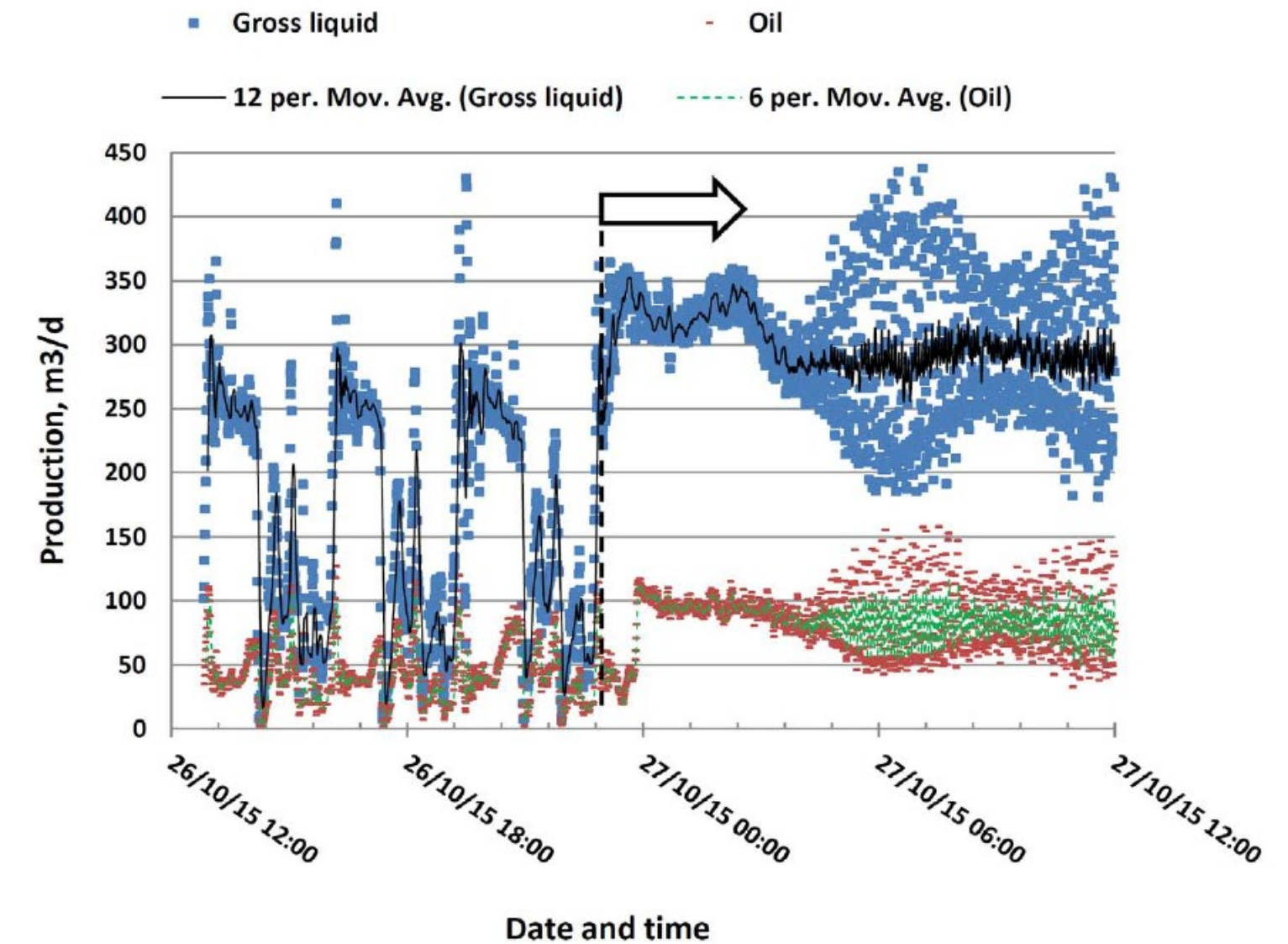
Field Trial (Monitoring)

- Establish key surveillance metrics
 - Production parameters (P, T, Q)
 - Gas lift volumes
 - BS&W values
 - OIW values
 - Vessel levels/visual observations
- Record baselines
- Initiate flow improver injection at desired PPM
- Adjust in stepped intervals and build foamer response curve, recording data at each step
 - Response time may vary based on application method used
- Once flow improver concentration is optimized, adjust gas lift volume down until production parameters just begin to decline



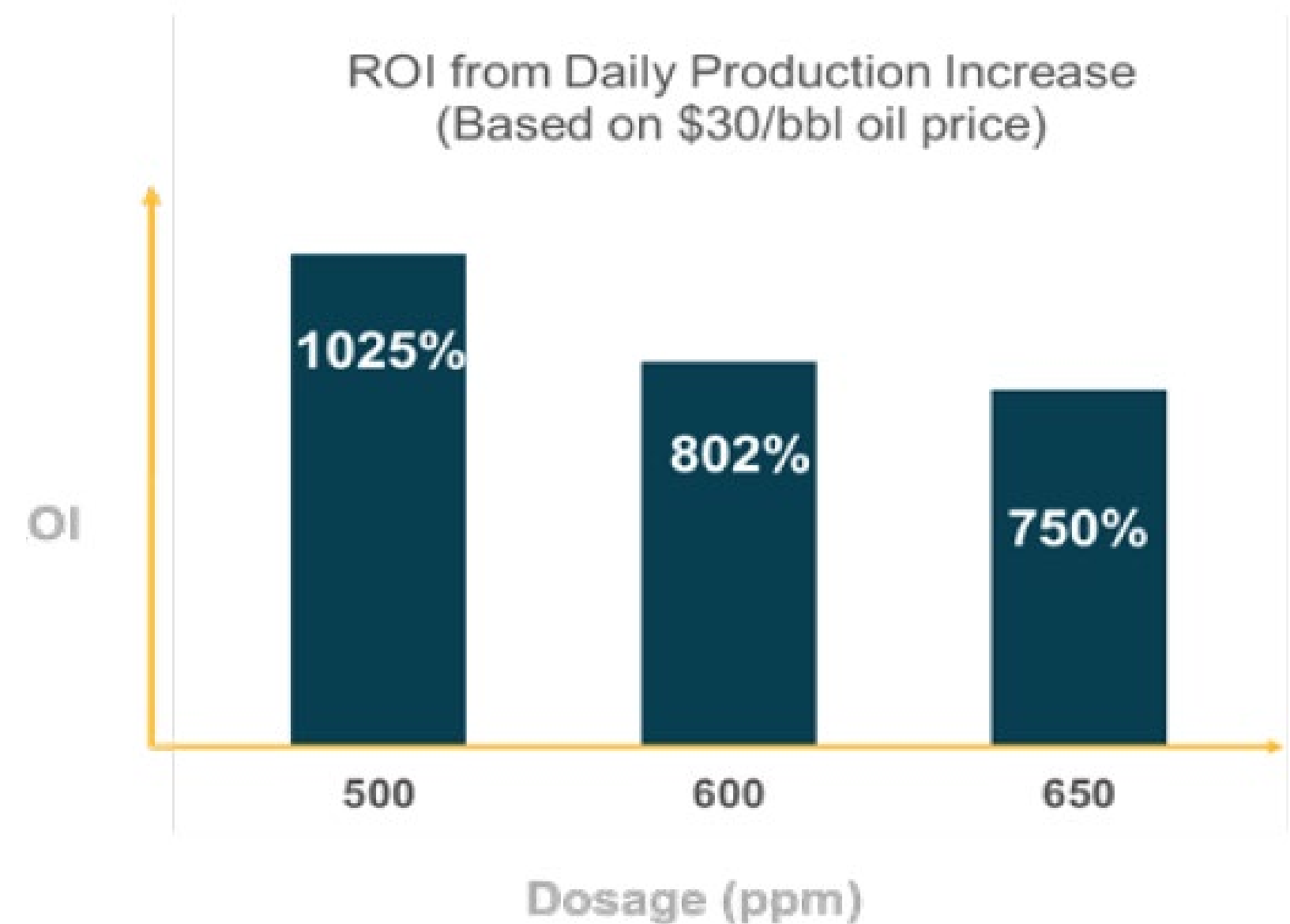
Measuring Success

Example Outcome	Production (Liquids) Rate	Gas Lift Rate	Equipment OPEX	Chemical OPEX	TCO	ROI
More Oil with Less Gas	▲	▼	▼	▲	▼	▲
Same Oil with Less Gas	—	▼	▼	▲	▼	▲
More Oil with Same Gas	▲	—	—	▲	▲	▲
Same Oil with Same Gas	—	—	—	▲	▲	▼
More Oil with More Gas	▲	▲	▲	—	▲	—



Return on Investment (ROI)

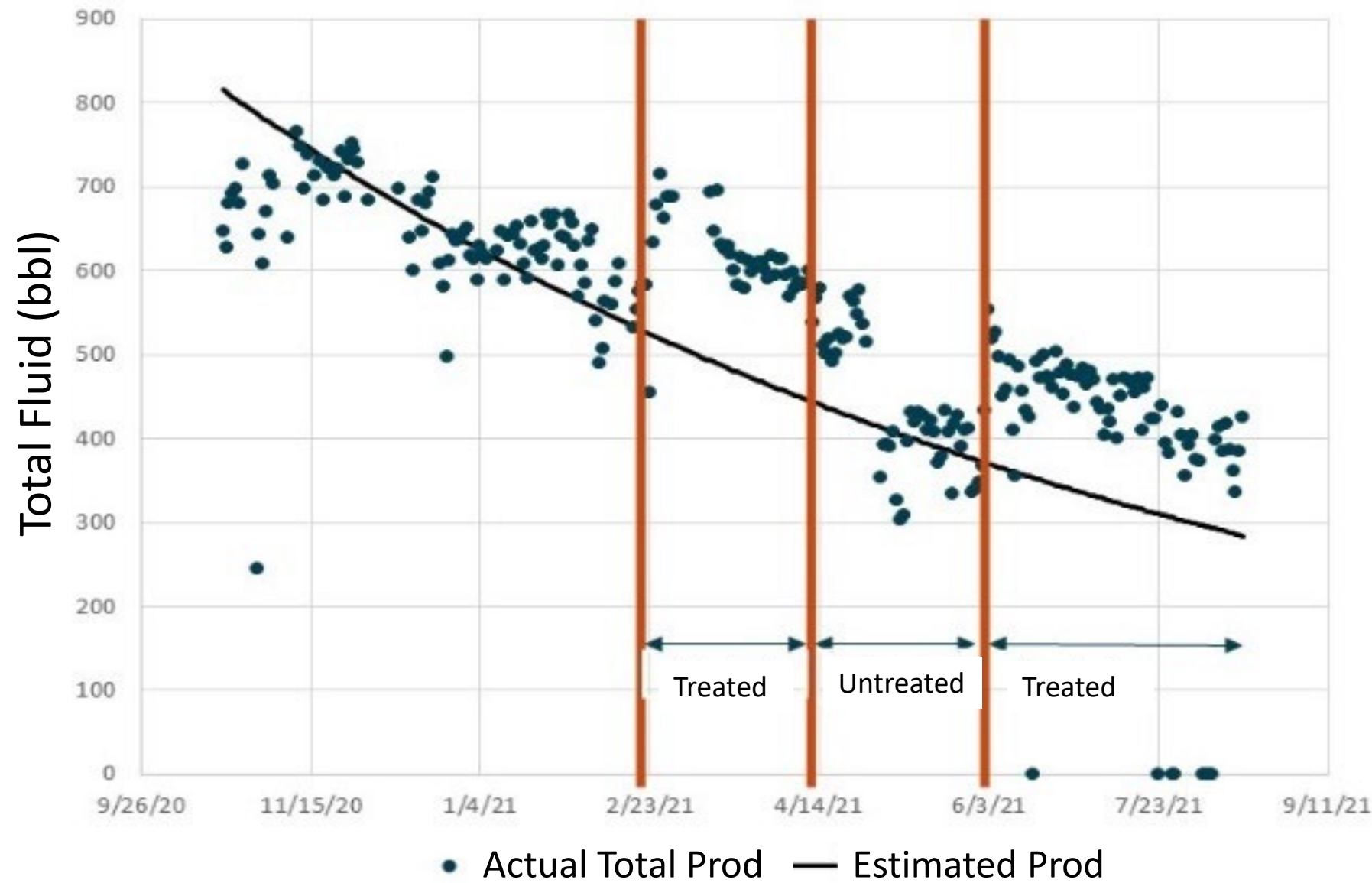
- Typical successes range from 20%+ more production
 - SPE-184217-MS
 - SPE-189201-MS
 - SPE-195452-MS
- Success will be situation and well dependent



* Actual Delaware Basin examples without gas lift optimization
 * * ROI based solely off liquid production increase via GLFI

Production Summary

Production (GLFI versus Untreated)



Well	Initial BTFD	Average Increase BTFD	Average Uplift (%)
1	606	254	42
2	550	193	35
3	769	200	26
4	810	129	16
5	1126	135	12
6	581	41	7
7	1279	76	6

Thank You!

Q&A

We welcome your questions!

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