WELLWORX

Artificial Lift R&D Council

A Case Study Regarding Further Improvements to Packer-Style Separator in Permian Basin

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ALRDC Artificial Lift Workshop
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AGENDA

- Background
- Why is Artificial Lift So Challenging?
- Importance of the BHA
- Casing Gas Rates Captured
- Overview and Flowpath
- Design Considerations
- Case Study Results
- Conclusion

BACKGROUND

New unconventional wells in the Permian Basin have been very challenging to convert from ESP to Rod Pump due to high gas to liquid ratio's experienced early in the life of the well.

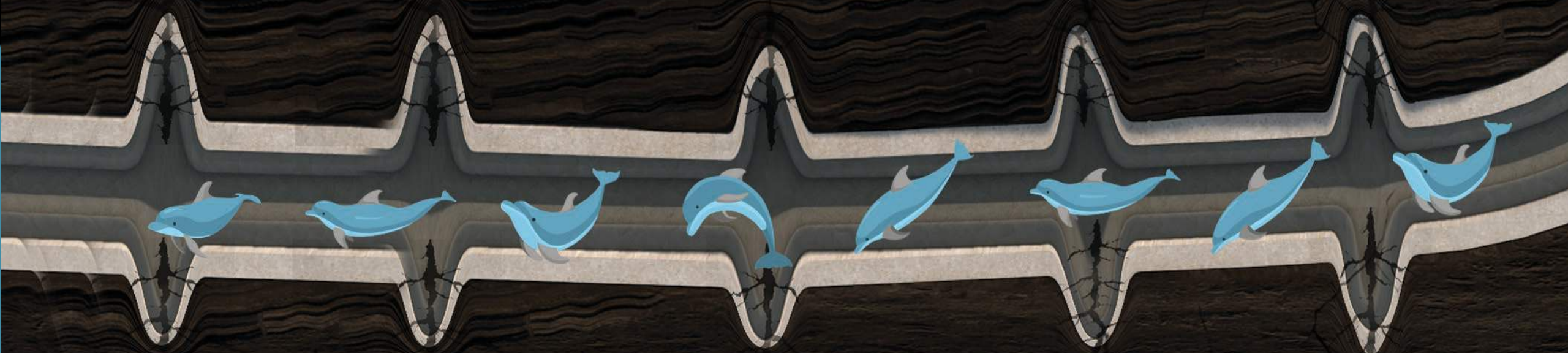
ESP's by nature are designed to pump only liquids and have difficulty handling a large amount of free gas.

While automation on the rod pump form of lift cannot differentiate between pump off and gas interference scenarios limiting runtimes.

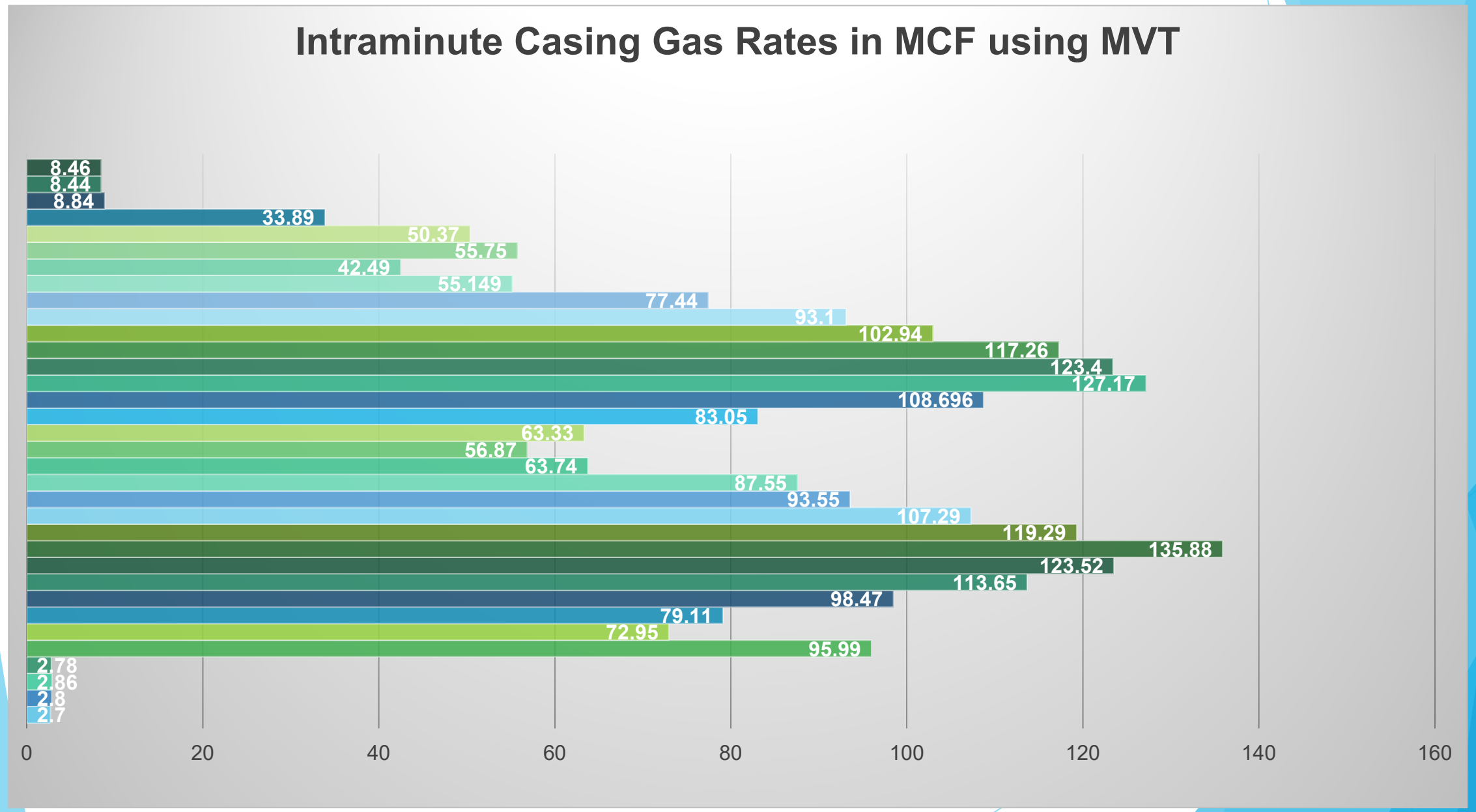
WHY IS ARTIFICIAL LIFT SO CHALLENGING?

Horizontal wells are extremely dynamic!

- Highly deviated and undulating (The “Drunken Porpoise”)
- Fracture irregularities
- Pressure and permeability inconsistencies
- Can produce all gas at times and rates are dynamic
- Can produce all liquid at times and rates are dynamic
- Constantly varying liquid gradient
- Heading up and flumping



DYNAMIC CASING GAS RATES



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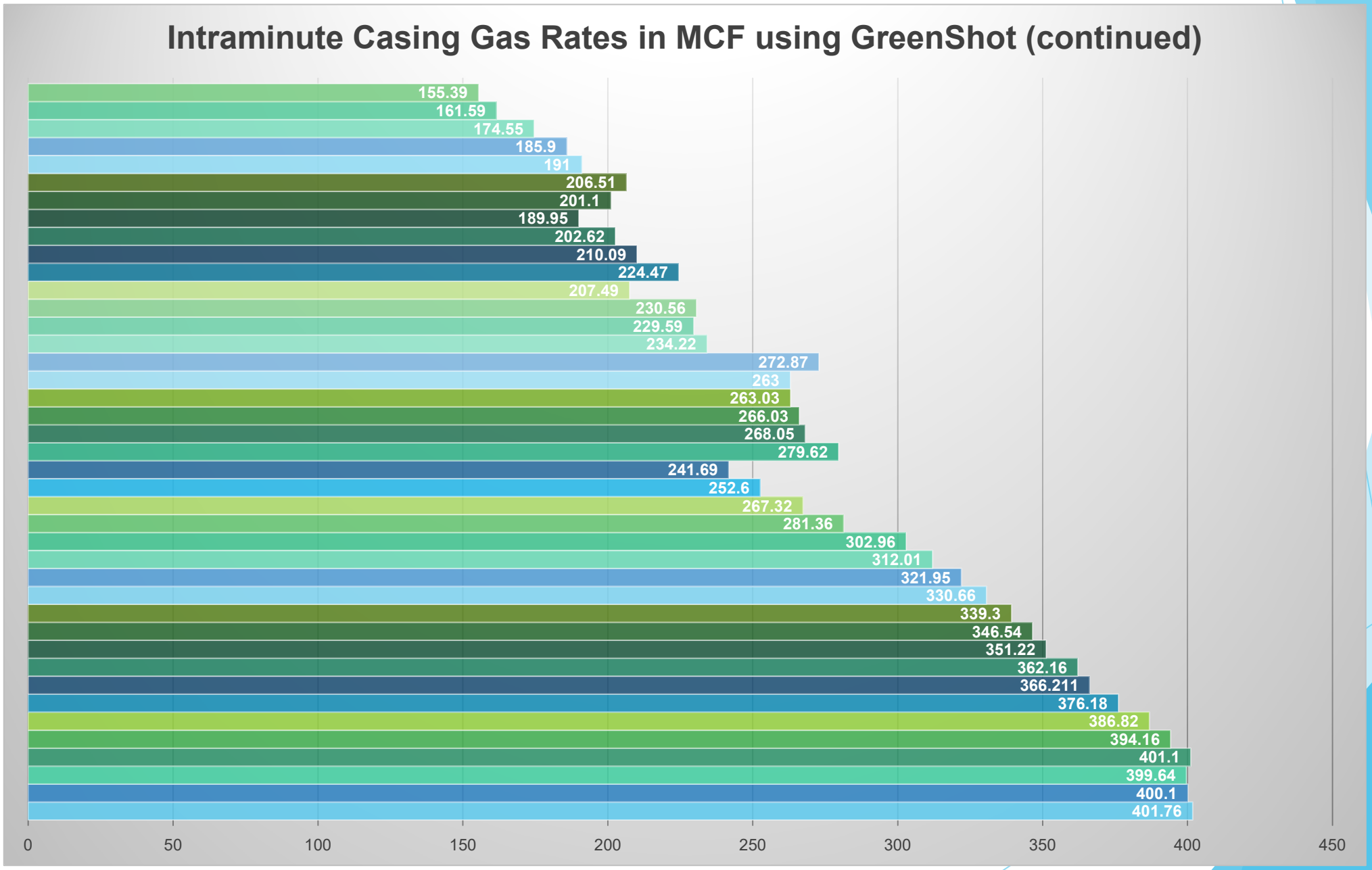
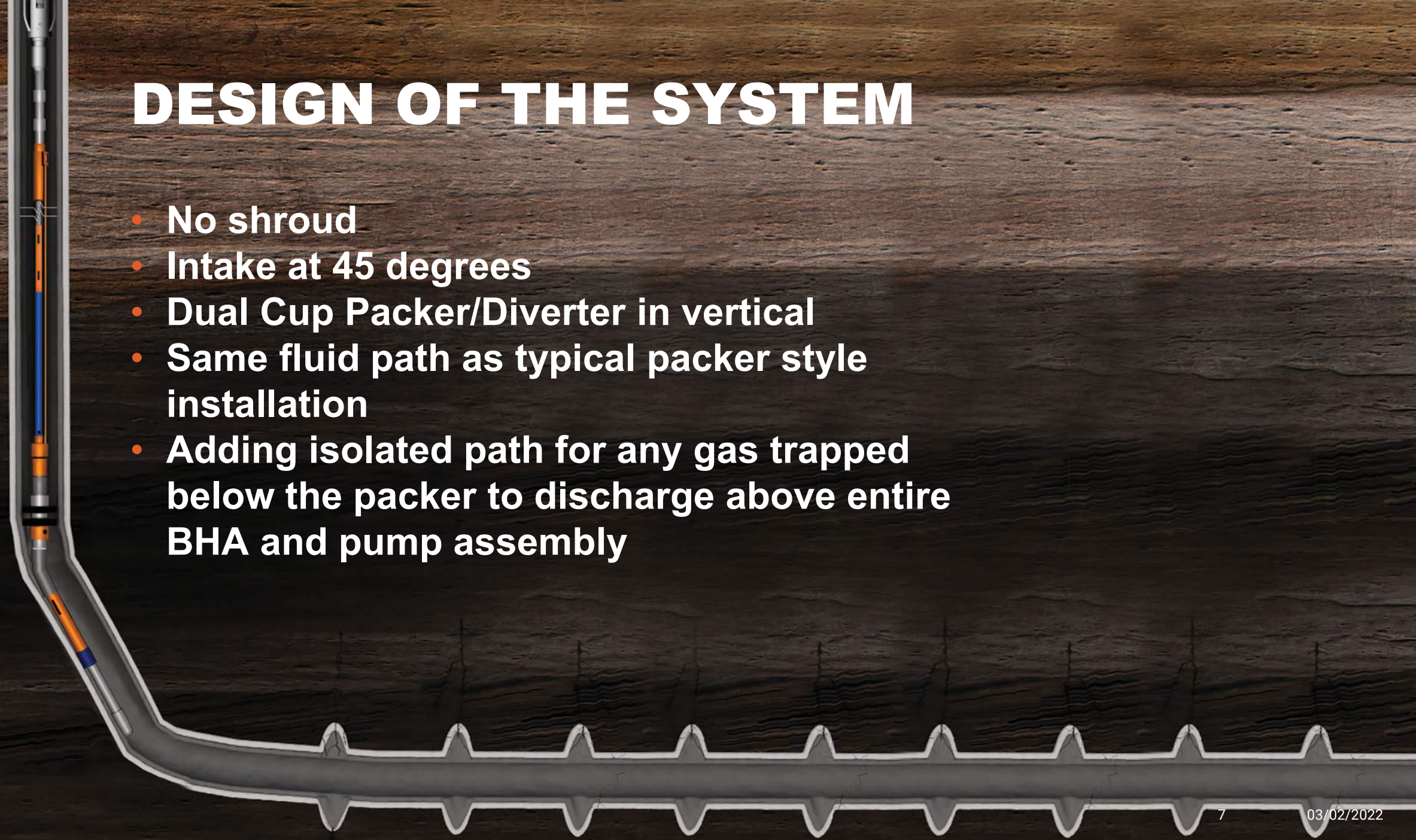


DESIGN OF THE SYSTEM

- No shroud
- Intake at 45 degrees
- Dual Cup Packer/Diverter in vertical
- Same fluid path as typical packer style installation
- Adding isolated path for any gas trapped below the packer to discharge above entire BHA and pump assembly



DESIGN RECOMMENDATIONS

5.5” 20Lb. Casing Scenario

WELLWORX Fluid Velocity Calculator	
Target Fluid Velocity ≤ 0.4	
Inner Diameter	4.778
Outer Diameter	2.043
Desired Production (BBLS / 24 HRS)	330
Downward Fluid Velocity	0.211
$FV = \frac{0.0119 \times (BPD)}{ID^2 - OD^2}$	ID^2 = 22.829 OD^2 = 4.174 Area = 18.655 in/bbl = 3.927

- **Notables:**
- **Length of bypass tube**
- **Length of tail pipe to get to 45 degrees**
- **3+ joints between gas discharge and TAC**

DESIGN RECOMMENDATIONS

5.5” 20Lb. Casing Scenario

Quantity	Item	Typical OD, in	Item Length (ft)	Total Length (ft)	Bottom Depth (ft)	Top Connection	Bottom Connection
197	2-7/8" Production Tubing*	2.875	32.7	6438.1	6,438.1	2.875	2.875
1	Conventional TAC	5.5	3.25	3.25	6,441.3	2.875	2.875
7	2-7/8" Tubing Joints*	2.875	32.7	228.9	6,670.2	2.875	2.875
1	Enduralloy Blast Joint	2.875	32.7	32.7	6,702.9	2.875	2.875
1	**Seat Nipple**	**2.875**	**1.1**	**1.1**	**6,704.0**	2.875	2.875
1	Gas Discharge Port	4.25	0.67	0.67	6,704.7	2.875	2.375
1	2-3/8" Tubing*	2.375	32.7	32.7	6,737.4	2.375	2.375
1	2-3/8" Lift Sub	2.375	2.0	2.0	6,739.4	2.375	2.375
1	MAX Gas Separator (no shroud)	1.9	40.0	40.0	6,779.4	2.375	2.375
1	2-3/8" Nipple	2.375	1.1	1.1	6,780.5	2.375	2.375
1	Gas Bypass Connection Sub	4.25	0.67	0.67	6,781.1	2.375	2.875
1	NR-1 (HNBR) Dual Cup Type Packer	5.5	2.0	2.0	6,783.1	2.875	2.875
1	Gas Bypass Sub (Gas Intake)	3.625	0.67	0.67	6,783.8	2.875	2.875
15	2-7/8” Tail Pipe*	2.875	32.7	490.5	7,274.3	2.875	2.875
1	2-7/8" Lift Sub	2.875	4.0	4.0	7,278.3	2.875	2.875
1	Helix Desander (Fluid Intake @ 46.15°)	3.75	9.0	9.0	7,287.3	2.875	2.875
4	2-7/8” Mud Joints*	2.875	32.7	130.8	7,418.1	2.875	2.875
1	Bull Plug	2.875	0.65	0.65	7,418.8	2.875	N/A

**estimated lengths, will depend on tubing tally*

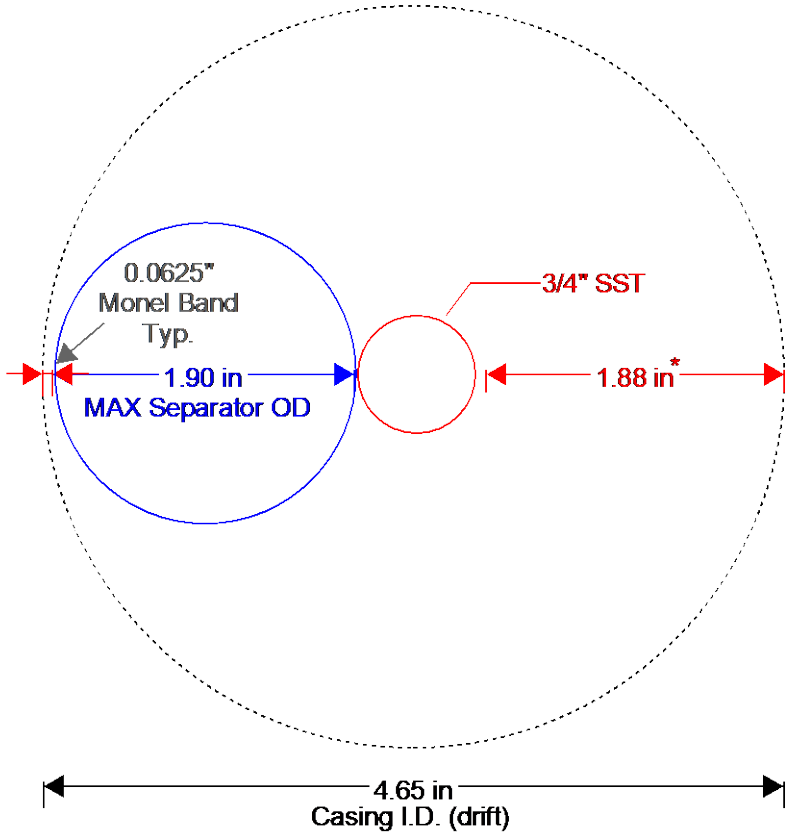
Notes: TAC must be set above Gas Discharge Port

Total Length of Rod Pump Components (ft):	79.81
Total Estimated Length of 3/4" Bypass Tube (ft):	104.81

includes additional 25' safety factor

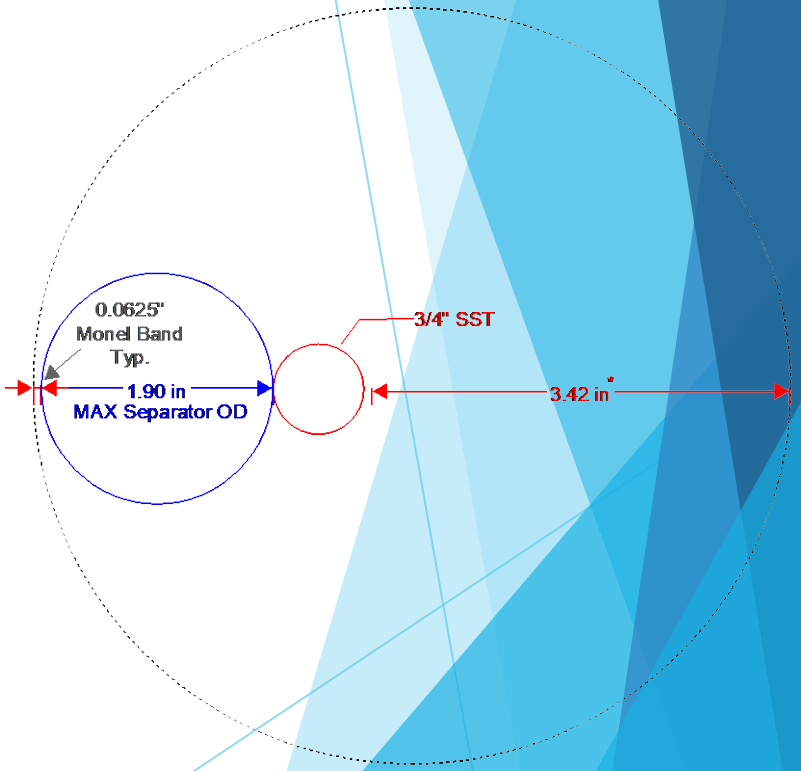
SYSTEM CLEARANCES

5.5” 20Lb. Casing Scenario



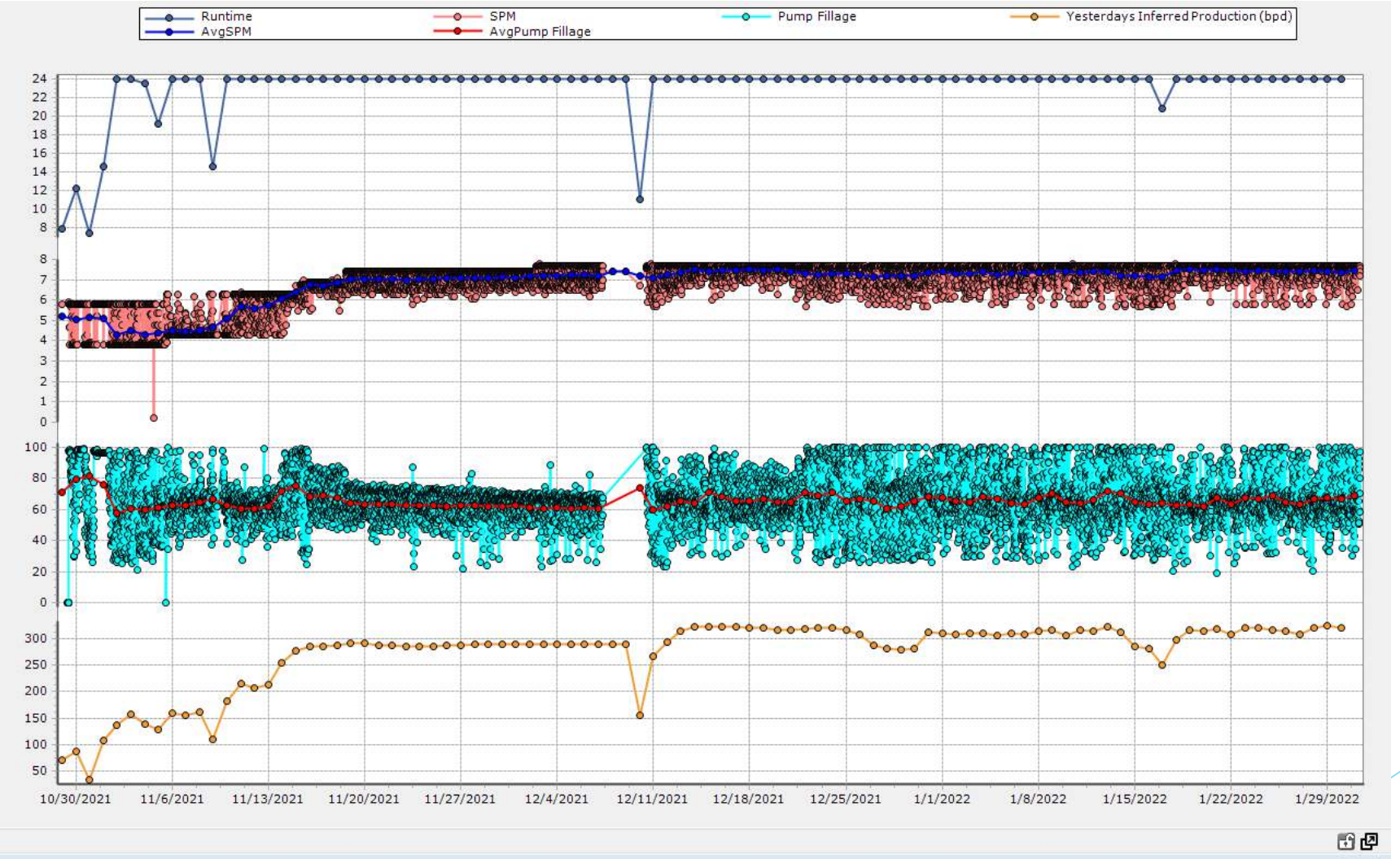
**Dimension accounts for Monel Band Thickness of 0.0625"*

7” 29Lb. Casing Scenario



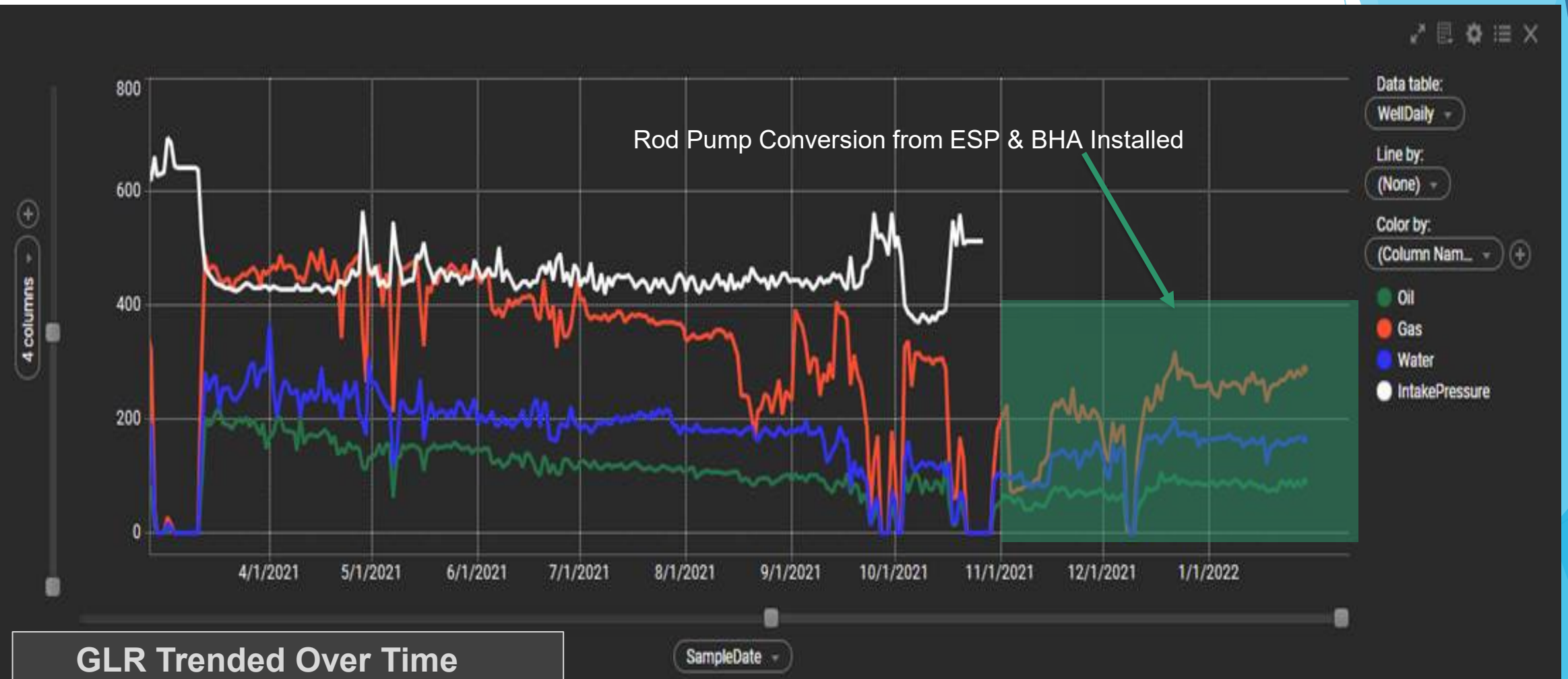
**Dimension accounts for Monel Band Thickness of 0.0625"*

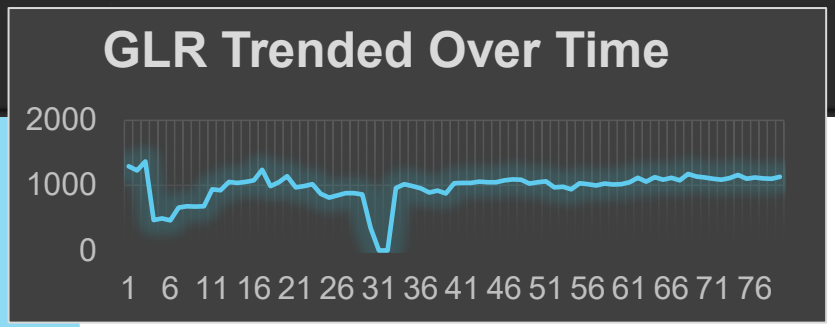
PRODUCTION DATA REVIEW



- Consistency
- Longer the system runs, the harder the well is produced the better the system performs
- Initial production is difficult as separation area is reduced by bypass tube and no free gas is seen below packer
- As more free gas is produced from the reservoir results improve and conditions stabilize

PRODUCTION DATA REVIEW



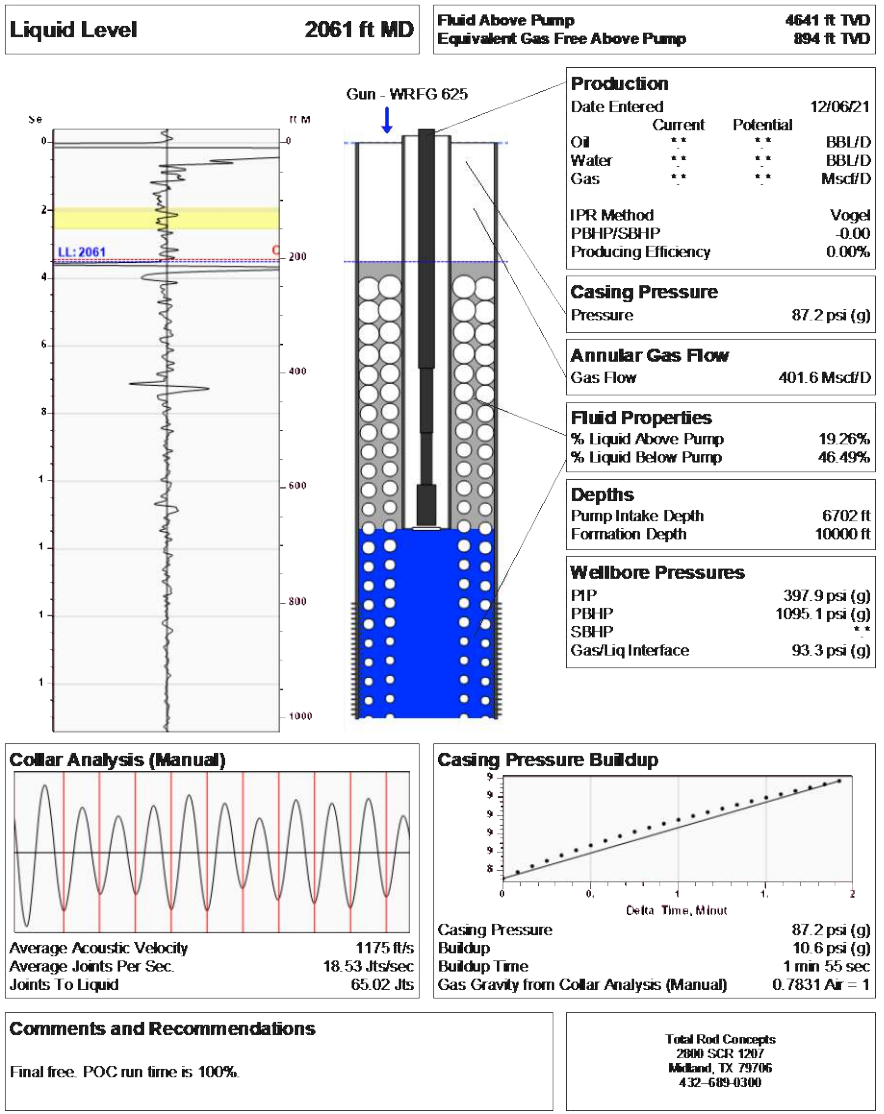


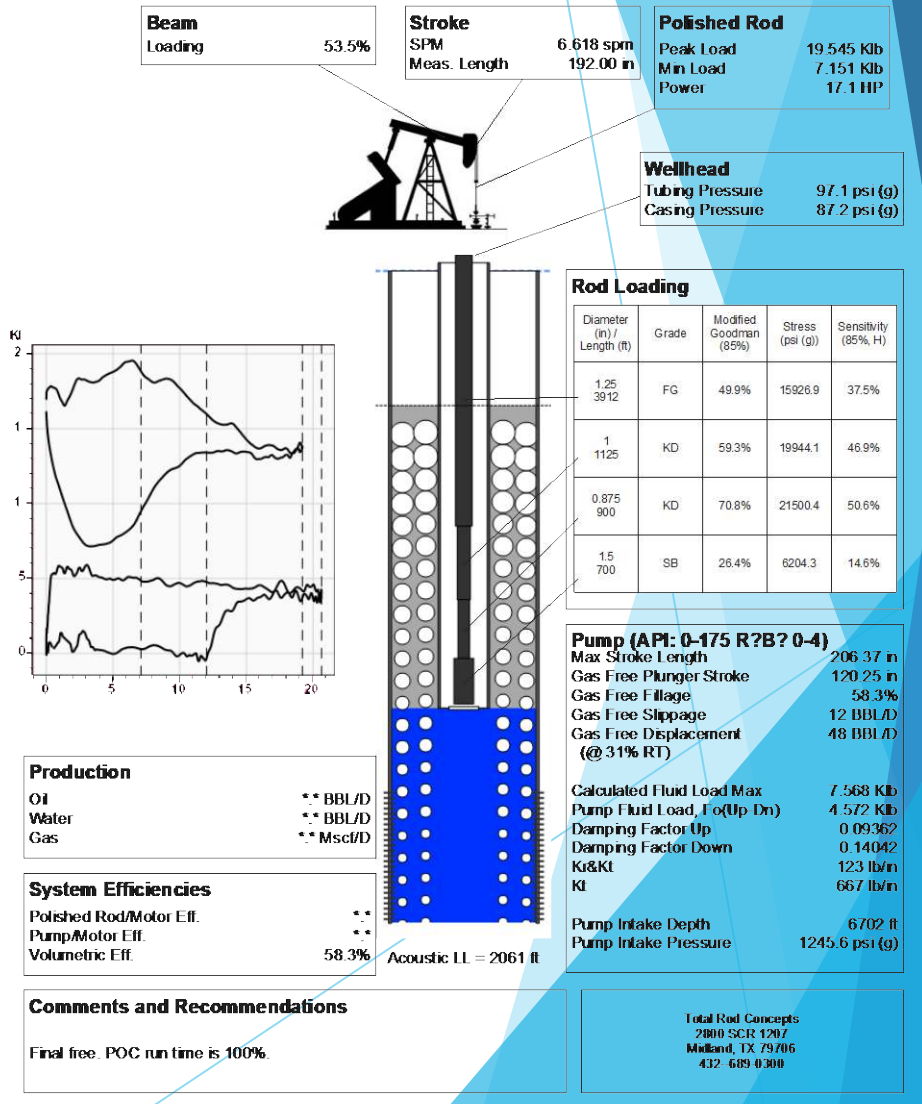
NOTABLES:

- **Downward production trend coming off ESP reversed**
- **Maintaining ESP Water and oil rates even through the high GLR's**

PRODUCTION DATA REVIEW

- Note the 401 MCF casing gas rate at time of shot
- 1.75” Pump
- FG Rods
- 192” Stroke
- 6,704 SN Depth
- 100% run times
- 6-7.5 SPM





CONCLUSION

- Though early in the life of this system, results appear promising. So much so that this operator has since installed 2 more Silver Bullet systems to further prove out the technology.

- Operating conditions can be significantly improved by utilizing the Silver Bullet, an innovative technology, when paired with proper rod pump design and operational practices.

- This technology can play a key role in improving the ability to move larger volumes of fluid on rod pumped wells converted off of dynamic ESP systems.

- This case study has shown improved production consistencies regarding rod pump efficiencies, optimized production and stabilized runtimes utilizing the Silver Bullet system.

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