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Continuous Optimization of Dual String Gas Lift

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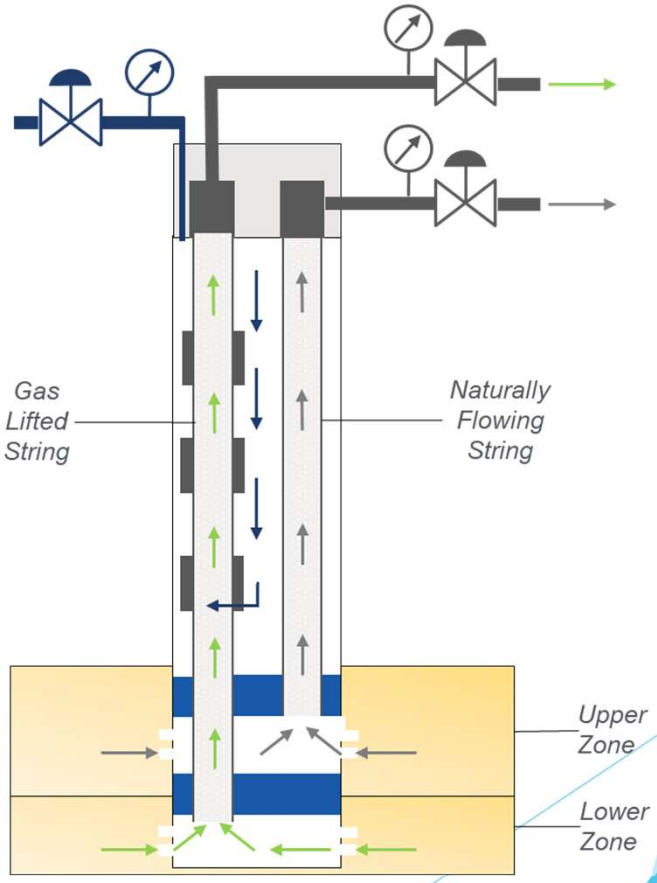
Introduction

- The majority of the world's gas lifted wells are **under-optimized**.
- Addressing this opportunity can deliver **production uplifts** approaching 20% for single completion wells and exceeding 40% for dual-string gas lifted wells.
- Recognizing this opportunity, ADNOC and Silverwell Energy partnered to co-develop a business case and implementation plan to pilot a **dual-string digitally controlled gas lift** optimization system.
- This presentation, drawing from and updates the work described in **SPE-196146-MS** paper, will describe, the screening phase, business case preparation, risk assessment and validation process, leading to this 1st implementation in the U.A.E. of a fully optimized dual completion gas lifted well.

ADNOC Gas Lift Background

- Using conventional gas lift across all assets since 2004, Onshore and Offshore for single and dual completions.
- For dual completions, the current practice is to adopt one string with gas lift and the other on natural flow.
- As water cut increases, the naturally flowing string ceases to flow.
- With depleting reservoirs, ADNOC is seeking new solutions which offer:
  - Increased oil recovery.
  - Increased production efficiency.
  - Digitisation and smart field vision.
  - Unmanned and autonomous operations.



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ADNOC Digital Gas Lift Adoption Strategy

Single Wells

- The benefits of the application range from intervention savings, production optimization and the ability to implement autonomous gas lift across a cluster of wells.

Dual Wells

- API does not recommend pressure operated gas lift in dual wells.
- Digital gas lift offers stability, simultaneous lifting of both strings through surface control and downhole data improving well production in the range of 40 to 100%, based on well designs.

ERD Wells

- ERD gas lifted well require flexibility.
- Digital gas lift enables real time changes of injection depths based on reservoir response, with gas lift installed at high angle without deviation limits.

In-situ (Auto)

- In-Situ gas lift is where a gas zone is used to lift production from the oil zone in the same well.
- Digital gas lift enables measurement and of the gas injection rate at the point of injection and adjustment.

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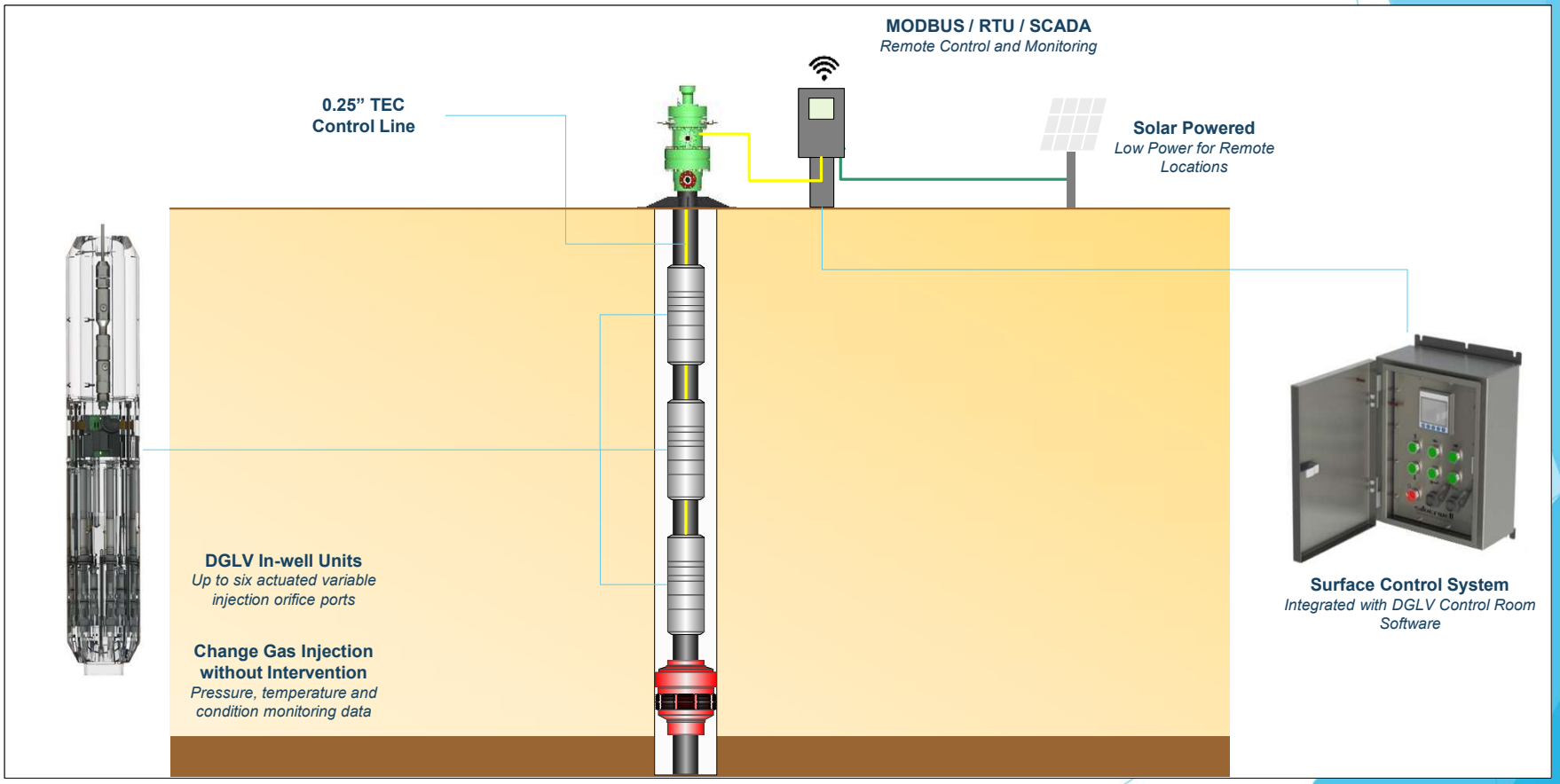
Digital Gas Lift Production Optimization



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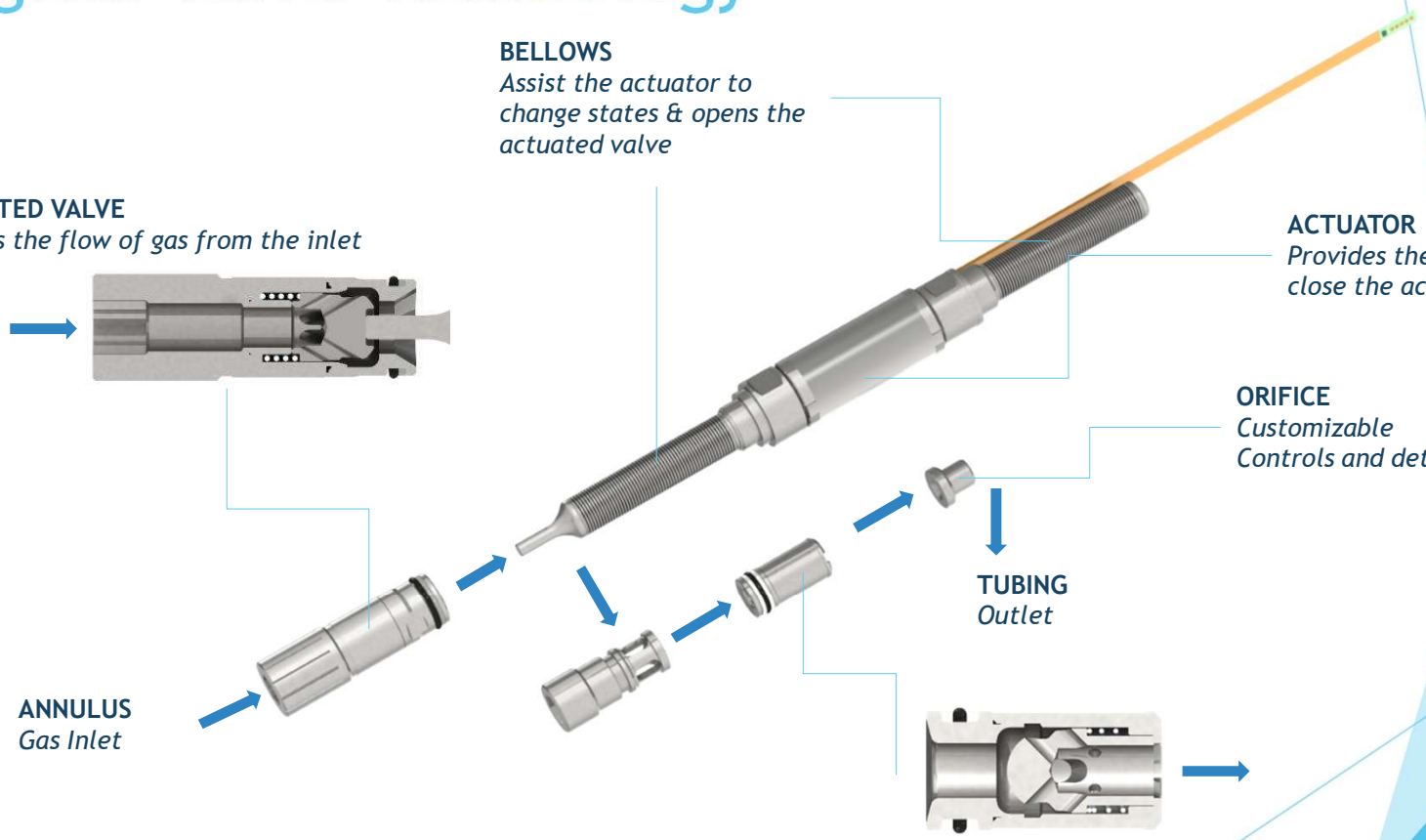
Digital Valve Technology

BELLOWS
Assist the actuator to change states & opens the actuated valve

ACTUATED VALVE
Enables the flow of gas from the inlet



ACTUATOR
Provides the motive force to open and close the actuated valve

ORIFICE
Customizable
Controls and determines the flow rate

TUBING
Outlet

ANNULUS
Gas Inlet

REVERSE FLOW CHECK VALVE
Prevents the reverse flow of hydrocarbons from the well

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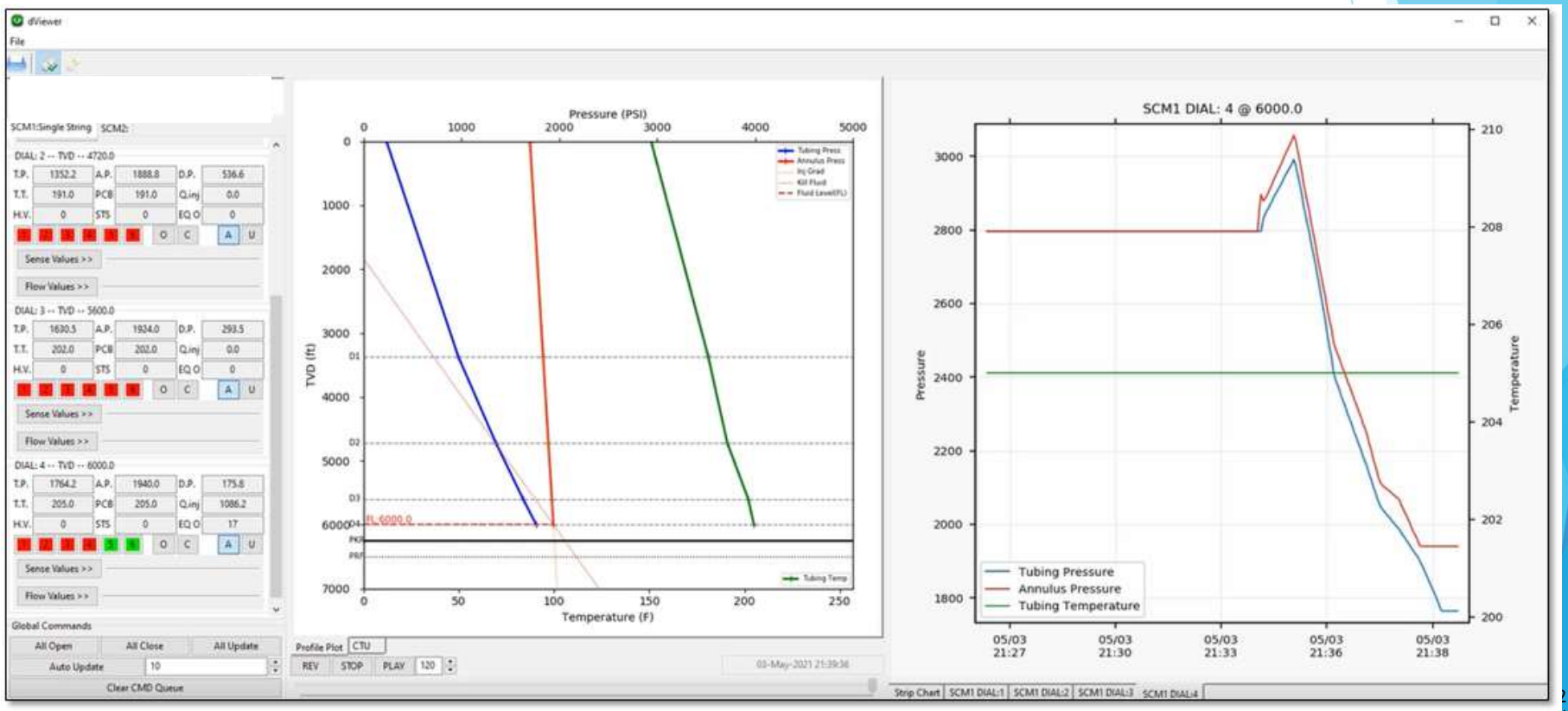
Digital Gas Lift User Interface

Well Performance Visualization | Data Analysis | Control | Automation



Pressure Operated Valves vs Digital

Dual Completion with Pressure Operated Valves

- Gas lift cannot be achieved efficiently on both strings of a dual completion well with pressure operated valves.
- Gas will always go to lower pressure point / Gas robbing of weaker string with loss of production in stronger string.
- Operators often decide to gas lift only one string and keep the other string on natural flow.
- Production loss between 40 to 100%.

Dual Completion with Digital Gas Lift

- Gas injection rate and injection depth controlled from surface.
- Not sensitive to downhole pressures or temperatures.
- Downhole sensors allow adjustment of gas lift to match well conditions in real time.
- Optimized production / efficient gas usage.

Pilot Screening Process

Collaboration of Multidisciplinary Teams Encompassing Several Phases of Analysis

Well Candidate Selection and Technical Review

- The screening phase considered several ADNOC assets both Onshore and Offshore, as well as different types of completion architecture.
- Benefits were analysed for several wells in each of these assets, which showed that most wells benefited significantly from potential implementation of the DGLV technology.

Business Case

- The financial benefits were the result of intervention savings and oil gains through continuous production optimization.
- Gas savings were also considered by avoiding gas lift multi-pointing, and associated lift inefficiency, that frequently occurs with conventional pressure operated valves.
- A robust business case was co-developed demonstrating ROI and NPV of the new solution implementation based on well modelling.

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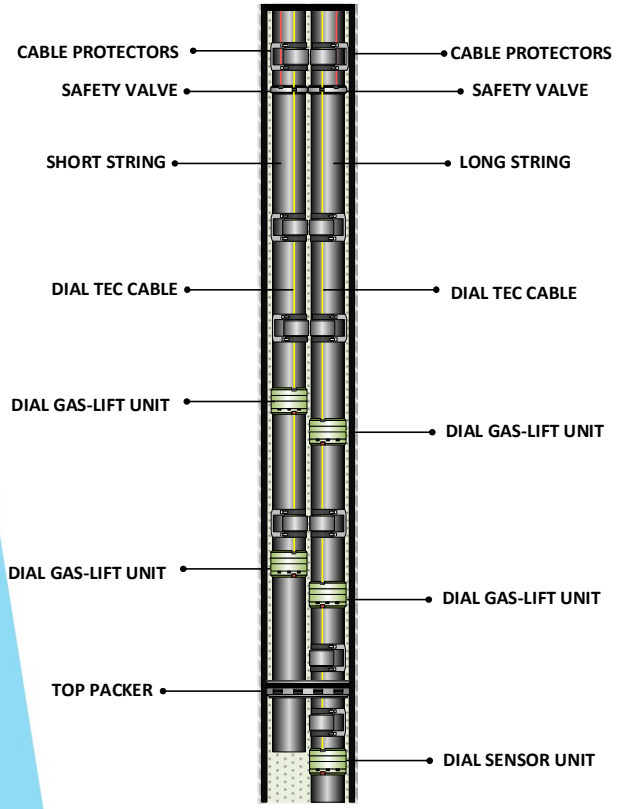
Candidate Well Background



- New drill dual completion well in the N field. Well spud in Q1 2022.
- Well will be completed with 2 x 2-7/8" tubing inside a 9-5/8" casing. The max. well inclination is 89Deg. Around 60Deg inclination at DGLV setting depths.
- 2 x 2-7/8" DGLV gas lift units on each string, with 3 gas lift injection orifice ports on each unit.
- The DGLV units are configured to deliver a range of injection rates up to the field max. compressor rate of 2MMscf/d.
- A DGLV sensing unit will be installed on the long string.
- The bottom hole sensing measurement can used to determine the optimum injection rate throughout the completion life.
- The DGLV system can also be configured for closed loop gas lift automation (in advanced stages of development).

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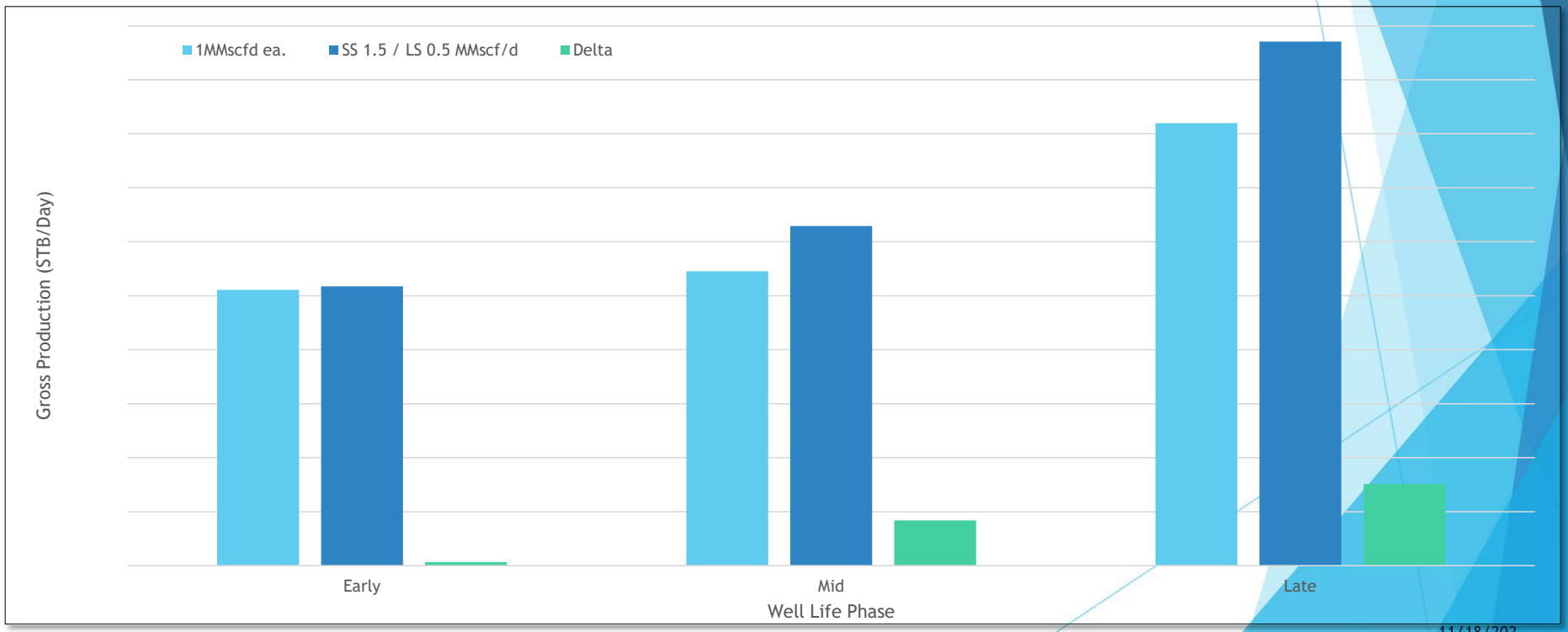
String Injection Gas Distribution

Through Data Analysis and Well Modelling, the Digital Gas Lift System Valves can be Configured to Deliver the Highest Gross Production Ensuring Efficient Injection Gas Distribution between Strings



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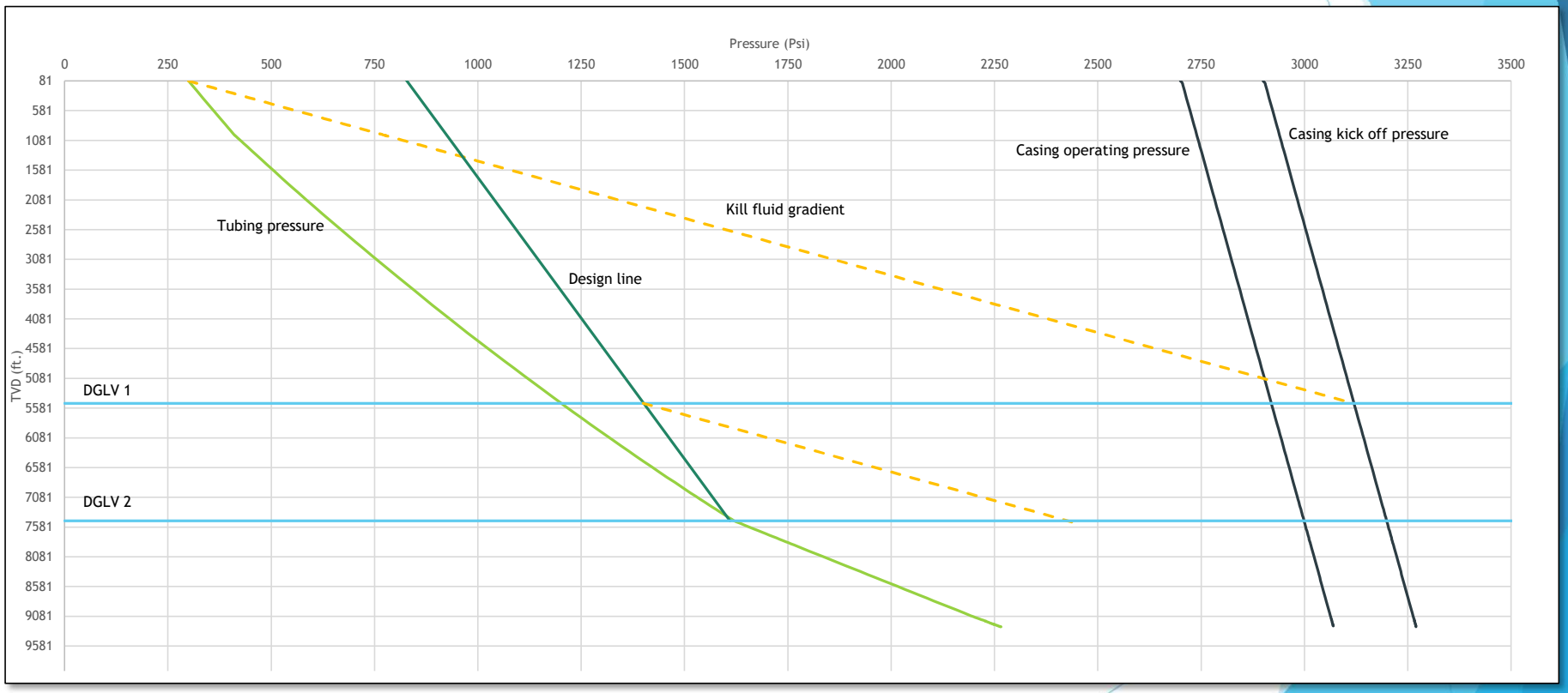
Gas Lift Design | Long String

Injection at DGLV #2 | Optimum Injection Rate is ~1MMscf/d for Early, Mid and Late Life Cases



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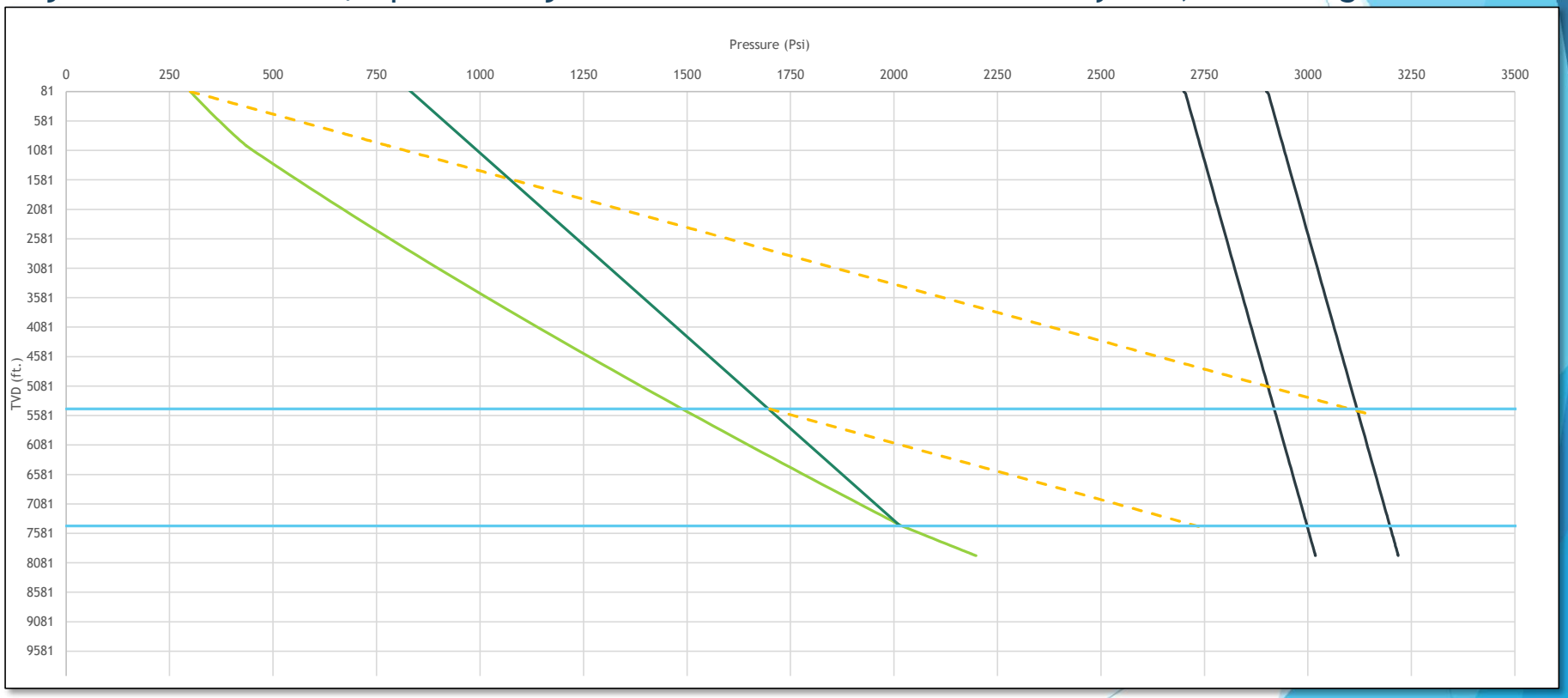
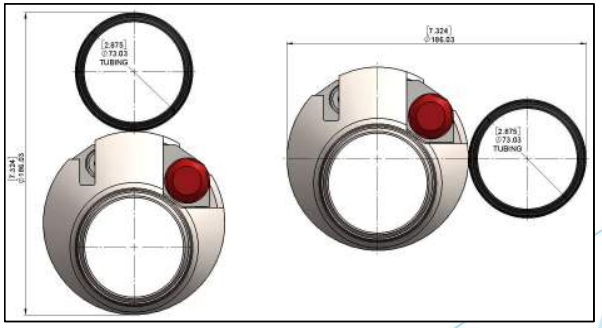
Gas Lift Design | Short String

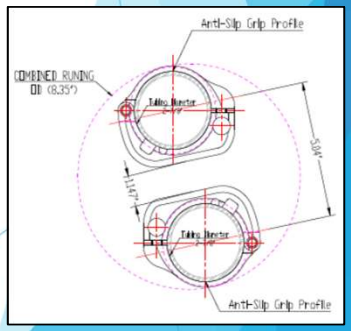
Injection at DGLV #2 | Optimum Injection Rate is ~2.5MMscf/d for Early Life, increasing for Mid and Late



Dual String Technical Specificities

- CWOP and HAZOP were conducted to review each step of the completion.
- All overall running ODs were checked to ensure they would fit casing drift ID.
- Cross coupling cable protectors were fit tested inside a section of 9-5/8 casing.
- Best practices and lessons learnt from previous installations in Malaysia will be applied.





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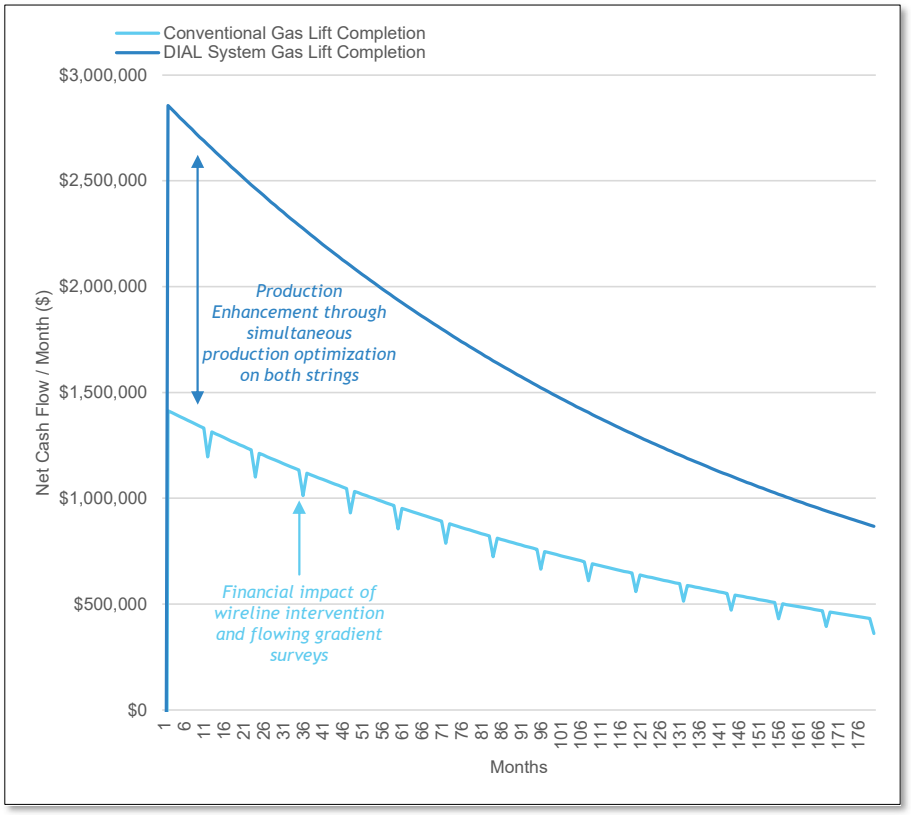
Business Case & Economic Justification

Cashflow Forecast based on Production Uplift and the Avoidance of Well Intervention



Assumptions

- 180 Month Completion life.
- Equipment CAPEX included.
- 30$/bbl. Oil Price.
- Discount rate of 8%.
- Annual decline rate of 8%.

Results

- NPV increased by +60Mn USD.
- OPEX reduction by avoiding well interventions.

Conclusion

- Game changer for development strategy of N Field.
- Minimizing bypassed oil.
- Improving recovery factor from upper reservoir.

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Conclusions

- This presentation described the business case and implementation plan for the introduction of the first DGLV dual completion well in ADNOC.
- The DGLV implementation enables efficient production of both strings whilst saving costs on drilling a new well, and challenges due to slot availability and associated costs especially in mature fields.
- The installation of the DGLV system is currently scheduled for the first quarter of 2022.
- Further installations are already envisaged beyond this initial pilot on both onshore and offshore assets enabling progress towards ADNOC's smart field vision.

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