2024 GAS LIFT WORKSHOP

Learnings from the Design and Testing of a New Surface-Controlled Gas Lift Valve

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PTC an Interwell company

SwRI Southwest Research Institute

Agenda

- Why Surface-Controlled Lift?
- Implementation of Electric Gas Lift
- API 19G2 Flow Testing
- Experimental Testing
- Results and Interpretation
- Conclusions

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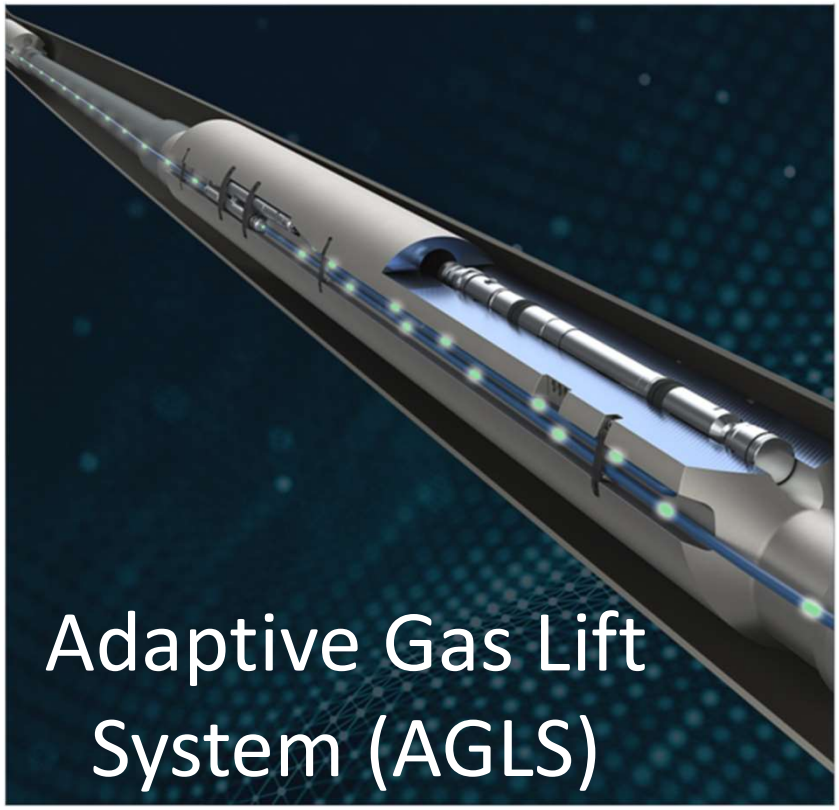

Why Surface-Controlled Gas Lift?

Advanced Production

- Maximize injection depth
- Variable orifice adjustment
- Remote control and adjustments
- Reduced intervention shutdowns

Increased Oil Recovery

- Improved drainage of reservoir
- Prolonged lifetime of well

Intervention Avoidance

- Avoid premature opening of valves
- Online adjustments avoid interventions to perform orifice adjustments

Climate Contribution

- Avoid carbon footprint associated with interventions
- Improved utilization of available gas, reducing CO_2 per barrel

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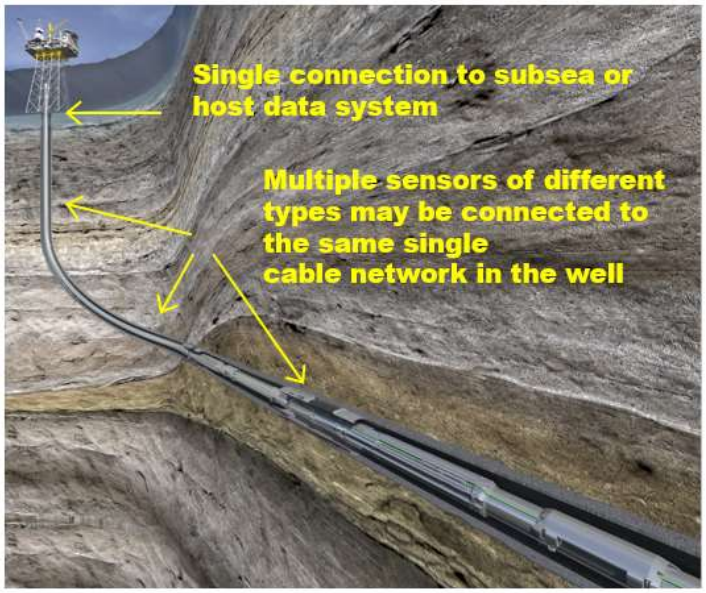
How?

- Combined existing and field-proven technologies from Emerson Roxar and PTC Interwell
- Integration and control of PTC gas lift valve on Roxar Integrated Downhole Network
- Electrification enables topside adjustment of gas lift application after installation
- Online and adjustable
- Project initiated in 2020
- Validation testing of prototype valve started in H2 2023 and was completed Q1 2024
- Validation testing according to AWES RP 3362-36 for electronic components
- Validation testing for API 19G2 and 19G1 for valve and side-pocket mandrel
- System designed and tested to an absolute pressure of 15,000 psi and a max temperature of 150°C



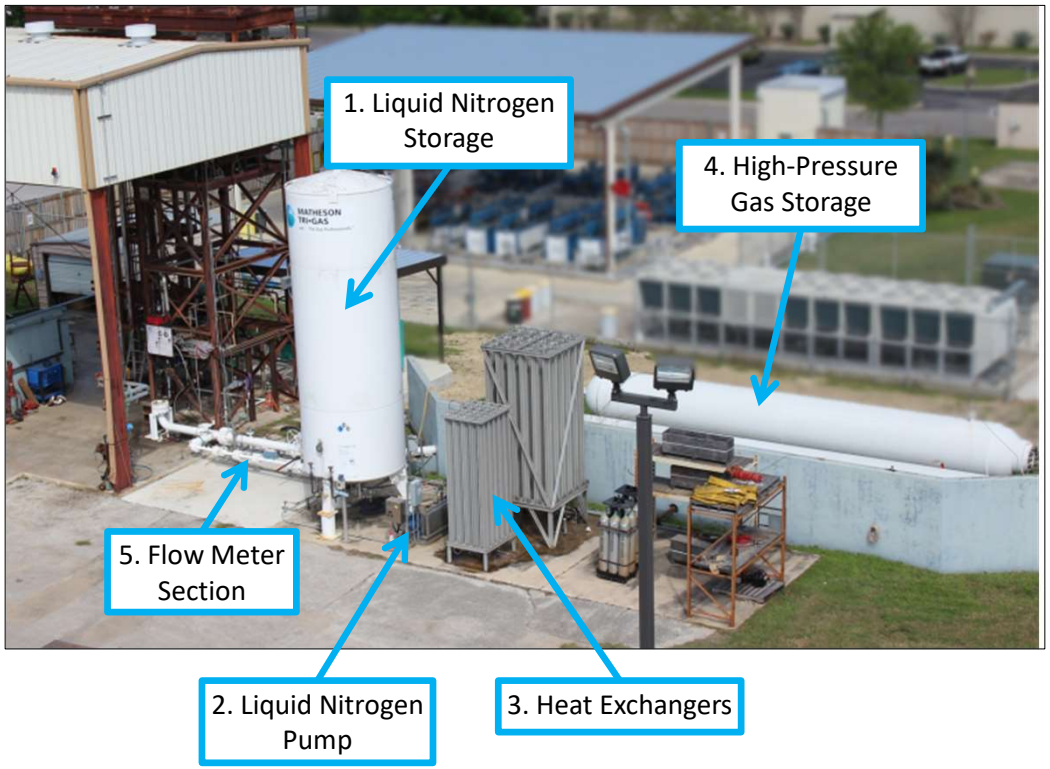
API 19G2 Annex G Testing

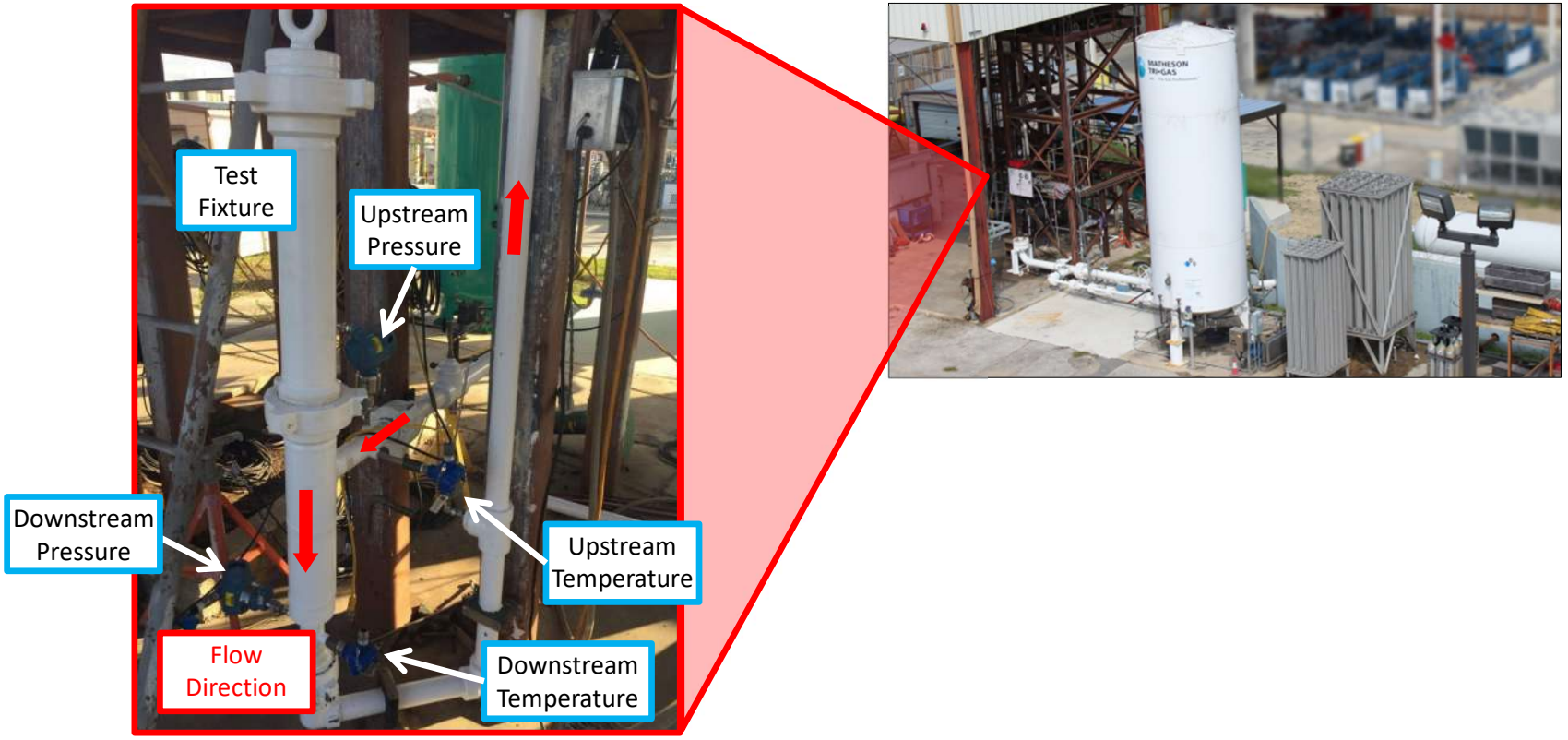
System Specifications

- 6,000-gal [23-m^3] liquid nitrogen storage
- 1,125-scf [32-scm] high-pressure nitrogen gas storage
- Pressures up to 3,000 psi [207 bar]
- Flow rates up to 12 MMscfd with nitrogen gas [0.4 MMscmd]

System Operation

- Accurate flow measurement
- Instrumented test section
- Upstream control valve (UCV) and downstream control valve (DCV) for pressure control
  - PID control on UCV to maintain pressure targets
  - Ramp profile on DCV to control downstream pressure and flow rate
- No temperature control

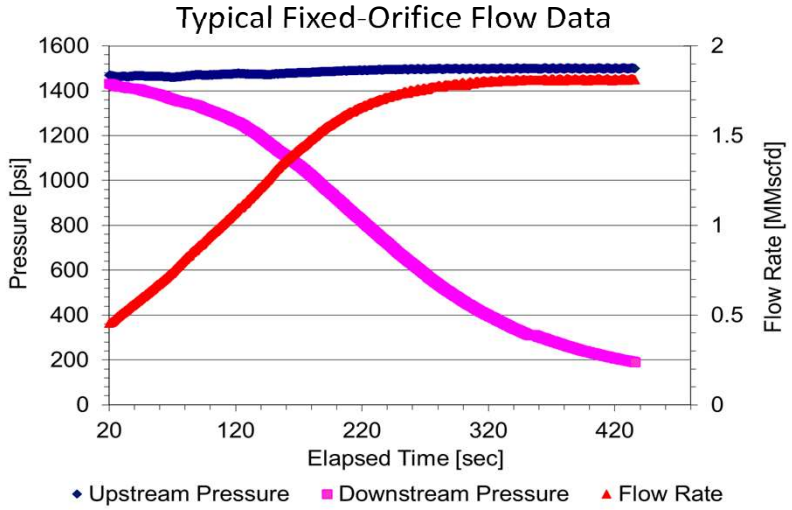


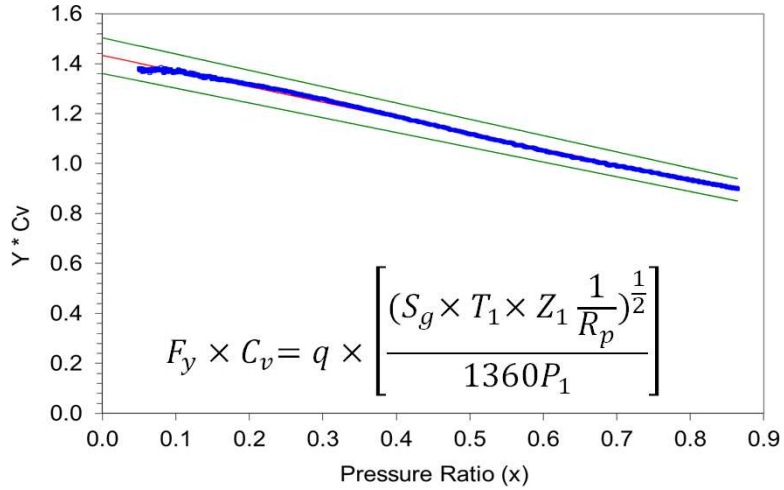

Test Fixture
Upstream Pressure
Downstream Pressure
Upstream Temperature
Flow Direction
Downstream Temperature

Flow Coefficient Testing

Flow Coefficient testing is performed in accordance with API 19G2, 2nd Edition

- Operator maintains approximately constant upstream pressure while decreasing the downstream pressure
- Flow is continually increased until choked flow is achieved, or facility limitations are reached
- Cv charts are generated according to the equation specified in API 19G2

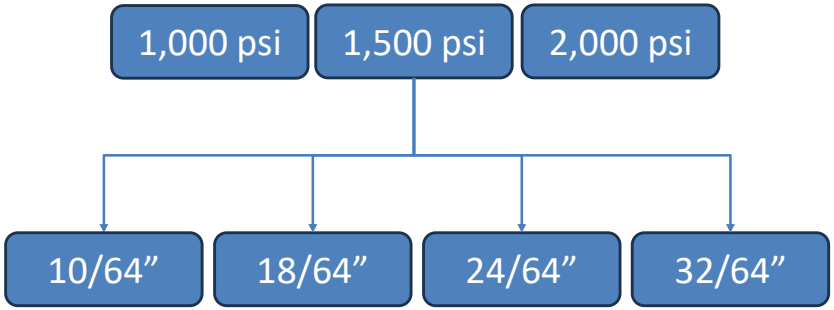




Test Plan for Electric Valve

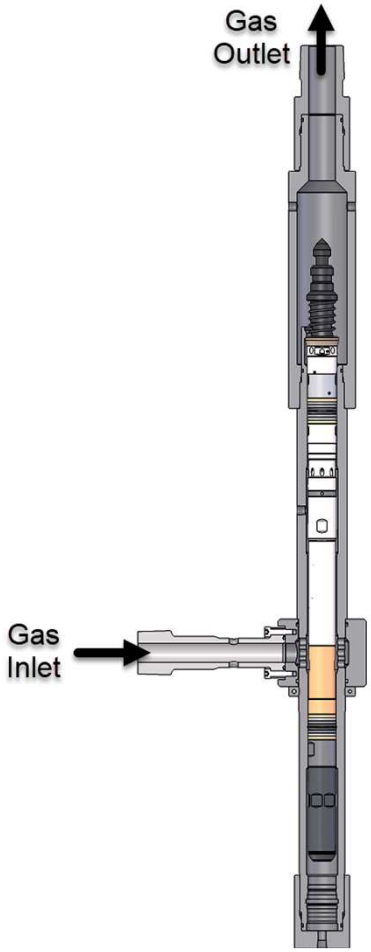
API 19G2 Flow Coefficient Testing

- Constant upstream pressures: 1,000 psi, 1,500 psi and 2,000 psi
- Orifice sizes: 10/64”, 18/64”, 24/64” and 32/64”



Experimental Testing

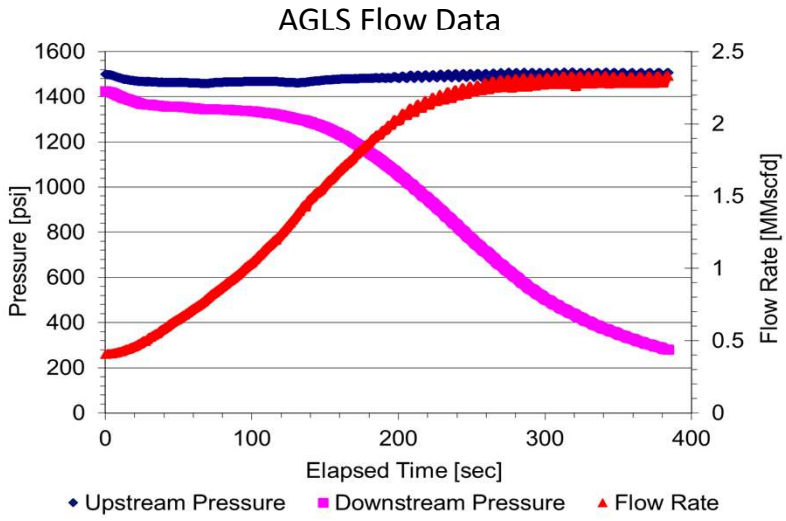
- Operate the electric valve between positions during continuous gas flow
- Operate valve across its operational region with a dP of up to 2,175 psi [150 bar]
- Open and close valve with up to 2,175 psi [150 bar] differential pressure
- Verify behavior of valve during dynamic flow conditions

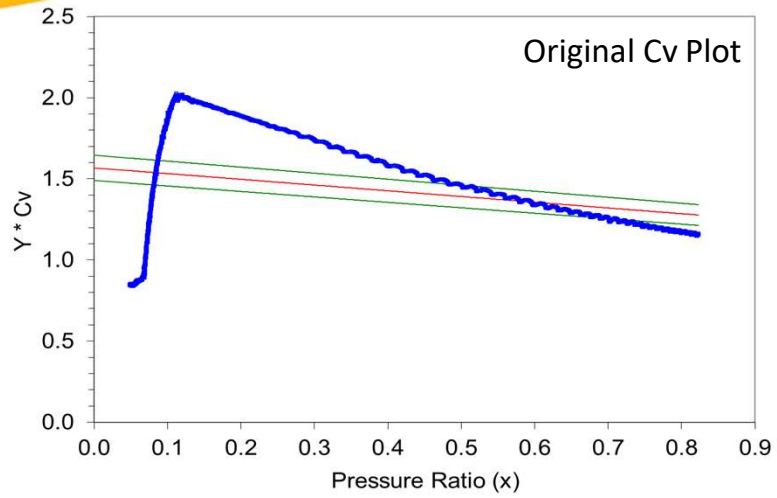


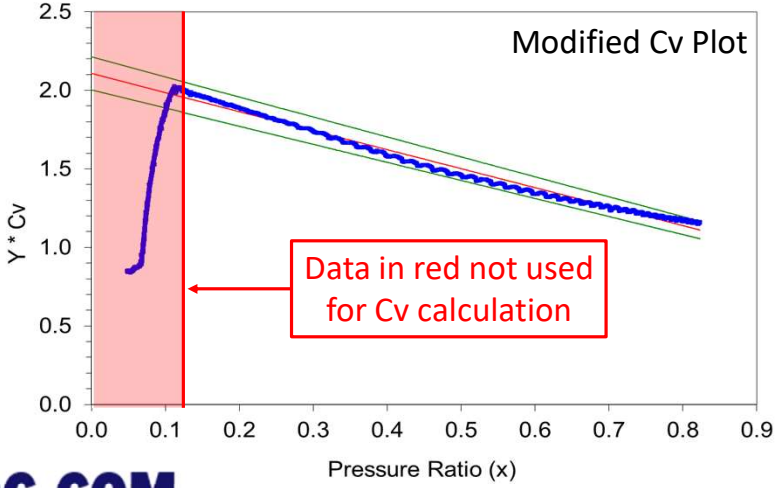
Flow Coefficient Results

Analysis methods were modified to fit the data collected

- Different port geometry → different plot shape
- Used data after inflection point, as progressing towards choked flow, to calculate flow coefficient and critical pressure ratio



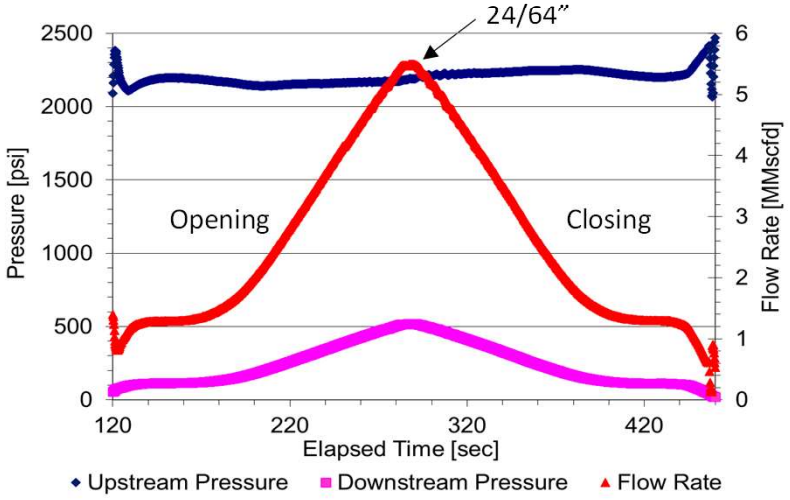


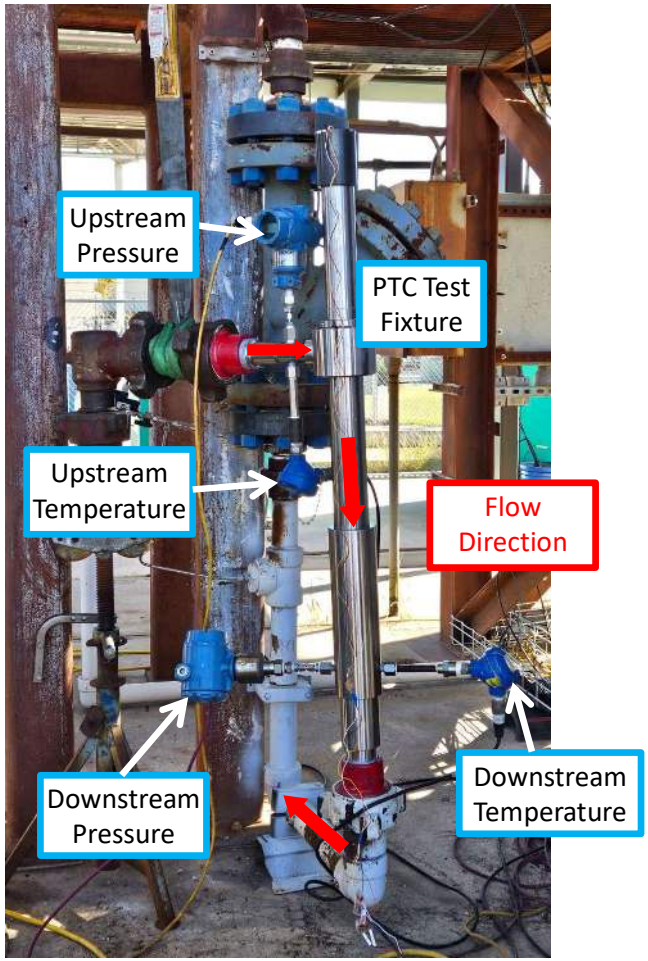


Experimental Testing

Experimental testing was performed while adjusting the position of the AGLS

- DCV was left in the fully open position to maintain the lowest backpressure possible (target differential pressure of 2,175 psi)
- Different AGLS position ranges were tested, optimizing flow control and measurement with different control valve trims and orifice plates





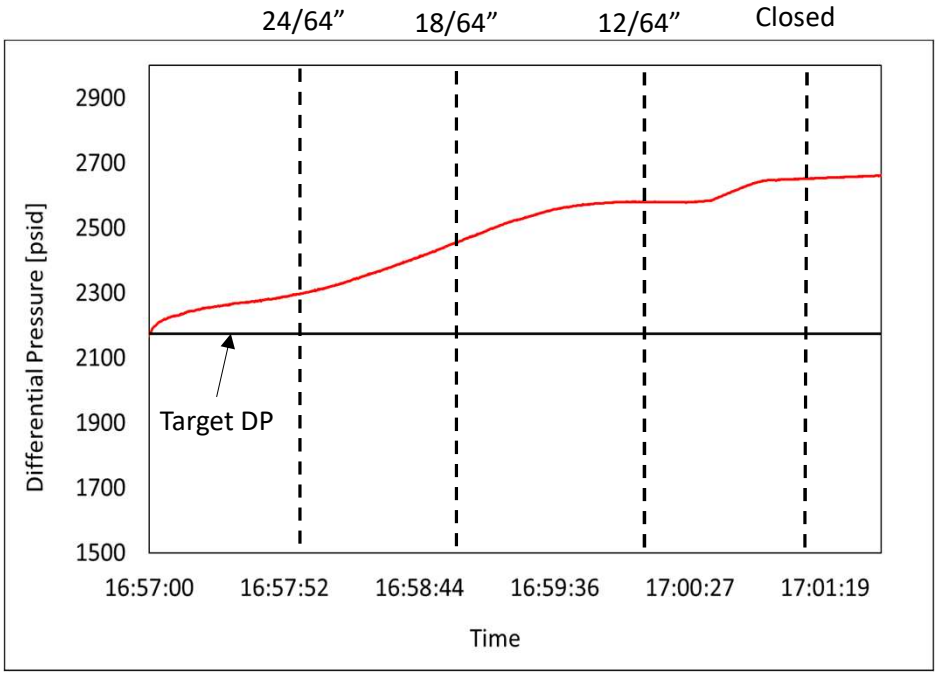
Experimental Test Results and Interpretation

Test results

- Opened/closed against 2,500-psi [~175-bar] differential pressure (DP)
- Closed → 24/64" with ≥ 2,175-psi [150-bar] DP
- 24/64" → Closed with ≥ 2,175-psi [150-bar] DP
- 24/64" → 32/64" with max facility DP ≥ 1,700 psi [~120 bar]
- 32/64" → 24/64" with max facility DP ≥ 1,700 psi [~120 bar]

Valve performance

- Experimental test was successfully completed according to requirements
  - Capable of adjusting orifice during high flow and high differential pressure
  - No abnormalities experienced during orifice adjustment
- Some limitations to flow facility experienced during testing due to high volume demand and longer flow durations



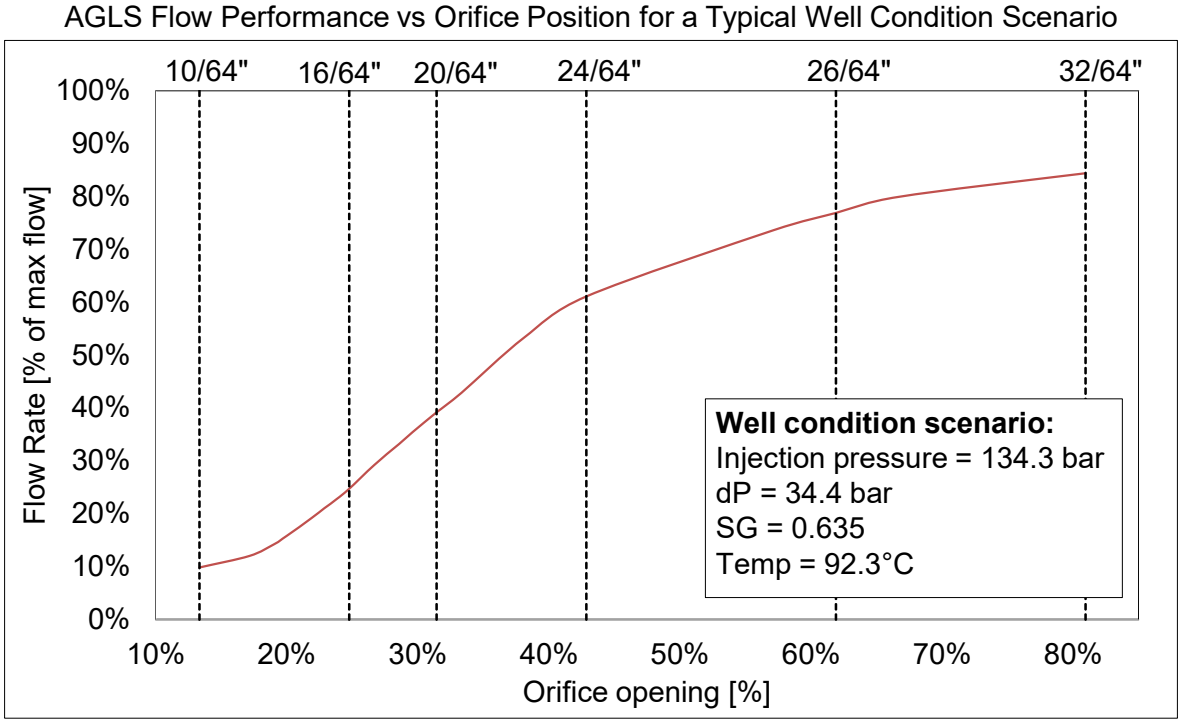
Experimental Test Results and Interpretation

Nonlinear ratio between flow rate and orifice size

- Equivalent orifice size vs % opening

Computational Fluid Dynamics (CFD) Analysis

- Good match between CFD and flow data
- CFD can be used to fill gaps between actual flow data
- Allows creation of dynamic flow performance curves



Conclusions

SwRI Nitrogen Blowdown Facility

- Good fit for the experimental tests
- Some limitations on higher flow rates and long-duration test
  - Possible upgrades to Nitrogen Blowdown Facility
  - Possible use of high-pressure recirculating loop (Gas Lift Test Facility)

API Testing

- Some challenges regarding Cv calculations – different equations may be necessary
- Identified a method for analysis in the meantime

Successful Experimental Testing

- Valuable information concerning valve movement characteristics
- Verified CFD model
- May bring value to include in future API test procedures

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Question Time

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