

Annular Flow Control

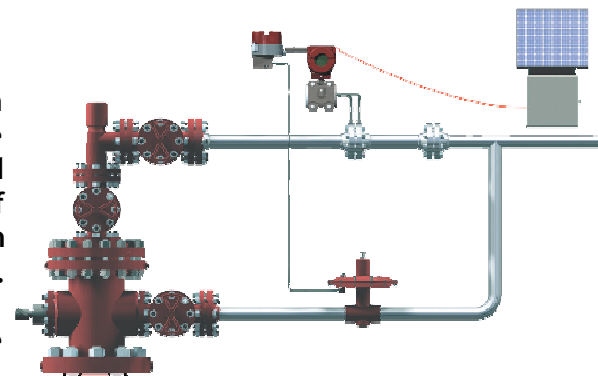
Raise Production’s Annular Flow Controller improves gas well performance by reducing pressure losses in the tubing string caused by friction. Reducing pressure losses results in a lower flowing bottom hole pressure thus increasing the wells productivity. A high Casing/Tubing differential pressure is a good indication that a well may be tubing restricted due to friction. Wells with lower reservoir pressure that produce at high rates make excellent candidates for annular flow control.

Understanding the Effects of Friction Loss

Understanding the effect that friction has on production can be illustrated using the analogy of a busy multi-lane freeway. A highly deliverable reservoir is represented as numerous lanes accommodating a large volume of traffic. In situations where considerable drawdown exists the presence of a mechanical restriction (i.e. undersized tubing) is equivalent to closing the freeway to one lane while trying to accommodate the same volume of traffic.

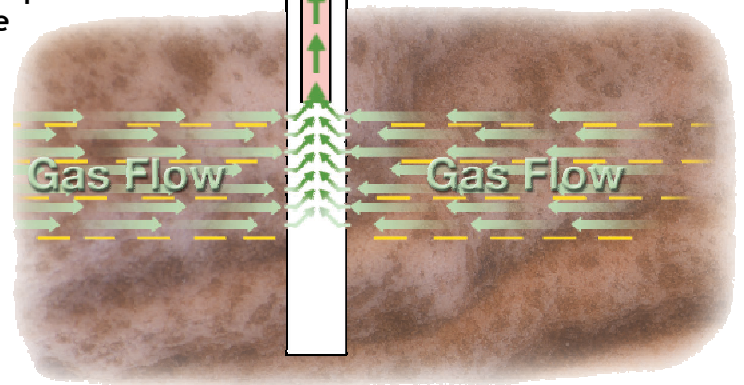
Friction Loss Prevention

Raise Production’s Annular Flow Controller eliminates friction loss by utilizing the annulus and tubing when flowing the well. The rate required to lift liquids up the tubing is modelled and the set point is entered in the controller. Tubing flow is measured using an Electronic Pressure Differential Flow Meter/Controller. The controller sends a signal to a motor valve on the casing which redirects some of the gas flow up the annulus while maintaining enough flow up the tubing to lift liquids. As the wells productivity drops off over time the amount of gas flowing up the annulus will automatically be cut back until all of the flow is directed up the tubing.



Annular Flow can be Applicable in the following scenarios:

- Does your well have low reservoir pressure and produce at high rates?
- Have you installed wellhead compression?
- Have you installed coiled tubing at a depth greater than 700m?
- Do you want to accelerate the payout of new wells with high initial deliverability?



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Case Study

ConocoPhillips Canada

RAISE PRODUCTION DIGITAL ANNULAR FLOW CONTROLLER WITH DYNAFLOW INTERLIFT SYSTEM

Pre Optimization Rate - 2.7 e³m³

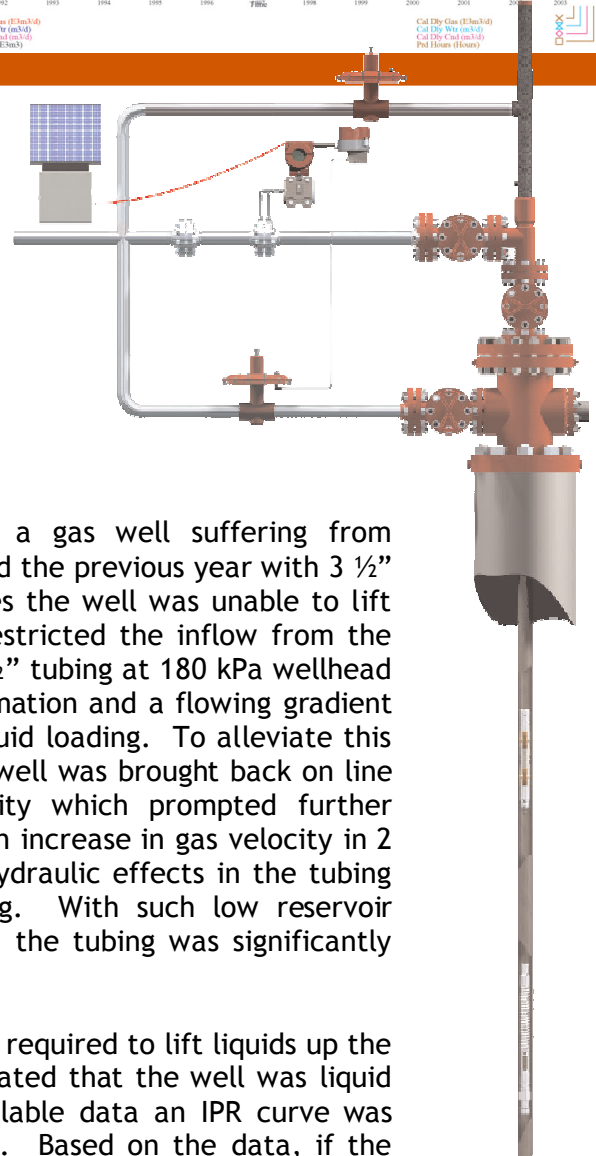
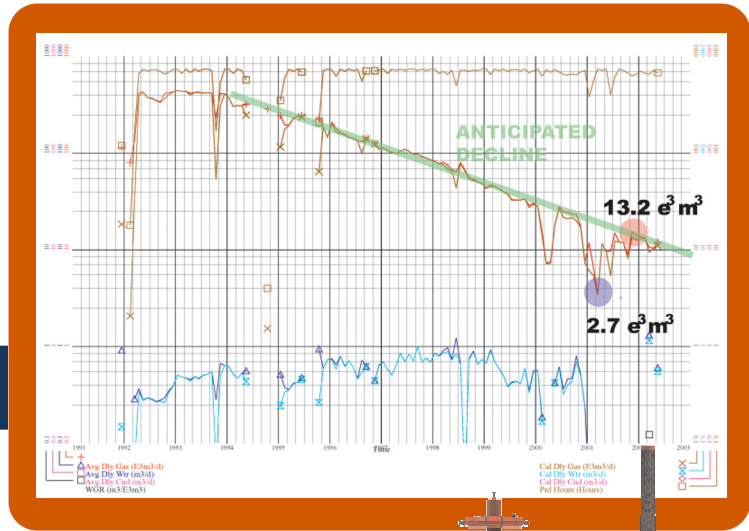
Predicted Optimization Rate - 11.0 e³m³

Actual Post Optimization Rate - 13.2 e³m³

Optimization Strategy

A customer approached Raise Production to evaluate a gas well suffering from unidentified production problems. The well was completed the previous year with 3 1/2" tubing, flowing at a rate of +/- 6-7 km³/d. At these rates the well was unable to lift liquids and was loading with fluids which significantly restricted the inflow from the reservoir. The calculated critical rate to lift liquids in 3 1/2" tubing at 180 kPa wellhead pressure was determined to be +/- 12 km³/d. This information and a flowing gradient test conducted in January indicated that the well was liquid loading. To alleviate this problem the tubing was changed with 2 3/8". When the well was brought back on line it was found to be producing well below its capability which prompted further investigation. Raise Production determined that due to an increase in gas velocity in 2 3/8" tubing, the pressure loss due to friction and fluid hydraulic effects in the tubing string had increased dramatically over the 3 1/2" tubing. With such low reservoir pressure, the increased friction and the liquid loading in the tubing was significantly impacting the wells productivity.

The study indicated that at the current flow rate, the rate required to lift liquids up the tubing string was +/- 6.9 km³/d. The current rates indicated that the well was liquid loading even with the smaller tubing string. Using available data an IPR curve was developed for the well to determine its actual potential. Based on the data, if the flowing bottomhole pressure could be lowered by +/- 150 kPa down to 300 kPa, the wells productivity should increase to +/- 11 km³/d. In order to achieve this rate the well will have to be flowed up the annulus and the tubing in order to reduce the friction losses in the tubing. Since the well was already flowing at the critical rate diverting gas from the tubing to the casing would cause the tubing to load with fluid. To avoid this Raise Production implemented a Dynaflow Interlift system to keep the tubing unloaded. In order to maintain the minimum flow rate, an Annular Flow Controller was installed to consistently measure the flow rate up the tubing and adjust the flow up the annulus to achieve the target flow rate.



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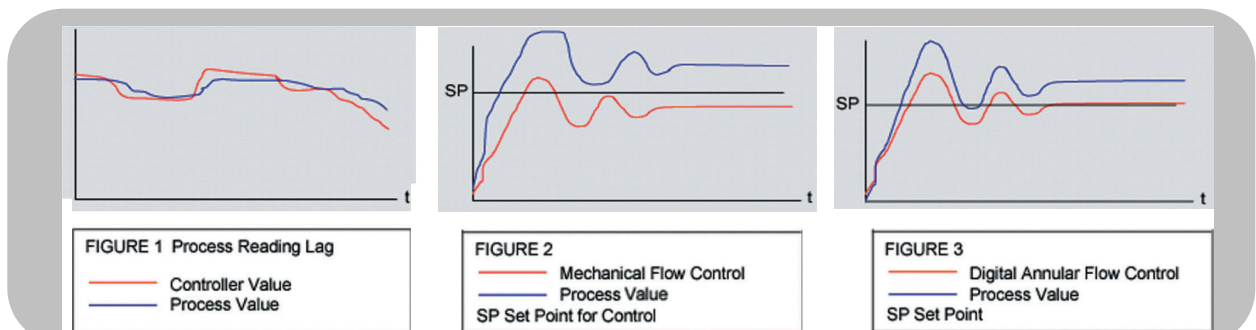
Mechanical vs. Raise Production Digital Annular Flow Control

DIGITAL	MECHANICAL
Raise Production's Digital Controller is mounted directly to the process taps. Any liquids that enter the system can drain straight back into the piping considerably reducing issues with freezing.	Pneumatic Controllers have many collection points internally due to the size of the diaphragm and access ports.
No diaphragm, o-rings or process seals inside the housing that will need replacing.	Number of components requiring servicing.
Set Point entered easily using a magnetic screwdriver, laptop, or palm pilot.	Multiple adjustments required for Set point.
Clear LCD screen displays exactly what the controller is set at.	Difficult to know the actual set point.
Set Point will not drift.	Differential pressure gauges are very expensive and not supplied with installs.
Differential set point can be set far closer to the minimum flow required as the flow control is much more precise.	Well must be operated with a large safety margin for mechanical controller dead-band. *see below

Dead Band?

Dead-band is a lag in the controller output relative to the process value. This is illustrated in (figure 1) by the time delay of the Controller Value in response to the Process value.

With Raise Production's Digital Annular Flow Controller the differential set-point can be set far closer to the minimum flow required as the flow control is much more precise than the mechanical alternative (figure 3). Mechanical flow controllers are very difficult to adjust to a precise set point. The Digital Annular Flow Controller virtually eliminates all control issues associated with 'dead-band' common to mechanical installations. Figure 2 illustrates the Dead-band associated with the Mechanical Flow controller and its inability to adjust to the Process value in a typical application.



Annular Flow Control

Features and Benefits

- Increased gas production
- Works with coiled tubing applications
- Easy to operate
- Run smaller tubing on initial completion and reduce future work-over costs
- Low-cost optimization
- Eliminates friction associated pressure loss
- Easy to read display
- Self regulating
- Low maintenance
- Re-useable