THE HOT ZONE

Spring 2017

THE HOT ZONE is a semi-annual newsletter from Blowout Engineers. Blowout Engineers is the well control division of Sierra Hamilton and provides the full scope of well control engineering, capping and well kill services to clients worldwide.

The newsletter is a compilation of technical well control information for Sierra Hamilton's clients and consultants. The focus of THE HOT ZONE is non-conventional well control topics.

This edition contains information on the following:

- Tubing buckling during snubbing operations
- Noise/Temp Logs for UGBOs

Ricky Erwin added to BD Staff

Ricky recently joined Blowout Engineers as the Business Development Representative. Ricky Erwin has seven years of experience in well control, encompassing both operations and business development. Prior to joining Blowout Engineers, he was the BD North America Representative for Wild Well Control with responsibilities for the Northeast U.S., Gulf of Mexico, West Texas and South Texas regions. He works closely with operators and drilling contractors focusing on the application of well control operations and engineering, emergency response and risk management for onshore and offshore operations.

Ricky holds a bachelor's degree in International Business as well as an MBA in Global Business from Texas A&M University–Kingsville. He is a member of SPE, AADE, and IADC.

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What's New?

Here's what's happening at Blowout Engineers.

- Recent projects include the following:
  - Blowout control on drilling well in West Texas
  - Well control drill for Marcellus operator
  - Kick consulting for well in PA.
  - Well control modeling for Utica operation
  - Participation in IADC Advanced Well Control Training Committee.
  - Kick control on well in Texas Gulf Coast
  - Rig audits in Oklahoma.
  - Mud Gas separator sizing for operator in GOM
  - Rig audit for Eagleford operator

Jason Sasarak

Jason Sasarak ("Sassy") passed away on 9 February 2017 after a courageous battle with cancer. Sassy worked for Halliburton, taught well control and worked with us at Cudd Well Control as a Sr. Well Control Specialist. He later joined BP in their well control group. Jason was a great guy and will be missed by all who knew him.

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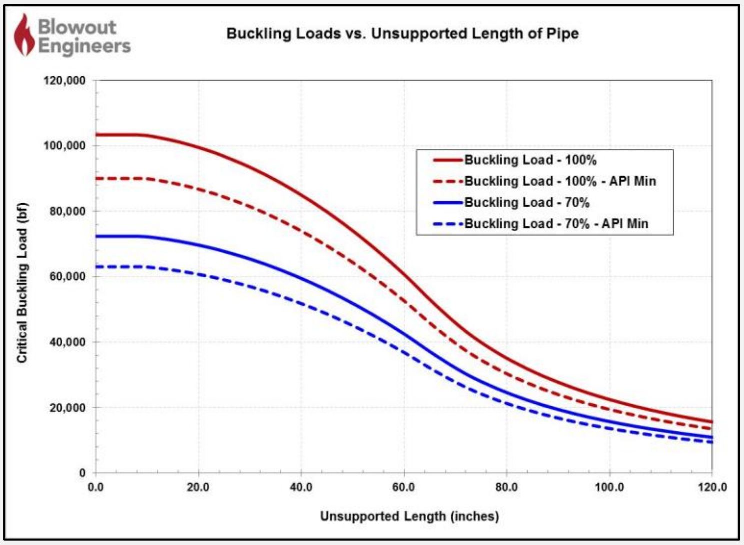
Tubing Limitations in Snubbing Operations

Snubbing operations have become increasingly common in the industry during the past decade. The benefits of "live" well operations are numerous and well documented. This live well work does not come without associated risks. With surface pressure, the risks associated with a tubing failure are generally unacceptable given the presence of personnel in the work basket. Tubular failures can result in loss of life, injuries and considerable damage to assets. This article is a brief introduction to the topic of tubing limitations during snubbing operations.

Running tubing into a well with no surface pressure relies on gravity (pipe weight). If a well has a surface pressure at the wellhead, a force is created on the tubular at the sealing element. Recall that the force equation is: *Force = Pressure X Area.* This force must be overcome by the snubbing unit to move pipe into the wellbore.

With pressure on the well, the pipe in the snubbing jack is in a compressive state and is subject to buckling loads. If no pipe guides are used in the snubbing jack, this load is assumed to be an "unsupported" buckling load. Failure of the tubing string can have catastrophic impact on personnel and equipment. Therefore, the tubing must be able to withstand this load without reaching a critical failure point. The tubing is generally treated as a column and the end conditions (pinned) are selected to provide a conservative result for the critical buckling load. The result is generally presented as a chart based on the unsupported length and the critical load limitation. The snubbing force to move pipe (including frictional loads through the ram or stripping element) can be calculated and seen on the weight indicator, and associated with a maximum unsupported length for the placement of the snubbing slips.



There are additional tubular considerations that should be accounted for with snubbing operations. API tubulars have a tolerance for the amount of steel available in the cross-sectional area. The "published" pipe specification may not be consistent with the exact dimensions of the string on location. Using the API minimum tolerances provide a calculation based on the minimum steel present in a tubular that is still within the API specification limits. Given the critical nature of the snubbing operations, this provides the most conservative solution when calculating the buckling loads.

The pipe tolerances can be located in the appropriate API documentation for further reference. For example purposes, a $2^3/_8$", N-80 tubing string is shown in the example chart for unsupported length. The critical limits for the published pipe dimensions and the API minimum dimensions are given. As can be seen, there is a reduction in the allowable critical loads when using the minimum API tolerance numbers.

$2^3/_8$", 4.7 ppf, N-80 Tubing	
Published OD	2.375"
Published ID	1.995"
API Min OD	2.344"
API Min ID	2.012"

It is widely accepted to set the compressive limits on the tubing to 70% of the maximum critical load. This adds an additional safety factor. These 70% limits are also shown on the chart. The chart provides the snubbing personnel with a maximum distance between the stationary and traveling slips that can be used when initiating pipe movement into the wellbore. As pipe is snubbed into the wellbore, the weight of the tubing will begin to offset the pressure-area force and result in less downward force required from the snubbing jack. This will allow larger unsupported lengths when the downward force is applied to the pipe above the stripping element.

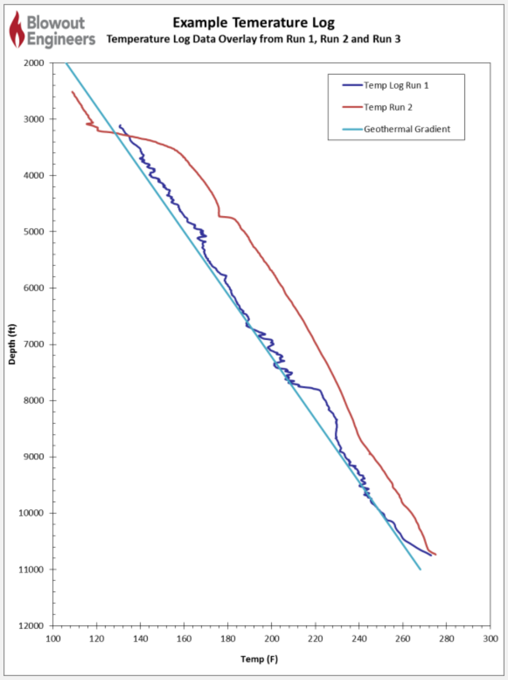
Further considerations for pipe limits should be included with the presence of pressure on a tubular. The tensile yield of a tubing string is also affected by torque and differential pressure acting across a tubular. This is typically modeled using the Von Mises Distortion Energy Theory. Please check our website and upcoming newsletters for more information on this subject as well.

Noise-Temperature Logs for UGBO Resolution

Underground Blowouts (UGBO) can be one of the most difficult well control issues to remediate. This often stems from a poor understanding of the actual physical properties of the UGBO. For any manner of problem solving, it is critical to properly define the problem in order to design an effective solution. This is a key aspect of solving the UGBO riddle.

Due to the subsurface nature of an UGBO, it can be difficult to assess if such an event is occurring. This is often debated or assumed until some manner of diagnostic tool is conveyed to determine the actual situation in the wellbore. For an UGBO, a Noise-Temperature (N/T) tool is the most common assessment method. There are two general conclusions desired from running the N/T tool:

- Confirmation of an active UGBO occurring win the well
- Identification of the UGBO flow path



These can typically be determined from the temperature survey logging run. The best temperature survey is taken from the initial down run into the wellbore. This temperature run can be compared to the geothermal gradient of the area to determine anomalies that can confirm flow and a flow path.

The geothermal gradient is the normal temperature gradient and is a linear trend increasing with depth for most areas. Local area knowledge of geothermal anomalies must be considered during the log evaluation.

A temperature survey can show the heat transfer from fluids moving in the wellbore. For example, a fluid entering the wellbore at ±10,000' will have an associated temperature that is warmer than the shallower depths of the wellbore. As fluid travels up the hole, it will transfer heat to the surrounding well and cause the wellbore temperature profile to shift towards a warmer trend. Where fluid movement is not occurring, the wellbore temperature will remain consistent with the geothermal gradient.

The temperature shift from flow is time dependent. Sufficient time must be allowed after the onset of a flow in order to observe the temperature on a log. This is normally 24 hours or more. The example log at the right demonstrates this clearly. The first log run was complete approximately 12 hours after the initiation of an UGBO. The second temperature log shows the same wellbore approximately 24 hours later. It can clearly be noted that the wellbore temperature has increased from ±10,000' to ±3,200' when compared to the geothermal gradient line.

This indicates the well was flowing behind the intermediate casing string to the surface casing shoe depth. Using this diagnostic data, a dynamic kill was designed and executed effectively stopping the flow and allowing for a remedial cement job to be performed.

A noise tool is basically a special "microphone" run on the wireline. Noise is generated by fluids flowing in a turbulent mode. Noise logs record the voltage for different frequencies (usually 200-2000+ MHz) depending on the wireline vendor. The higher the voltage differs from the norm (usually 1 mV), the louder the noise. The wireline must be static to accurately record the background noise in the wellbore. Once the tool has been stopped at depth, the wireline operator will allow the tool to "stop bouncing around" and record the voltage for various frequencies "heard" by the tool.

Noise logs can be used to confirm the flow that is suspected after the temperature log has been run. Noise log "stops" are run at the temperature anomalies. The log consists of straight lines drawn between the values for the different frequencies at the different depths. The different frequency responses can be used to determine the type of flow (single phase, bubbles etc.) The voltage output at different levels can be used to determine fluid entry, restrictions and exit points in the wellbore. The entire scope of noise logs is too voluminous to discuss here but it is important to know that the noise log can be used to determine characteristics of the flow that cannot be interpreted from the temperature log.

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