Pressure Management in Upstream Completions

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Table of Contents

Abstract: *Many aspects of pressure management are misunderstood, passed down only by tribal knowledge, or have just not been taught.*

When it comes to protecting people from life changing injuries, or expensive capital equipment from catastrophic damage, it's critical to understand pressure boundaries and options available to lower total recordable incident rates (TRIR)--including near misses--in an ever more fiscally constrained industry.

Problem: Service companies know pressure variances and spikes can wreak havoc on timely stage completion, due to formation and shale play variances that result in well kickback.

Impact: You are asked to incorporate more technologies while maintaining a full safety focus. Additionally, non-productive time (NPT) can add up quickly while you address pressure issues. This leaves no room for error in your pressure relief device technology, and current equipment has not kept pace.

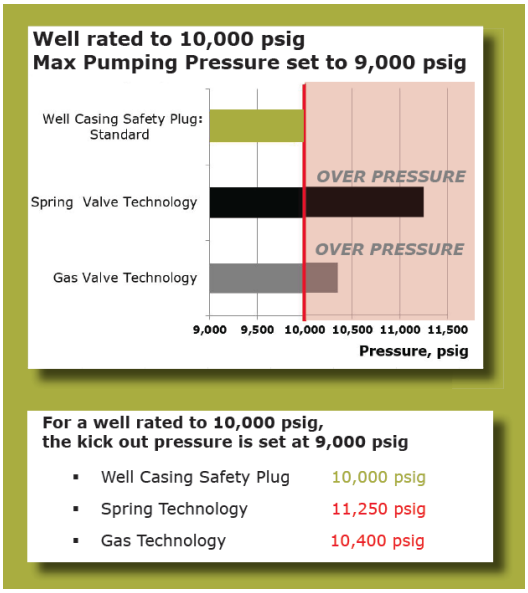
Tolerances: Why do they matter?

Does Your Technology Stack Up?

Due to aggressive, high-performance completion designs intended to deliver greater yields, wells have:

- **Substantial safety risk**
- **Imminent threat of over pressurization**
- **Economic impact to both Service and Operation Companies**

When you compare the current technologies on the market, it becomes clear that yesterday's better technology no longer stacks up to today's demand for tighter boundaries.



Spring Operated*

- Full bore opening only occurs at 25% above set pressure to get 430 GPM flow
- Refurbish every 20 stages
- Logistic, maintenance and refurbishment costs of valves
- Spares kit contain 29 items or more

Gas Operated*

- Tolerance +/-7% combined housing, gauges, and moving components
- 1,000 GPM max flow at full bore opening
- Logistic, maintenance and refurbishment costs of valves
- 17 internal components and 11 parts for seal kits
- Hazmat and Health & Safety control, storage, handling, and transportation of Nitrogen gas

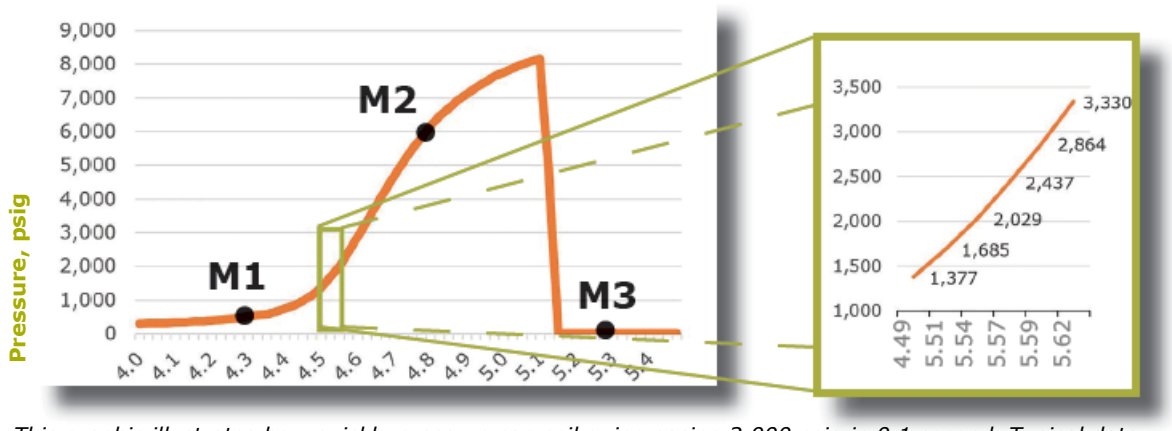
This is partly due to the gaps left by tribal knowledge and lack of clear understanding as to what the "tolerance" really means. Tolerances have been assumed to be satisfactory across the board, when really this is only true when treating at the lower end of the 8,000's psig. Historically this has been the common range, depending on the shale play. Today, as the treatment pressures are pushed closer to the allowable yield strengths of iron, well casing, and well head--commonly around 10,000 psig--the tolerance range becomes a critical matter in selecting the correct technology.

Further problems occur, as Service companies always work from the tolerance mid-point. The thought is that a valve set to 9,500 psig will protect the casing from ever seeing 10,000 psig. However, some simple math on a +/- 7.5% range yields an upper limit of 10,213 psig, which is clearly an over pressure. Alternatively, a tolerance of +/- 5% or less will remove the risk of exceeding the Exploration and Production companies' boundary of 10,000 psig. These tolerance settings can only be found in Safety Plug technology.

Pressure spikes: How fast do they move?

How fast does the data acquisition van catch your data?

The growing need to route data through the "data van," which controls the completions process, is a massive undertaking. As a result, information is measured with less frequency or is tweaked before it hits the data van's monitors, often skewing information such as data averaging, graph smoothing and sampling rates. The common practice of recording completions data at 1 or 2 measurements-per-second helps reduce this considerable sample load and data volume that is inflicted on the process, so that real-time decisions can be made.



This graphic illustrates how quickly pressure can spike, increasing 2,000 psig in 0.1 second. Typical data acquisition vans only measure 1-2 times per second, meaning the episode is unobserved (M1-M3), appearing as though the Well Casing Safety Plug activated low when it actually performed as calibrated.

There are often unintended consequences in compromise, as is the case with pressure spikes. If spikes are missed pressure safety devices will activate seemingly without reason, much to the displeasure of all concerned. The data in the van shows measurements M1, M2 and M3 in the above graphic, a max pressure of 6,000 psig, so all looks to be well. In actuality, it will have missed the spike of 8,000 psig. Now if the iron, casing, or well head are rated up to 10,000 psig, all is still well. However, if any of those items are rated to 7,000 psig, an over pressurization will have occurred. So if it is not seen, should we be concerned? It will definitely cause a heated discussion between the Service Company and the owner, which can be avoided altogether with implementation of Safety Plug technology.

Electrical Fuses and last lines of defense for Well Completions

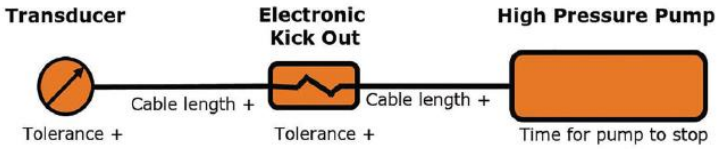
Why does your home have a fuse box in the garage?

The National Electrical Code, introduced by the National Fire Protection Association back in 1897, is generally accepted as the guiding code for electrical installations. These codes, much like those issued by the API American Petroleum Institute provide general guidance and standards for protecting a piece of property with a common fail-safe switch system. The purpose of the fuse box in the corner of the average garage, aside from meeting rigorous quality control and manufacturing standards, installation trade training certification, licensing, inspections, etc., is ultimately to act as a fail-safe switch in the event that electrical systems fail. External influences such as extreme weather, and people driving into electrical posts really do happen, so preparation is imperative to avoid potential catastrophe. But we may live many years with safety systems in play that lie dormant until the point they are needed. Then, **requiring no human intervention,** they trip, shut down, or activate to stop further damage in the event of a system failure or external force of damage. Factory built and specifically calibrated to codes and standards, ***fuses are simple items that hold***

great responsibility to save lives and property when least expected. Once used, they must be disposed of and replaced by a new one in case of another emergency.

"Fuses" in well completion operations

Traditional mechanical-moving pressure safety devices of the spring and gas design have been around for many years. When used within their broad tolerance range they provide users with a great deal of flexibility. These systems are now often found accompanied with electrical kick out systems. The addition of digital technology "allows for faster response to pressure spikes…" but is that really true?



Logically this is an example where adding technology has, in fact, slowed the response further rather than speed up the process. In motion, a mechanical device has momentum that must be dissipated, whether by human intervention or digitally-signaled activation. Even though an electrical signal moves very fast, the moment in time that the transducer on a pressured line records a pressure reading it has to travel back to the CPU logic box in the van, the decision network has to conclude 'keep going' or send a 'shut down signal' to the kick-outs on the pumping trucks. When it does, that signal has to be converted to mechanical energy that kicks the gears into neutral on the trucks. The gears and drive train are connected to triplet or quintuplet pumps that are pumping a sizable amount of volume, up to 420 GPM depending on the horse power.

Electronic Kick Outs

- GP:50 Model 370GSDCA pressure transducer +-0.25%
- Electronic Kick outs have processor time and electronic component tolerances
- How fast can a quintuplex or triplex high pressure pump, pumping at 420 GPM, get to a hard stop?
- Pressure spikes continue to grow as these multiple systems react to the transducer

So how fast is fast enough? Experience tells you that, at best, you have eaten at least 0.5 to 1.5 seconds of time. But pressure can jump 2,000 psig in 0.1 second!

That's a lot of complexity to still have the pressure spike pip you to the post.

Technology that has you covered, always.

Well Casing Safety Plug

Safety Plug technology reacts to the pressure readings at the same time the transducer gets the signal, but opens in 0.04 seconds. That's about the time it takes for an electrical fuse to protect your house. Basically, it's all over before you knew you had a problem. No damaged iron, casing, or well head, and no heated debate with your client as to what just happened. Change out the blown plug, open up your new Safety Plug and finish the stage without further delay. That could significantly reduce non-productive time (NPT) across the board.

Can we be of service?

If you wish to further investigate and understand whether your current pressure safety devices' tolerance settings could be putting you at risk, please contact Oseco. We can arrange a Pressure Management Consultant to meet with you and review your particular situation and needs.