MANAGING LEAKING VALVES FOR HIGH ANGLE WELLS

Ryan L. Beeton
QSO Inc.

INTRODUCTION

Plunger lift, gas lift, (GAPL)(PAGL), and sucker rod pumping are a few common forms of artificial lift that are heavily reliant on valves to maintain a seal in the system to extract fluids efficiently from the wellbore.

This paper will outline the increase in well production performance when using a horizontal check valve on wells with Gas Liquid Ratios (GLR's) conducive to plunger lift systems installed optimally in horizontal wells, also highlight design improvements when using these same valves in vertical situations.

Check valves are usually a key component of any bumper spring to allow fluid to enter the tubing string during a flowing cycle through the bumper spring itself, yet preventing fluid from escaping back into the reservoir while the plunger is descending to begin its next lifting cycle.

HZCV (Horizontal check valves) or could also be referred to as horizontal standing valves are relatively new to the industry yet their functionality is similar to the traditional check valve or standing valve method which was typically a round ball creating a mechanical seal, or in other words, metal-to-metal contact between the valve and the associated seat.

HISTORY

Plunger lift has been a very simple and elegant solution for extracting wellbore fluids without the need of a prime mover. As horizontal well technology became available, traditional check balls remained unevolved and functionality was compromised when optimally located in the heel of the well near the deepest vertical section, therefore bumper springs consisting of check valves were located higher in the tubing intentionally where their design parameters were met, and they could close properly.

Operators struggled if traditional valves were located at an angle exceeding +/- 38 degrees, with these valves exhibiting detrimental side effects such as, fluid not being held above the valve, fluid not being displaced to surface with plunger travel, liquid loading the well below the bumper spring, very inconsistent and/or erratic plunger arrivals, with all side effects contributing to higher hydrostatic pressure exerted on the formation, limiting well production and in many cases adding well intervention costs such as swabbing to re-establish well production.

The Invention

HZCV's were developed to allow producers the opportunity to land the bumper spring assembly lower in the well than traditional valve assemblies, where higher degree of deviations will be encountered and where standard check valve designs have no ability to maintain a seal. Historically traditional valves were often located higher up in the tubing string where they could be effective, but at the same time sacrificing potentially hundreds of feet of achievable true vertical depth distance of fluid recovery. HZCV was designed as a universal and cost-effective solution to maintain valve effectiveness at high deviation angles, allowing wells to both produce at higher rates and reduce or eliminate ongoing additional well costs associated with poor valve performance.

Design

HZCV primary function is to hold fluid at high angles. HZCV's are designed for most nominal tubing sizes, are available in different material types to handle ranges of well conditions and pressures encountered. HZCV could appear like Figure 1 which consist of two round spheres joined together by a connecting stem. Based on the geometry of a design like this, the horizontal check valve can now simply slide into its seating position on extreme angles due to the mass of the higher ball on the stem pushing the seating ball into position, whereas a round ball is unable to find or maintain its center at higher angles because the traditional ball is held to the low side of the enclosure by its own mass and has difficulty seating.

Discussion of the "Benefits" of the HZCV

The horizontal check valve also consists of much more surface area for fluid to act on. Further geometry of this horizontal check valve allows the fluid contacting the top sphere to act as a fulcrum point sealing the bottom sphere against the seat quicker and more effectively at higher wellbore angles. Figure 2 reveals the fulcrum effect with lines of force. Figure 3 shows standard check ball unable to seat in high angle application. Figure 4 shows the horizontal check valve seated in high angle application.

Due to geometry, overall stability is observed along with reduced wear characteristics of the horizontal check valve and associated housings as it is unable to spin and ricochet in all directions like a single ball is capable of, this could be kept in consideration when selecting check valves for vertical applications.

During laboratory testing a 2 3/8 translucent tubing style flow run was utilized at 60-degree inclination, with introduced water rates of 40 gal/min and injected gas flow rates of 100 scfm. Standard check balls were measured to have decibel readings of 110 decibels where the HZCV were measured at 93 decibels. It was concluded that the excessive chatter and vibration from the standard check ball was responsible for the 18% increase in decibel readings. This was also visually validated during the test. Figure 5 and 6 shows images of simultaneous laboratory testing as it was being performed.

Results

An example that one Operator supplied was their observation of over 400 wells during a two-year period in Western Canada where traditional single ball check valves located at +/- 60 degrees deviation were replaced with horizontal check valves at +/- 60 degrees deviation.

This Producer observed a 20% increase in marketable production by replacing traditional valves with HZCV.

- many wells were now able to be produced which were otherwise shut in
- several wells showed over 200% production increases
- noticeably flattened out the natural decline curve
- extended the life cycle of the wells
- changed how wells are being drilled going forward, kick off points, etc.
- 20% increase in BOE

Gas Field Name							**Before**	**After**	**% Increase**
	Average Depth (ft)	Average Deviation (degrees)	Number of Wells	Date	Study Period	Tubing Size	Average Gross Production BOE/day	Average Gross Production BOE/day	Gross Production (%)
Western Canadian Sedimentary Basin	6,000	60^0	400	2020	2 year	2 3/8	80 BOE	100 BOE	20%

Further to the immediate and obvious economic benefits of increased production, this producer (and others) has recognized further savings which include:

-reduction in operator time (more consistent well-run time, less operator intervention) allow operations to increase well count or reduce staffing. Afford time for other required tasks.
-reduction in emission/venting (lowered events for blowdowns and shut-ins).
-increased reserve values (achieved with larger recoverable volumes).
-reduced overall “Opex” by increasing production.
-very quick netback returns.

SUMMARY

Horizontal check valves have solidified their existence in the plunger lift environment as a simple, cost-effective, and elegant solution for holding fluid in horizontal wells. Further applications in the oil and gas industry have been explored with findings underway, stay tuned!

Acknowledgments

Greg Volk, Bonavista Energy; Benny Williams, Consultant Q2 Artificial Lift Systems; Corbin Coyes, Q2 Artificial Lift Systems; QSO Inc.; Q2 Artificial Lift Systems

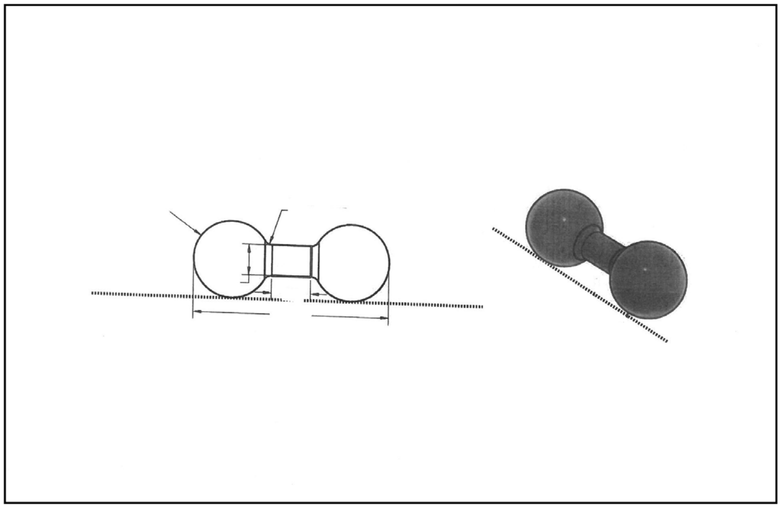

Figure 1

Horizontal Check Valve

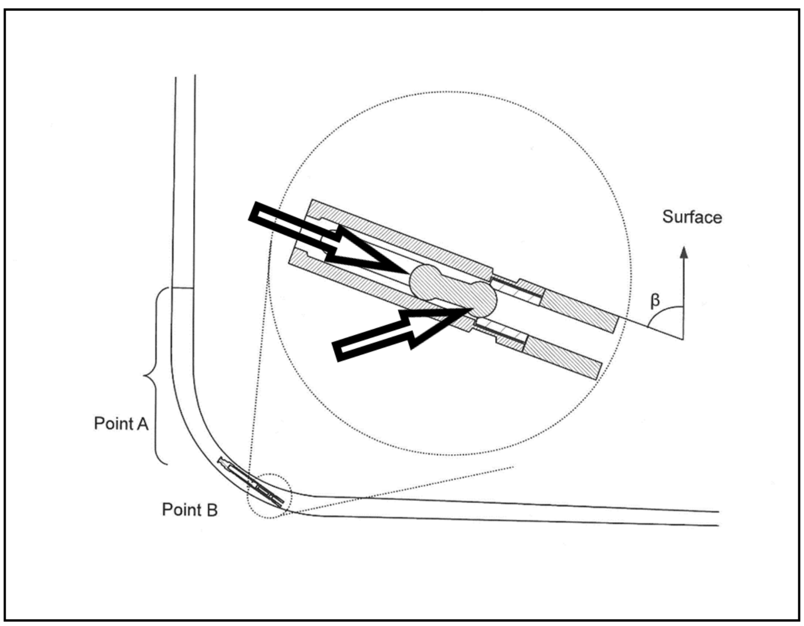

Figure 2
Showing how lines of force act on HZCV

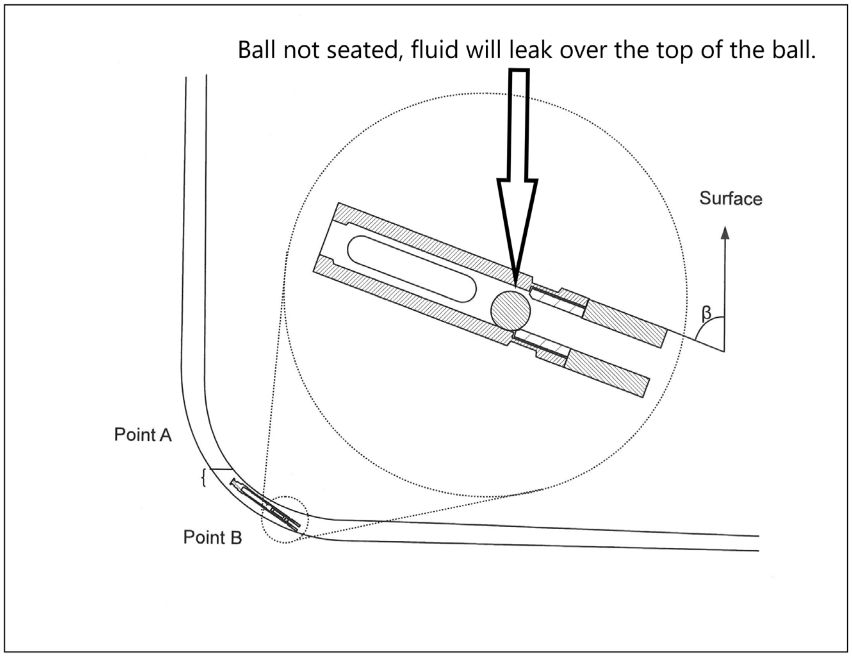

Figure 3
Standard ball unable to enter the seat

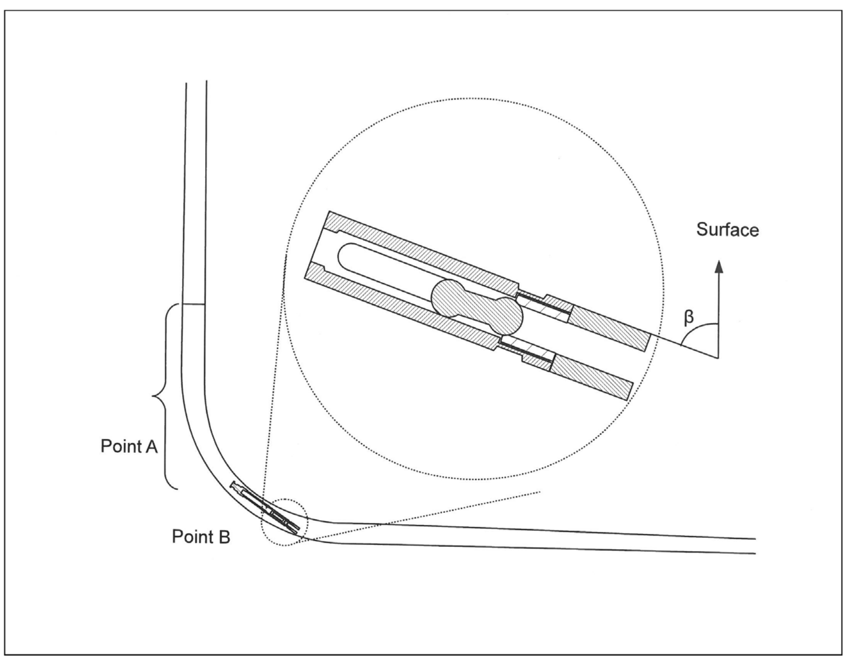

Figure 4
HZCV seated correctly at high angle

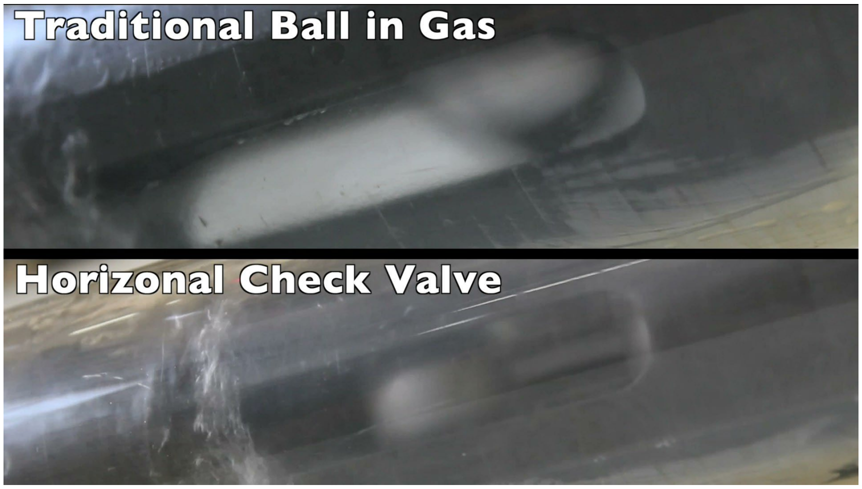

Figure 5
Flow testing comparison in gas

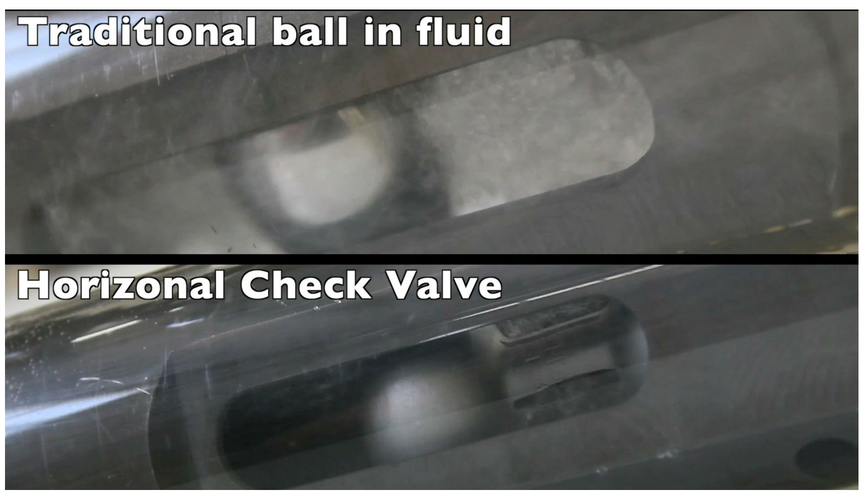

Figure 6
Flow testing comparison in fluid