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"Maximising Economic Lift"

Are R Ratios Causing Problems with your Gas Lift Wells?

KEN DECKER, ALMOST RETIRED

Constant R Ratios?

We’ve all done it - we go to the manufacturers’ table of R ratios for the valve and port, plug it into the formula to calculate the PvoT and go merrily along our way.

We have because.. We have always done it that way and we haven’t had any problems. Or at least we don’t think we have had problems.

There always seem to be those nagging problem wells that just will not behave properly and for all the work and troubleshooting we do, they just will not comply with our wishes.

It is very possible the problem had nothing to do with your analysis or troubleshooting efforts. It is very possible the valve you put in the well was not the valve you designed for the well.

The R Ratio is a Variable !!

What would happen to your gas lift well if the R ratio you used to calculate the PvoT was NOT the R ratio of the valve you installed in the well?

That is exactly what you have been doing when you used the manufacturers published R ratio.

BUT…

If your wellhead injection pressure was less than 1500 psig, everything worked just fine.

If your wellhead injection pressure was higher, it worked most of the time but there might have been a few cases of multipointing.

If the R ratio was 'off the ranch' multipointing occurred before you could reach the orifice and you just could not inject enough gas to get past the unloading valves.

R Ratios are Larger than Published

A series of tests were conducted at LSU to measure the R ratio as a function of port material and valve dome pressure.

The R ratio increases with dome pressure

When the R ratio increases, the PvoT of the valve does NOT increase but the PvcT of the valve is much lower than calculated.

When the PvcT of the valve is lower than calculated, the valve stays open when it should close.

The PvcT of the valve dictates the performance of the valve – NOT the PvoT.

The R Ratio Sweet Spot

When the R ratio is near the published value, valve performance is disappointing but workable.

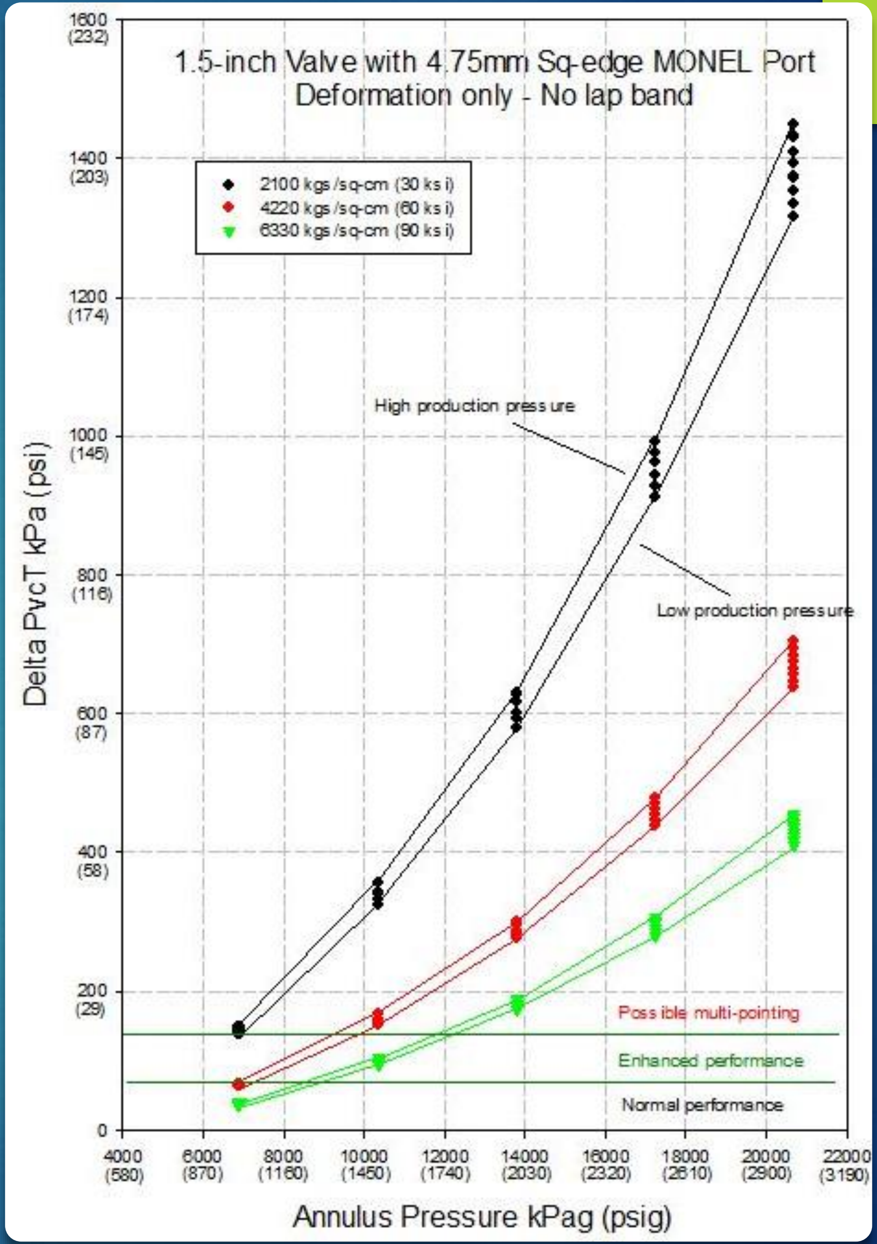
When the R ratio is just a little larger than the published value, the valve is in turbo mode – the sweet spot.

When the R ratio is too large, it just won't close even when annulus pressure drops 30-40 psi.

Where is your valve?

My experience indicates most 1-1/2" valves are in turbo mode and a few in multi-pointing.

My experience indicates most 1" valves are disappointing and a few in turbo mode.



What Can You Do?

Trust

Trust the company preparing the valve is reputable, have good test equipment, and are using the manufacturers specifications for materials and preparation.

No Trust?

Hedge your bets. Plan on the R ratio being slightly larger than published if the set pressure is less than 1500 psi and much larger if the pressure is over 1500 psi.

Pro-active!

Test the R ratio and use it in your design.

More Info

The following SPE papers provide much more information about the R ratio and how it affects valve performance

SPE 186110 “ *Effect of R Ratio on Performance of IPO Gas Lift Valves”*

SPE 189450 “ *Gas Lift Valve R Ratios”*

OR

Ask me!

Thank you to the EuALF Programme Committee for the opportunity to participate in the Gas Lift MasterClass.

Gas Lift Valve *R*-Ratios

K. L. Decker, Decker Technology Incorporated

Summary

The *R*-ratio is considered a constant, equal to the area of the port (A_p) divided by the bellows effective area. When gas lift valves are tested for both opening and closing pressures, it is possible to calculate the *R*-ratio. The calculated *R*-ratio from test data is consistently larger than the manufacturers' published *R*-ratios. This paper presents a discussion of the factors affecting the *R*-ratio and an explanation for the difference between published and tested *R*-ratios. The *R*-ratio is not a constant but varies with dome pressure, port-material strength, bellows size, and port size. A method is proposed to calculate or test the true *R*-ratio.

The use of the area of the port (A_p) in the *R*-ratio is not completely accurate. The area should be the seal area (A_s) defined by the outer-sealing diameter of the ball (D_s) on the port. It is possible to test valve behavior to determine the seal area, and it is recommended that the tests be conducted in order to use the correct *R*-ratio when designing gas lift wells. A method to apply the use of the measured *R*-ratio is also provided.

Valve/Port Geometry

The common valve/port geometry is a ball on a square-edged seat, as shown in **Fig. 1.** The ball is usually 1.59mm (0.062 in.) larger than the port diameter, but larger-sized balls are also used in some cases.

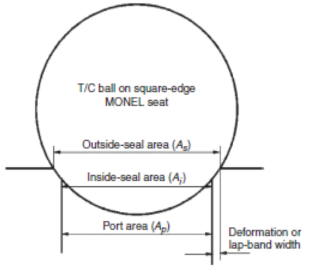


Fig. 1—MONEL™ 400 alloy square-edged port.

There are two methods of determining the *R*-ratio: the first is based on valve areas, and the second is based on pressure tests of the valve. Traditionally, the published *R*-ratio is defined as

$$R = A_p/A_b. \quad (1)$$

Manufacturers publish *R*-ratios by using Eq. 1. In most cases, the manufacturer has increased the size of the port diameter to allow deformation and lap bands. **Table 1** is typical of the published *R*-ratios.

The tested *R*-ratio is derived from the static-force-balance equation and is

$$R = (P_{voT} - P_{vcT})/P_{voT}. \quad (2)$$

Discussion

Manufacturers use a seal diameter 0.15 mm (0.006 in.) larger than the port diameter to compute the area of the port (A_p). This larger diameter is an acknowledgment that the ball seals at a larger diameter than the port diameter. The ball/seat contact forms an annular ring on the port surface that serves as the seal barrier between the upstream and downstream pressures. This annular seal area is subject to neither upstream nor downstream pressure.

The use of a seal diameter 0.15mm (0.006 in.) larger than the port diameter is optimistic. This paper will show that the dome pressure acting on the effective area of the bellows creates a force that deforms the edge of the port to create a seat larger than the allowance given in published data. The contact area is a function of the dome pressure, bellows effective area, port size, and the yield strength of the port material.