

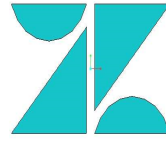


Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

GLV-gas lift valve ageing process

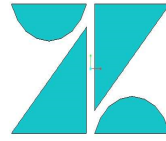
8/25/2023

Z Tech Design, 6376 Red Pepper Dr. Gulf Breeze FL 32563,
web site <https://ztechdesign.org>, e mail ozo@cox.net



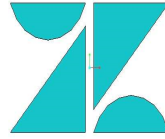
Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

- GLV ageing process is being used in oil industry for 50-60 years. The purpose of ageing process is “to expose bellow to pressure significantly higher than max working pressure which will cause final bellow crimping/compression with intent to stabilize valve/bellow operating parameters, provide consistent valve performance as opening, closing pressure and valve load rate”. Ageing process permanently changes bellow convolution radiuses. Only convoluted/formed bellows are exposed to ageing process, edge welded bellows are not exposed to ageing process.
- Ageing process is usually performed by applying 1000 PSI dome pressure and 5000 PSI water injection pressure, valve is opened and closed several times and ageing process might be repeated several times. Ageing process is performed by submerging valve in water in custom designed ageing chamber.
- **Ageing process does not work as described/desired, and it is wrong process that should not be performed.**



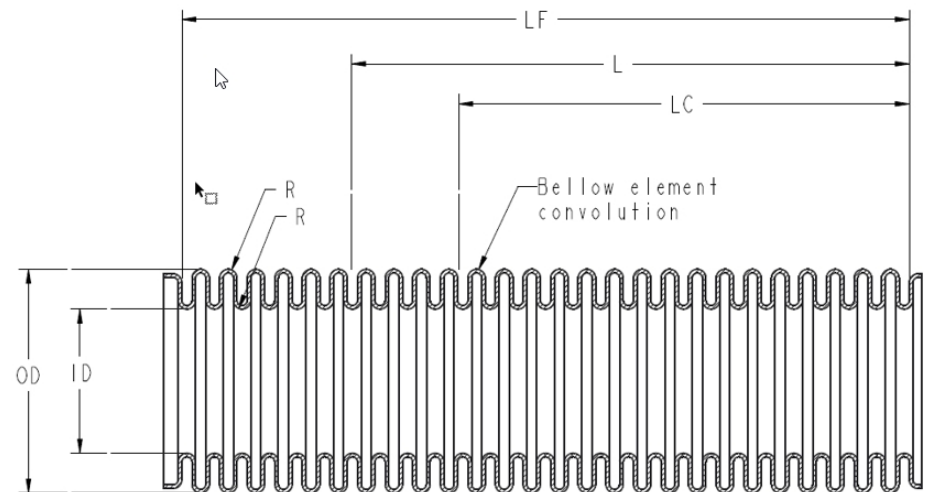
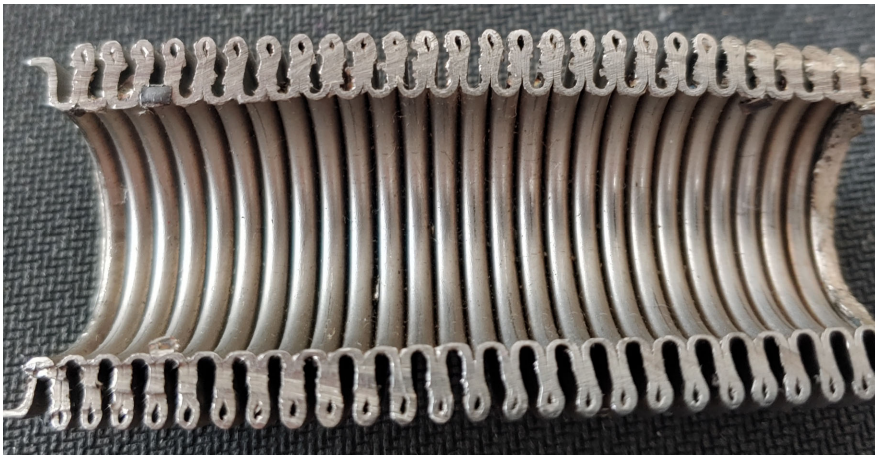
Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

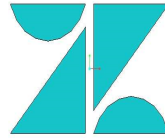
- Bellows used in GLV are made from three 0.005” thick layers usually rated by manufacturers to 250 PSI working pressure. Material used is usually Monel 400, Inc 625 and 718.
- Being manufactured from very thin material bellows plastically deform every time when exposed to pressures differential larger than 500-600 PSI.
- During ageing process when 1000 PSI dome pressure is applied bellow convolution radiuses R changes depending on pressure orientation, external or internal. If pressure is internal, OD convolution radius R increases while ID radiuses decreases and vice versa. When 5000 PSI injection pressure is applied convolution radiuses change in opposite direction. Changes are severe. After ageing, 5000 PSI is released and now convolution deformation occur in opposite direction driven by 1000 PSI dome pressure. This is happening every time injection pressure is released to atmospheric pressure.
- Valve is shipped with no dome pressure and ageing process is usually repeated at well site where deformation explained above occur again. When valve TROP-test rack opening pressure is being set, say to 2000 PSI bellow is again plastically deformed.
- For bellows to work properly and as designed bellow geometry must not be changed except bellow length from LF to LC during accurate crimping process. Bellow convolution radiuses must not be changed.



Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

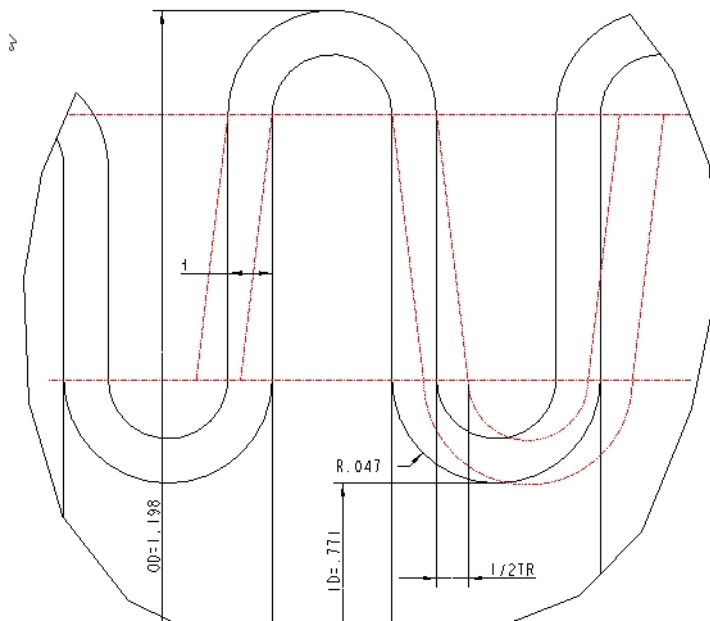
- Picture below left shows bellow cross section exposed to 1000 PSI external pressure, note that ID convolution radiuses R are enlarged, while OD radiuses are reduced. Bellow convolution radiuses deforms plastically every time 500-600 PSI differential pressure is applied to below.
- Picture below right shows convoluted/formed bellow typical dimensions.



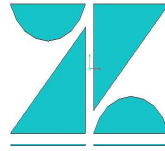


Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

- Typical dimensions for 1.5" nominal size bellow are shown below.

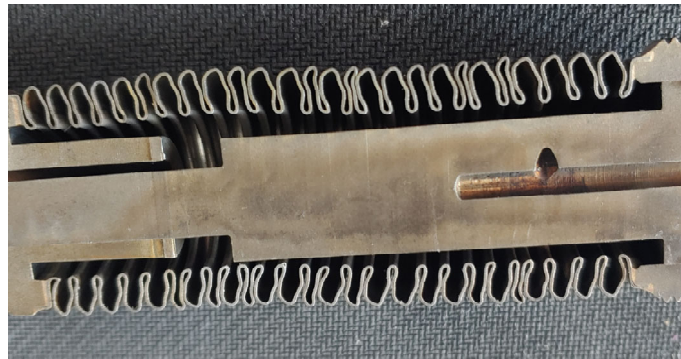


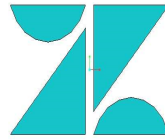
Bellow travel-TR depends on t-wall thickness, bellow OD and ID, convolution radius R and material. During crimping and ageing process bellow dimensions must not change except bellow length from LF to LC. However, in most cases depending on type of crimping/ageing process used, bellow convolution radius R changes or/and convolution shape is completely deformed. This change of radius and shape changes/reduces bellow allowable travel TR and in application convolutions are exposed to plastic deformations resulting in bellow premature failures due to the fatigue. In GLV application bellow must never be compressed to length shorter than LC.



Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

- The worst gas lift valve in the business:
- Picture bellow shows cross section of GLV. This is very first GLV design, note horrible shape of bellow convolutions.
- This GLV bellow is first soldered against mating parts in free length L, crimped usually using external pressure and then aged. Picture is worth more than thousand words. Everything that could be wrong went wrong with this design.
- Unfortunately, this is the best selling GLV in the business.





Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

- Interestingly, although valve aging process is used for 50-60 years there is patent # US 2021/0246769A1 issued for bellow ageing process, I am not sure how this was possible. This patent describes ageing process performed with air pressure. This patent is good example how not to age GLV and bellow. No one is ageing GLV with air but water to avoid explosive decompression problems.
- **So, what is the solution?**
- First step is proper bellow crimping where only bellow length LF is changed to LC as per manufacturer recommendation. Proper bellow crimping must result in crimped bellow where it is essential to maintain bellow radiuses. My approved patent # US 11,845,120 B2 produces perfectly crimped bellows, see picture of bellow cross section below. Note perfectly formed bellow convolution Ω -omega shape.

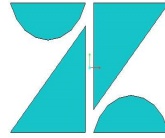




Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

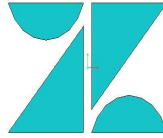
- Picture below shows perfectly crimped bellow per my approved patent # US 11,845,120 B2 using custom designed crimping device. Note that bellow is crimped as self standing, not soldered against mating parts.





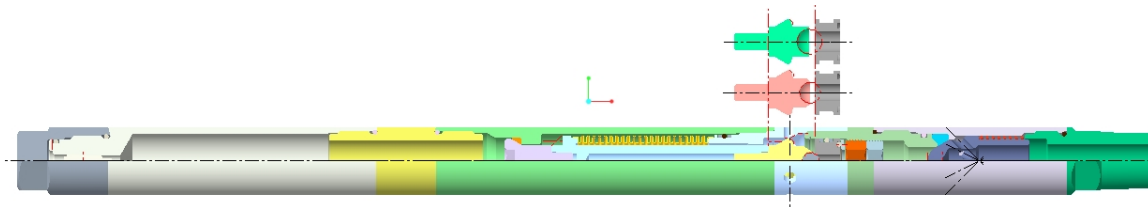
Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

- Second, by design, GLV bellow should never be exposed to differential pressure higher than manufacturer recommended working pressure, usually 250 PSI for formed bellows.
- **Today, there is no GLV on the market that meet this criteria.**
- **Introducing game changer: GLV with dual Fortress™ seals per my patent # US11242732.**
- Dual Fortress™ seal GLV features formed bellow that is never exposed to differential pressure higher than 200 PSI.
- Bellow in this GLV is completely protected from high injection and dome pressure by Fortress™ seals.
- Bellow in this valve is crimped per my pending patent # 17/108,491 resulting in perfectly crimped bellow.
- This GLV can be exposed to 15 KSI injection pressure without any danger for bellow.
- This GLV features spring loaded telescoping stem, which is complex, however applying my patent # US 11643910 B2-"GLV with two simultaneous mechanical stops" telescoping stem is not needed and is eliminated from design resulting in simpler and more reliable design.
- This gas lift valve is not aged, this is wrong and unnecessary procedure. Valve is prepared for use by applying max dome pressure of 3500 PSI depending on bellow material used.

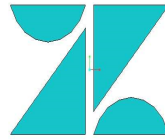


Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer

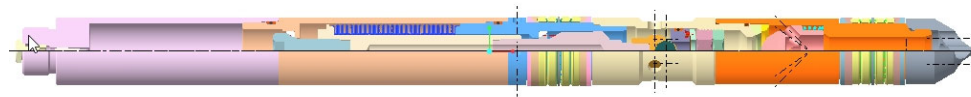
- Drawing bellow shows GLV with dual Fortress™ design, patent # US 11,242,732 B2 with applied two simultaneous mechanical stops.



Z Tech Design, 1" TSMS-DFS-C1 conventional gas lift valve Inc 625
version. Max dome pressure 3500 PSI based on patents # US
11,242,732 B2 and US 11,643,910 B2
TSMST™-Two simultaneous mechanical stops
DFS™-Dual fortress seal
C-Conventional gas lift valve
R-wireline retrievable gas lift valve



Z Tech Design-Zlatko Salihbegovic graduated mechanical engineer



Z Tech Design, 1.5" DFS-R2 conventional gas lift valve. Max dome pressure 2800 PSI based on patent # US1124273282 and US11643910B2. Max check valve pressure 15KSI.

TSMST™-Two simultaneous mechanical stops

SFS-Single fortress seal

DFS™-Dual fortress seal

C-Conventional gas lift valve

R-Wireline retrievable gas lift valve