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PenTech FAQ # 4 by Gary G. Sanders, Vice President - Engineering

Recessed vs. plane gage glass chambers:

Two de facto standards have evolved for the chambers of glass liquid level gages. Most process gage chambers are made from square barstock. The gasket/glass contact area is prepared on a single surface for reflex style gages and on opposing surfaces for transparent. For this FAQ, the design that uses a ground flat surface(s) as the gasket/glass contact area(s) will be called the 'plane' design. The other design places a recess into the chamber surface roughly the size and shape of the gasket and will be referred to as the 'recess' design.

Over the years, various marketing claims have been made about the superiority of one design over the other, these various claims will be discussed by consolidating them into two basic claims per design. The purpose of this FAQ is to attempt to examine each design from a strictly technical standpoint.

Claims by: <u>Recess</u>

1. Easy to line up gasket and glass with chamber vision slot due to 'drop' into recess.
2. Recess provides shoulder for gasket, preventing blow out.

Claims by: <u>Plane</u>

1. Easier to remove gasket 'residue'.
2. Lighter chamber

Note: Penberthy catalogs and manufactures both styles, any bias is therefore mooted.

<u>Recess claim #1</u>

Aligning the gasket/glass may be by tactile as well as auditory and optical senses. Gasket alignment with glass and chamber vision slot is easy, it nestles into the recess. Downside, if the glass is allowed to contact the wall of the chamber recess, stress risers will be created that has a high probability of breaking the glass. For plane chambers, line up is by sight. Since the gasket, glass, cushion and cover must all be aligned visually, the possibility of misalignment is higher, especially the gasket. I.O.M.'s state that maintenance (section replacement) should always be done with the gage removed to a work table and placed into a horizontal position. It is recognized that field expedience sometimes allows maintenance work on a gage in its mounted vertical position. Handling of parts (esp. gasketing) is facilitated with a recessed chamber for vertical mounts.

<u>Bottom line</u>: There is justification to this claim. However, to properly maintain a gage (refer to its I.O.M. for all the steps involved) , Penberthy recommends that proper section replacement maintenance can only be done in a shop environment on a work table. For either design; disassembly, cleaning, checking and especially re-assembly is much easier and more precise when the gage is horizontal. There is little difference in alignment difficulty when working with the gage horizontal.

Tip: Although Penberthy never uses this, many users apply a thin coat or dabs of a process compatible viscous material to the gasket and cushion as an aid during assembly, e.g., grease, paraffin, silicone grease, vacuum grease, asphalt, etc.

Recess claim #2

Starting with the basics, a compression seal is made by the force generated by the residual (below yield) tension of axial bolt loading (or Belleville washer, if used). This closing force is distributed by a cover, buffered by a cushioning gasket, transmitted through the glass where the force compresses the gasket against the chamber. For this to be an effective seal, the applied compressive force (in conjunction with the coefficients of friction of glass/gasket/metal) MUST exceed the hydrostatic end forces which process fluids under pressure exert against the inner edge of the gasket. The minimum bolt loading required may be calculated based upon the design pressure, the gasket material and the effective gasket contact area. The second two items establish the effective coefficients of friction as well as other factors. Refer to ASME B&PV Code Section VIII, Appx. 2, 2-5 for details. There is another sealing method called self-energized or pressure activated. For seals of this type, axial bolt loading is only used to prevent cover separation. No compressive force on the gasket is needed, it is provided by process pressure (ASME "m" and "y" factors are both zero). An example using this type of seal is Penberthy's TU gage. For this to work, all pressure boundaries of the sealing gasket except the edge exposed to process fluids must be completely contained by precision rigid mechanical structures. Recess claim #2 attempts to allude to this and many claims have been based on this. Reality - recesses in the chamber are a convenience to hold the gasket and align the glass. The recesses are not a precision fit to the gasket or glass. Therefore, the seal remains a simple compression seal. Any gasket material extruded that contacts the recess wall will only be - at optimum - temporarily impeded from end force creep continuing to blow out. Consider if recess claim #2 were true, then the fundamental failure mechanism would become glass blow-out rather than gasket blow-out which is the standard for compression seals. This means essentially every failure would tend to be catastrophic, out the front with glass shrapnel and process fluids rather than the usual leak or process fluid jetting deflected at least 90° from the frontal vision area.
Bottom line: There is no difference between the two designs in gasket retention. This claim cannot be substantiated.

Aside: Although 1/16" [1.6 mm] thick gasketing has been the standard for many years, today's machining practices allow this to be reduced to 1/32" [0.8 mm] (Penberthy's current standard). Consider a size 9 glass section gasket containing a process pressure of 2,000 psi [13,800 kPa].
If 1/16" [1.6 mm] thick gasketing is used, it has over 3,200 pounds [≈ 1,500 kg] of extruding (hydrostatic end) force applied to it.
If a 1/32" [0.8 mm] gasket is used, the extruding force is halved, i.e., 1,600 pounds [≈750 kg]. Remember that this extruding force can only be counteracted upon in a compression seal by axial bolt load (read torque or by Belleville washers).
Bottom line: Using 1/32" gasketing reduces by half the force trying to extrude the gasket. Torquing requirements to maintain a seal are therefore somewhat relaxed.

Plane claim #1

When replacing glass/gaskets, one fundamental requirement is the restoration of the glass contact surfaces. One step involves the removal of old gasket/cushion residue. This insures that no stress risers will telegraph through the new gasketing and result in glass breakage. With asbestos and non-asbestos gasketing, the elastomeric binders would 'fry on' the surfaces (actually carbonize in place). Removing this residue was occasionally like chipping rock. I.O.M.'s suggest using a brass scraping tool to avoid damage to the glass contact surfaces. Chipping away at this 'rock' with a brass scraper is difficult. Removing old gasket residue has become much easier since the change of standard material to graphite ribbon gasketing due to its friable nature. In any case, when the scraping is done on a plane surface, it is relatively easy. Working down in a 1/16" recess with hemispherically radiused ends is difficult and frustrating.
Part 2. When checking chamber flatness, laying a piece of glass on the plane chamber makes verification of chamber flatness easy. Trying to ascertain chamber flatness in a 1/16" recess is extremely difficult and essentially impossible when examining for chamber bowing.

Bottom line: This basic claim is valid. However, the change to graphite ribbon gasketing as standard has greatly reduced the demands of this once onerous task. Checking flatness vs. glass, however, remains much easier with the plane design.

Plane claim #2

Looking at the cross section of a gage chamber, it is obvious that as the glass seating surface(s) are approached, the cross-sectional area of chamber material increases. This is where the majority of side beam strength exists. If recesses are cut into this area, it greatly reduces strength and enhances pressure change 'breathing' leading to premature gasket failure (refer to FAQ #3 for more information). Solution: make the chamber larger by adding mass which makes it heavier.

Bottom line: This claim is valid as stated.

Conclusions:

Bottom line: Both designs are effective. If manufacturer's recommendations about removing gages to a work table and placing them horizontally for maintenance are followed - the choice is the plane surfaced chamber. If these instructions are ignored for whatever reason and maintenance on vertical gages is attempted in situ, then there is rationale for using recessed chambers.