

Permanent Packer Failure Causes

- Factors causing failures

Permanent Packer Performance

- Hoppman and Walker, PEI, May 1995
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- Rating envelope - regions of stress
- catastrophic failure - packer no longer able to maintain seal integrity
- non-catastrophic - limit the ability of the packer to function as designed

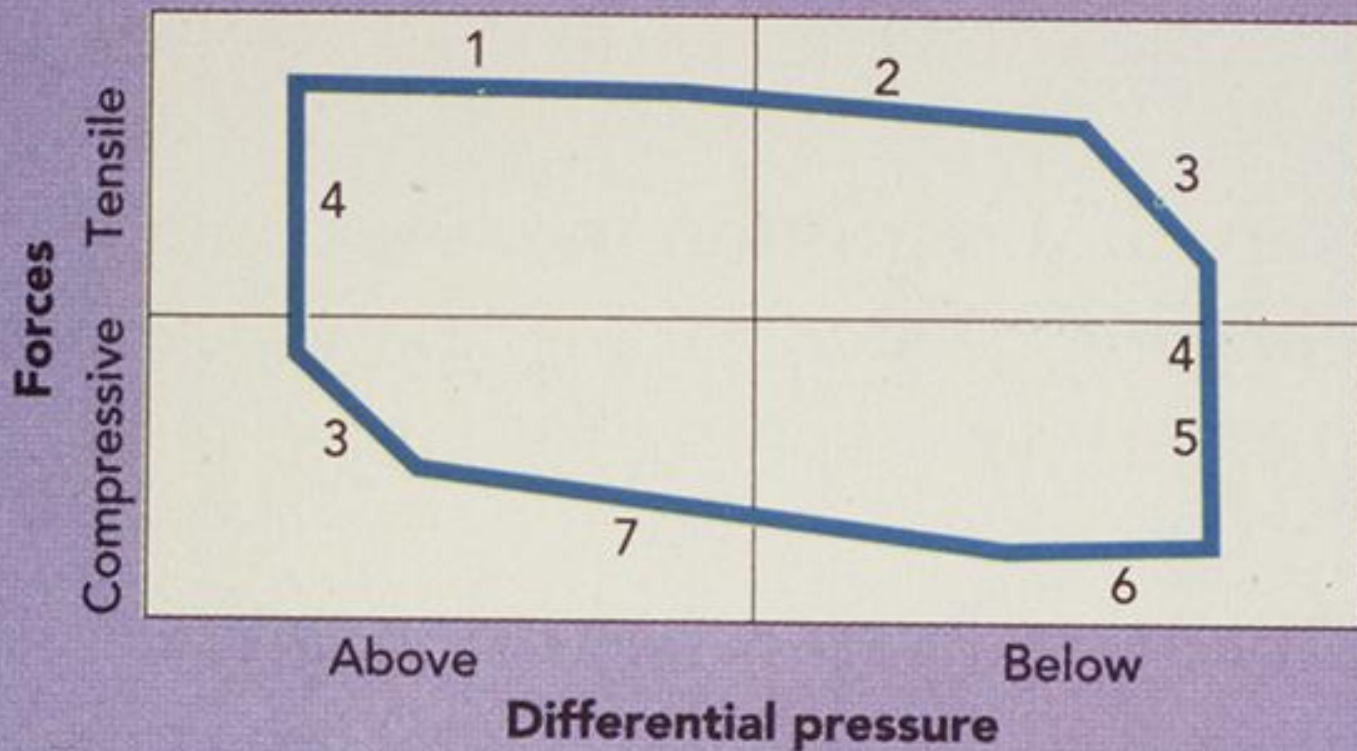


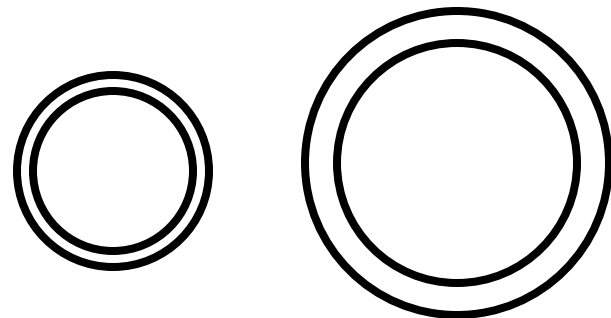
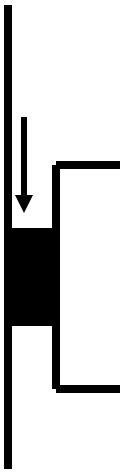
Fig. 1. Safe operating areas are inside the envelope for permanent packers considering axial and differential loading. Areas falling outside the envelope may cause packer failure. Each number represents a mode of which a given axial and differential pressure may cause failure. (Hopman/Walker, PEI)

Packer Failure Causes

- Body Collapse
 - ID of seal bore contacts OD of seal assembly
 - Caused by differential pressure above or below the packer, or by packer and tubing forces; or by a combination of the two.
 - Virtually all of the pressure and forces exerted on the packer are locked in by the slip system. The body remains collapsed even after the forces are removed.

Packer Failure Causes

- Body Collapse (continued)
 - Since pressures and forces are dependent on the cross-sectional area of the packing element, they are dependent on the casing ID.
 - Each size packer is used in a range of casing ID's (weights)
 - As casing ID increases, the expansion of the packing element must be greater - adversely affects packer rating.



Consequences of Body Collapse

- Not a catastrophic failure (sealing not compromised)
 - often cannot remove seals from packer bore
 - Safe Operating Region - 3 on envelope

Packer Failure Causes

- Packing Element System Failure
 - failure of the element occurs when the element extrudes through the back-up system



Packer Failure Causes

- Causes of packing element failure
 - temperature of seal material exceeded
 - excess pressure on element causes extrusion
 - chemical attack (breakdown or softening)
 - gas permeation and sudden decompression causing blisters and seal ruptures
 - backup system failures
 - seal bore corrosion or erosion leaves sealing surface rough

SPECIFICATION GUIDE

CASING		CASING I.D. RANGE (IN.)		MAX O.D. OF TOOL (IN.)	PACKER BORE (IN.)	THREAD CONNECTION BOX UP/PIN DOWN	PRODUCT NUMBER
O.D. (IN.)	WEIGHT (LBS./FT.)	MIN	MAX				
2 $\frac{7}{8}$	6.4- 6.5	2.375	2.441	2.250	.750	1.315 NU 10Rd BOX UP 1.250 EU 10Rd PIN DOWN	620-25
3 $\frac{1}{2}$	7.7-10.2	2.922	3.068	2.750	.750		620-30
4	9.5-11.0	3.476	3.548	3.250	1.625	2.375 EU 8Rd	620-40
4 $\frac{1}{2}$	15.1-16.6	3.754	3.826	3.562	1.625	2.375 EU 8Rd	620-41
4 $\frac{1}{2}$	9.5-13.5	3.920	4.090	3.750	2.000	2.375 EU 8Rd	620-45
5	18.0-20.8	4.156	4.276	4.000	2.000	2.375 EU 8Rd	620-52
5	13.0-18.0	4.276	4.494	4.125	2.000	2.375 EU 8Rd	620-50
5 $\frac{1}{2}$	20.0-23.0	4.670	4.778	4.500	2.000	2.375 EU 8Rd	620-57
5 $\frac{1}{2}$	14.0-20.0	4.778	5.012	4.625	2.000	2.375 EU 8Rd	620-55
5 $\frac{1}{2}$	13.0-17.0	4.892	5.004	4.750*	2.000	2.375 EU 8Rd	620-58
6	15.0-20.0	5.352	5.524	5.156	2.000	2.375 EU 8Rd	620-60
6 $\frac{5}{8}$	24.0-28.0	5.701	5.921	5.625	2.500	2.875 EU 8Rd	620-65
7	17.0-23.0	6.366	6.538	6.125*	2.500	2.875 EU 8Rd	620-72
7	26.0-35.0	6.004	6.276	5.875	2.500	2.875 EU 8Rd	620-70
7	17.0-29.0	6.184	6.538	5.969	3.000	3.500 EU 8Rd	620-73
7 $\frac{5}{8}$	26.4-33.7	6.765	6.969	6.500	2.500	2.875 EU 8Rd	620-75
8 $\frac{5}{8}$	24.0-40.0	7.725	8.097	7.500	2.500	2.875 EU 8Rd	620-85
9 $\frac{5}{8}$	43.5-53.5	8.535	8.755	8.250	2.500	2.875 EU 8Rd	620-96
9 $\frac{5}{8}$	32.3-42.5	8.755	9.001	8.500	2.500	2.875 EU 8Rd	620-95
13 $\frac{3}{8}$	48.0-77.0	12.275	12.715	12.000	4.000	4.500 EU 8Rd	621-13

* Across retracted drag blocks.

Other sizes available upon request.

Consequences of Seal Failure

- Catastrophic failure (sealing compromised)
 - seal is lost - leaks may cause other problems
 - often cannot remove seals from packer bore (baked, hardened, fused, etc.)
 - Safe Operating Region - 4 on envelope

Packer Failure Causes

- Pin collapse at the body/guide connection
 - like a body collapse, collapse of the pin connection at the lower connection with maximum deflection at the middle of the lower thread.
 - Differential pressure can occur when the seals are in a seal bore extension below packer or if a wireline plug is set in a nipple in the tailpipe.
 - Consequences - non-catastrophic
 - Region - 5 on envelope

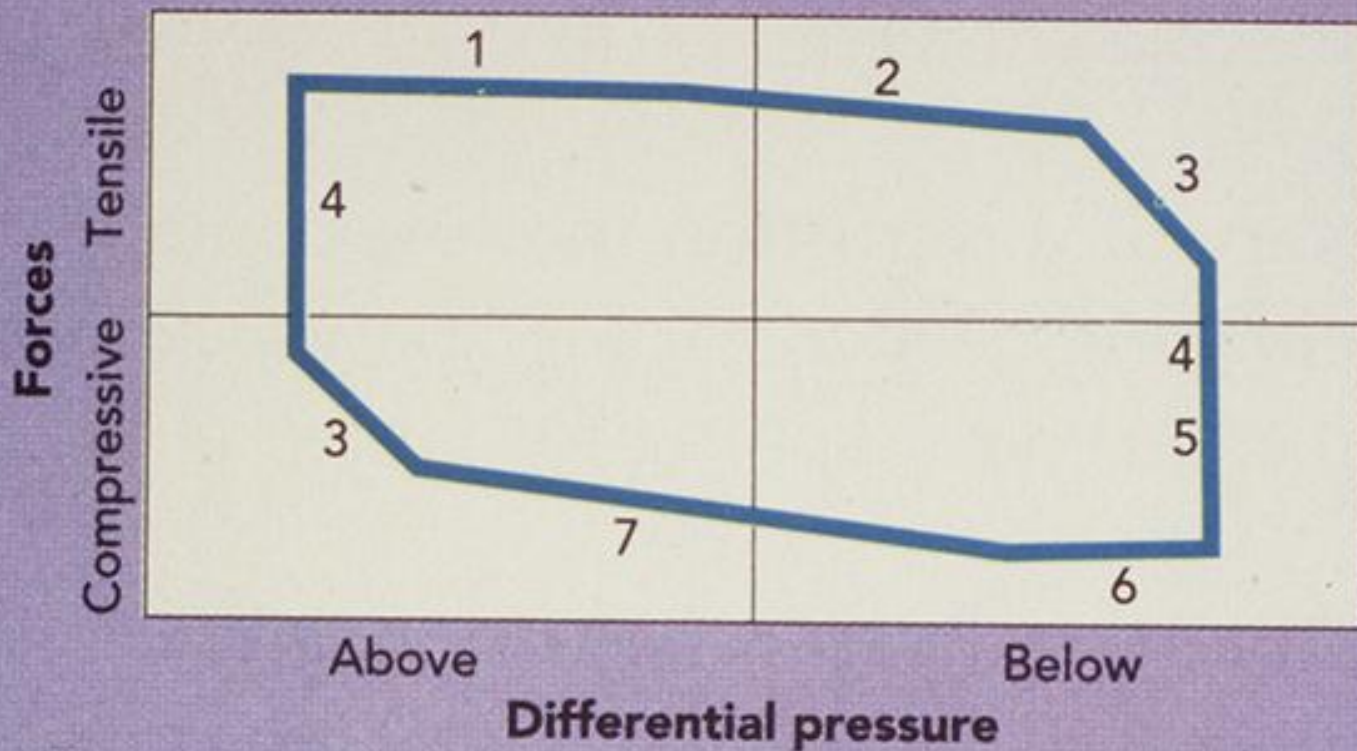


Fig. 1. Safe operating areas are inside the envelope for permanent packers considering axial and differential loading. Areas falling outside the envelope may cause packer failure. Each number represents a mode of which a given axial and differential pressure may cause failure. (Hopman/Walker, PEI)

Packer Failure Causes

- Body to Guide Failure
 - fails at thread relief or in thread itself.
 - Thread relief failure occurs when the yield strength of the body is exceeded.
 - Thread failure occurs when the tensile loads exceed the shear or bearing strength of the threads.

Packer Failure Causes

- Body to Guide Failure (continued)
 - Sources of the loads are pressure differential below the packer, packer-to-tubing tensile forces or a combination of the two.
 - If both forces are present, their effects are additive.
- Failure is catastrophic - body becomes free to move upward through the packer and the guide is free to fall downhole.
- Safe Operating Region - 2

Packer Failure Causes

- Anchor Attachment Failure (failure of left hand square thread)
 - can occur only when a tubing anchor seal assembly is used. Tread can fail in the tread relief, in the tread, or due to swelling of box.
 - Thread relief fails when body tensile exceeded
 - Threads fail when bearing strength exceeded
 - Swelling occurs when elastic burst limit of the wall is exceeded

Packer Failure Causes

- Anchor Attachment Failure (continued)
 - Consequences -
Failure in thread relief or threads is catastrophic - anchor seal pulls out of the packer - pressure integrity is lost.
Most likely effect of a box swelling failure is loss of contact area between anchor and packer. If box swells to the point where anchor can pull out - the failure will be catastrophic.
 - Safe Operating Region - 1

Packer Failure Causes

- Body Lock Ring System Failure
 - The body lock ring fails when the stresses in the threads exceed the material shear or bearing strength in the ring or its supporting elements.
 - Consequences - body is free to float, even though slips continue to trap the packoff force. When pressure cycles - leads to reciprocation and wear on packing element - produces a leak.
 - No pressure cycle - no serious consequences.
 - Safe operating Limit - region 6.

Packer Failure Causes

- Bearing Failure
 - occurs with locator and anchor seal assemblies.
 - Bearing failure at contact of anchor/locator and packer occurs when compressive stress exceeds bearing strength of the material.
 - An added force may be stress in body and seal sub generated by radial component of the contact forces (this is caused strictly by compressive packer-to-tubing forces).

Bearing Failure

- Consequences
 - Generally, only result is deformation of the contact surface of each part.
 - In cases of extreme, high set-down loads, the seal assembly can be swaged into the bore or body of the packer.
- Bearing failure is represented in the envelope as region 6

Using The Packer Envelope in Well Design

- Plot data from tubing movement and stress programs on a packer envelope to determine if the loads fall in the safe area during initial setting, production, stimulation and kill operations.

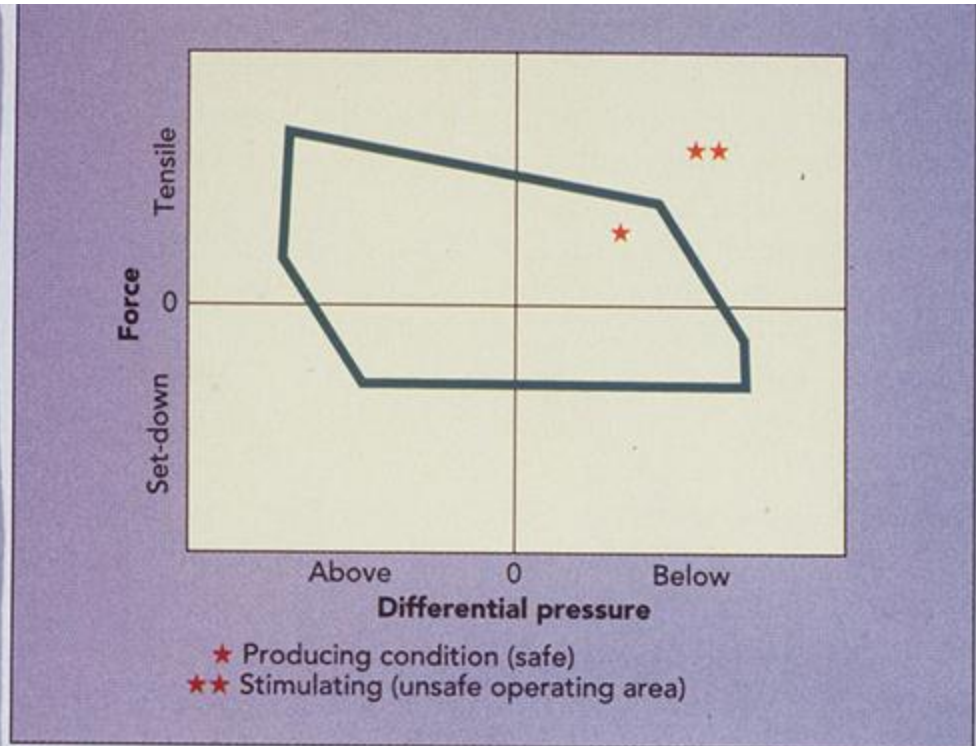


Fig. 3. The first asterisk represents a well under producing conditions. Note that it falls well within the safe operating area of the packer. The two asterisks represent an area that might occur during a stimulation in which the tensile forces are increased due to ballooning and contraction. The area is outside the safe operating limit and may cause packer failure.

(Hopman/Walker, PFI)

Using The Packer Envelope in Well Design

- The envelope can be used to determine optimum material for packer construction.
- Check outer limits of the packer for its casing weight range.
- All future operations must be accounted for in a permanent packer design.
- Failure rate for permanent packers is less than 1%.

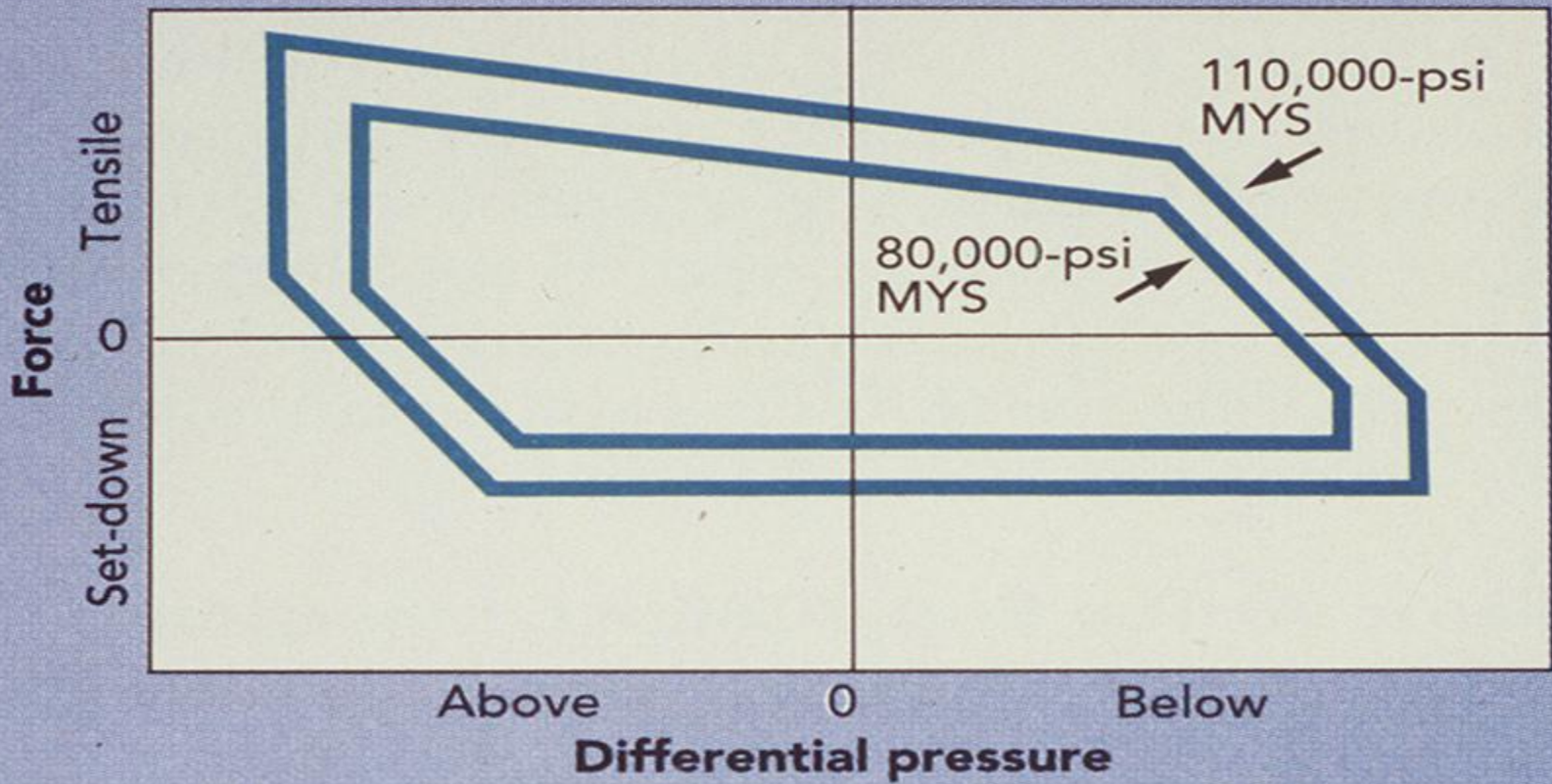


Fig. 4. By changing the yield strength of the materials in a permanent packer, the packer's rating can be increased. When the packer material changed from an 80,000 psi MYS (material yield strength) to an 110,000 psi MYS material, packer performance increased proportionally.

(Hopman/Walker, PEI)