

PetroQuip Engineering Design Specification Document

Tool Name: 7" Open-Hole Packer (OHP)

Written by: Robert Coon

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Application:

Develop a 7-inch OHP that will isolate the different external sections (stages) of the casing by sealing between the 7-inch casing and the 8.500-inch to 9.750-inch open-hole. The OHP should be designed to withstand a differential pressure of 6,000 psi (41.37 MPA) and temperatures up to 437°F (225°C).

Operations:

Desired Method of Setting the OHP

The OHP should be threaded in the casing string at each point of external isolation. Proposed running procedure below:

1. The OHP is Run in Hole (RIH).
2. Once the casing is positioned in the Open-Hole, 3500 psi is applied to the ID of the casing string.
3. This setting pressure shears the anti-pre-set pins in each of the setting pistons of the OHP, which then compresses the packing element stack from both sides, setting the packer. This force is locked in via a Body Lock Ring. This piston remains in communication with the tubing ID for the life of the well, such that when any pressure greater than 3500 psi is applied, the force is transmitted to the element, potentially compressing it further.

Desired Method of Removing the OHP

The OHP can't be retrieved from the wellbore.

Specs: OHP

CASING	
Casing Size (in)	7
Casing Weight (lbs / ft)	38
Casing Drift (in)	5.795
OHP	
OD (in)	8.319 (max)
ID (in)	5.920 (nom) 6.043 (max)
OAL (in)	< 120
Pressure Rating Burst (psi)	10,800
Pressure Rating Collapse (psi)	11,390
Pressure Rating across the element (psi)	7,500
Open Hole ID	8.500 (min) 9.750 (max)
Element Length (in)	> 12
Temperature Rating (°F)	450
Min Pressure to Set (psi)	3500
Piston to set	Dual pistons pushing from both directions
Thread	TBD
Material	P-110
Coating	quench-polish-quench (QPQ), nitriding process

OHP Testing:

Pressure Test

This test confirms the design specs of the OHP for burst and collapse pressure ratings. The specs give it a pressure rating equal to 7,000 psi, 38 lb/ft casing. API typically applies a 20% safety factor to all ratings. The OHP should be designed to be more burst and collapse resistant than the casing.

Ambient Burst Pressure Test

1. Thread a bull plug to each end of the OHP. Attach a control line to one bull plug providing access to the ID of the OHP.
2. Replace the shear screws with steel pins or utilize a test clamp that keeps the setting pistons from moving.
3. Place the assembly (OHP and Bull Plugs) in the test cell and fill with water through the control line to the data acquisition panel. Ensure all air pockets are removed.
4. Apply 10,800 psi to the ID of the OHP for 30 minutes. A leak rate equal to or better than API 14L (1% loss over 15 minutes) is acceptable after stabilization.
5. Disassemble the test fixture and the OHP.
6. Perform a 100% inspection of the OHP to ensure that no damage occurred during the pressure test.

Ambient Collapse Pressure Test

7. Thread a bull plug to each end of the OHP. Attach a control line to one bull plug providing access to the ID of the OHP. Fill plugged LP with water, removing all air pockets.
8. Place the plugged OHP assembly into a chamber with a burst rating of at least 15,000 psi. Place another control line to the chamber itself. Thread Bull Plugs to each end of the chamber.
9. Secure test assembly into a Test Cell, and fill the chamber with water, removing all air pockets.
10. Apply 500 psi to the ID of the OHP and 11,900 psi to the ID of the chamber for 30 minutes. A leak rate equal to or better than API 14L (1% loss over 15 minutes) is acceptable after stabilization.
11. NOTE: A leak is defined as an increase in the ID of the OHP and a decrease in the ID of the Chamber.
12. After the test, bleed all pressure from both fixtures and disassemble.
13. Perform a 100% inspection of the OHP to ensure that no damage occurred during the pressure test.

Element Differential test at Temperature with Min Open Hole ID of 8.500 in.

1. Place the OHP in a section of horizontal casing with an ID of 8.500 inches. Bull plug the bottom end of the OHP and connect the top end to the same Bull plug that is threaded into the Test Casing (TC).
2. Bull plug the bottom of the TC and connect a control line to the test panel. This control line will monitor pressure below the elements.
3. Connect a control line to the ID of the top Bull Plug. This control line will monitor the pressure in the Packer ID.
4. Connect a control line to the outer portion of the same Bull Plug. This control line will monitor pressure above the elements.
5. Wrap the OD of the TC with heating coils.
6. Fill both chambers in the TC and OHP with water.
7. Heat the TC to 450°F, while keeping all fluid pressures between 500 psi and 1500 psi, and balanced.
8. After the temperature is stabilized at 450°F, balance all pressures to 500 psi.
9. Apply 4000 psi (3500 psi differential) to the ID of the OHP. This pressure will shear the setting pins and set the packer. Hold pressure for five minutes.
10. Relieve setting pressure on the OHP ID to 500 psi.
11. Communicate pressure below the elements and pressure in the OHP ID.
12. Apply 6500 psi (6000 psi differential) to the ID of the OHP and the bottom pressure chamber. This simulates a frac below the OHP.
13. Monitor the pressure above the OHP for communication across the elements. This increase would indicate a leak.

14. Once pressure is stabilized, hold the pressure for a minimum of 15 minutes. (Acceptance criteria is no more than 1% reduction in rated differential pressure over the hold period)
15. After the 15-minute pressure test, re-balance all pressures to 500 psi.
16. Apply 6500 psi (6000 psi differential) to the above pressure chamber. This simulates a frac above the OHP.
17. Monitor the pressure below the OHP for communication across the elements. This increase would indicate a leak.
18. Once pressure is stabilized hold the pressure for a minimum of 15 minutes. (Acceptance criteria is no more than 1 % reduction in rated differential pressure over the hold period).

Element Differential test at Temperature with Max Open Hole ID of 9.750 in.

1. Place the OHP in a section of horizontal casing with an ID of 9.750 inches. Bull plug the bottom end of the OHP and connect the top end to the same Bull plug that is threaded into the Test Casing (TC).
2. Bull plug the bottom of the TC and connect a control line to the test panel. This control line will monitor pressure below the elements.
3. Connect a control line to the ID of the top Bull Plug. This control line will monitor the pressure in the Packer ID.
4. Connect a control line to the outer portion of the same Bull Plug. This control line will monitor pressure above the elements.
5. Wrap the OD of the TC with heating coils.
6. Fill both chambers in the TC and OHP with water.
7. Heat the TC to 450°F, while keeping all fluid pressures between 500 psi and 1500 psi, and balanced.
8. After the temperature is stabilized at 450°F, balance all pressures to 500 psi.
9. Apply 4000 psi (3500 psi differential) to the ID of the OHP. This pressure will shear the setting pins and set the packer. Hold pressure for five minutes.
10. Relieve setting pressure on the OHP ID to 500 psi.
11. Communicate pressure below the elements and pressure in the OHP ID.
12. Apply 6500 psi (6000 psi differential) to the ID of the OHP and the bottom pressure chamber. This simulates a frac below the OHP.
13. Monitor the pressure above the OHP for communication across the elements. This increase would indicate a leak.
14. Once pressure is stabilized, hold the pressure for a minimum of 15 minutes. (Acceptance criteria is no more than 1% reduction in rated differential pressure over the hold period)
15. After the 15-minute pressure test, re-balance all pressures to 500 psi.
16. Apply 6500 psi (6000 psi differential) to the above pressure chamber. This simulates a frac above the OHP.
17. Monitor the pressure below the OHP for communication across the elements. This increase would indicate a leak.
18. Once pressure is stabilized hold the pressure for a minimum of 15 minutes. (Acceptance criteria is no more than 1 % reduction in rated differential pressure over the hold period).