Pioneer in the development of Expandable Steel Solutions

Remedial Case History

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As optimizing the recovery of hydrocarbon reserves has grown in importance, and effective reservoir management has become increasingly complex, the need for shutting-off unwanted perforations in both production and injection wells has been growing.

Numerous solutions have been developed to repair tubular damages besides the traditional cementing or straddling methods. Among these, one of the best performing technologies is the Saltel Expandable Steel Patch – SES Patch. The SES Patch has proven its efficiency in terms of setting reliability, resistance to harsh environments, and other advantages.

Currently available through local our bases in France, Canada, United States, Australia, Romania and Argentina, SES Patches are available throughout the world from a flying squad of specialised engineers.

More than 440 Saltel Expandable Steel Patches have now have been set worldwide.

**SES Patch Innovative Features**

- Expandable stainless steel
- Top – Down setting
- Real time Quality Control
- Maximum ID allowed
- Settable in casing, tubing or openhole
- High efficiency seals
- Multi-diameter sealing
- Sets in ovalized casing
- Casing will recover its original internal differential pressure rating
- Patch through patch capabilities
- Gentle setting process with energized seals

**SES Patch Applications**

- **Production Optimisation:** Water Shut-off, Gas Shut-off, Sand Control
- **Well maintenance and repair:** Parted Casing, Casing leaks, Tubing Leaks, Corrosion, Sliding Sleeves, Sealing leaking couplings, Screen Repair.
- **New well applications:** Sealing Frac Ports, DV tools, Cement ports

**Links to Full Data**

- For detailed setting procedures, see “Saltel Expandable Steel Patch”
- See data tables for full range and product specifications
Field statistics

**Well type**
- Oil producing wells: 81%
- Gas producing wells: 7%
- Water injection wells: 2%
- Disposal wells: 7%
- SAGD wells: 1%
- Others: 2%

**Application type**
- Perforation shut off: 55%
- Casing repair: 20%
- Frac/cement port repair: 11%
- Others: 2%
- Water shut off: 4%
- Gas shut off: 3%
- Tubing repair: 5%

**Casing size**
- 7.0in: 60%
- 8in 5/8: 1%
- 9in 5/8: 3%
- 5.5in: 12%
- 4.5in: 16%
- Others: 8%

**SES Patch size**
- 7.0in: 62%
- 4.5in: 19%
- 5.5in: 13%
- Non standard: 3%
- 9.625in: 3%
CASE STUDY

Water shut off
Middle East

Zone: Middle East
Application: onshore 7in water production shut-off
Date of the job: Summer 2011

THE CONTEXT

Oil producer well 7in 32 lb/ft casing (ID= 6.09 in / 154.8 mm)
Perforation to shut-off @ 9770 ft / 2978 m
Perforation length: 21.3 ft / 6.5 m
Temperature: 212°F / 100°C
Drilling rig, drill pipe is 3.5 in 13.3 lb/ft

THE OBJECTIVES

• Preserve maximum ID passage after Patch is set
• External service pressure above 1500 psi

THE SOLUTION

• Patch 7in Slimline Stainless Steel.
• Total assembly length 43.52 ft / 13.3 m
• 690 lb / 307 kg
• Patch length 32.8 ft / 10m before expansion
• Expansion Pressure 4,630 psi / 319 bar
• Patch length 32.05 ft / 9.77 m after expansion
• External differential rating 1,542 psi / 105 bar
• Expansion duration: 8h15
• (15 steps, 25 minutes per step)

RESULTS

A GR-CCL log confirmed the Patch is correctly in place across the target perforated interval. A PLT survey showed that the well was producing at 22% BSW vs. 61% BSW before the operation.

LINKS TO FULL DATA

• For detailed setting procedures, see “Saltel Expandable Steel Patch”
• See data tables for full range and product specifications
CASE STUDY

Gas Shut off
Canada

Zone: Canada
Application: onshore, 5.5in gas shut-off
Date of the job: Spring 2011

THE CONTEXT

Oil producer well
To Shut off two perforation zones
To reduce Gas cut
5.5 in 14 lb/ft casing (ID= 5.01 in / 127.3 mm)
Perforation to shut off @ 1625 ft / 495 m
Perforation length: 7 ft / 2.1 m
Down hole temperature 75°F / 23°C
Drilling Rig, Drill pipe is 27/8 7.8 lb/ft

THE OBJECTIVES

• Preserve maximum ID passage after SES Patch is set
• Get an efficient gas seal

THE SOLUTION

• Patch 5.5 in Ultraslim, Stainless Steel
• Total assembly length 29.38 ft / 8.95 m (162 lb / 72 kg)
• Patch length 19 ft / 5.8 m before expansion
• RIH OD= 4.12 in / 104.6 mm
• Operational Characteristics Set Patch ID= 4.72 in / 119.9 mm
• Expansion Pressure 3,720 psi / 260 bar

OPERATIONAL CHARACTERISTICS

5200psi/360bar
Expansion pressure
2h15
Expansion duration
3.4in/86.4mm
Patch drifted during setting

RESULTS

2 Patches were successfully set in the same well to cover two perforated zones. The well was re-perforated below the Patches after the job. Well back on production immediately after the job. No more gas production.

LINKS TO FULL DATA

• For detailed setting procedures, see “Saltel Expandable Steel Patch”
• See data tables for full range and product specifications
CASE HISTORIES n°SIQ605-AD

REASON OR NEED FOR NEW TECHNOLOGY

Directional drilling techniques combined with hydraulic fracturing have enabled the commercial development and exploitation of non-conventional hydrocarbon reserves. Different types of completions are used, usually either “plug and perf” or open-hole completions with annular zonal isolation packers.

The increasing use of complex completions, with DV tools, cementors, sliding sleeves and numerous frac ports means that in spite of the quality of the equipment available some integrity problems are inevitable. Methods of repairing downhole integrity problems are few, fully reliable solutions able to withstand the fracking pressures necessary are even fewer, and combined with the need for a large I.D. to allow the passage of different ball sizes to activate the ports below there was no satisfactory solution available. The possible solution for any leak in the integrity of the well inevitably led to a situation where some or many of the zones below could not be fracked.

A solution has been developed, tested, and field trialed to use a relatively thin (3mm/0.118in) expandable stainless steel tubular to seal off holes or leaks without blocking access below. This is the first solution available to reseal leaking completions and restore well integrity without blocking access below, therefore avoiding potentially serious consequences for the economic viability of the well.

TECHNICAL DETAILS

The company has previously developed a technology to use an inflatable packer element and surface pressure to expand a steel tubular Patch to seal perforations or repair damaged casing. Commercialized since 2011, the challenge was to adapt the materials and setting techniques to be able to expand the Patch into a variable inside diameter, making the steel “flow” to fit into the spaces and orifices as required, and to demonstrate that a very thin layer of steel could seal pressures of 1,000bar/14,500psi.

The working principle is straightforward. A high pressure inflatable packer is inserted into an Expandable Steel Pre Frac Patch, connected to drill pipe or work string, and run in hole opposite the zone to be sealed. Hydraulic pressure is applied from the surface through the tubing to inflate the packer and expand the top of the Patch, anchoring it in place. The Packer is then deflated, run-in just below the expanded section, and re-inflated to expand the following section. This is repeated as often as necessary until the entire Patch is fully expanded.

CONTEXT

4.5in Frac horizontal completion
7094 ft/2162m Zone to seal
3.88in/98.4mm Drift ID
140°F/60°C Estimated temperature

SOLUTION

4.5in Reinforced Pre-frac Patch
1626psi/112bar External differential pressure
19.7ft/6m Patch length before expansion
19ft/5.8m Patch length after expansion

OPERATIONAL CHARACTERISTICS

5200psi/360bar Expansion pressure
6 hours Expansion duration
3.4in/86.4mm Patch drifted during setting

RESULTS

The Patch was successfully set, as programmed and with no delay. Patch pressure tested to 200 bar (3000psi). After the job, the customer continued with the frac program:
• 18 frac stages at 7m3/min
• Peak pressure of 620bar (9000psi)
• 425 Ton of sand injected

LINKS TO FULL DATA

• For detailed setting procedures, see “Saltel Expandable Steel Annular Zonal Isolation Packer”
• See data tables for full range and product specifications
Perenco Gabon
Offshore perforation shut off

Operator: Perenco Gabon
Application: Perforation shut-off in a 7 5/8 in expanded casing
Date of the job: March 2011

CONTEXT OF APPLICATION
Well: Offshore oil producer, using ESP
The objective was to shut off two perforated zones.
- Zone #1: 47 ft (14.3 m), top @ 5368 ft (1636 m)
- Zone #2: 15 ft (4.6 m), top @ 5069 ft (1545 m)
Produced fluids: oil with high water cut, 800 ppm H2S.
Temperature (BHST): 166°F (75°C)

CHALLENGES & SOLUTIONS
An expanded casing with initial OD 7 5/8 in gives a non-standard ID of 7 5/8 in (193.5 mm).
This application required a customized patch
- Saltel flexible manufacturing provided a tailor-made patch in 3 weeks
A 55.8 ft (17.1 m) long Patch was required
- Short lengths were shipped then welded onshore, and transported to offshore location in a custom-made basket
Very short delivery time: 6 weeks from order to offshore installation

RESULTS
The two Patches were successfully set, as programmed and with no lost time. The well was re-perforated below the patched zones and immediately put back in production

SES PATCH DETAILS
Patch Running OD: 7.07” (179.5 mm)
Material: 321 Stainless steel, 0.20” (5 mm) nominal wall thickness
External differential pressure rating 1347 psi (93 bar)
Patch #1 length before expansion: 56 ft (17 m)
Patch #2 length before expansion: 23 ft (7 m)
Patch ID when set: Nominal 7.07” (179.5 mm), Drift 6.95” (176.6 mm)

Operations Details
Rig: Snubbing unit
Expansion Pressure: 4000 psi (280 bar)
Expansion duration to set the 17m-long Patch: 11 h
Expansion duration to set the 7m-long Patch: 3 h
SES Patch was drifted with a gauge-ring during the setting at 6.88” (175 mm), which is suitable for the ESP to be run through it.
Testimonials

CNRL Bonnyville Heavy Oil has set approximately 30 Saltel casing patches in the last 2.5 years. The casing patches are very strong while still permitting all downhole tools to be run through the patches for any stimulation or abandonment of zones below the patch. The majority of the casing patches have been set in 177.8 mm, 34.2 kg/m (7in 23 lb/ft) casing. The most common use of the patch is to plug off a set of perforations to allow production from zones further down in the wellbore. Zones are perforated using 127.0 mm guns @ 26 SPM using Extra Big Hole & Deep Penetrating Charges (Entry Holes are about 0.8 – 1.2” in diameter). Leaving very little casing integrity after the interval has been perforated. Casing damage is also common in the area. The Saltel casing patches have been set successfully in many wellbores with poor casing integrity. We have also set one patch overlapping another to make the up a longer patch to cover a longer interval. Due to the robust qualities, large ID after setting & ease of setting; the Saltel casing patch is Canadian Natural’s 1st choice for casing patches in the Bonnyville Heavy Oil area.

David McNamara, CET.

We successfully ran a 2mm x 4m Saltel casing patch across a fracport in our Berland River 102/13-10-59-23W5 well. The patch was set successfully with the Saltel inflatable setting tool run on our 2 3/8’’ tubing, operations during the running and setting procedure went well. We successfully placed 5 ball-drop slickwater fracs through the casing patch at internal pressures reaching 61MPa (8,845 psi) (at the wellhead). The casing patch held pressure throughout the fracs and sleeve shifting operations. We believe expandable steel technology is an improvement over traditional casing patches and should be applied when the performance of the patch is critical to the success of future well operations.


Thanks to Saltel team for the great work they have done.

Murat Kilic, Tanak CPF Production Technologist Al Furat Petroleum Company.

We regained a 94.6% BSW ratio for a 5m³ per day liquid debit since the casing patch was set, that is what we had while producing under packer. This operation will barely redeem even if the most important is to have found this remedial process we will now resort to in any similar issue with one of our big producers.

Alain Rozoy, Lundin.

SES Patch Global Client Satisfaction Stats

A - Excellent
B - Satisfactory
C - Could be better
D - Unsatisfactory