Well Integrity
Annular Zonal Isolation Packer

DEA November 2013

JIP
JIP presentation Agenda

- Saltel Industries
  - General Presentation
  - Expertise
- Annulus isolation problematic
- Proposed solution
  - SES-AZIP
  - Activation Valves
  - Electronic and telemetry
- JIP Scope of the work
- Time line
- Who as joined the project
- Ticket Price
Saltel Industries
Background and expertise
Saltel Industries in 2013

- **Company created 2004 from zero (after selling Drillflex company to Schlumberger)**
- **Family company**
- **Turnover:**
  - 2013: 20M$
- **R&D: Develop different Technologies as existing**
  - 2,0M$ in 2013 self financed
  - 14 R&D Engineers and PHD
  - 23 international family patents
- **95 employees:**
  - France Brittany (75) Canada (12) USA (8)
- **Range of products:**
  - Inflatable Packers (2,400 successful set worldwide)
  - Expandable Steel Patches (240 successful set worldwide)
  - Annular Zonal Isolation Packers AZIP (launch in 2013)
From Development to Operation

Based in France, Canada, USA, Argentina, Australia
Saltel Industries Expertise

- **Inflatable Packers and elastomer composites**
  - High Performance Inflatable packers (T; P; cycling)
  - MDT tool 100% success ratio

- **Elastomers (Development and qualification)**
  - HNBR, FEPM; Viton, Viton Extreme, FFKM
  - Swelling Elastomers
    - Water and oil

- **Expandable steels behavior and metallurgy**
  - Very deep knowledge
    - >100 collapse tests under different conditions (T°; e; D; Materials)
    - >500 expansion and pressure record on different materials
    - Expertise from the metal sheet to the sleeve
  - Austenitic SS, Highly Alloyed Austenitic, Nickel Based Alloys
Annulus isolation problematic

and proposed solution
The Annulus Isolation
Overview of the problematic

- Cementation has some risks
  - Losses and flow from the formation?
  - Temperature variation (cement job, frac, stimulation...)?
  - Channeling, how to deal with gas migration?
  - High deviated wells, free fluid at the top annulus?
- Annulus Pressure is higher and higher
  - Stimulation and Fracturation pressure 10-15,000psi
  - But Sealing system must not weakness the formation (contact pressure bellow Fracturation pressure)
- Annulus sealing over the Life of the Well
  - Life of well technology
- The sealing system must keep the casing integrity
  - No accessory in the string, only the qualified casing
  - No hole in the casing (to activate the system)
- Necessity to prove the sealing integrity of the annulus
  - Zero leak (liquid, gas)
  - Prove it over the time
Principles of the Proposed Solution

- **Expandable Steel Packer (AZIP)**
  - Slide and crimped around the casing (not an accessory of the string)
  - Very high sealing capacity (casing limit)
  - Pressure contact with the formation is related with the pressure to seal

- **Low volume elastomer packing**
  - Pressure balanced
  - Not temperature sensitive

- **Activation port is definitively plugged**
  - AZIP is activated with pressure inside the casing (activation port)
  - The activation port is definitively plugged after setting (double barrier metal to metal gas tight)

- **Metal in compliance with well environment**
  - Life of well system (NACE MR0175)

- **After setting control and long term pressure/temperature log**
  - Control the AZIP is correctly set (log opening and closing of the activation port)
  - Log the annulus pressure and temperature over long term period
WI-AZIP
System General Principle
Technology is composed of three different elements:

A) SES-AZIP
B) Activation valves
C) Electronic and monitoring
A) SES-AZIP
SES-AZIP
SES-AZIP

- Casing
- End fittings
- Expandable sleeve
- Sealing elements
SES-AZIP DESCRIPTION

- A - Crimped and fixed end fittings
- B - End fitting anchoring to casing
- C - End fitting sealing with casing
- D - Dynamic sealing with formation
CRIMPED AND FIXED END FITTINGS

- Both end fittings are crimped on casing
  - No sliding end, no parts in movement
  - Example 4-1/2in test results
    - Internal pressures up to 17000psi
    - Anchoring forces up to 150tons on 4-1/2in #15,1lb/ft P110 casing
4-1/2in Anchoring & Sealing System
100 Mpa, 15,000 psi, 150 Tons, 160/50°C
## Ongoing Qualification

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ISO 14310 QUALIFICATION STATUS

- Tests conditions
  - Differential Pressure 11,000psi
  - Thermal cycling
    - Max: 160°C
    - Min: 50°C
    - Min: 160°C
- Without Axial Load results
  - 4-1/2in (completed)
    - Expansion: 5,700+700psi
    - 11,000psi no leak
  - 5-1/2in (ongoing)
- With Axial Load
  - 4-1/2in (Dec 2013)
  - 5-1/2in (Dec 2013)
Dummy well for ISO 14310 Without Axial Load

Test facilities to qualify prototypes under well environment

Dummy well Characteristics
- Depth: 6m/20ft
- Inside diameter: 366mm / 14.4in
- Fully instrumented for simulated down hole conditions:
  - Pressure vs Temperature:
    - 10,000psi @ 20°C
    - 6,500psi @ 220°C

Elastomer laboratory for developing, mixing, and testing new compounds
ISO 14310 V3 QUALIFICATION WITH AXIAL LOAD

- ISO 14310 V3 WITH AXIAL LOAD
Set up de test
AZIP
ISO 14310
With Axial Load

• Operational:
  • November 2013

• Specifications:
  • Qualifications under 14310
  • V3 to V0
  • 15,000psi
  300°C
  560 tons axial load
B) Activation Valves
Metal to metal gas tight
Opening and Closing expansion device
C) Electronic and Monitoring
Two different possible solutions

- **Electromagnetic data transmission using casing as a medium (Expro, Metrol)**
  - Data are recorded
  - Long distance transmission
  - High power Batteries necessary for transmission
  - Time limitation
  - Heavy and expensive system
  - Advantage: Not necessary to use a Wire line to read the data

- **Acoustic signal is read on short distance using a Wire Line Tool**
  - Data are recorded
  - Short distance transmission
  - Low power Batteries
  - Possible to reactive batteries with wire Line tool
  - Simple system
  - Drawback: Necessary to run a Wire Line tool to read the data
Gauge miniaturization: The Power of a Small World

MEMS enables revolutionary measurement deployment solutions

- Micro Tools
- Micro-packaging
- MEMS devices
- Technology bricks

Small size + Low power + Smart + Wireless = New deployment solutions
Data are recorded and a Wire Line tool is run to read data. Micro-Tool + Wireless communication + Power.

Opening and closing signals are recorded. Annulus pressure is recorded.

After setting, data are retrieved using a tool run on Wire Line. Electronic is powered by the Wire Line Tool.
Casing integrity remains (no communication with annulus)

Cement integrity remains

Can be used with no cement

- Cemented or not cemented annulus
Open hole or cased Hole

- Open Hole ou Cased Hole
• Pressure rating = Casing rating
  • Between inside and outside Casing
  • Between outside and inside Casing

• Between bottom and top annulus
  • Up to 15,000psi
Pressure applied by the WI-AZIP to the formation

No pressure: 500psi to the formation

5000psi differential: 5500psi to the formation
Wireless Monitoring system

• Opening and closing of the expansion device

• Annulus pressure and temperature recorded over the time and timely readed using a Wire Line tool
Activation from Bottom to Top
## Scope of the work and timeline

### Mechanical WI-AZIP

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### Electronic and signal to surface

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### Total Budget in k€ for 9-5/8in qualification

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| TOTAL GENERAL                                           | 1203         | 162  | 801  | 240  |
Sponsors needed

- Total program cost
  - 1200k€ for 9-5/8in qualification
  - Other sizes 10-3/4in; 13-3/8in and 16in

- Already financed
  - Two companies: 750k€

- New needed finance
  - Total needed 450k€
  - 3*150k€
  - Plus or less depending on number of sponsors and perimeter of the program (other sizes)

- Presentations:
  - CITEPH France: June 2013
  - DEA Europe: Sep-13 2013
  - DEA US: Nov-13 2013
THANK YOU

You can contact Jean-Louis SALTEL

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Steel compliance with NACE MR0175

Field of use

Any combinations of chloride concentration and in situ pH occurring in production environments is acceptable (from NACE MR0175)

Cl⁻ ≤ 5 g/L and in situ pH (from NACE MR0175)

Any chloride concentration and in situ pH (from NACE MR0175)

Ni-based Alloy

Highly-alloyed Austenitic

Austenitic Stainless Steel

Cl⁻ ≤ 0.05 g/L - pH ≤ 5.0 psi
Any in situ pH
(from NACE MR0175)
Steel compliance with Literature

Field of use

Any combinations of chloride concentration and in situ pH occurring in production environments is acceptable (from NACE MR0175)

- Cl⁻ ≤ 150 g/L - pH = 3.5 - pH2S ≤ 217.5 psi - pCO₂ ≤ 435 psi (from SPE N° 133382)
- Cl⁻ ≤ 5 g/L and in situ pH (from NACE MR0175)
- Cl⁻ ≤ 60 g/L - pH = 4.5 - pH2S ≤ 0.5 psi - pCO₂ < 1,000 psi (from NACE Publication 1F192)
- Cl⁻ ≤ 50 g/L - pH = 3.5 - pH2S ≤ 0.5 psi - pCO₂ < 100 psi (from NACE Publication D4138)

Any chloride concentration and in situ pH (from NACE MR0175)

- Cl⁻ ≤ 30 g/L - pH = 5.5 - pH2S ≤ 15 psi
- Cl⁻ ≤ 1 g/L - pH = 3.5 - pH2S ≤ 15-150 psi (from TWI Corrosion 2010 paper)

Nickel-based Alloy
Highly-alloyed Austenitic
Austenitic Stainless Steel

Temperature (°C)

Partial pressure H₂S (psi)